B. Tech. (Computer Science and Engineering)
OVERALL CREDIT STRUCTURE

Undergraduate Core(UC)		Undergraduate Elective (UE)	
Category	*Credit*	*Category*	*Credit*
DC	67	**DE**	23 (minimum)
BS	19	**HM**	06 (minimum)
ES	22	**OC**	18 (Balance)
HM	05	**UN**	0 (03 Courses)
Total	**113**	**Total**	47
Grand Total (UC + UE)			**160**

Basic Science (BS)			
Course Code	**Course**	**L-T-P**	**Credit**
MAL102	Applied Mathematics-I	3-2-0	04
MAL103	Applied Mathematics-II	3-2-0	04
MAL201	Applied Mathematics-III	3-0-0	03
PHL151	Applied Physics	3-0-0	03
PHP151	Applied Physics Lab	0-0-2	01
CYL101	Applied Chemistry	3-0-0	03
CYP101	Applied Chemistry Lab	0-0-2	01
Grand Total			**19**

Humanities and Management (Core) (HM)			
Course Code	**Course**	**L-T-P**	**Credit**
HSP152	Technical Communication	1-2-2	03
HSL151	Social Science	2-0-0	02
Grand Total			**05**

Engineering Arts and Science (ES)			
Course Code	**Course**	**L-T-P**	**Credit**
MEL152	Elementary Mechanical Engineering	3-0-0	03
EEL151	Elementary Electrical Engineering	3-0-0	03
EEP151	Elementary Electrical Engineering Lab	0-0-2	01
ECL151	Basic Electronics Engineering	3-0-0	03
ECP151	Basic Electronics Engineering Lab	0-0-2	01
MEL151	Engineering Drawing	3-0-0	03
MEP151	Engineering Drawing Lab	0-0-2	01
CSL151	Computer Programming and Problem Solving	3-0-0	03
CSP151	Computer Programming and Problem Solving Lab	0-0-2	01
MEP152	Mechanical Workshop	0-0-2	01
CEL151	Environmental Science	2-0-0	02
Grand Total			**22**

Non-Credit Requirement (UN)			
Course Code	**Course**	**L-T-P**	**Credit**
NCN101	NCC#	-	0
NSS152	NSS-I#	-	0
NSS153	NSS-II#	-	0
NCN103	NSO#	-	0
SPB151	Sports-I#	0-0-4	0
SPB152	Sports-II#	0-0-4	0
HSD251	Community Project	-	0
CST251	Practical Training	-	0
#A student has to opt at least one from NCC, NSS, NSO and Sports (I & II both).			

Departmental Core (DC)			
Course Code	**Course**	**L-T-P**	**Credit (67)**
CSL251	Data Structures	3-0-0	03
CSP 251	Data Structures Lab	0-0-2	01
CSL252	Operating Systems	3-0-0	03
CSP 252	Operating Systems Lab	0-0-2	01
CSL253	Object Oriented Programming	3-0-0	03
CSP 253	Object Oriented Programming Lab	0-0-2	01
CSL254	Design and Analysis of Algorithms	3-0-0	03
CSP 254	Design and Analysis of Algorithms Lab	0-0-2	01
CSL255	Computer Networks	3-0-0	03
CSP 255	Computer Networks Lab	0-0-2	01
CSL256	Software Engineering	3-0-0	03
CSP 256	Software Engineering Lab	0-0-2	01
CSL257	Data Communication	3-0-0	03
CSL258	Computer Organization & Architecture	3-0-0	03
CSL259	Theory of Computation	3-0-0	03
CSL351	Database Management Systems	3-0-0	03
CSP 351	Database Management Systems Lab	0-0-2	01
CSL352	Compiler Design	3-0-0	03
CSL353	Data Science	3-0-0	03
CSP 353	Data Science Lab	0-0-2	01
CSL354	Information and Network Security	3-0-0	03
CSP354	Information and Network Security Lab	0-0-2	01
CSL355	Artificial Intelligence	3-0-0	03
CSP355	Artificial Intelligence Lab	0-0-2	01
SCL254	Discrete Mathematics	3-2-0	04
ECL256	Digital Circuits	3-0-0	03
ECP256	Digital Circuits Lab	0-0-2	01
ECL353	Microprocessor and Interfacing	3-0-0	03
ECP353	Microprocessor and Interfacing Lab	0-0-2	01
CSD351	Minor Project	-	01
CSD451	Major Project	-	02

Departmental Elective (DE)			
Course Code	**Course**	**L-T-P**	**Credit**
CSL356	Digital Image Processing	3-0-0	03
CSP356	Digital Image Processing Lab	0-0-2	01
CSL357	Web Technologies	3-0-0	03
CSL358	Information Retrieval	3-0-0	03
CSL359	Neuro-Fuzzy Techniques	3-0-0	03
CSL451	Real Time Systems	3-0-0	03
CSL452	Cloud Computing	3-0-0	03
CSL454	Machine Learning	3-0-0	03
CSL453	Public Key Infrastructure and Trust Management	3-0-0	03
CSP454	Machine Learning Lab	0-0-2	01
CSL455	Parallel and Distributed Computing	3-0-0	03
CSP455	Linux Lab	0-0-2	01
CSL457	Concepts in Blockchaining	3-0-0	03
CSL458	Cyber Security and Forensic	3-0-0	03
CSL459	System Programming	3-0-0	03
CSL460	Fundamental Algorithms in Computational Biology	3-0-0	03
CSL461	Wireless Sensor & Ad Hoc networks	3-0-0	03
CSL462	5G Networks	3-0-0	03
CSL463	Geo Informatics	3-0-0	03
CSL464	Multimedia Technology and Virtual Reality	3-0-0	03
EEL458	Soft Computing Techniques	3-0-0	03
EEP467	Soft Computing Techniques Lab	0-0-2	01
MEL461	Robotics	3-0-0	03
MEP461	Robotics Lab	0-0-2	01
ECL352	Digital Signal Processing	3-0-0	03
ECL355	Digital Communication Systems	3-0-0	03
ECL468	Embedded System Design	3-0-0	03
CSL525	Statistical Models for Computer Science	3-0-0	03
CSL524	Optimization Techniques (Operation Research)	3-0-0	03
CSL527	Data Mining	3-0-0	03
CSL529	Data Analytics	3-0-0	03
CSL531	Internet of Things (IoT)	3-0-0	03
CSL532	Advanced Computer Network	3-0-0	03
CSL534	Advanced Cryptography	3-0-0	03
CSL535	Edge Computing	3-0-0	03
CSP524	Programming in R	0-0-4	02

Course Syllabi
(Under Graduate)
Department of Computer Science and Engineering

Course Code: CSL151
Course Title: COMPUTER PROGRAMMING AND PROBLEM SOLVING
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objective:
To provide students with a comprehensive understanding of the fundamental concepts of computer programming and problem-solving techniques using the C programming language. The course aims to equip students with the necessary knowledge and skills to develop efficient and robust computer programs.
Course Outcomes (COs)
CO1: Understand the fundamental concepts of computer programming, different levels of programming languages, major parts of a computer, the need for an operating system, and the tree structure of storage.
CO2: Demonstrate proficiency in using different numbering systems such as binary, octal, and hexadecimal, and understand the ASCII code.
CO3: Define and use different data types, storage classes, and scope of variables in C. Understand the concept of conditional statements, decision-making, branching, looping, and switch statements.
CO4: Define and use structures and unions in C. Understand pointers and their application in dynamic memory allocation, pointers to arrays, and pointers to structures.
CO5: Work with files in C by opening, closing, reading, and writing operations on sequential and text files.
Contents for Essential Course Outcomes (If any)
Overview of a computer system, Block diagram and major parts of a computer, history of computer development, introduction to binary, octal, & hexadecimal numbers, ASCII code, different levels of programming languages – machine language, assembly language, high level language; need of operating system, introduction to assembler, compiler and interpreter. Introduction: Flow charts, data types and storage classes, scope of variables, arithmetic operators, assignment, conditional, arithmetic expressions, enumerated data types, decision making, branching, looping, Switch concept, function and parameter passing, recursive functions, macros. Arrays and applications: Introduction to one dimensional and 2-D array with examples. Representing a polynomial using 1-D array and polynomial operations, Use of 2-D array to represent a matrix and matrix operations. Character arrays (strings): String related functions (strlen, strcpy, strcat, strcmp, reverse etc.) and their function definitions. Searching and Sorting methods: Selection sort, Bubble sort, Insertion sort, Linear and binary search, partitioning an array, merging of 2 sorted arrays. Structures and Unions: Basic concept, array of structures and its applications. Pointers: Introduction (declaration and initialization), pointers and arrays, concept of dynamic memory allocation, use of pointers to represent variable-sized 1-D and 2-D arrays, pointers to structures. File Management in C: Open, close, read and write operations, Sequential and text files.
Contents for Desired Course Outcomes (If any): NIL
Text Books:
T1: Kernighan, B.W. And Ritchie, D.M., The C Programming Language, 2nd ed., PHI, Delhi, 2012.
T2: Balguruswamy, E., Programming in ANSI C, 8th ed., Tata McGraw Hill, New Delhi, 2019.
Reference Books:

R1: Deshpande, P.S. and Kakde, O.G., C and Data Structures, Dreamtech Press, New Delhi, 2009.
R2: Dromey, R.G., How to Solve it by Computer, Pearson Education, Delhi, 2008.

Course Code: CSP151
Course Title: COMPUTER PROGRAMMING LAB
Structure (L-T-P): 0-0-2
Course Prerequisite: NIL
Course Objective: To provide students with hands-on experience in programming and problem-solving using the C language. The course aims to equip students with practical skills in programming, debugging, and testing C programs.
Course Outcomes
Essential
CO1: Demonstrate the ability to develop and implement efficient algorithms in the C programming language.
CO2: Develop proficiency in using basic programming constructs in C such as data types, operators, control statements, function and s, arrays.
CO3: Understand and use the C standard library functions, including string manipulation, file handling, and mathematical functions.
CO4: Understand and use advanced C programming concepts such as pointers, structures.
CO5: Understanding of the syntax and semantics of C programming constructs and the ability to apply these constructs to real-world problems.
Desirable/Advanced (If any): NIL
Experiments for Essential Course Outcomes

1. Demonstrate number system conversion using C programming.
2. Implement if else construct in C programming.
3. Implement C programs using switch case construct.
4. Write C programs to implement looping constructs.
5. Implement functions using Call be value and Call by reference.
6. Demonstrate working of one dimensional and two dimensional arrays.
7. Implement sorting techniques.
8. Write a C program to perform linear and binary search on an array of integers.
9. Write a program to demonstrate the working of string manipulation functions.
10. Implement structures and unions in C language.
11. Demonstrate the use of pointers in arrays, structures and strings.
12. Implement file handling concepts in C programming.

Experiments for Desired Course Outcomes (If any): NIL
Text Books:

T1: Let Us C: Authentic guide to C programming language, BPB Publications; 19th edition 2022.
T2: Balguruswamy, E., Programming in ANSI C, 8th ed., Tata McGraw Hill, New Delhi,2013.
Reference Books:
R1: Herbert Schildt, C: The Complete Reference, 4th edition, McGraw Hill Education, 2017.
R2: Srini Devadas, Programming for the Puzzled: Learn to Program While Solving Puzzles, MIT Press, 2017

Course Code: DATA STRUCTURES
Course Title: CSL251
Structure (L-T-P): 3-0-0
Prerequisite:
Computer Programming and Problem Solving
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, students are expected to:
The objective of the course is to provide the knowledge about the various data structures and their applications in problem solving. To apply the data structure approaches for the solution of real-life engineering problems and can exploit complexities of algorithms.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To be able to understand the basics of algorithm writing and implementation through programming language
CO2: To be able to understand the concepts of basic data structures and their supported operations.
CO3: To be able to analyze the problem and solve using most suitable data structure
CO4: To be able to devise the solution for naïve problems
Desirable/Advanced (If any):
Introduction to Program complexity (Big Oh notation), Recurrence relations, Overview of arrays, ADT for Arrays, Memory Representation of 1D, 2D and Multi-Dimensional Arrays, array-based algorithms - searching and sorting, Matrices and Operations, Sparse Matrices, Fast Transpose, Dynamic memory allocation and deallocation, Heap Management. Stack and Queues: Concepts, Implementations and Applications. Lists – Self-referential structures, Singly-linked lists, doubly linked lists and circular linked lists, List traversal, insertion, deletion at different positions in the linked lists, concatenation, reversing a list, Applications of lists in polynomial representation, multi-precision arithmetic, hash-tables etc. Multi linked structures and an example application like sparse matrices. Implementation of priority queues. Trees: Trees and related nomenclatures, Binary trees: Algorithms and Traversals, Binary Search Trees (BSTs): Operations and Applications, Threaded Binary Tree, Height-balanced Trees (AVL): Insertion/Deletion and Rotations. Heap: Binary Heaps and Heap sort, Multi-way Trees and external sorting: B-trees and B+ trees, Operations and Applications, Graphs: Representations, Traversals, Dijkastra's and Prim's and Topological Sorting Algorithms, Applications of Graphs
Contents for Desired Course Outcomes (If any)
Books/Material:
T1: Kruse, R.L., Tondo, C. L. and Leung, B.P., Data Structures and Program Design in C, 2nd ed., Pearson Education, Delhi, India, 2013.
T2: Horowitz, E., Sahni, S. and Anderson-Freed, S., Fundamentals of Data Structures in C, 2nd ed., University Press, Hyderabad, 2012.
Reference Books:
R1: Kernighan, B.W. and Ritchie, D.M., The C Programming Language, 2nd ed., PHI, Delhi, 2012.
R2: Dromey, R.G., How to Solve it by Computer, Pearson Education, Delhi, 2008.

Course code: CSP251
Course Title: DATA STRUCTURES LAB
Structure (L-T-P): 0 0 2
Prerequisite: Computer Programming and Problem Solving

Course Objectives:

The course objectives define the student learning outcome for the course:
The objective of the course is to provide the knowledge about the various data structures and their applications in problem solving. To introduce the concept of complexities of algorithms.
Course Outcomes
Essential:
CO1: To be able to understand the basics of algorithm writing and implementation through programming language
CO2: To be able to understand the concepts of basic data structures and their supported operations.
CO3: To be able to analyze the problem and solve using most suitable data structure
CO4: To be able to devise the solution for Engineering Problems
Desirable/Advanced (If any):

To be able to devise solution for Naive Problems in Engineering

Experiments for Essential Course Outcomes

1. Implementation of Quick sort, Insertion Sort, Selection, Bubble and Merge sort.
2. Implement Polynomials with Arrays and supporting Addition, Multiplication, Scalar Multiplication and Subtraction.
3. Implement Polynomials with Linked List and supporting Addition, Multiplication, Scalar Multiplication and Subtraction.
4. Implement Doubly Linked Lists with all possible Addition and Deletion cases. Consider Linked List Header/start node.
5. Implement Stacks with Arrays and Linked Lists.
6. Implement Queue with Arrays and Linked Lists.
7. Implement Circular Queue with Arrays and Linked Lists.
8. Implement Linear and Binary Search on Arrays of Elements.
9. WAP for insertion and deletion of nodes from the sequence: A, B, C, D, E,F, G, H, I, J , K, L, M, N, O. using binary search tree algorithm.
10. WAP to implement max heap sort for the sequences: A, B, C, D,E, F,G,H,I,J,K,L,M,N,O.
11. Implementation of Binary Search Tree with:
(a) In-order traversal (b) Preorder Traversal (c) Post Order traversal
12. Implementation 4-way B-Tree using 12, 13, 76, 77, 89, 94, 48, 19, 55, 35,35, 87, 11, 32.
13. Implementation of Heap Sort using Binary heap on 12, 13, 76, 77, 89, 94,48, 19, 55, 35, 35, 87, 11, 32, 31.
Experiments for Desired Course Outcomes (If any)

1. Decide and Implement most suitable data structure for Different Components of Drone Management System.
2. Decide and Implement most suitable data structure for Different Components of Processing a Data Set in IDS, Drug Design and COVID-19.

Books/Material

T1: Kruse, R.L., Tondo, C. L. and Leung, B.P., Data Structures and Program Design in C, 2nd ed., Pearson Education, Delhi, India, 2013.

T2: Horowitz, E., Sahni, S. and Anderson-Freed, S., Fundamentals of Data Structures in C, 2nd ed., University Press, Hyderabad, 2012.

Reference Books:

R1: Kernighan, B.W. and Ritchie, D.M., The C Programming Language, 2nd ed., PHI, Delhi, 2012.

R2: Dromey, R.G., How to Solve it by Computer, Pearson Education, Delhi, 2008.

Course code: CSL252
Course Title: OPERATING SYSTEMS
Structure (L-T-P): 3 0 0 3
Course Prerequisite Data Structures
Course Objectives
The course objectives define the student learning outcome for the course:
The objective of the course is to provide knowledge about the various operating system structures, services provided by the operating system, process scheduling and synchronization, different memory management techniques, resource and file management by the operating system.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: Understand the various operating system types, structures, and services.
CO2: Synthesize the solutions for problems related to process scheduling.
CO3: Construct the solution for critical section problems in concurrent processes using the synchronization tools.
CO4: Construct solutions for deadlocks and synchronization in a multiprogrammed operating system.
CO5: Understand and analyze theory and implementation of Physical and Virtual memory, Disk scheduling and File Systems.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Introduction, basic h/w support necessary for modern operating systems - Services provided by OS, system programs and system calls – brief discussions of evolution of OS- real time and distributed systems: a brief overview of issues. File systems, user interface - disk space management and space allocation strategies- examples from UNIX, DOS, Windows, etc. –directory structures- disk caching- file system consistency and logs disk arm scheduling strategies. Processes and 3 levels of scheduling - process control block and context switch - goals of scheduling and different scheduling algorithms- threads: user-level and kernel level. Memory management techniques - contiguous and non-contiguous paging and segmentation - translation look-aside buffers (TLB) and overheads - virtual memory and demand paging- page faults and instruction restart - problems of large address spaces – page replacement algorithms and working sets - miscellaneous issues. Process cooperation and synchronization - mutual exclusion and implementation - semaphores, conditional critical regions and monitors - classical inter - process communication problems message passing. Deadlocks and strategies for handling them. Protection and security issues - access lists, capabilities, cryptographic techniques - introduction to distributed systems.
Syllabus for Desired Course Outcomes (If any):Nil
Text Books
T1. Silberschatz, A., Galvin, P.B. and Gagne, G., Operating System Concepts, 8th ed., Wiley, 2014.
T2. Stallings, W., Operating Systems: Internals and Design Principles, 7th ed., Pearson, 2012.
Reference Books
R1. Crowley, C., Operating Systems: A Design-Oriented Approach, Tata McGraw Hill, 2001.
R2. Tanenbaum, A.S., Modern Operating Systems, 3rd ed., Prentice Hall of India, 2014.
R3. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education,3rd Edition.
R4. Maurice J. Bach, "Design of UNIX Operating System", PHI.

Course code: CSP252
Course Title: OPERATING SYSTEMS LAB
Structure (L-T-P): 0 0 2 1
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:
Simulate the process synchronization problems, CPU scheduling algorithms, Deadlock avoidance and prevention techniques, memory management and file allocation techniques.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Implement process creation and synchronization.
CO2. Implement programs on CPU scheduling algorithms.
CO3. Simulation of Deadlock Avoidance and prevention algorithms.
CO4. Implement programs on page replacement algorithms.
Desirable/Advanced (If any): NIL
Experiments for Essential Course Outcomes
1. Basic LINUX commands and system calls for file, directory and process management.
2. Shell scripts to display operating system and processes information.
3. Implementation of one or two Linux basic commands using Kernel APIs.
4. Process Management Commands in Linux.
5. Simulation of Mutex and Semaphores.
6. Implementation of the Process synchronization
7. Simulation of the CPU scheduling algorithms using the concept of pre-emption and non-pre-emption of processes.
8. Simulation of Deadlock Avoidance and Prevention algorithms.
9. Simulation of Paging and Segmentation memory management techniques.
10. Simulation of page replacement algorithms.
11. Simulation of file allocation Strategies.
12. Simulation of file organization techniques.
13. Implementation of disk scheduling strategies.

Experiments for Desired Course Outcomes (If any): NIL
Text Books

T1. Lab Manual
T2. "Advanced Programming in the UNIX environment", 3rd Edition, W. Richard Stevens and Stephen A. Rago, Addison-Wesley, 2013
T3. John Guttag. Introduction to Computation and Programming using Python, MIT Press, 2013.
Reference Books
R1. Modern Operating Systems, Andrew S Tanenbaum, 3rd Edition, PHI.
R2. "Beginning Linux Programming", 4th Edition by Richard Stones, Neil Matthew, Wiley Publishing, Inc.
R3. Sumitabha Das, "UNIX: Concepts and Applications", McGraw Hill, 4thEdition.
R4. Arnold Robbins, Nelson H. F. Beebe, Classic Shell Scripting, O'Reilly Media 2005

Course code: CSL253
Course Title: OBJECT ORIENTED PROGRAMMING
Structure (L-T-P): 3-0-0
Prerequisite: NIL
Course Objective:
To familiarize the object-oriented concepts and their uses in real life applications along with introduction to Java programming.
Course Outcomes
Essential:
CO1. Understand and explain the fundamental concepts and features of object-oriented programming languages such as data encapsulation, inheritance, polymorphism and late binding.
CO2. Design, develop and implement Java programs that use classes, interfaces, static and non-static members, and method overloading.
CO3. Comprehend the abstract class and interfaces and apply to design solution prototypes by proposing customized and extending interfaces. Analyze programs against run-time errors and apply exception handling.
CO4. Develop Java programs that implement data structures like linked lists, stacks, queues, and hash tables using object-oriented programming principles.
CO5. Implementation of input/output, networking and database connectivity using Java
Desirable/Advanced (If any): NIL
Contents for Essential Course Outcomes:
Object Oriented Programming, Features of object-oriented programming languages like data encapsulation, inheritance, polymorphism and late binding. Introduction to Java language, Concept of a class, Access control of members of a class, instantiating a class, static and non-static members, overloading a method. Deriving a class from another class, access control of members under derivation, different ways of class derivation, overriding of a method, runtime polymorphism. Concept of an abstract class. Concept of an interface. Implementation of an interface. Exception and exception handling mechanisms. Study of exception handling mechanisms in object-oriented languages. Introduction to streams, use of stream classes. Serialization and deserialization of objects. Templates, Implementation of data structures like linked lists, stacks, queues, trees, graphs, hash tables etc. using object-oriented programming languages. Java Database connectivity and networking
Contents for Desired Course Outcomes (If any): NIL
Text Books:
T1: Arnold K., Gosling J. and Holmes, D., The Java Programming Language, 3rd ed., Pearson Education, 2013.
T2: Weisfeld, M.A.,The Object-Oriented Thought Process, 3rd ed., Pearson, 2013.
Additional Books:
R1: Dietel H.M, Dietel P.J, "Java: How to Program", Prentice-Hall, 11th Edition, 2017.

R2: Schildt, H., Java: The Complete Reference, 12th ed., McGraw-Hill, 2021.

Course code: CSP253
Course Title: OBJECT ORIENTED PROGRAMMING LAB
Structure (L-T-P): 0-0-2
Prerequisite: NIL
Course Objectives:
Programming Lab course aims at the following educational objectives:
· To become familiar with the Object Oriented Programming paradigm.
· To use object oriented features to solve real life problems.
· To enhance logical and problem solving skills using Java programming.
· To impart hands-on experience in Java language

Course Outcomes
Course Outcomes (COs): At the end of this lab course, students will be able to-
Essential:
CO1: Understand the Object Oriented paradigm and use it to solve problems related to real world applications.
CO2: Develop proficiency in the Java programming language, including its syntax and basic data types.
CO3: Implement and use classes and objects to solve problems in various domains, including data structures and algorithms.
CO4: Implement concepts of multithreading, files, and abstraction in java.
Desirable/Advanced (If any): NIL
Experiments for Essential Course Outcomes

1. Demonstrate object oriented programming features using Java language.
2. Implement a java program to demonstrate working of conditional statements and loops.
3. Implement a java program to show working of access modifiers.
4. Write a java program to show use of static and non static members of a class.
5. Implement Java program to show the concept of Inheritance and demonstrate the concept of Run time Polymorphism and Compile time Polymorphism.
6. Use String Class to demonstrate all the functionality available in Java for string manipulation.
7. STACK_EMPTY and STACK_FULL as methods of inner class and remaining methods should be implemented in outer class STACK.
8. Write a program to implement the concept of Queue and Implement Insert, Delete, Traverse, Queue Empty, Queue Full operations. Queue Empty, Queue Full methods should be private methods.
9. Define outer class STACK. Demonstrate the concept of inner class and implement Java programs for Linkedlist, stack, queue and arraylist using Collection Framework.
10. Write programs to demonstrate exception handling mechanisms in java.
11. Implement input/ output operations and file handling concepts in java.
12. Write a java program to implement networking in java.

13. Write a java program to connect to the database and read and write in the database.

Experiments for Desired Course Outcomes (If any): NIL

Textbooks/Materials:

T1: Xavier C, "Java Programming - A Practical Approach", Tata McGraw-Hill, 2011.

T2: Dietel H.M, Dietel P.J, "Java: How to Program", Prentice-Hall, 11th Edition, 2017.

Reference Books:

R1: Dietel H.M, Dietel P.J, "Java: How to Program", Prentice-Hall, 11th Edition, 2017.

R2:Schildt, H., Java: The Complete Reference, 12th ed., McGraw-Hill, 2021.

Course Code: CSL254

Course Title: DESIGN AND ANALYSIS OF ALGORITHMS

Structure (L-T-P): 3-0-0

Prerequisite: Data Structures

Course Objectives:

Analyze algorithms for time and space complexities. Develop algorithms for various problems by applying various algorithms design strategies. To study divide & conquer, a greedy and dynamic approach to solve various problems.

Course Outcomes

Essential:

CO1. Understand and apply mathematical foundations for analyzing algorithms, including summations, recurrence relations, and asymptotic notations.

CO2. Describe the divide-and-conquer paradigm. Derive and solve recurrence relations of various divide and conquer algorithms and analyze their best and worst case complexities.

CO3. Usage of greedy algorithms to solve problems requiring optimal solutions.

CO4. Apply a dynamic programming approach to solve problems and analyze them. Use of a backtracking approach to solve graph problems.

CO5. Understand the significance of NP-hard and NP-complete problems and be able to apply polynomial reduction to demonstrate NP-hardness.

Desirable/Advanced (If any): NIL

Contents for Essential Course Outcomes (If any)

Asymptotic notations of analysis of algorithms, analyzing control structures, worst case and average case analysis, amortized analysis. sorting algorithms such as selection sort, insertion sort, bubble sort, heap sort, lower bound proof, elementary and advanced data structures with operations on them and their time complexity. Divide and conquer basic strategy, binary search, quick sort, merge sort, etc. Greedy method - basic strategy, application to job sequencing with deadlines problem, minimum cost spanning trees, single source shortest path etc. Dynamic Programming basic strategy, multistage graphs, all pairs shortest path, single source shortest paths, optimal binary search trees, traveling salesman problem. Basic Traversal and Search Techniques, breadth first search and depth first search, connected components. Backtracking basic strategy, 8-Queens problem, graph coloring, Hamiltonian cycles etc. NP-hard and NP-complete problems, basic concepts, nondeterministic algorithms, NP-hard and NP-complete, Cook's Theorem, decision and optimization problems, polynomial reduction.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1.Cormen, T.H., Leiserson, C.E. and Rivest, R.L., Stein, C., Introduction to Algorithms, 4th ed., The MIT Press, 2022.

T2.Horowitz, E., Sahni, S. and Rajasekaran, S., Fundamentals of ComputerAlgorithms, 2nd ed., University Press, 2012.

Reference Books:

R1. Brassard, G. and Bratley, P., Fundamentals of Algorithmics, PHI Learning Private Limited, 2008.

R2. S. Sridhar, Design And Analysis Of Algorithms, Oxford University Press, 2014.

Course Code: CSP254

Course Title: DESIGN AND ANALYSIS OF ALGORITHMS LAB

Structure (L-T-P): 0-0-2

Prerequisite:

Course Objectives:

To Analyze the asymptotic performance of algorithms and learn the importance of designing an algorithm in an effective way by considering space and time complexity. Selection of appropriate data structures while developing algorithms to reduce the complexity.

Course Outcomes:

Essential:

CO1: To implement different types of algorithms and analyze their time and space complexity.

CO2: To understand and implement the divide and conquer strategy to solve the sorting and searching problems.

CO3: Implementation of greedy algorithms to find minimum spanning trees, shortest paths and other optimization problems.

CO4: To implement a dynamic programming approach to solve traveling salesman problems and 0/1 knapsack problems.

CO5: To solve various computational problems, such as graph algorithms, optimization problems, using appropriate algorithms.**Desirable/Advanced (If any):** NIL

Experiments for Essential Course Outcomes

1. Implement sorting algorithms to analyze their time and space complexity.
2. Perform operations on heap data structure.
3. To implement maximum and minimum problems using divide and conquer strategy.
4. To implement binary search using divide and conquer strategy.
5. Implement greedy algorithms to solve optimization problems.
6. Write programs to find minimum spanning trees and shortest paths.
7. Use a dynamic programming approach to solve problems like 0/1 knapsack, traveling salesman problem etc.
8. Implement graph traversal and search techniques.
9. Implement N Queens problem using Backtracking.

Experiments for Desired Course Outcomes (If any): NIL

Text Books:

T1. Cormen, T.H., Leiserson, C.E. and Rivest, R.L., Stein, C., Introduction to Algorithms, 3rd ed., PHI Learning Private Ltd., 2013.

T2. Horowitz, E., Sahni, S. and Rajasekaran, S., Fundamentals of ComputerAlgorithms, 2nd ed., University Press, 2012.

Reference Books:

R1. Brassard, G. and Bratley, P., Fundamentals of Algorithmics,PHI Learning Private Limited, 2008.

R2. S. Sridhar, Design And Analysis Of Algorithms, Oxford University Press, 2014.

Course Code: CSL255
Course Title: COMPUTER NETWORKS
Structure (L-T-P): 3-0-0
Course Prerequisite: Data Communications CSL-257
Course Objectives:
Computer Networks course aims at the following educational objectives:
To become familiar with the Computer Networks.
To understand the fundamental principles of Networking and other related equipment.
To understand application of Networking Protocols and its applications
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Describe the terminology of computer networks and core concepts of open system interconnection (OSI) and TCP/IP reference models.
CO2. Compare the working of protocols, network interface and design/performance issues in local area networks, metropolitan area networks, and wide area networks.
CO3. Solve and analyze the data link layer, network layer, transport layer and application layer protocols.
CO4. Analyze the basic concepts of wireless networking.
CO5. Design network socket programming and networker simulator using NS-2 and NS-3.
Desirable (if any): NIL
Contents:
Introduction to Network Architecture, Layering and Protocols, Internet Architecture Topologies, Transmission Media (Guided and Unguided), Performance, Bandwidth and Latency, Encoding (Unipolar, Polar, Bipolar), Data Transmission, Multiplexing and De-Multiplexing, Framing, Error Detection and Correction Techniques, Line Discipline, Flow Control, and Error Control, Bit stuffing and Corrector Stuffing, Byte-Oriented Protocols (PPP), Bit-Oriented Protocols (HDLC), internetworking (IEEE 802.1), LLC (IEEE 802.2), MAC (IEEE 802.3), Token Bus (IEEE 802.4) and Token Ring (IEEE 802.5), FDDI, Switching (Circuit Switching and Packet Switching), Point-to-Point Protocol(PPP), Link Control Protocol(LCP).

Routing, Bridging, Gateway, Brouters, Routing Protocols (Distance Vector (RIP), Link State (OSPF). IP Addressing (Classful and Classless), Masking, Subneting and Superneting, ARP and RARP, Host Configuration (DHCP), 1Pv4, IPv6, UDP, TCP. Connection Establishment and Termination, Triggering Transmission, Adaptive Retransmission Error Reporting (ICMP, IGMP), Presentation layer functions, Electronic Mail (SMTP, MIME, 1MAP), World Wide, Web(HTTP), Web services multimedia applications, Session control and call control, SDP, SIP, H.323, Name service (DNS), Network Management(SNMP).

Text Books:

T1. Peterson, L.L. and Davie, B.S., Computers Networks: A Systems Approach, 5th ed., Elsevier, 2013.

T2. Forouzan, B.A., Data Communications and Networking, 5thed.Tata McGraw- Hill, 2013.

Reference Books:

R1. Tanenbaum, A. S. and Wetherall, D., Computer Networks, 5th ed., Pearson, 2014.

R2. Haykin, S.S. and Moher, M., Communication Systems, 5th ed., John Wiley and Sons, 2012.

R3. Comer, D., Computer Networks and Internets, 6th ed., Pearson, 2014.

R4. Kurose, J.F. and Ross, K.W., Computer Networking: A Top-Down Approach, 6th ed., Pearson Education, 2013.

R5. Stallings, W., Data and Computer Communications, 10th ed., Pearson Education, 2014.

Course Code: CSP255
Course Title: COMPUTER NETWORKS LAB
Structure (L-T-P): 0-0-2
Course Prerequisite: Data Structures and Computer Programming
Course Objectives:
Computer Networks Lab course aims at the following educational objectives:
To become familiar with Socket Programming.
To understand the fundamental principles of client server programming.
To understand the application of Networking Protocols and its applications through programming.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Describe the terminology of computer networks and core concepts of open system interconnection (OSI) and TCP/IP reference models.
CO2. Compare the working of protocols, network interface and design/performance issues in local area networks, metropolitan area networks, and wide area networks.
CO3. Solve and analyze the data link layer, network layer, transport layer and application layer protocols.
CO4. Analyze the basic concepts of wireless networking.
CO5.Design network socket programming and networker simulator using NS-2 and 3.
Desirable (if any): NIL
Experiments for Essential Course Outcomes

1. Using TCP sockets or network socket programming.
2. Client server application for chat.
3. PC to PC file transfer using serial port.
4. Implementation of shortest path routing.
5. Implementation of Sliding window protocol.
6. Implementation of open shortest path first protocol.
7. Using n/w simulation like NS2, DLC/DLL simulator.
8. Implementation of TCP/IP echo.
9. Using simple UDP protocol.
10. Implementation of a packet analyzer for traffic classification and protocol information.

Experiments for Desirable Course Outcomes (if any): NIL

Text Books:

T1: Peterson, L.L. and Davie, B.S., Computers Networks: A Systems Approach, 5th ed., Elsevier, 2013.

T2: Forouzan, B.A., Data Communications and Networking, 4th and 5th edition of Tata McGraw-Hill, 2013.

Reference Books:

R1: Tanenbaum, A. S. and Wetherall, D., Computer Networks, 5th ed., Pearson, 2014.

R2: Stallings, W., Data and Computer Communications, 10th ed., Pearson Education, 2014.

Course Code: CSL256
Course Title: SOFTWARE ENGINEERING
Structure (L-T-P): 3-0-0-3
Course Prerequisite: CSL256
Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

Understand the Software Engineering Practices for software Design, development and testing along with Software Project Management.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Understand the software development life cycle and Prepare SRS document for a project.

CO2. Able to apply software design and development techniques to construct the various software systems.

CO3. Able to implement the various testing methods at each phase of SDLC.

CO4. Analyze and Apply project management techniques for a software solution.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction to Software Engineering, software Characteristics, software life-cycle models, process models, software project management, software configuration management, software requirements specifications, software architecture, software design, function-oriented software design, object-oriented design, UML modeling, user interface design, software implementation, software testing, verification and validation, Software Quality Frameworks, ISO 9001 Model, SEI-CMM Model, Software reliability and fault tolerance, software metrics.

Syllabus for Desired Course Outcomes (If any): NIL

Text Books

T1. Roger Pressman, Software Engineering: A Practitioner's Approach", McGraw-Hill Publications

T2. Sommerville, I., Software Engineering, 9thed.,Pearson Education 2013

Reference Books

R1. Singh,Y.,Software Testing, Cambridge University Press, 2013.

R2. Aho, A.V., and Ullman, J.D., Principles of Compiler Design, Narosa Publishing House, 2002

R3. Pankaj Jalote, "An integrated approach to Software Engineering", Springer/Narosa.

R4. Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall India.

Course Code: CSP256
Course Title: SOFTWARE ENGINEERING LAB
Structure (L-T-P): 0-0-2-1
Course Prerequisite: NIL
Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

Develop the well documented software by working in a team and using the principles of software engineering in a phased manner like SRS document preparation, design, coding, testing and Maintenance.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Preparation of Software Requirement Specification document

CO2. Preparation of Design Document using UML

CO3. Implementation of Design document to executable programs using coding techniques

CO4. Preparation of test cases to perform testing

CO5. A well-documented Software

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. A project group with 2-3 students is formed and a small Software Project is assigned to the group.
2. Group is required to prepare a thorough problem statement for the assigned project and find a suitable process model for developing the software. The output of each phase has to be submitted by the students in the form of a phase outcome/deliverables after performing the required activities in each phase within a given time line.
3. Software Requirement Specification (SRS) document is required to be prepared for the project.
4. Utilize a project management tool to create a project schedule.
5. Use the UML to develop the use case and class diagram after identifying potential scenarios for the project.
6. Prepare the activity and state transition diagram.
7. Prepare sequence and collaboration diagram.
8. Write the code using proper coding standards and guidelines.
9. Develop the test cases to perform the White box and Black box testing.
10. Prepare the software usage manual as an external document.
11. After completion of the project, each group has to submit the project report.

Experiments for Desired Course Outcomes (If any): NIL

Text Books

T1. Roger Pressman, Software Engineering: A Practitioner's Approach", McGraw-Hill Publications.

T2. Martin Fowler, UML Distilled: A Brief Guide To The Standard Object Modeling Language, 3rd Edition, Pearson.

Reference Books

R1. Singh,Y.,Software Testing, Cambridge University Press, 2013.

R2. Jibitesh Mishra and Ashok Mohanty, Software Engineering, Pearson.

Course Code: CSL257
Course Title: DATA COMMUNICATION
Structure (L-T-P): 3-0-0

Course Prerequisite: CSL151
Course Objective

Data Communication course aims at the following educational objectives:

To become familiar with the fundamental concepts of data communication as well as the relevant state-of-

the-art.
Able to analyze concepts of error detection in data communication, encoding, modulation and transmission of data through various modems, clock-based framing, integrated services digital network (ISDN).
To understand the basics of Networking Protocols.

Course Outcomes (COs): At the end of the course, students will be able to-

CO1: Ability to analyze data communication and core concepts of open system interconnection (OSI) and TCP/IP reference models.
CO2: Ability to demonstrate knowledge on Analog and Digital signals, Digital transmission, Analog transmission, Multiplexing, and Transmission Media.
CO3: Ability to analyze the concept of Error Detection and Correction, DTE-DCE Communication, DTE-DCE Interface, Modems, and various Encoding Processes.
CO4: Ability to use the basic concepts of Data Communication.

Desirable/Advanced (If any): NIL

Contents:

Introduction to data communication and networking, OSI and TCP/IP protocol suit, Analog and Digital signals, Digital transmission, Analog transmission, Multiplexing (Frequency division Multiplexing, Wavelength division Multiplexing, Time division Multiplexing, Multiplexing applications), transmission media (Guided Media, Unguided Media, Transmission Impairments, Performance Wavelength , Shannon Capacity , Media Comparison, PSTN , Switching), Error Detection and Correction, DTE-DCE Communication (Digital data transmission, DTE-DCE Interface, Modems, 56K Modems , Cable Modems), Encoding (NRZ, NRZI, Manchester, Differential Manchester, 4B/5B), Clock based framing, Integrated services digital network (ISDN), Introduction to networks.

Syllabus for Desired Course Outcomes (If any): NIL

Text Books:

T1. Data communication & Networking by Bahrouz Forouzan.
T2. Computer Networks by Andrew S. Tanenbaum.
T3. Forouzan, B.A., Data Communications and Networking, 5thed.Tata McGraw- Hill, 2013.

Reference Books:

R1. Stallings, W., Data and Computer Communications, 10th ed., Pearson Education, 2014.

Course Code: CSL258
Course Title: COMPUTER ORGANIZATION AND ARCHITECTURE
Structure (L-T-P): 3-0-0
Course Prerequisite:-Digital Circuits
Course Objectives
The objective of the course is to present an understanding of the basic principles on which computers work. To know about the various components and their organization.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Understand the structure, function and characteristics of computer systems.
CO2. Understand the design of the various functional units and components of computers.
CO3. Identify the elements of modern instruction sets and their impact on processor design.
CO4. Understand the function of each element of a memory hierarchy.
CO5. Identify and compare different methods for computer I/O
CO6. Be able to write assembly language code.

Desirable/Advanced (If any): NIL

Overview of Computer Architecture and Organization: Fundamentals of computer architecture, Organization of von Neumann machine, Basic operation concepts and performance equation.
Computer Arithmetic and Machine Instruction: Representation of integers and real numbers algorithm for carrying out common integer and floating-point operations: Integer Addition and Subtraction, Ripple carry adder, carry look-ahead adder, etc. Multiplication - Shift-and-Add, Booth algorithm, bit pair recording, etc. Division - non-restoring and restoring techniques. Floating point arithmetic.
Memory Locations and Addresses, Memory operations, Instruction format, execution cycle, Instruction types and addressing modes. Assembly Language program.
Memory Organization: Memory system hierarchy, main memory organization, cache memory, auxiliary memory. Mapping, Replacement, Writing policies.
Input-Output Organization: Input-output subsystems, I/O transfers- Program controlled, Interrupt driven and DMA, Privileged and non-privileged instructions, Introduction to Peripheral Devices and their Characteristics.
Control Unit Design: Instruction sequencing, Instruction interpretation, control memory, Hardwired Control, Micro programmed Control, Microprogrammed Computers.
Organization of CPU: Single vs multiple data path ISA Control unit Instruction, pipelining, Trends in computer architecture: CISC, RISC, VLIW, Introduction to ILP Pipeline Hazards: Structural, data and control. Reducing the effects of hazards, Multiprocessors Architectures.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Hamacher, V.C., Vranesic, Z.G. and Zaky, S.G., Computer Organization, 5th ed., Tata McGraw Hill, 2013.
T2. Computer System Architecture", by M. Morris Mano (PHI).

Reference Books:

R1. Patterson, D.A.and Hennessy, J.L., Computer Organization and Design: The Hardware/Software Interface, 5th ed., Morgan Kaufmann, Amsterdam, 2014.

R2. Stallings, W., Computer Organization and Architecture: Designing for Performance, 9th ed., Pearson Education, Boston, 2013.

R3. Tanenbaum, A.S. and Austin, T., Structured Computer Organization, 6th ed., Pearson Education, 2013.
R4. Computer Architecture and Organization", by John P. Hayes (McGraw Hill)

Course Code: CSL259
Course Title: THEORY OF COMPUTATIONS
Structure (L-T-P): 3-0-0
Course Prerequisite:- Data Structures
Course Objectives
The objective of the course is to provide fundamental knowledge about how to solve various computational problems using Automaton.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Outline the concept of Finite Automata and Regular Expression.
CO2. To understand Context-Free Grammars (CFG) and their different forms of representation.
CO3. Demonstrate the push down automaton model for the given language.
CO4. Make use of the Turing machine concept to solve the simple problems.
CO5. Explain decidability or undecidability of various problems.
Desirable/Advanced (If any): NIL
Contents for Essential Course Outcomes (If any)
Introduction: Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.
Regular languages and finite automata: Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions, nondeterministic finite automata (NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages, pumping lemma for regular languages, minimization of finite automata.
Context-free languages and pushdown automata: Context-free grammars (CFG) and languages (CFL), Chomsky and Greibach normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, parse trees, ambiguity in CFG, pumping lemma for context-free languages, deterministic pushdown automata, closure properties of CFLs.
Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.
Turing machines: The basic model for Turing machines (TM), Turing-recognizable (recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines, TMs as enumerators.
Undecidability: Overview of Church-Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice s theorem, undecidable problems about languages.
Contents for Desired Course Outcomes (If any): NIL
Text Book:
T1. Martin, J.C., Introduction to Languages and the Theory of Computation, 3rded., Tata McGraw Hill, 2014.
T2. Michael Sipser, Introduction to the Theory of Computation. Cengage Learning, 2013.
Reference Book:
R1. Hopcroft, J.E., Motwani, R. and Ullman, J.D., Introduction to Automata Theory, Languages and Computation, 3rd ed., Pearson Educations, 2014.
R2. K. L. P. Mishra, N. CHANDRASEKARAN, Theory of Computer Science Automata, Languages and Computations.

Course Code: CSL351
Course Title: DATABASE MANAGEMENT SYSTEMS
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives
After completing the above course, student is expected to:
The objective of the course is to present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from a DBMS.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: Understand the fundamental concepts, principles and applications of DBMS.
CO2: Apply the different SQL queries on relations.
CO3: Analyze the ER diagram and produce the relations from the ER diagram.
CO4: Design and implement a database project, considering the issues like normalization, concurrency control, recovery and security.
CO5: Understand the storage structure in DBMS.
Desirable outcomes (If any): NIL
Contents for Essential Course Outcomes (If any)
Introduction: Overview of a DBMS, File processing system, Advantages of a DBMS, Applications, Recent advances in database technology, Database system architecture.
Query Languages: Relational algebra, Relational calculus, SQL
Data Models: Relational model, ER model, EER model, Object relational data model, Hierarchical data model, Network data model, ER model to relation model conversion.
Database Design: Types of keys, Functional dependencies, Normal forms, Relation decomposition, Denormalization.
Data Storage & Indexing: File organization overview, Storage structures, B and B+ tree, Indexing overview, Dense and Sparse index.
Transaction management and Concurrency control: Transaction management overview, ACID properties, Serial and Concurrent schedules, Serializability and Recoverability of schedule, Concurrency control mechanisms, Locking and Timestamp based protocol.
Query Processing & Optimization: Overview, Relational operator's evaluation, Techniques for query optimization, strong and weak equivalence, cost base optimization, Heuristic-based optimization.
Contents for Desired Course Outcomes (If any): NIL
Text Book:
T1: Silberschatz A., Korth H.F., and Sudarshan S. Database System Concepts, 7th Edition, McGraw-Hill Education, 2020.
T2: Elmasri Ramez, Navathe Shamkant. Fundamentals of Database Systems, 7th Edition, Pearson Education, 2017.
Reference Books:
R1: Ullman, J.D.. Principles of Database Systems, 3rd Edition, Galgotia Publications, 1994.

R2: Ramakrishnan, and Gehrke. Database Management Systems, 3rd Edition, McGraw-Hill, 2003.

Course Code: CSP351
Course Title: DATABASE MANAGEMENT SYSTEMS LAB
Structure (L-T-P): 0-0-2
Course Prerequisite: NIL
Course Objectives
After completing the above course, student is expected to:

1. Understand the basics of database management systems and their applications.
2. Gain proficiency in SQL programming language and its application in manipulating data.
3. Develop skills in designing, implementing and maintaining a database.
4. Understand how database management systems can be used to solve real-world problems.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: Students get practical knowledge on designing and creating relational database systems.
CO2: Design, create and manipulate databases using SQL.
CO3: Create backups and recovery plans for a database.
CO4: Use database management systems to solve real-world problems.
CO5: Understand various advanced queries execution such as relational constraints, joins, set operations, aggregate functions, triggers, views and embedded SQL.
CO6: Use of various software to design and build ER Diagrams, UML, Flow charts for related database systems.
Desirable/Advanced (If any):
CO1: Evaluate the performance of a database management system.
CO2: Students will be able to design and implement database applications on their own.
Experiments for Essential Course Outcomes

1. Design and create a relational database system for a real-world scenario by identifying key entities, attributes, and relationships and designing necessary tables, fields, and constraints.
2. Use SQL to manipulate the database by performing tasks such as adding, deleting, updating records, and performing joins.
3. Create a backup and recovery plan for the database system to understand the importance of data backup and recovery in maintaining the integrity of a database.
4. Use advanced SQL queries such as relational constraints, set operations, aggregate functions, triggers, and views to manipulate and analyze data in a database.
5. Solve real-world problems using front and back end with database management systems: finding books (SQL aggregate), tracking patients (SQL queries with joins), managing inventory (SQL operations), analyzing sales data (SQL subqueries and joins), building recommendation systems (SQL queries and ML algorithms), detecting fraud (SQL queries and data analysis).
6. Use software tools to design and build ER diagrams, UML diagrams, and flowcharts for database systems to develop skills in using software tools to visualize and plan a database system.
7. Write a program to identify the highest normal form.
8. Write a program to check if the decomposed relations are loss or lossless.
9. Write a program to check if the decomposed relations preserve dependency or not.
10. Write a program to execute DML, DDL sql queries by using mysql database through front end.
11. Write a program to implement B and B+ tree storage structure.
12. Write a program to implement a dense and sparse index.
13. Implementation of query optimization techniques.
14. Implementation of locking protocol in concurrency control.
15. Implementation of timestamp based protocol in concurrency control.

Experiments for Desired Course Outcomes (If any)

1. Students can design and implement web applications that interact with databases using web frameworks.

Books/Material
T1. Silberschatz, A.,Korth, H.F. and Sudarshan, S.Database System Concepts, 6th ed., Tata McGraw-Hill, 2011.
T2. Elmasri Ramez, Navathe Shamkant. Fundamentals of Database Systems, 7th Edition, Pearson Education, 2017.
Reference Books
R1. Ullman, J.D.. Principles of Database Systems, 3rd Edition, Galgotia Publications, 1994.
R2. Ramakrishnan, and Gehrke. Database Management Systems, 3rd Edition, McGraw-Hill, 2003.

Course Code: CSL352
Course Title: COMPILER DESIGN
Structure (L-T-P): 3-0-0
Course Prerequisite: Theory of Computation
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:
1. Students should be able to understand the need and concepts behind Compilers.
2. Students should be able to understand the implementation details of a Compiler.

Course Outcomes:
At the end of the course, students will be able to-
Essential:
CO1: To be able understand the basics of Lexical and Syntactical Analysis in a Compiler Design.
CO2: To be able to Symbol Table, Semantic Analysis and Error Handling Concepts in Compilers.
CO3: To be able to understand code optimization and generation in the context of underlying Hardware Machine.
CO4: To be able to analyze the recent requirements and implement new improvements.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Introduction to compilers, compilers and translators, phase structure of a typical compiler, Number of passes, ideas about lexical analysis, syntax analysis, code optimization and code generation, design of

lexical analyzer. Syntax specification of programming languages**,** Design of top-down parser, bottom up parsing technique, LR parsing algorithm, Design of SLR, LALR,LR parsers. Dealing with ambiguity of the grammar. Study of syntax directed definitions and syntax directed translation schemes as notational framework to specify the translations. Using syntax directed translation schemes for translation of expressions, controls structures, declarations, procedure calls. Symbol table management, Error detection and recovery, error recovery in LR parsing, error recovery in LL parsing, Automatic error recovery in YACC Introduction to Important code optimization techniques, loop optimization, control flow analysis, data flow analysis, setting up data flow equations to compute reaching definitions, available expressions, Live variables. Problems in code generation, simple code generator code generation from DAG, Peephole optimization.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1: Aho, A.V., and Ullman, J.D., Principles of Compiler Design, Narosa Publishing House, 2002.

T2: Modern Compiler Implementation in C/Java" by Andrew W Appel, 2004

Additional Books:

R1: Holub, A.I., Compiler Design in C, Prentice-Hall of India, 2006.

R2: Fischer, C.N., Cytron, R.K. and LeBlanc, R.J., Crafting a Compiler, Addison Wesley, 2010.

Course Code: CSL353
Course Title: DATA SCIENCE
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL

Students should have completed at least Computer Programming and Problem Solving.

Course Objectives:

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

1. Analyze a problem and Datasets for the domain under consideration.
2. Devise appropriate Data Science technique for solving the problem at hand.

Course Outcomes:

At the end of the course, students will be able to-

Essential:

CO1: To be able understand the basics of various Linear Algebra and Probabilities.

CO2: To be able to understand the concepts of Exploratory Data Analysis and Visualization

CO3: To be able to understand the concepts of Clustering and Classifications

CO4: To be able to analyze the problem and draw inferences for naïve problems.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction: What is Data Science? Data Science and Ethical Issues: Discussions on privacy, security, ethics., probabilistic distributions, univariate and multivariate normal distributions, Central Limit Theorem, hypothesis testing, confidence interval, Statistical modeling, Exploratory Data Analysis, Data Visualization, Basics of Learning, Gradient Descent, Regressions, Classification, Clustering, Testing-Evaluation-Validation of Models. Learning Networks: Perceptron, Multi-Layered Perceptrons(MLP), L1 and L2 Regularization, Cross Validation, Data Science vs Data Analytics.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.

T2. Christopher M. Bishop F.R.Eng., Pattern Recognition and Machine Learning, Springer.

Reference Books:

R1. Gilbert Strang, Introduction To Linear Algebra, WellesleyCambridge Press and SIAM, Fifth Edition (2016).

R2. Douglas Montgomery, Applied Statistic And Probability For Engineers, John Wiley & Sons, Inc., Third Edition.

R3. Deep Learning, An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville (http://www.deeplearningbook.org.)

R4. Jure Leskovec, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014. (free online)

Course Code: CSP353
Course Title: DATA SCIENCE LAB
Structure (L-T-P): 0-0-2
Course Prerequisite: Computer Programming and Problem Solving.

Course Objectives:

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

1. Analyze a problem and Datasets for the domain under consideration.
2. Devise appropriate Data Science technique for solving the problem at hand.

Course Outcomes:

At the end of the course, students will be able to-

Essential:

CO1: To be able to understand the concepts of Exploratory Data Analysis and Visualization

CO2: To be able to understand the concepts of Clustering and Classifications

CO3: To be able to analyze the problem and draw inferences for naïve problems.

CO4: To be able to implement Real time Classification using Anomaly Detection

Desirable/Advanced (If any):

CO5: To be able to analyze generic problems in Data Science and Implement a Solution.

Experiments for Essential Course Outcomes

1. Working with Numpy arrays and Pandas data frames
2. Develop Basic plots using Matplotlib
3. Develop Frequency distributions, Variability and Averages
4. Develop program for Normal Curves
5. Develop program for Correlation and scatter plots
6. Develop program for Correlation coefficient
7. Develop program Regression Techniques
8. Develop program for Clustering Techniques
9. Develop a python program for Decision Tree and Ensemble Trees.

Experiments for Desired Course Outcomes (If any)

10. Implementation of Fraud Detection through Anomaly Detection in Financial Data Sets
11. Implementation of Fraud Detection through Anomaly Detection in IDS

Books/Material

T1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.
T2. Christopher M. Bishop F.R.Eng., Pattern Recognition and Machine Learning, Springer.

Reference Books

R1. Gilbert Strang, Introduction To Linear Algebra, WellesleyCambridge Press and SIAM, Fifth Edition (2016).
R2. Douglas Montgomery, Applied Statistic And Probability For Engineers, John Wiley & Sons, Inc., Third Edition.
R3. Deep Learning, An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville (http://www.deeplearningbook.org.)
R4. Jure Leskovec, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014. (free online)

Course Code: CSL354
Course Title: INFORMATION AND NETWORK SECURITY
Structure (L-T-P): 3-0-0
Course Prerequisite: CSL 255, CSL252
Course Objectives
To develop an ability to learn underlying principles of cryptography and network security by developing the mathematical tools required to understand the topic of cryptography to design and analyze cryptographic protocols to ensure a secure computing environment.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: Understand the basic concepts of cryptography and network security paradigm.
CO2: Analyze the vulnerabilities in the computing system and apply the security solution.
CO3: Compare and analyze different symmetric and asymmetric encryption algorithms.
CO4: Understand and comprehend the basis of hashing algorithms and requirements.
CO5: Design and implement the algorithm, considering the issues like confidentiality, integrity, authentication, non-repudiation, security and privacy.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Introduction: Introduction to information security, network security model, security attacks, security services and mechanism. Introduction to cryptography, role of cryptography in information and network security. **Number theory for cryptography:** prime numbers and modular arithmetic, algebraic structures like group, ring and field, polynomial arithmetic over GF(), Euclidean algorithm, Euler's phi function, Fermat's and Euler's theorems, Chinese remainder theorem and Discrete logarithms. **Classical Ciphers:** monoalphabetic, polyalphabetic and transposition ciphers. Security analysis of Classical ciphers. **Modern stream and block ciphers:** design principles of stream and block ciphers, block mode of operations, Feistel network and modern block ciphers. Pseudorandom number generations and stream ciphers, **Asymmetric Key Cryptosystems:** Introduction to public key cryptography, mathematical intractable problems, RSA cryptosystem, discrete logarithm problem and Diffie-Hellman key exchange, ElGamal cryptosystem, cryptanalysis of public key cryptosystems, **Cryptographic Hash Functions:** Introduction, random oracle model, security of hash functions, Merkle–Damgard construction and iterative hash functions, message authentication codes and digital signature schemes, **Key Management and Distribution:** Symmetric key distribution using symmetric & asymmetric encryption, distribution of public Keys, Kerberos, digital certificate and Public Key Infrastructure, **Network and Transport-level Security:** IPSec, Web security considerations, Secure Socket Layer and Transport Layer Security, HTTPS, Secure Shell (SSH), **Wireless Network Security:** Wireless Security, Mobile Device Security, IEEE 802.11 Wireless LAN, IEEE 802.11i Wireless LAN Security, **EMail Security:** Pretty Good Privacy, S/MIME.

Contents for Desired Course Outcomes (If any): NIL
Text Book:
T1. Forouzan, B.A. and Mukhopadhyay, Debdeep, Cryptography and Network Security, 2nd ed., Tata McGraw Hill, 2013.

T2. Stallings, W., Cryptography and Network Security: Principles and Practice, 7th ed., Pearson, 2017.
Reference Book:
R1. Mao W., Modern Cryptography Theory and Practice, 3rd ed., Prentice Hall PTR, 2003.
R2. Stinson, D.R., Cryptography: Theory and Practice, 4rd ed., Chapman and Hal CRC Press, 2019.
R3. Menezes, A.J., Oorschot, P.C.V. and Vanstone, S.A., Handbook of Applied Cryptography, 5th ed., CRC Press, 2001.
R4. Kaufman, C., Perlman, R. and Speciner, M., Network Security: Private Communication in a Public World, 2nd ed. Prentice Hall, 2010.

Course Code: CSP354
Course Title: Information and Network Security Lab
Structure (L-T-P): 0-0-2
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:
1. Identify the security issues in the network and resolve it.
2. Analyze the vulnerabilities in any computing system and hence be able to design security solution.
3. To have the ability to compare merits and demerits of different cryptographic techniques and take decision while securing a network.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: Implement and validate number theoretic algorithms and classical cryptosystem.
CO2: Use number theoretic algorithms in design and implementation of cryptographic protocols.
CO3: Implement symmetric and asymmetric cryptographic algorithms.
CO4: Design and implement authentication and key exchange protocols.
CO5: Design and Implement cryptographic tools.
Desirable/Advanced (If any): NIL
Experiments for Essential Course Outcomes
1. Implement various number theory algorithms like Euclidean and extended Euclidean algorithms, modular arithmetic over Z_n, Polynomial arithmetic over GF(2^n), Chinese Remainder Theorem (CRT), etc.

2. Implementation, testing and finding attacks on various classical ciphers like Affine, Playfair, Hill Cipher, etc.
3. Implementation of various modern block ciphers and stream ciphers like DES, AES, RC4, A5/1, etc.
4. Implementation of cryptographic hash functions.
5. Implementation of public key cryptosystems and digital signature algorithms like RSA, ElGamal, DSS, etc.
6. Implementation of Diffie-Helman key exchange, station to station key agreement and MAC protocols.
7. Other experiments related to the course content of CSL354- Information and Network Security.

Experiments for Desired Course Outcomes (If any)

1. Experiments to extend the existing tow party Diffie- Hellman protocol for multi-party.
2. Implementation of Shamir Secret Sharing Scheme.

Text Books

T1: Forouzan, B.A. and Mukhopadhyay, Debdeep, Cryptography and Network Security, 2nd ed., Tata McGraw Hill, 2013.

T2: Stallings, W., Cryptography and Network Security: Principles and Practice, 6th ed., Pearson, 2014.

Reference Books

R1: Schneier, B., Applied Cryptography: Protocols, Algorithms and Source Code in C, 2nd ed., Wiley-India, 2007.

R2: Stinson, D.R., Cryptography: Theory and Practice, 3rd ed., Chapman and Hal CRC Press, 2006.

R3: Menezes, A.J., Oorschot, P.C.V. and Vanstone, S.A., Handbook of Applied Cryptography, 5th ed., CRC Press, 2001.

R4: Kaufman, C., Perlman, R. and Speciner, M., Network Security: Private Communication in a Public World, 2nd ed., Prentice Hall, 2010.

Course Code: CSL355
Course Title: ARTIFICIAL INTELLIGENCE
Structure (L-T-P): 3-0-0
Course Prerequisite: Data Structures
Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, students are expected to: Understand the AI Paradigm as an alternate problem solving paradigm. Able to Scrutiny the particular AI approach applicable for problem solving in real time.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: To be able understand the basics of various modeling and their artifacts.

CO2: To be able to understand the concepts of classical and modern AI.

CO3: To be able to analyze the problem and solve using the most suitable model.

CO4: To be able to design the solution for naïve problems.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction: What is AI?, History, Overview, Intelligent Agents, Performance Measure, Rationality, Structure of Agents, Problem-solving agents, Problem Formulation, Uninformed Search Strategies, Informed (Heuristic) Search and Exploration, Greedy best first search, A* search, Memory bounded heuristic search, Heuristic functions, inventing admissible heuristic functions, Local Search algorithms, Hill-climbing, Simulated Annealing, Genetic Algorithms, Online search, Constraint Satisfaction Problems, Backtracking Search, variable and value ordering, constraint propagation, intelligent backtracking, local search for CSPs, Adversarial Search, Games, The minimax algorithm, Alpha-Beta pruning, Imperfect Real-Time Decisions, Games that include an Element of Chance Knowledge Based Agents, Logic, Propositional Logic, Inference, Equivalence, Validity and Satisfiability, Resolution, Forward and Backward Chaining, DPLL algorithm, Local search algorithms, First Order Logic, Models for first order logic, Symbols and Interpretations, Terms, Atomic sentences, complex sentences, Quantifiers, Inference in FOL, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution Planning, Language of planning problems, planning with state-space search, forward and backward state-space search, Heuristics for state-space search, partial order planning, planning graphs, planning with propositional logic. Uncertainty, Handling uncertain knowledge, rational decisions, basics of probability, axioms of probability, inference using full joint distributions, independence, Baye's Rule and conditional independence, Bayesian networks, Semantics of Bayesian networks, Exact and Approximate inference in Bayesian Networks.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, 3rd edition, Pearson Education, 2014.

T2. Kevin Knight, Elaine Rich, B. Nair, Artificial Intelligence, 2010, Tata McGraw-Hill Education Pvt. Ltd.

Reference Books:

R1. Nilsson, N.J. Artificial Intelligence and New Systems, 1st ed., Elsevier, 2011.

R2. Patterson, D. W. Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India, 2012

Course Code: CSP355
Course Title: ARTIFICIAL INTELLIGENCE LAB
Structure (L-T-P): 0-0-2
Course Prerequisite: Data Structures
Course Outcome
Essential:

CO1: To be able understand the basics of various modeling and their artifacts.

CO2: To be able to understand the concepts of classical and modern AI.

CO3: To be able to analyze the problem and solve using the most suitable model.

CO4: To be able to design the solution for naïve problems.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Implement Bidirectional Search on any map of cities in Uttarakhand with the State Dehradun and Goal State Rudrapur. Provide a map to students.
2. Implementation of 4 Queen Solution and generate at all intermediate states from some given random initial state.
3. Implementation of A* Algorithm on Uttarakhand Map with start state Dehradun and Goal State Rudrapur. Provide a map to students.

4. Implement the CSP paradigm based upon the concepts such as Backtracking, Ordering of Variables

and Value heuristics to solve the N-Queen Problem or N-Puzzle. Display the positions of Queens/Tiles on the board.
5. Implement one AI Agent based upon Proposition Logic which can draw conclusions on the basis of a. Forward Chaining, b. Backward Chaining c. Resolution
6. Implement the algorithm to implement the conversion of Predicates to Clausal Form.
7. Implement the algorithm to implement the concept of Unification in Predicate Logic.
8. Implement one AI Agent based upon Predicate Logic which can draw conclusions on the basis of a. Backward Chaining b. Resolution
9. Identify a model for the given wffs using DPLL.
10. Implementation of Route Planner for Autonomous Cars using Google Maps API.

Experiments for Desired Course Outcomes (If any)
NIL

Text Book:

T1. Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, 3rd edition, Pearson Education, 2014.

T2. Kevin Knight, Elaine Rich, B. Nair, Artificial Intelligence, 2010, Tata McGraw-Hill Education Pvt. Ltd.

Reference Books:

R1. Nilsson, N.J. Artificial Intelligence and New Systems, 1st ed., Elsevier, 2011.

R2. Patterson, D. W. Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India, 2012.

Course Code: CSL356
Course Title: DIGITAL IMAGE PROCESSING
Structure (L-T-P): 3-0-0-3
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course:
The objective of the course is to provide the knowledge about the digital image processing concepts, image enhancement techniques, filtering operations on image in spatial and frequency domain, image morphology, image segmentation & color image processing.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Understand the fundamental concepts of a digital image processing system.
CO2. Apply and evaluate the techniques for image enhancement in the spatial and frequency domain.
CO3. Students will have the knowledge about image restoration and morphology.
CO4. Students will learn about image segmentation and color image processing techniques.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
DIGITAL IMAGE FUNDAMENTALS: Overview of Image Processing, Digital Image Representation, Sampling, Quantization, Basic relationships between pixels, Labeling of connected components. IMAGE ENHANCEMENT IN SPATIAL DOMAIN: Some basic gray level transformations, Histogram processing, Smoothing and sharpening spatial filters. IMAGE ENHANCEMENT IN FREQUENCY DOMAIN: Smoothing and Sharpening frequency domain filters, Homomorphic filtering. IMAGE RESTORATION: Noise models, Restoration in the presence of noise only-spatial filtering, Estimating the degradation functions, Inverse filtering. MORPHOLOGICAL IMAGE PROCESSING: Dilation and erosion, Opening and closing, Some basic morphological algorithms. IMAGE SEGMENTATION: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation. COLOR IMAGE PROCESSING FUNDAMENTALS: Color fundamentals and models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening.
Syllabus for Desired Course Outcomes (If any): NIL
Text Books
T1. Gonzalez and Woods. Digital Image Processing, Pearson, Fourth Edition.
T2. A. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1st Edition, 1988.
Reference Books
R1. J.C. Russ," The Image Processing Handbook", (5/e), CRC, 2006.
R2. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", 2nd Edition, Thomson, 2007.2010.
R3. S. Sridhar, Digital Image Processing', Oxford University Press, Second Edition, 2012.
R4. Sanjit Mitra, Digital Signal Processing: A Computer Based Approach', TataMcGraw Hill, 3rd Edition.

Course Code: CSP356
Course Title: DIGITAL IMAGE PROCESSING LAB
Structure (L-T-P): 0-0-2-1
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, students are expected to: Work on gray scale and color images for image enhancement, restoration and segmentation.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Understand the representation, manipulation, and use of histograms in digital images.
CO2. Able to apply the various transforms on the image to convert it into frequency domain.
CO3. Able to utilize and compare various linear and nonlinear filters in spatial and frequency domain.
CO4. Understand the basics of working with color images.
CO5. Understand the various segmentation techniques.
Desirable/Advanced (If any): NIL
Experiments for Essential Course Outcomes
1. Implementation of pixel wise transformation of given image using image negative, logarithmic transformation and gray level slicing.
2. Display the bit planes of an image.
3. Use of histogram equalization for contrast enhancement of a given image.
4. Apply low pass filters for Image smoothing.
5. Apply High pass filters for Image sharpening.
6. Conversion of image from spatial domain to frequency domain by applying the Discrete Cosine Transform (DCT).
7. Implementation of image smoothing using low pass frequency domain filters.
8. Implementation of image smoothing using high pass frequency domain filters.
9. Apply the image morphological operations on binary and gray scale images.

10. Apply the edge detection techniques like canny edge detection on the given image.
11. Conversion of image from one color space to another.
12. Histogram equalization of color image.
13. Noise removal from gray scale and color images.
Experiments for Desired Course Outcomes (If any): NIL
Text Books
T1. Lab Manual
T2. Digital Image Processing using Matlab, Rafeal C.Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson Education.
T3. Digital Image Processing, Rafeal C.Gonzalez, Richard E.Woods, Second Edition, Pearson Education/PHI.
Reference Books
R1. Image Processing, Analysis, and Machine Vision, Milan Sonka, Vaclav Hlavac and Roger Boyle, Second Edition, Thomson Learning.
R2. A. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1st Edition, 1988.
R3. S. Sridhar, Digital Image Processing', Oxford University Press, Second Edition, 2012.
R4. A. Anand Kumar, Digital Signal Processing', PHI Learning Pvt. Ltd. 2013.

Course Code: CSL357
Course Title: WEB TECHNOLOGIES
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, students are expected to: Implement a website or portal with optimal selection of component technologies for both, frontends and backends.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To understand the web fundamentals
CO2: To understand web services and technologies
CO3: To understand various tools for components and functionalities in websites
CO4: To optimize the basic functionality and diversify the application domain
Desirable outcome (if any)
Syllabus for Essential Course Outcomes
Planning and designing a website, maintaining view state, connecting and hosting database, choosing a web server for hosting, domain name registration, configuration and optimization settings, promotion and maintenance of website Uniform Resource Locators (URLs) & Web Browser, Semantic Web applications and services, Semantic Search, e-learning, Semantic Bioinformatics, Knowledge Base, XML Based Web Services, Creating an OWL-S Ontology for Web Services, Semantic Search Technology, Web Search Agents and Semantic Method, Web technologies: Terminology & Applications; Active X Components, XML, Chat applets, Ajax, Servlet, Java Beans, J2ME, SQL, Ftp Android: Ice cream Sandwich, Jellybean Peer to Peer and Cloud Network, Social Network Analysis, development of the social networks analysis, Electronic Sources for Network Analysis – Electronic Discussion networks, Blogs and Online Communities, Web Based Networks. Building Semantic Web Applications with social network features.
Text Books:
T1.J .Davies, R.Studer, P.Warren. Semantic Web Technologies, Trends and Research in Ontology Based Systems, John Wiley & Sons, 2006.
T2. Liyang Yu. Introduction to Semantic Web and Semantic Web Services, CRC Press, 2007.
Reference Books:
R1. Heiner Stuckenschmidt, Frank Van Harmelen. Information Sharing on the semantic Web, Springer Publications, 2005.
R2.T. Segaran, C.Evans, J.Taylor. Programming the Semantic Web, O"Reilly, 2009.

Course Code: CSL358
Course Title: INFORMATION RETRIEVAL
Structure (L-T-P): 3-0-0-3
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course:
Students will be able to use the data structures like inverted indices to develop the IR system. Learn techniques for compression of index, dictionary and its posting. Will be able to analyze the performance of IR systems.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Students will know the fundamentals of Information Retrieval.
CO2. Understand and be able to use the data structures, such as inverted indices, used in information retrieval systems.
CO3. Understand the various methods for compressing an index, dictionary and its posting lists.
CO4. Learn how to compute scores in a complete search system and measure the effectiveness of the IR systems.
CO5. Learn the probabilistic model, language model and various machine learning approaches in Information retrieval systems.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Boolean retrieval, the term vocabulary and postings lists, Dictionaries and tolerant retrieval, Introduction to index-construction and index-compression. Scoring, term weighting and the vector space model, Computing scores in a complete search system, Evaluation in information retrieval, Introduction to Relevance feedback and query expansion. Probabilistic information retrieval, review of basic probability theory, the probability ranking principle, the binary independence model, Language models for information retrieval, Language modeling versus other approaches to IR, Text classification and Naive Bayes, Bayesian Network approaches to IR. Vector space classification, Support vector machines and machine learning on documents, Flat clustering, Hierarchical clustering, Matrix decomposition and latent semantic indexing. Introduction to Web search basics, Web crawling and indexes, Link analysis.
Syllabus for Desired Course Outcomes (If any): NIL
Text Books
T1. Manning, C.D., Raghavan, P. and Schutze, H.,Introduction to Information Retrieval, Cambridge University Press, England, 2012.
T2. Buttcher, S., Clarke, C.L.A. and Gordon V Cormack, Information Retrieval: Implementing and Evaluating Search Engines, MIT Press, 2010.
Reference Books

R1. Grossman, D.A. and Ophir, F.,Information Retrieval: Algorithms and Heuristics, Springer, 2013.
R2. Frakes, W.B., Pearson, Information Retrieval: Data Structures and Algorithms, Prentice Hall, 2002.
R3. Soumen Chakrabarti, Mining the Web, Morgan-Kaufmann Publishers, 2002
R4. Bing Liu, Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, Springer, Corr. 2nd printing edition, 2009

Course Code: CSL359
Course Title: NEURO-FUZZY TECHNIQUES
Structure (L-T-P): 3-0-0-3
Course Prerequisite: NIL
Course Objectives
After completing the above course, student is expected to:
The main objective of this course is to provide the student with the basic understanding of neural networks and fuzzy logic fundamentals.
Course Outcomes
At the end of the course, students will be able to-
Essential
CO1. Identify different neural network architectures, their limitations and appropriate learning rules for each of the architectures.
CO2. Demonstrate knowledge and understanding of fuzzy systems as they apply in engineering and science.
CO3. Identify and Apply Artificial Neural Network & Fuzzy Logic models in building intelligent machines to handle uncertainty and solve engineering problems.
CO4. Integrate neural network and fuzzy logic to extend the capabilities for efficient and effective problem solving methodologies.
Desirable Outcomes (if any): NIL
Syllabus for Essential Course Outcomes
Neural Networks: History, overview of biological Neural-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks. Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Application of Fuzzy Logic: Medicine, Economics etc. Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks Genetic Algorithm: An Overview of GA, GA operators, GA in problem solving, Implementation of GA.
Syllabus for Desirable Course Outcomes
Text Books:

T1. Haykin, S.S., Neural Networks and Learning Machines, 3rd ed., PHI Learning, 2013.
T2. Ross, T.J., Fuzzy Logic with Engineering Applications, 3rd ed., John Wiley & Sons, 2013.
Reference Books:
R1. Aliev, R.A. and Aliev, R.R., Soft Computing and its Applications, World Scientific, 2001.
R2. Kosko, B., Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence, Prentice-Hall of India, 1994.
R3. Yegnanarayana, B., Artificial Neural Networks, Prentice Hall of India, 2006.

R4. Jang, J-S.R., Sun, C-T. and Mizutani, E., Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, PHI Learning, 2010.
R5. Hertz, J.A., Krogh, A. and Palmer, R.G., Introduction to the Theory of Neural Computation, Addison Wesley, 1999.Mehrotra, K., Mohan, C. K. and Ranka, S., Elements of Artificial Neural Networks, Penram International Publishing,1997.

Course Code: CSL451
Course Title: REAL-TIME SYSTEMS
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives
The objective of the course is to provide the student with the basic understanding of Real-Time Systems and various Job Scheduling fundamentals.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Identify different types of real-time systems, timing constraints, and reference models of real-time systems.
CO2. Demonstrate knowledge and understanding of precedence constraints & dependencies, scheduling Hierarchy, various scheduling approaches, and Optimality of EDF and LST.
CO3. Identify and Apply various real-time scheduling approaches in building various kinds of real-time systems to handle uncertainty and solve engineering problems.
CO4. Demonstrate knowledge and understanding of multiprocessor scheduling including job priority scheduling.
Desirable outcome (if any)
Syllabus for Essential Course Outcomes
Real time applications: Hard and soft real time systems, timing constraints, A Reference model of Real-time systems, temporal parameters, precedence constraints & dependencies, scheduling Hierarchy, Commonly used approaches to scheduling, cyclic and priority drive approaches, Optimality of EDF and LST. Clock Driven Scheduling: Static timer driven scheduler, Cyclic Executives, Improving Average Response times of Aperiodic Jobs, Scheduling Sporadic jobs, Practical Considerations, Pros and Cons of Clock Driven Scheduling Priority-driven scheduling of periodic tasks: Fixed Priority vs Dynamic Priority schemes, Maximum schedulable Utilization, Optimality of the RM and DM algorithms, As Schedulable Test for Fixed Priority Tasks, Practical Factors. Scheduling Aperiodic and Sporadic Jobs in Priority-driven scheduling: Deferrable Servers, Sporadic Servers, Constant Utilization. Total Bandwidth, and Weighted Fair-Queuing Servers, multiprocessor scheduling, Scheduling of Sporadic Jobs.
Text Book:
T1. Liu, J.W.S., Real-Time Systems, Pearson Education, 2013.
Reference Book:
R1. Krishna, C.M. and Shin, K.G., Real Time Systems, 3rd ed.,Tata McGraw Hill, 2010

Course Code: CSL452
Course Title: CLOUD COMPUTING
Structure (L-T-P): 3-0-0-3
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:
Understand the benefits of migrations to Cloud Service Providers
Able to make informed decisions with reference to Cloud Computing adoption
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To be able understand basics of virtualization, Services and Deployment Models
CO2: To be able to understand Cloud Enabling Technologies such as Map Reduce, Hadoop etc.
CO3: To be able to analyze the small and large industry's perspective and their cloud requirement
CO4: To be able to propose industry grade solutions for small and large industries using available cloud standards such as MongoDB, AWS, Azure etc.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Contents: Overview of Computing Paradigm- Recent trends in Computing: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud computing; Evolution of cloud computing Business driver for adopting cloud computing Cloud Computing Architecture- Cloud computing stack: Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services; Service Models (XaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Deployment Models: Public cloud, Private cloud, Hybrid cloud, Community cloud Service Management in Cloud Computing: Service Level Agreements (SLAs), Billing and Accounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling: Benefitting Enormously, Managing Data: Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing. Cloud Security- Infrastructure Security, Network level security, Host level security, Application level security, Data security and Storage, Data privacy and security Issues, Jurisdictional issues raised by Data location, Identity & Access Management, Access Control, Trust, Reputation, Risk Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations Introduction to Big Data-Distributed file system–Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce. Introduction to Hadoop and Hadoop Architecture: Data – Apache Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce -Data Serialization NoSQL-What is it?, SQL vs NoSQL, NewSQL Data Base for the Modern Web- Introduction to MongoDB key features, Core Server tools, MongoDB through the JavaScript's Shell, Creating and Querying through Indexes, DocumentOriented, principles of schema design, Constructing queries on Databases, collections and Documents , MongoDB Query Language.
Contents for Desired Course Outcomes (If any)
Text Books
T1: Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010 2.
T2: Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley, 2011
T3: Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012
T4: Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India, 2010
Reference Book:
R1: Boris lublinsky, Kevin t. Smith, AlexeyYakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.
R2: Chris Eaton,Dirk derooset al. , "Understanding Big data ", McGraw Hill, 2012.
R3: BIG Data and Analytics , Sima Acharya, Subhashini Chhellappan, Willey

Course Code: CSL454
Course Title: MACHINE LEARNING
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives
After completing the above course, student is expected to:
To understand the basic theory underlying machine learning.
To be able to formulate machine learning problems corresponding to different applications.
To understand a range of machine learning algorithms along with their strengths and weaknesses.
To be able to apply machine learning algorithms to solve problems of moderate complexity.
To apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To familiarize with the mathematical and statistical techniques used in machine learning.
CO2: Understand the fundamental concepts of supervised learning algorithms and analyze the different supervised learning algorithms.
CO3: Understand the fundamental concepts of unsupervised learning algorithms and analyze the different unsupervised learning algorithms.
CO4: Understand and apply the different performance metrics on supervised and unsupervised learning algorithms.
CO5: Design the learning algorithm models to real world problems, optimize the models and evaluate the models using different performance metrics.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Introduction: Mathematics, Applications, Current technologies, platforms used in ML. Supervised learning: Introduction, Nearest Neighbor, Naive Bayes, Decision Trees, Random Forest, Rule-based classification, Support Vector Machine (SVM), Artificial Neural Network, Bagging, Boosting, Improving classification algorithms, Performance metrics for supervised classification. Unsupervised learning: Introduction, Centroid-based Clustering, Density-based clustering, Distribution-based Clustering, Hierarchical clustering, Connectivity based clustering, Performance metrics for unsupervised classification. Regression: Introduction, Linear regression, Multiple regression, Polynomial regression,

Logistics regression, Performance metrics for regression. Reinforcement learning: Introduction, Applications, Markov decision process, Q-learning, SARSA, DQN.

Text Books:

T1. Ethem Alpaydin, Introduction to Machine Learning, Second Edition, PHI, 2010 2. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.

T2. Tom.M.Mitchell, Machine Learning, McGraw Hill International Edition.

Additional Book:

R1. C. M. Bishop. *Pattern Recognition and Machine Learning.* 2nd Edition. Springer, 2015.

R2. Miroslav Kubat, An Introduction to Machine Learning, 2nd ed., Springer, 2017

Course Code: CSL453
Course Title: PUBLIC KEY INFRASTRUCTURE AND TRUST MANAGEMENT
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Prerequisite: CSL354
Course Objectives

The objective of the course is to provide fundamental knowledge about the role of PKI in secure digital communication.

Course Outcomes

At the end of the course, students will be able to-

CO1: Understand the working constraints of public key cryptosystems and their limitations.

CO2: Distinguish between public key technology and a public key infrastructure.

CO3: Understand the relationship of identity management to PKI.

CO4: Understand the different components of a public key infrastructure and their usage.

CO5: Understand the issues related to Trust management mechanisms.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction to the need of PKI, overview of asymmetric key cryptography like RSA cryptosystem, RABIN Cryptosystem ElGamal Cryptosystem and their weaknesses, message Integrity & Authentication; Random Oracle model, message authentication, Cryptographic hash functions; MD hash families, Whirlpool, SHA-512.

Digital Signature; Process and services, attacks on digital signatures, Digital Signature Schemes; Digital certificates and PKIs; Different PKIs: PGP (Pretty Good Privacy): Web of trust, applications; X.509: X.500, Certification Authority (CA), Registration Authority (RA), Root-CA, X.509 Protocols, Simple PKI (SPKI)

Entity Authentication; Passwords and Challenge Response, zero-knowledge and biometrics, Key management; security key distribution, Kerberos, Symmetric Key agreement, Public Key Distribution and Hi-jacking, Issues of revocation, Anonymity and Privacy Smart Card integration with PKIs, Trust management systems, Email Security, PGP and S-MIME, Cloud security through PKI, Application in e-commerce, e-business, e-payment, e-health and mobile applications.

Syllabus for Desirable Course Outcomes (if any)

Text Book:

T1. Cryptography and Network Security by Behrouz Forouzan and D. Mukhopadhyay

T2. Public Key Infrastructure Overview by Joel Weise, Sun BluePrints

Reference Book:

R1. Stallings, W., Cryptography and Network Security: Principles and Practice, 7th ed., Pearson, 2017.

Course Code: CSP454
Course Title: MACHINE LEARNING LAB
Structure (L-T-P): 0-0-2
Course Prerequisite NIL
Course Objectives

After completing the above course, student is expected to:

Understand the basic concepts, mathematics, and applications of machine learning.

Develop and implement machine learning algorithms for real-world problems.

Gain proficiency in Python programming language and its application in machine learning.

Learn about data preprocessing, feature engineering, and model selection techniques.

Evaluate and optimize machine learning models for better accuracy and efficiency.

Understand the ethical considerations and limitations of machine learning.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: Develop and implement machine learning algorithms such as Nearest Neighbor, Naive Bayes, Decision Trees, Random Forest, Rule-based classification, Support Vector Machine (SVM), Artificial Neural Network

CO2: Apply regression techniques such as Linear regression, Multiple regression, Polynomial regression, and Logistics regression.

CO3: Understand and implement reinforcement learning algorithms such as Q-learning, SARSA, and DQN.

CO4: Apply data preprocessing, feature engineering, and model selection techniques to improve model performance.

CO5: Evaluate and optimize machine learning models.

Desirable/Advanced (If any):

CO6. Apply machine learning models in real-time applications.

Experiments for Essential Course Outcomes

1. Implement supervised learning algorithms such as Nearest Neighbor, Naive Bayes, Decision Trees, Random Forest, Rule-based classification, Support Vector Machine (SVM),
2. Implement a single layer perceptron learning rule.
3. Implement a multilayer neural network.
4. Implement Centroid-based Clustering algorithms.
5. Implement Distribution-based Clustering algorithms
6. Implement Hierarchical clustering algorithms
7. Write a program to implement Linear regression.
8. Write a program to implement Multiple regression.
9. Write a program to implement Polynomial regression.
10. Write a program to implement Logistics regression.
11. Implement Reinforcement learning algorithms such as Q-learning, SARSA, and DQN.
12. Write a program to check the performance of the model using evaluation metrics.
13. Group project: designing, implementing, and presenting a machine learning application.

Experiments for Desired Course Outcomes (If any) NIL

Books/Material

T1. Ethem Alpaydin, Introduction to Machine Learning, Second Edition, PHI, 2010 2. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.

T2. Tom.M.Mitchell, Machine Learning, McGraw Hill International Edition.

Reference Books

R1. C. M. Bishop. *Pattern Recognition and Machine Learning.* 2nd Edition. Springer, 2015.

R2. Miroslav Kubat, An Introduction to Machine Learning, 2nd ed., Springer, 2017

Course Code: CSL455
Course Title: PARALLEL AND DISTRIBUTED COMPUTING Structure (L-T-P): 3-0-0
Course Prerequisite NIL
Course Objectives:

Parallel and Distributed Computing course aims at the following educational objectives:

To become familiar with the Distributed and Centralized computing concepts.

To understand the fundamental principles of GPU architecture, and Memory Hierarchies.

To understand the concepts and application of Message Passing Interface (MPI), Multithreaded Programming,.

TO understand the basic concepts of parallel task, process centric, and shared/distributed memory.

To understand the working/programming of distributed and parallel application tools.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: Describe the terminology of Asynchronous/synchronous computation/communication.

CO2: Compare the working of GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies.

CO3: Solve and analyze the concepts of Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, and parallel I/O.

CO4: Analyze the basic concepts of parallel task, process centric, and shared/distributed memory.

CO5: Design and analyze the concepts of distributed and parallel application tools.

Desirable Outcome (if any)

Syllabus for Essential Course Outcomes

Asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).

Syllabus for Desirable Course Outcomes

Text Books:

T1: Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet (DCC) by Kai Hwang, Jack Dongarra & Geoffrey C. Fox (Required).

T2: Andrew S. Tanenbaum and Maarten van Steen. "Distributed Systems: Principles and Paradigms" (DSPD), Prentice Hall, 2nd Edition, 2007.

Course Code: CSP455
Course Title: LINUX LAB
Structure (L-T-P): 0-0-2
Course Prerequisite NIL
Course Objectives

The objective of the course is to provide the foundations of the practical implementation and usage of enormous capabilities of the Linux Ecosystem.

Course Outcomes:

At the end of the course, students will be able to-

Essential:

CO1: To be able to understand the basics of Linux Programming Basics, administration, directory structure and files handling.

CO2: To be able to exploit I/O, Hardware Interfacing and Networking Capabilities of Linux

CO3: To be able to maintain Databases and Security systems in Linux Ecosystem

CO4: To be able to develop smart surveillance, Microcontroller Interfacing and Chat-bots like advanced applications

Desirable Outcomes (if any): NIL

List of Experiments for Essential Outcomes:

1. Build a Clustering Server with Linux
2. Build Your Own Operating System with Linux
3. Build a Linux Web Server
4. Build GPS Location Tracker
5. Build a Weather Monitoring with Raspberry Pi
6. Build a Wireless Surveillance with Raspberry Pi
7. Build a Cloud Service with Raspberry Pi
8. Build a Surveillance Robot

List of Experiments for Desirable Outcomes (If any): NIL

Books/Material:

T1. Richard Blum, Linux Command Line and Shell Scripting Bible, 3rd edition, Wiley

T2: Jason Cannon, Linux Administration, Independently Published.

Reference Books:

R1: Richard Petersen, Linux: The Complete Reference Independently Published.

R2: W. Stevens Advanced Programming in the UNIX Environment, 3rd Edition, Addison-Wesley.

Course Code: CSL457
Course Title: CONCEPTS IN BLOCKCHAINING
Structure (L-T-P): 3-0-0
Course Prerequisite NIL
Course Prerequisite: NIL
Course Objectives

After completing the above course, students are expected to: To give students the understanding of emerging abstract models for Blockchain Technology and to familiarize with the functional/operational aspects of the cryptocurrency ecosystem. Develop familiarity of current technologies, tools, and implementation strategies of blockchain. Introduce application areas, current practices, and research activity.

Course Outcomes

At the end of the course, students will be able to:

Essential

CO1: Understand the fundamentals of block chain technology: validation, verification, and consensus.

CO2: Understand distributed systems basics and challenges, and different paradigms of distributed computing.

CO3: Knowledge of cryptographic techniques and their applications.

CO4: Ability to analyze blockchain use cases in different domains, and understanding of distributed consensus algorithms and crypto currency protocols and vulnerabilities**.**

Desirable Course outcome (If any): NIL

Syllabus for Essential Course Outcomes

Contents: Basics: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. Cryptography: Hash functions, Digital Signature ECDSA, Memory Hard Algorithm, Zero Knowledge Proof. Blockchain: Introduction, History, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain. Distributed Consensus: Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate. Cryptocurrency: History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin. Cryptocurrency Regulation: Stakeholders, Roots of Bitcoin, Legal Aspects – Cryptocurrency Exchange, Black Market and Global Economy Blockchain Applications: Internet of Things, Medical Record Management System, Smart contracts, future of Blockchain etc. The use cases from different application domains.

Text Books:

T1: Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press, 2016.

T2: Roger Wattenhofer, The Science of the Blockchain, 2016.

Reference Books:

R1: Don Tapscott, Alex Tapscott. Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies is Changing the World, 2018.

R2: Melanie Swan. Blockchain: Blueprint for a New Economy, 2015.

Course Code: CSL458

Course Title: CYBER SECURITY AND FORENSIC

Structure (L-T-P): 3-0-0

Course Prerequisite NIL

Course Prerequisite: CSL354-Information and Network Security

Course Objectives

The objective of the course is to contribute to securing corrupted systems, protect personal data, and secure computer networks in an organization. Correctly collect and analyze computer forensic evidence.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Understand the threats in networks and security concepts.

CO2: Apply authentication applications in different networks.

CO3: Understand essential methodology of cyber forensics.

CO4: Correctly define and cite appropriate instances for the application of cyber forensics.

Desirable outcome (if any): NIL

Syllabus for Essential Course Outcomes

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

Introduction to computer and cyber forensics basics like Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues. Types of cybercrime and cyber laws, Understanding Computing Investigations – Procedure for corporate High-Tech investigations, understanding data recovery workstation and software, conducting and investigations. Data and Evidence Recovery, Deleted file recovery, recovery Tools, Forensics Tools. Data acquisition- understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisitions tools. Introduction to IT laws and Cyber Crimes, Security Attacks, Digital Evidence collection, preservation and investigation. Current computer forensics tools-software, hardware tools, Incidence response, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions, E-Mail investigations investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool. Processing crimes and incident scenes, securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case. Methodologies of forensics: Case Studies.

Syllabus for Desirable Course Outcomes

Text Book:

T1: Warren G. Kruse II and Jay G. Heiser, —Computer Forensics: Incident Response Essentialsǁ, Addison Wesley, 2002.

T2: Nelson, B, Phillips, A, Enfinger, F, Stuart, C., —Guide to Computer Forensics and Investigations, 2nd ed., Thomson Course Technology, 2006, ISBN: 0-619-21706-5. **Reference Book:**

R1: Vacca, J, Computer Forensics, Computer Crime Scene Investigation, 2nd Ed, Charles River Media, 2005, ISBN: 1- 58450-389.

R2. Charles P. Fleeger, "Security in Computing", Prentice Hall, New Delhi, 2009.

R3. Stallings William. Cryptography and Network Security, Pearson Education, 7th Edition, 2017.

R4. C. Altheide & H. Carvey Digital Forensics with Open Source Tools, Syngress, 2011. ISBN: 9781597495868.

Course Code: CSL459

Course Title: SYSTEM PROGRAMMING

Structure (L-T-P): 3-0-0
Course Prerequisite NIL
Course Prerequisites: Data Structures
Course Objectives
The objective of the course is to
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1:Able to understand the macros and designing a macro processors
CO2: Able to understand the loaders and linkers as system softwares and their functionalities
CO3:Exposure to popular scripting utilities such as grep, awk with understanding of shell programming
CO4: Able to understand the know how of device drivers
Desirable outcome (if any)
Syllabus for Essential Course Outcomes
Assembler, Macro processor - Concept of assembler, design of single pass and two pass assembler, forward reference, design of output file of assembler, concept of macro, macro call within macro, macro definition within macro, recursive macro calls, design of macro processor.

Linker and Loader - Concept of static and dynamic relocation, external symbols, design of linker, design of object file for different loading schemes.

Common Object file format - Structure of object file and executable file, section or segment headers, symbol table, concept of storage class.

System utilities –Shell programming, make, link editor, symbolic debugger, pattern matching language like awk.

Device Drivers - Incorporation of driver routines, Basic device driver operation, character and block drivers.
Syllabus for Desirable Course Outcomes: NIL
Text Books:

T1: Beck, L.L. and Manjula, D., System Software: An Introduction to Systems Programming, 3rd ed., Pearson Education, 2013.

T2: Gorsline, G.W, Assembly and Assemblers: The Motorola MC68000 Family, Prentice Hall, 1988.
Reference Books:
R1: Dhamdhere, D.M., Systems Programming, Tata McGraw Hill Education, 2011.

R2: Kernighan, B.W. and Pike, R.,The Unix programming Environment, Prentice Hall of India, 1993.
R3: Egan, J.I. and Teixeira, T.J., Writing a UNIXDevice Driver, 2nd ed., John Wiley and Sons, 1992.
R4: Norton, D.A., Writing Windows Device Drivers, Addison Wesley, 1996.

Course Code: CSL460
Course Title: FUNDAMENTAL ALGORITHMS IN COMPUTATIONAL BIOLOGY
Structure (L-T-P): 3-0-0-3
Course Prerequisite NIL
Course Objectives
The course objectives define the student learning outcome for the course:
Students will be able to obtain the information from large biological databases and will be able to apply the computational algorithms on the extracted information for biological analysis.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: Knowledge of sequence alignment and analysis including pairwise sequence alignment , algorithms and tools for pairwise alignment, Multiple Sequence Alignment, its significance, algorithms and tools used for MSA.
CO2: Students will learn about the various techniques, algorithms and tools used for Phylogenetic Analysis.
CO3: Understand the structural organization, structural properties and various techniques employed in the structure determination of Biological macromolecules – DNA, Protein and Carbohydrates. Ability to apply various computational methods and tools used for protein structure prediction and genome analysis.
CO4: Knowledge about the different types of Biological databases.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
DNA and Sequence Alignment – KMP algorithm, BLAST and FASTA, Sorting by Reversals, Biological Databases – formats, downloading and using data, Phylogeny – Distance based algorithms (Hamming /Euclidean distance), Suffix Trees, Prediction of RNA secondary structure, Gene Prediction using Bayesian Methods and Markov Chains/HMMs, Modeling-Based on Cellular Automata, Based on Agent Based Modeling Techniques, Based on Partial Differential Equations, Single Nucleotide Polymorphism and algorithms for their identification, Microarray Data and Clustering – Hierarchical/K-Means, Pathway Data and their analysis, Protein Folding and Docking based on Entropy Calculation.
Syllabus for Desired Course Outcomes (If any): NIL
Text Books
T1. Ellner, S. P. and Guckenheimer, J., Dynamic Models in Biology, New Age International, 2010.
T2. Murray, J. D., Mathematical Biology: An Introduction, 3rd ed.Springer, 2002.
Reference Books
R1. Mandoiu, I.and Zelikovsky, A., Bioinformatics Algorithms: Techniques and Applications. Wiley Series on Bioinformatics: Computational Techniques and Engineering, John Wiley & Sons, 2008.
R2. Introduction to Bioinformatics – T.K. Attwood and Parry Smith.

Course Code: CSL461
Course Title: WIRELESS SENSOR AND ADHOC NETWORKS
Structure (L-T-P): 3-0-0-3
Course Prerequisite: Data Communication
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To understand the working of MAC and Routing Protocols for ad hoc and sensor networks

CO2: To understand the working of Transport Layers in Ad Hoc and Sensor Networks.
CO3: To understand and analyze the QoS for ad hoc and sensor networks.
CO4: To understand various security issues in ad hoc and sensor networks and the corresponding solutions.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Ad Hoc Networks: Issues and challenges in ad hoc networks, MAC Layer Protocols for wireless ad hoc networks, Contention-Based MAC protocols, MAC Protocols Using Directional Antennas, Multiple-Channel MAC Protocols, Power-Aware MAC Protocols, Routing in Ad hoc Networks, Design Issues, Proactive, Reactive and Hybrid Routing Protocols, TCP's challenges and Design Issues in Ad Hoc Networks – Transport protocols for ad hoc networks – Issues and Challenges in providing, MAC Layer QoS solutions, Network Layer QoS solutions, QoS Model.
Sensor Networks: Introduction, Applications, Challenges, Sensor network architecture, MAC Protocols for WSNs, Low duty cycle protocols and wakeup concepts, Contention- Based protocols, Schedule-Based protocols, IEEE 802.15.4 Zigbee, Topology Control , Routing Protocols: Data-Centric and Contention-Based Networking, Transport Layer and QoS in WSNs, Congestion Control in network processing, Operating systems for WSNs, Examples, Security Issues: Key Distribution and Management, Intrusion Detection, Software based Anti-tamper techniques, Watermarking techniques, Defense against routing attacks, Secure Ad hoc routing protocols – Broadcast authentication WSN protocols , TESLA, Biba, Sensor Network Security Protocols, SPINS
Contents for Desired Course Outcomes (If any)
Text Books:
T1. C.Siva Ram Murthy and B.S.Manoj, ―Ad Hoc Wireless Networks – Architectures and 2 Protocols‖, Pearson Education, 2006.
T2. Holger Karl, Andreas Willing, ―Protocols and Architectures for Wireless Sensor Networks‖, John Wiley & Sons, Inc., 2005.
Reference Books:
R1. Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, ―Ad Hoc Mobile Wireless Networks‖, Auerbach Publications, 2008.
R2. Carlos De Morais Cordeiro, Dharma Prakash Agrawal, ―Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition)‖, World Scientific Publishing, 2011.
R3. Waltenegus Dargie, Christian Poellabauer, ―Fundamentals of Wireless Sensor Networks Theory and Practice‖, John Wiley and Sons, 2010
R4. Xiang-Yang Li , "Wireless Ad Hoc and Sensor Networks: Theory and Applications‖, 1227 th edition, Cambridge university Press,2008.

Course Code: CSL462
Course Title: 5G NETWORKS
Structure (L-T-P): 3-0-0-3
Prerequisite: Data Communications
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:
Understand the benefits of 4G, LTE and 5G
Able to make informed decisions with reference to Network Technology Requirements
Course Outcome:
Essential:
CO1: To acquaint with basics of 5G Networks
CO2: To acquaint with basics of Device to Device Communications
CO3: To acquaint with Multiple Access Technologies for 5G
CO4: To acquaint with Types of 5G Networks, Mobility and Handovers in 5G
Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes 5GModeling requirements and scenarios, Channel mode requirements, Propagation scenarios, Relaying multi-hop and cooperative communications: Principles of relaying, fundamentals of relaying, Cognitive radio: Architecture, spectrum sensing, Software Defined Radio (SDR). Multiple-input multiple-output (MIMO) systems, Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems, Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, NFV and SDN, RAN architecture, 5G architecture, Functional architecture and 5G flexibility, Integration of LTE and new air interface to fulfill 5G, Requirements, Enhanced Multi-RAT coordination features, Physical architecture and 5G deployment. Device-to-device (D2D) communications, Device to Device: from 4G to 5G, D2D standardization, Radio resource management for mobile, broadband D2D, RRM techniques for mobile broadband D2D, RRM and system design for D2D, 5G D2D, 5G radio-access technologies, design principles for multi-user communications, Orthogonal multiple-access systems, Spread spectrum multiple access systems, Capacity limits of multiple-access methods, Sparse code multiple access (SCMA), Interleave division multiple access (IDMA), Radio access for dense deployments, non-orthogonal multiple access (NOMA), OFDM numerology for small-cell deployments, Small-cell sub-frame structure, Radio access for V2X communication, Medium access control for nodes on the move, Radio access for massive machine type communication. Interference, mobility and security management in 5G Network
Contents for Desired Course Outcomes (If any)
Text Books
T1. Osseiran, A., Monserrat, J.F. and Marsch, P. eds., 2016. 5G mobile and wireless communications technology. Cambridge University Press.
T2. Dahlman, E., Parkvall, S. and Skold, J., 2020. 5G NR: The next generation wireless access technology. Academic Press.
Reference Books
R1. Rodriguez, J., 2015. Fundamentals of 5G mobile networks. John Wiley & Sons.
R2. Hu, F. ed., 2016. Opportunities in 5G networks: A research and development perspective. CRC press.
R3. Chen, W., Gaal, P., Montojo, J. and Zisimopoulos, H., 2021. Fundamentals of 5G Communications: Connectivity for enhanced mobile broadband and beyond. McGraw-Hill Education.
R4. Wong, V.W., Schober, R., Ng, D.W.K. and Wang, L.C. eds., 2017. Key technologies for 5G wireless systems. Cambridge university press.

Course Code: CSL463
Course Title: GEO INFORMATICS
Structure (L-T-P): 3-0-0-3

Prerequisite: Data Communications

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, students are expected to: Understand the Important Geographical Aspects that need IT support for easy availability and support Geotagging, Navigation. Able to make informed decisions with reference to Geographical Concepts in Applications.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: To introduce use of computer in mapping, GIS, components, data structure, modeling, DBMS

CO2: To learn about encoding methods and editing of data

CO3: To know various capabilities of GIS

CO4: To study about various models of GIS

CO5: To understand working GIS and SDSS

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Basic Concepts about spatial information, Philosophy and definition of GIS, features, pictures, variables: points, lines, areas, Position on the earth; Basics of map. Fundamentals of Data Storage, Information Organization and Data Structure Basic File Structures; Tabular Databases; Advantages of Databases, Types of Databases- hierarchical systems, network systems, relational systems and Object-oriented database systems (OODS), Data Models-Entity Relationship model, Relational Model, Data Structures; Raster Structures, Vector Structures, GIS Data Requirement, sources and collection, Methods of data capture-scanning, digitization and associated errors, Conversion from Other Digital Sources, Attribute data input and management, Edge matching, creating digital data -remote sensing; generating data from existing data ; Metadata ;Different Kinds of geospatial data, Detecting and Evaluating Errors, Data Quality Measurement and Assessment, digital output options.Image storage formats, Data retrieval, Data compression, NSDI,GSDI; geographic information in decision making; human resources and education; Interactive data exploration, Vector & Raster data query, Geographic visualization; Raster data and structure, Local operations, Neighborhood operations, Zonal operations, Distance measure operations, Spatial auto correlations, DEM generation, Spatial Modeling, combining data; terrain mapping finding and quantifying relationships; spatial interpolation; Vector database, Topological Relationships; Creation of Topology and Error Correction; Accuracy and Precision; The Importance of Error, Accuracy, and Precision, types of error, sources of error, data quality, Spatial interpolation, Overlay Operations and Buffering, Neighborhood functions Distant Measurement , Map Manipulation, Network analyses, GIS and Remote Sensing data Integration, Thematic Mapping , GIS and Integration of other types of data, Virtual GIS and SDSS, Project design and management, need assessment

Text Books:

T1. Kang-tsung Chang 2002,'Introduction to Geographic Information Systems' Tata McGraw Hill, New Delhi.

T2. C.P.Lo and Albert K.W.Yeung 2005 "Concepts and Techniques of Geographic Information Systems" **Prentice Hall of India,New Delhi.**

Reference Books:

R1. Burrough, Peter A. and Rachael McDonnell,1998, ' Principles of Geographical Information Systems' Oxford University Press, New York.

R2. Magwire, D. J., Goodchild, M.F. and Rhind, D. M. Ed. 1991,'Geographical Information Systems: Principles and Applications, Longman Group, U.K.

Course Code: CSL464

Course Title: MULTIMEDIA TECHNOLOGY AND VIRTUAL REALITY

Structure (L-T-P): 3-0-0

Course Prerequisite: NIL

Course Objectives

After completing the above course, students are expected to: Work in virtual reality and augmented reality domain with basic knowledge of multimedia technologies.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: To give each student a firm grounding in the fundamentals of the underpinning technologies in graphics, distributed systems and multimedia

CO2: To teach students about the principled design of effective media for entertainment, communication, training and education

CO3: To provide each student with experience in the generation of animations, virtual environments and multimedia applications, allowing the expression of creativity

CO4: To provide each student with a portfolio of their own completed work at the end of the programme

Desirable outcome (if any)

Syllabus for Essential Course Outcomes

Concept of Non- Temporal and Temporal Media, Hypertext and Hypermedia, Presentations, Synchronization, Events, Scripts and Interactivity, Authoring Systems, Compression, Video Compression: MPEG- 1&2 Compression Schemes, MPEG-4 Natural Video Compression. Audio Compression: Introduction to Speech and Audio Compression, Video Compression, Introduction to Multimedia PC/Workstation Architecture, Characteristics of MMX instruction set, I/O systems, Operating System Support for Multimedia Dat, Multimedia Database Design, Content Based Information Retrieval, MPEG-7, Video-on-Demand Systems, Virtual Reality and Virtual Reality Systems, Teleoperation and Augmented Reality, Interface to the Virtual World, Interface to the Virtual World, haptic and force feedback, VRML Programming

Syllabus for Desirable Course Outcomes (if any)

Text Books:

T1: Ralf Steinmetz and Klara Nahrstedt , Multimedia: Computing, Communications & Applications , Pearson Ed.

T2: Nalin K. Sharda , Multimedia Information System , PHI.

Reference Books:

R1. Fred Halsall , Multimedia Communications , Pearson Ed.

R2 Koegel Buford , Multimedia Systems , Pearson Ed.

R3: Fred Hoffstetter , Multimedia Literacy , McGraw Hill.

R4. Ralf Steinmetz and Klara Nahrstedt , Multimedia Fundamentals: Vol. 1- Media Coding and Content Processing, PHI

Course Code: CSL525

Course Title: STATISTICAL MODELS FOR COMPUTER SCIENCE
Structure (L-T-P): 3-0-0
Course Prerequisites: NIL
Course Objectives
The objective of the course is to introduce the students with fundamental concepts of probability, statistics, probability distributions, stochastic processes and Markov models. These fundamental concepts help the student to understand how the real-world processes can be modeled with the help of concepts discussed in this course. In addition, several examples from the computer science domain such as reliability, computer networks, and statistical pattern recognition have also been included.
Course Outcomes:
At the end of the course, students will be able to
Essential:
CO1. Understand the fundamentals of probability and random variables
CO2. Explain various discrete and continuous probability distributions
CO3. Illustrate expectation, moments and different types of stochastic processes
CO4. Apply Markov models for problem solving
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Probability, Random Variables: Random variables, and their event spaces, Probability mass function, Distribution functions, Discrete distributions, Probability Generating Function, Discrete random vectors, Continuous random variables, Functions of random variables, jointly distributed random variables. Expectation: Introduction, Moments, Expectation of functions of more than one random variable, Brief introduction to Conditional pmf, pdf and expectation, Moments and transforms of some distributions (Uniform, Bernoulli, Binomial, Geometric, Poisson, Exponential, Gamma, Normal), Computation of mean time to failure. Stochastic Processes: Classification of stochastic processes, The Bernoulli process, The Poisson process, renewal process, renewal model of program behavior. Markov Chains: Computation of n-step transition probabilities, State classification and limiting distributions, Distribution of times between state changes, Irreducible finite chains with aperiodic states, M/G/1 queuing system, Discrete parameter Birth-Death processes, Analysis of program execution time. Continuous parameter Markov Chains, Birth-Death process with special cases, Non-Birth-Death Processes.
Contents for Desired Course Outcomes (If any)
Text Books

T1. Trivedi, Kishor S. Probability, Statistics with Reliability, Queuing and Computer science Applications. Wiley-India, 2008.
T2. Feller, W. An Introduction to Probability Theory and its applications, 2 vols., Wiley Eastern, 1975

Reference Books

R1. Ross, Sheldon M. Introduction to Probability Models. 11th ed. Academic Press Inc., 2014.
R2. Kleinrock, L. Queuing Systems, 2 vols, John Wiley, 1976.

Course Code: CSL524
Course Title: OPERATION RESEARCH
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives
Students should be able to exploit optimizations in unconstrained and constrained contexts. He should be able to apply game theory and queuing theory for problems in AI.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To be able to understand LP paradigm and applications of Solution approaches to LP problem
CO2: To be able to understand Network Models and solve basic network problems
CO3: To be able to understand pure and mixed Integer Problems
CO4: To be able to understand Queuing Theory and Game Theory
Desirable/Advanced (If any):
Syllabus for Essential Course Outcomes
Linear Programming Problems (LPP): Basic LPP and Applications; Components of LP Problem Formulation, Simplex Duality Theory; Duality in linear programming, Charnes Big – M Method. Network Models: Shortest Path Problems, Maximum Flow Problems, CPM and PERT, Minimum Cost Network Flow Problems, Minimum Spanning Tree Problems, local and global optima. Integer Programming: Formulating Integer Programming Problems, Branch-and-Bound Method: Solving Pure and mixed Integer Programming Problems and Knapsack problems, unconstrained optimization techniques, constrained optimization. Queuing Network Models: Poisson distributions, wait time, server utilization, SRPT, Pure Birth and Death Models; M/M/1 queue, ∞ /FIFO, N/ FIFO. Game Theory: 2- person Zero – sum Game; Saddle Point; Mini-Max and Maxi-Min Theorems, Inventory Control: EOQ Models ; Deterministic and probabilistic Models; Optimization and Performance in Web Computing, Internet Application, Curse of dimensionality.
Contents for Desired Course Outcomes (If any): NIL
Text Books

T1: Taha, H.A. Operations Research, 5th ed., Macmillan Publishing Company, 1992.
T2: Kanth, K. Introduction to Computer System Performance Evaluation, McGraw Hill, 1992

Reference Books

R1: Mustafi, C. K. Operations Research, 4th ed., New Age International, 2009
R2: Hadley G. Linear Programming, Narosa Publishers, 1997
R3: Hillier F. and G. J. Liebermann. Operations Research, Holder Day Inc, 1974.
R4: Mohapatra, P.K.J. Introduction to System Dynamics Modelling, 1st ed., Universities Press, 1994.
R5: Schaum Outline Series. Operations Research, 2nd ed., Tata McGraw Hill, 2003.
R6: Smith, David K. Network Optimization in Practice. Ellis Harwood Publications, 1982.

Course Code: CSL527
Course Title: DATA MINING
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives
After completing the above course, students are expected to: understand the fundamental data mining concepts and techniques for discovering interesting patterns from data in various applications.

Emphasizes techniques for developing effective, efficient, and scalable data mining tools.

Course O**utcomes**

At the end of the course, students will be able to:

Essential:

CO1. Understanding of the basic concepts and techniques of data mining and knowledge discovery in databases.

CO2. Ability to perform data pre-processing, cleaning, integration, transformation, and reduction as part of the data mining process.

CO3. Familiarity with various data mining tasks and algorithms, such as association rule mining, classification, and clustering, and ability to apply them to real-world problems in different domains.

CO4. Proficiency in data analysis and visualization, and use of appropriate data mining tools for scientific and real-time applications.

CO5. Exposure to advanced concepts in data mining, such as sequential pattern mining, mining text and web data, graph mining, spatiotemporal and trajectory pattern mining, and multivariate time series mining.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Data Mining: Introduction, Data analysis like Data visualization, probability, histograms, multinomial distributions. Data Mining and Knowledge Discovery in Databases, Data Mining Functionalities, Data Pre-processing, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization and Concept Hierarchy Generation. Overview of data mining, data mining tasks, data mining tools. Processing and visualizing data: Data types, Data quality, Data pre-processing, Measures of similarity, Visualization. Association Rule Mining: Frequent itemset generation algorithms, Rule generation algorithms, Compact representation, Evaluation measures. Algorithms: Introduction to Supervised and unsupervised classification. Advanced Concepts: Introduction, Sequential Pattern Mining, Mining Text and Web data, Graph mining, Mining Spatiotemporal and Trajectory Patterns, Multivariate Time Series (MVTS) Mining, Complex data mining. Applications: Healthcare, Fraud detection, Intrusion detection, Market basket analysis, Banking and Finance.

Desired Course Outcomes (If any): NIL

Text Book:

T1. Jiawei Han, Micheline Kamber, Jian Pei. Data Mining: Concepts and Techniques, 3rd Edition, MK publisher, 2011.

T2. Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar. Introduction to Data Mining, 2nd ed., Pearson Education, 2021.

Reference Books:

R1: Ian H., Eibe Frank, Mark A. Hall. Data Mining: Practical Machine Learning Tools and Techniques, 3rd Edition, MK publisher, 2011.

Course Code: CSL529
Course Title: DATA ANALYTICS
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL

Course Objectives: After completing the above course, students are expected to: Apply the concepts of Descriptive and Inferential statistics to data obtained. Also, able to understand and exploit supervises, unsupervised and reinforcement learnings.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Understand the basic concepts of the Statistics

CO2. Understand Classification, Clustering and Regression

CO3. Understand the applications data science concepts in Big Data

CO4. Able to perform data analytics using models in Machine Learning

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Descriptive and Inferential Statistics: Introduction, Descriptive Statistics, Probability Distributions, Inferential Statistics through hypothesis tests, Permutation & Randomization Test Regression & ANOVA: Regression, ANOVA (Analysis of Variance) Machine Learning: Introduction and Concepts, Differentiating algorithmic and model based frameworks Regression: Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbors Regression & Classification Supervised Learning with Regression and Classification techniques -1: Bias-Variance Dichotomy Model Validation Approaches, Logistic Regression, Linear Discriminant Analysis, Quadratic Discriminant Analysis, Regression and Classification Trees, Support Vector Machines, Ensemble Methods: Random Forest, Neural Networks, Deep learning Unsupervised Learning and Challenges for Big Data Analytics: Clustering Associative Rule Mining, Challenges for big data analytics Prescriptive analytics: Creating data for analytics through designed experiments, Creating data for analytics through Active learning, Creating data for analytics through Reinforcement learning.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. New York: springer, 2009.

T2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010.

Reference Books

R1: Storytelling with Data: A Data Visualization Guide for Business Professionals by Cole Nussbaumer Knaflic

R2: Python for Everybody: Exploring Data in Python by Dr. Charles Russell Severance

Course Code: CSL531
Course Title: INTERNET OF THINGS
Structure (L-T-P): 3-0-0
Course Prerequisite: Computer Networks CSL255

Course Objectives

The course Internet of Things (IoT) aims at the following educational objectives:

To become familiar with the IoT architecture. To understand the fundamental principles of various kinds of IoT platforms, like IoT in Health, IoT in Agriculture, IoT in E-Commerce, IoT in Smart Cities, IoE, IIoT, etc.To understand various protocols used in data link layer and network layer of IoT.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Describe the terminology of architecture of IoT reference model.

CO2. Compare the working of protocols used for M2M communication, business process in IoT, and IoE.

CO3. Solve and analyze the data link layer, network layer, transport layer and application layer protocols.

CO4. Analyze the basic concepts of IoT used for real world design constraints.
CO5. Analyze and Design protocols used in data link layer and networks layer of IoT model.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
IoT-An Architectural Overview– building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics.
IoT Reference Model - IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.
Data Link Layer & Network Layer Protocols: PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), WirelessHART, Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP.
Upper Layer Protocols: Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS), Session Layer: HTTP, CoAP, XMPP, AMQP, MQTT, M2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4, 6LoWPAN, RPL, Application Layer.
Contents for Desired Course Outcomes (If any): NIL
Text Book:
T1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
T2. Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI
Reference Books
R1. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2,Springer.
R2. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications.
R3. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands- onApproach)", 1st Edition, VPT, 2014.
R4. Waltenegus Dargie, Christian Poellabauer , "Fundamentals of Wireless Sensor Networks, Theory and Practice", Wiley Series on wireless Communication and Mobile Computing, 2011.
R5. Kazem Sohraby, Daniel manoli , "Wireless Sensor networks Technology, Protocols and Applications", Wiley InterScience Publications 2010.
R6. Bhaskar Krishnamachari " Networking Wireless Sensors", Cambridge University Press, 2005.
R7. C.S Raghavendra, Krishna M.Sivalingam, Taiebznati , "Wireless Sensor Networks", Springer Science 2004.

Course Code: CSL532
Course Title: ADVANCED COMPUTER NETWORKS
Structure (L-T-P): 3-0-0
Course Prerequisite: Computer Networks
Course Objectives
Advanced Computer Networks course aims at the following educational objectives: To become familiar with the concepts of Computer Networks and MAC layer issues. To understand the fundamental principles of IEEE 802.3, 802.4, and 802.5 Networking protocols To understand the concepts of subnet masking and End to End protocol To understand the basic concepts of Routing, Multicasting, Peer to Peer and overlay Networking protocols.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Describe the terminology of advanced computer networks and concepts of MAC layer issues.
CO2. Compare the working of protocols, network interface and design/performance issues in End to End protocols.
CO3. Solve and analyze the data link layer, network layer, transport layer and application layer protocols.
CO4. Analyze the concepts of Routing, Multicasting protocols.
CO5. Analyze the concept of Peer to Peer and overlay networks.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Review of Networking Concepts, MAC layer issues, Ethernet 802.3, ARP, IP addressing and Subnetting, NAT and PAT, Variable Length Subnet Masking, CIDR, End to End protocols, TCP connection establishment and termination, Sliding window concepts, other issues: wraparound, silly window syndrome, Nagle's algorithm, adaptive retransmission, TCP extensions. Congestion and flow control, Queuing theory, TCP flavors: Tahoe, Reno, New-Reno, TCP-SACK, TCP-RED and TCP-Vegas. Transport protocol for real time (RTP), Integrated Services, Differentiated services, Routing and Multicast, Structure of internet: Autonomous systems, Intra-domain routing: OSPF and RIP, Inter-domain routing: BGP. Multicasting: Group Management (IGMP), Internet scale multicasting: Reverse path broadcast, MOSPF, DVMPRP, PIM, Peer to peer and overlay networks: Concept of overlays, Unstructured Overlays: Gnutella, Concepts of Distributed Hash Table, Structured Overlays: Chord, CAN, Pastry.
Contents for Desired Course Outcomes (If any): NIL
Text Book:
T1. Computer Networks: A Systems Approach, by Peterson and Davie, 5th Ed. Morgan Kauffman, 2011
T2. Computer Networking: Top Down Approach, by Kurose and Ross, 6th Ed. Pearson, 2011
Reference Books
R1: V. Paxson. "End-to-end Internet packet dynamics," in IEEE/ACM Transactions on Networking, Vol 7, No 3, June, 1999.
R2: W. Stevens, "TCP Slow Start, Congestion Avoidance, Fast Retransmit, and Fast Recovery Algorithms," RFC2001
R3: K. Fall and S. Floyd, "Simulation-based comparison of Tahoe, Reno, and SACK TCP," Computer Communication Review, vol. 26, pp. 5--21, July 1996.
R4: L. Brakmo and L. Peterson, "TCP Vegas: End-to-End Congestion Avoidance on a Global Internet," IEEE Journal on Selected Areas in Communications, 13(8), October 1995, 1465--1480.
R5: Stoica, I., Morris, R., Karger, D., Kaashoek, F., Balakrishnan, H.: Chord: A scalable peer-to-peer lookup service for Internet applications.

R6: Rowstron, A., Druschel, P.: Pastry: Scalable, decentralized object location and routing for large-scale peer-to-peer systems.

Course Code: CSL534
Course Title: ADVANCED CRYPTOGRAPHY
Structure (L-T-P): 3-0-0
Course Prerequisite: Cryptography
Course Objectives
After completing the above course, student is expected to:
To make the student learn different cryptology techniques along with hash functions, MAC, digital signatures and their use in various protocols for security domain. To design and develop the security solutions to the formulated problems
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. To understand the mathematical background of the advanced cryptography paradigm.
CO2. Understand and analyze the different symmetric and asymmetric encryption algorithms.
CO3. To understand how to maintain Confidentiality, Integrity, Availability, Authentication, Non-repudiation.
CO4. To understand the basics of advanced topics like secret sharing, steganography, watermarking, attribute and identity based cryptography.
CO5. To design and develop solutions to the formulated problems in the field of cryptography.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Number Theory: Probability and information theory, Provable security, Shannon's theory, Computational complexity. Symmetric key cryptography: Introduction, Classical and Modern ciphers, S-box: Overview, Design principles and security analysis, Asymmetric key cryptography: Introduction, RSA algorithm, Rabin cryptosystem, ElGamal cryptography, Elliptic curve cryptography, Key management: Design principles, Key establishment and Group key establishment protocols, Complexity and Security Analysis, Hash functions: Overview of cryptographic hash functions, Security requirements, Random Oracle Model, Analysis of hash functions, Message Authentication and Digital Signature: Importance, Digital signature schemes, security analysis, Message Authentication Codes (MAC), Other advanced topics: Identity based cryptosystem, Attribute based cryptography, Secure multiparty computation, Visual cryptography, Threshold cryptography, Secret sharing schemes, Steganography, Watermarking.
Contents for Desired Course Outcomes (If any): NIL

Text Book:
T1: Douglas R. Stinson. Cryptography: Theory and Practice, CRC publisher, 4th Edition, 2019.
T2: Behrouz A. Forouzan, Debdeep Mukhopadhyay. Cryptography and Network Security, McGraw Hill Education, 2nd Edition, 2010.
Reference Books:
R1: Stallings William. Cryptography and Network Security, Pearson Education, 7th Edition, 2017.
R2: Dominic Welsh. Codes and Cryptography, Oxford University Press, 1988.
R3: Bruce Schneier. Applied Cryptography: Protocols, Algorithms and Source Code in C, Wiley, 2007.
R4: Cox, Ingemar, et al. Digital watermarking and steganography, MK publisher, 2007.
R5: Cimato, Stelvio, and Ching-Nung Yang, eds. Visual cryptography and secret image sharing. CRC press, 2017.

Course Code: CSL535
Course Title: EDGE COMPUTING
Structure (L-T-P): 3-0-0
Course Prerequisite: Cloud Computing
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, students are expected to: Establish EDGE computing implementation for real life data collection, routing and finally processing at the EDGE devices.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To understand the basic concepts of EDGE Computing vis-à-vis fog and cloud computing
CO2: To understand the IoT Architecture and Requirements
CO3: To learn the implementation of IoT and WSNs using RaspberryPi
CO4: To implement MQTT with reference to EDGE Computing using RaspberryPi
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
IoT and Edge Computing Definition and Use Cases Introduction to Edge Computing Scenarios and Use cases - Edge computing purpose and definition, Edge computing use cases, Edge computing hardware architectures, Edge platforms, Edge vs Fog Computing, Communication Models - Edge, Fog and M2M. IoT Architecture and Core IoT Modules-A connected ecosystem, IoT versus machine-to-machine versus, SCADA, The value of a network and Metcalfe's and Beckstrom's laws, IoT and edge architecture, Role of an architect, Understanding Implementations with examples-Example use case and deployment, Case study – Telemedicine palliative care, Requirements, Implementation, Use case retrospective. RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout and Pinouts, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi, Connecting Raspberry Pi via SSH, Remote access tools, Interfacing DHT Sensor with Pi, Pi as Webserver, Pi Camera, Image & Video Processing using Pi. Implementation of Microcomputer RaspberryPi and device Interfacing, Edge to Cloud Protocols Protocols, MQTT, MQTT publish-subscribe, MQTT architecture details, MQTT state transitions, MQTT packet structure, MQTT data types, MQTT communication formats, MQTT 3.1.1 working example. Edge computing with RaspberryPi, Industrial and Commercial IoT and Edge, Edge computing and solutions.
Contents for Desired Course Outcomes (If any): NIL
Text Books:
T1. IoT and Edge Computing for Architects - Second Edition, by Perry Lea, Publisher: Packt Publishing, 2020, ISBN: 9781839214806
T2. Raspberry Pi Cookbook, 3rd Edition, by Simon Monk, Publisher: O'Reilly Media, Inc., 2019, ISBN: 978149204322.
Reference Books:
R1. Fog and Edge Computing: Principles and Paradigms by Rajkumar Buyya, Satish Narayana

Srirama, wiley publication, 2019, ISBN: 9781119524984.
R2. David Jensen, "Beginning Azure IoT Edge Computing: Extending the Cloud to the Intelligent Edge, MICROSOFT AZURE

Course Code: CSP524
Course Title: PROGRAMMING IN R
Structure (L-T-P): 0-0-2-1
Course Prerequisite: Data Structures and Algorithms
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, a student is expected to: Perform Implementation of solutions using R Programming Language preferably in AI Domain.
Course Outcome
Essential
CO1: To be able understand the basics of various Data Types and Looping constructs
CO2: To be able to understand the usage of Plotting functionality in R
CO3: To be able to implement the concepts of Descriptive Statistics and Testing
CO4: To be able to implement Predictive Analysis
Desirable/Advanced (If any): NIL
Experiments for Essential Course Outcomes
1. To Work in the Console and perform basic operations such as Arithmetic Operators - Logical Operations - Using Functions - Getting Help in R and Quitting R Studio Installing and loading packages. Data structures, variables, and data types in R: Creating Variables - Numeric, Character and Logical Data - Vectors - Data Frames - Factors -Sorting Numeric, Character, and Factor Vectors - Special Values
2. Implementing Data Visualization using R: Scatter Plots - Box Plots - Scatter Plots and Box and-Whisker Plots Together -Customize plot axes, labels, add legends, and add colors.
3. Implementing Descriptive statistics in R: Measures of central tendency - Measures of variability - Skewness and kurtosis - Summary functions, describe functions, and descriptive statistics by group.
4. Testing of Hypothesis using R: T-test, Paired Test, correlation, Chi Square test, Analysis of Variance and Correlation
5. Predictive Analytics: linear Regression model, Non-Linear Least Square, multiple regression analysis, Logistic Regression, Panel Regression Analysis, ARCH Model, GARCH models, VIF model

Experiments for Desired Course Outcomes (If any): NIL
Books/Material
T1. Crawley, M. J. (2006), "Statistics - An introduction using R", John Wiley, London 32.
T2. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015), "Statistics using R", second edition. Narosa Publishing House, New Delhi.
Reference Books:
R1: Shahababa B. (2011), "Biostatistics with R", Springer, New York. 4. Braun & Murdoch (2007), "A first course in statistical programming with R", Cambridge University Press, New Delhi.

B. Tech. (Computer Science and Engineering) with specialization in Artificial Intelligence and Machine Learning

OVERALL CREDIT STRUCTURE

Undergraduate Core(UC)		**Undergraduate Elective (UE)**	
Category	***Credit***	***Category***	***Credit***
DC	67	**DE**	23 (minimum)
BS	19	**HM**	06 (minimum)
ES	22	**OC**	18 (Balance)
HM	05	**UN**	0 (03 Courses)
Total	**113**	**Total**	47
Grand Total (UC + UE)			**160**

Humanities and Management (Core) (HM)			
Course Code	**Course**	**L-T-P**	**Credit**
HSP152	Technical Communication	1-2-2	03
HSL151	Social Science	2-0-0	02
Grand Total			**05**

Basic Science (BS)			
Course Code	**Course**	**L-T-P**	**Credit**
MAL102	Applied Mathematics-I	3-2-0	04
MAL103	Applied Mathematics-II	3-2-0	04
MAL201	Applied Mathematics-III*	3-0-0	03
PHL151	Applied Physics	3-0-0	03
PHP151	Applied Physics Lab	0-0-2	01
CYL101	Applied Chemistry	3-0-0	03
CYP101	Applied Chemistry Lab	0-0-2	01
Grand Total			**19**

Engineering Arts and Science (ES)			
Course Code	**Course**	**L-T-P**	**Credit**
MEL152	Elementary Mechanical Engineering	3-0-0	03
EEL151	Elementary Electrical Engineering	3-0-0	03
EEP151	Elementary Electrical Engineering Lab	0-0-2	01
ECL151	Basic Electronics Engineering	3-0-0	03
ECP151	Basic Electronics Engineering Lab	0-0-2	01
MEL151	Engineering Drawing	3-0-0	03
MEP151	Engineering Drawing Lab	0-0-2	01
CSL151	Computer Programming and Problem Solving	3-0-0	03
CSP151	Computer Programming and Problem Solving Lab	0-0-2	01
MEP152	Mechanical Workshop	0-0-2	01
CEL151	Environmental Science	2-0-0	02
Grand Total			**22**

Non-Credit Requirement (UN)			
Course Code	**Course**	**L-T-P**	**Credit**
NCN101	NCC#	-	0
NCN102	NSS#	-	0
NCN103	NSO#	-	0
SPB101	Sports-I#	0-0-4	0
SPB102	Sports-II#	0-0-4	0
HMD251	Community Project	-	0
CST251	Practical Training	-	0
#A student has to opt at least one from NCC, NSS, NSO and Sports (I & II both).			

Departmental Core (DC)			
Course Code	**Course**	**L-T-P**	**Credit (67)**
CSL151	Computer Programming and Problem Solving	3-0-0	
CSP151	Computer Programming and Problem-Solving Lab	0-0-2	
AIL251	Data Structures	3-0-0	03
AIP251	Data Structures Lab	0-0-2	01
AIL252	Operating Systems	3-0-0	03
AIP252	Operating Systems Lab	0-0-2	01
AIL253	Object Oriented Programming	3-0-0	03
AIP253	Object Oriented Programming Lab	0-0-2	01
AIL254	Design and Analysis of Algorithms	3-0-0	03
AIP254	Design and Analysis of Algorithms Lab	0-0-2	01
AIL255	Computer Networks	3-0-0	03
AIP255	Computer Networks Lab	0-0-2	01
AIL256	Artificial Intelligence	3-0-0	03
AIP256	Artificial Intelligence Lab	0-0-2	01
AIL257	Machine Learning	3-0-0	03
AIP257	Machine Learning Lab	0-0-2	01
AIL258	Computer Organization & Architecture	3-0-0	03
SCL254	Discrete Mathematics	3-2-0	04
ECL256	Digital Circuits	3-0-0	03
ECP256	Digital Circuits Lab	0-0-2	01
AIL351	Database Management Systems	3-0-0	03
AIP351	Database Management Systems Lab	0-0-2	01
AIL352	Advances in Machine Learning	3-0-0	03
AIP352	Advances in Machine Learning Lab	0-0-2	01
AIL353	Data Science	3-0-0	03
AIP353	Data Science Lab	0-0-2	01
AIL354	Information and Network Security	3-0-0	03
AIP354	Information and Network Security Lab	0-0-2	01
AIL355	Fundamentals of Data Analytics	3-0-0	03
AIP355	Data Analytics using R	0-0-4	02
AIL356	Introduction to Deep Learning	3-0-0	03
ECL353	Microprocessor and Interfacing	3-0-0	03
ECP353	Microprocessor and Interfacing Lab	0-0-2	01
AID351	Minor Project	-	01
AID451	Major Project	-	02

Departmental Elective (DE)			
Course Code	**Course**	**L-T-P**	**Credit**
AIL357	Digital Image Processing	3-0-0	03
AIP357	Digital Image Processing Lab	0-0-2	01
AIL358	Web Technologies	3-0-0	03
AIL359	Information Retrieval	3-0-0	03
AIL360	Neuro-Fuzzy Techniques	3-0-0	03
AIL451	Real Time Systems	3-0-0	03
AIL361	Theory of Computation	3-0-0	03
AIL362	Data Communication	3-0-0	03
AIL363	Software Engineering	3-0-0	03
AIP364	Software Engineering Lab	0-0-2	01
AIL365	Compiler Design	3-0-0	03
AIL451	Geo Informatics	3-0-0	03
AIL452	Cloud Computing	3-0-0	03
AIL453	Public Key Infrastructure and Trust Management	3-0-0	03
AIL454	Parallel and Distributed Computing	3-0-0	03
AIP454	Linux Lab	0-0-2	01
AIL455	Concepts in Block Chaining	3-0-0	03
AIL456	Cyber Security and Forensic	3-0-0	03
AIL457	System Programming	3-0-0	03
AIL458	Fundamental Algorithms in Computational Biology	3-0-0	03
AIL459	Wireless Sensor & Ad Hoc networks	3-0-0	03
AIL460	5G Networks	3-0-0	03
AIL461	Natural Language Processing	3-0-0	03
AIL462	Mobile Application	3-0-0	03
AIL463	Multimedia and Virtual Reality	3-0-0	03
ECL355	Digital Communication Systems	3-0-0	03
ECL352	Digital Signal Processing	3-0-0	03
EEL458	Soft Computing Techniques	3-0-0	03
CSL525	Statistical Models for Computer Science	3-0-0	03
CSL524	Optimization Techniques (Operation Research)	3-0-0	03
CSL527	Data Mining	3-0-0	03
CSL531	Internet of Things (IoT)	3-0-0	03
CSL532	Advanced Computer Network	3-0-0	03
CSL534	Advanced Cryptography	3-0-0	03
CSL535	Edge Computing	3-0-0	03

Course Code: CSL151
Course Title: COMPUTER PROGRAMMING AND PROBLEM SOLVING
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objective:
To provide students with a comprehensive understanding of the fundamental concepts of computer programming and problem-solving techniques using the C programming language. The course aims to equip students with the necessary knowledge and skills to develop efficient and robust computer programs.
Course Outcomes (COs)
CO1: Understand the fundamental concepts of computer programming, different levels of programming languages, major parts of a computer, the need for an operating system, and the tree structure of storage.
CO2: Demonstrate proficiency in using different numbering systems such as binary, octal, and hexadecimal, and understand the ASCII code.
CO3: Define and use different data types, storage classes, and scope of variables in C. Understand the concept of conditional statements, decision-making, branching, looping, and switch statements.
CO4: Define and use structures and unions in C. Understand pointers and their application in dynamic memory allocation, pointers to arrays, and pointers to structures.
CO5: Work with files in C by opening, closing, reading, and writing operations on sequential and text files.
Contents for Essential Course Outcomes (If any)
Overview of a computer system, Block diagram and major parts of a computer, history of computer development, introduction to binary, octal, & hexadecimal numbers, ASCII code, different levels of programming languages – machine language, assembly language, high level language; need of operating system, introduction to assembler, compiler and interpreter. Introduction: Flow charts, data types and storage classes, scope of variables, arithmetic operators, assignment, conditional, arithmetic expressions, enumerated data types, decision making, branching, looping, Switch concept, function and parameter passing, recursive functions, macros. Arrays and applications: Introduction to one dimensional and 2-D array with examples. Representing a polynomial using 1-D array and polynomial operations, Use of 2-D array to represent a matrix and matrix operations. Character arrays (strings): String related functions (strlen, strcpy, strcat, strcmp, reverse etc.) and their function definitions. Searching and Sorting methods: Selection sort, Bubble sort, Insertion sort, Linear and binary search, partitioning an array, merging of 2 sorted arrays. Structures and Unions: Basic concept, array of structures and its applications. Pointers: Introduction (declaration and initialization), pointers and arrays, concept of dynamic memory allocation, use of pointers to represent variable-sized 1-D and 2-D arrays, pointers to structures.
File Management in C: Open, close, read and write operations, Sequential and text files.
Contents for Desired Course Outcomes (If any): NIL
Text Books:
T1: Kernighan, B.W. And Ritchie, D.M., The C Programming Language, 2nd ed., PHI, Delhi, 2012.
T2: Balguruswamy, E., Programming in ANSI C, 8th ed., Tata McGraw Hill, New Delhi, 2019.
Reference Books:

R1: Deshpande, P.S. and Kakde, O.G., C and Data Structures, Dreamtech Press, New Delhi, 2009.
R2: Dromey, R.G., How to Solve it by Computer, Pearson Education, Delhi, 2008.

Course Code: CSP151
Course Title: COMPUTER PROGRAMMING LAB
Structure (L-T-P): 0-0-2
Course Prerequisite: NIL
Course Objective: To provide students with hands-on experience in programming and problem-solving using the C language. The course aims to equip students with practical skills in programming, debugging, and testing C programs.
Course Outcomes
Essential
CO1: Demonstrate the ability to develop and implement efficient algorithms in the C programming language.
CO2: Develop proficiency in using basic programming constructs in C such as data types, operators, control statements, function and s, arrays.
CO3: Understand and use the C standard library functions, including string manipulation, file handling, and mathematical functions.
CO4: Understand and use advanced C programming concepts such as pointers, structures.
CO5: Understanding of the syntax and semantics of C programming constructs and the ability to apply these constructs to real-world problems.
Desirable/Advanced (If any): NIL
Experiments for Essential Course Outcomes
1. Demonstrate number system conversion using C programming.
2. Implement if else construct in C programming.
3. Implement C programs using switch case construct.
4. Write C programs to implement looping constructs.
5. Implement functions using Call be value and Call by reference.
6. Demonstrate working of one dimensional and two dimensional arrays.
7. Implement sorting techniques.
8. Write a C program to perform linear and binary search on an array of integers.
9. Write a program to demonstrate the working of string manipulation functions.
10. Implement structures and unions in C language.
11. Demonstrate the use of pointers in arrays, structures and strings.
12. Implement file handling concepts in C programming.

Experiments for Desired Course Outcomes (If any)
Text Books:
T1: Let Us C: Authentic guide to C programming language, BPB Publications; 19th edition 2022.
T2: Balguruswamy, E., Programming in ANSI C, 8th ed., Tata McGraw Hill, New Delhi, 2013.

Reference Books:

R1: Herbert Schildt, C: The Complete Reference, 4th edition, McGraw Hill Education, 2017.

R2: Srini Devadas, Programming for the Puzzled: Learn to Program While Solving Puzzles, MIT Press, 2017

Course Code: AIL251
Course Title: DATA STRUCTURES
Structure (L-T-P): 3-0-0

Prerequisite: Computer Programming and Problem Solving

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, students are expected to:

The objective of the course is to provide the knowledge about the various data structures and their applications in problem solving. To apply the data structure approaches for the solution of real-life engineering problems and can exploit complexities of algorithms.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: To be able to understand the basics of algorithm writing and implementation through programming language

CO2: To be able to understand the concepts of basic data structures and their supported operations.

CO3: To be able to analyze the problem and solve using most suitable data structure

CO4: To be able to devise the solution for naïve problems

Desirable/Advanced (If any):

Introduction to Program complexity (Big Oh notation), Recurrence relations, Overview of arrays, ADT for Arrays, Memory Representation of 1D, 2D and Multi-Dimensional Arrays, array-based algorithms - searching and sorting, Matrices and Operations, Sparse Matrices, Fast Transpose, Dynamic memory allocation and deallocation, Heap Management. Stack and Queues: Concepts, Implementations and Applications. Lists – Self-referential structures, Singly-linked lists, doubly linked lists and circular linked lists, List traversal, insertion, deletion at different positions in the linked lists, concatenation, reversing a list, Applications of lists in polynomial representation, multi-precision arithmetic, hash-tables etc. Multi linked structures and an example application like sparse matrices. Implementation of priority queues. Trees: Trees and related nomenclatures, Binary trees: Algorithms and Traversals, Binary Search Trees (BSTs): Operations and Applications, Threaded Binary Tree, Height-balanced Trees (AVL): Insertion/Deletion and Rotations. Heap: Binary Heaps and Heap sort, Multi-way Trees and external sorting: B-trees and B+ trees, Operations and Applications, Graphs: Representations, Traversals, Dijkastra's and Prim's and Topological Sorting Algorithms, Applications of Graphs

Contents for Desired Course Outcomes (If any)

Books/Material:

T1: Kruse, R.L., Tondo, C. L. and Leung, B.P., Data Structures and Program Design in C, 2nd ed., Pearson Education, Delhi, India, 2013.

T2: Horowitz, E., Sahni, S. and Anderson-Freed, S., Fundamentals of Data Structures in C, 2nd ed., University Press, Hyderabad, 2012.

Reference Books:

R1: Kernighan, B.W. and Ritchie, D.M., The C Programming Language, 2nd ed., PHI, Delhi, 2012.

R2: Dromey, R.G., How to Solve it by Computer, Pearson Education, Delhi, 2008.

Course Code: AIP251
Course Title: DATA STRUCTURES LAB
Structure (L-T-P): 0 0 2

Prerequisite: Computer Programming and Problem Solving

Course Objectives:

The course objectives define the student learning outcome for the course:

The objective of the course is to provide the knowledge about the various data structures and their applications in problem solving. To introduce the concept of complexities of algorithms.

Course Outcomes

Essential:

CO1: To be able to understand the basics of algorithm writing and implementation through programming language

CO2: To be able to understand the concepts of basic data structures and their supported operations.

CO3: To be able to analyze the problem and solve using most suitable data structure

CO4: To be able to devise the solution for Engineering Problems

Desirable/Advanced (If any):

To be able to devise solution for Naive Problems in Engineering

Experiments for Essential Course Outcomes

1. Implementation of Quick sort, Insertion Sort, Selection, Bubble and Merge sort.
2. Implement Polynomials with Arrays and supporting Addition, Multiplication, Scalar Multiplication and Subtraction.
3. Implement Polynomials with Linked List and supporting Addition, Multiplication, Scalar Multiplication and Subtraction.
4. Implement Doubly Linked Lists with all possible Addition and Deletion cases. Consider Linked List Header/start node.
5. Implement Stacks with Arrays and Linked Lists.
6. Implement Queue with Arrays and Linked Lists.
7. Implement Circular Queue with Arrays and Linked Lists.
8. Implement Linear and Binary Search on Arrays of Elements.
9. WAP for insertion and deletion of nodes from the sequence: A, B, C, D, E,F, G, H, I, J , K, L, M, N, O. using binary search tree algorithm.
10. WAP to implement max heap sort for the sequences: A, B, C, D,E, F,G,H,I,J,K,L,M,N,O.
11. Implementation of Binary Search Tree with:

(a) In-order traversal (b) Preorder Traversal (c) Post Order traversal

12. Implementation 4-way B-Tree using 12, 13, 76, 77, 89, 94, 48, 19, 55, 35,35, 87, 11, 32.
13. Implementation of Heap Sort using Binary heap on 12, 13, 76, 77, 89, 94,48, 19, 55, 35, 35, 87, 11, 32, 31.

Experiments for Desired Course Outcomes (If any)

1. Decide and Implement most suitable data structure for Different Components of Drone Management System.
2. Decide and Implement most suitable data structure for Different Components of Processing a Data Set in IDS, Drug Design and COVID-19.

Books/Material

T1: Kruse, R.L., Tondo, C. L. and Leung, B.P., Data Structures and Program Design in C, 2nd ed., Pearson Education, Delhi, India, 2013.

T2: Horowitz, E., Sahni, S. and Anderson-Freed, S., Fundamentals of Data Structures in C, 2nd ed., University Press, Hyderabad, 2012.

Reference Books:

R1: Kernighan, B.W. and Ritchie, D.M., The C Programming Language, 2nd ed., PHI, Delhi, 2012.

R2: Dromey, R.G., How to Solve it by Computer, Pearson Education, Delhi, 2008.

Course Code: AIL252
Course Title: OPERATING SYSTEMS
Structure (L-T-P): 3 0 0 3
Course Prerequisite: Data Structures
Course Objectives

The course objectives define the student learning outcome for the course:

The objective of the course is to provide knowledge about the various operating system structures, services provided by the operating system, process scheduling and synchronization, different memory management techniques, resource and file management by the operating system.

Course Outcomes: At the end of the course, students will be able to-

Essential:

CO1: Understand the various operating system types, structures, and services.

CO2: Synthesize the solutions for problems related to process scheduling.

CO3: Construct the solution for critical section problems in concurrent processes using the synchronization tools.

CO4: Construct solutions for deadlocks and synchronization in a multiprogrammed operating system.

CO5: Understand and analyze theory and implementation of Physical and Virtual memory, Disk scheduling and File Systems.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction, basic h/w support necessary for modern operating systems - Services provided by OS, system programs and system calls – brief discussions of evolution of OS- real time and distributed systems: a brief overview of issues. File systems, user interface - disk space management and space allocation strategies- examples from UNIX, DOS, Windows, etc. –directory structures- disk caching- file system consistency and logs disk arm scheduling strategies. Processes and 3 levels of scheduling - process control block and context switch - goals of scheduling and different scheduling algorithms- threads: user-level and kernel level. Memory management techniques - contiguous and non-contiguous paging and segmentation - translation look-aside buffers (TLB) and overheads - virtual memory and demand paging- page faults and instruction restart - problems of large address spaces – page replacement algorithms and working sets - miscellaneous issues. Process cooperation and synchronization - mutual exclusion and implementation - semaphores, conditional critical regions and monitors - classical inter - process communication problems message passing. Deadlocks and strategies for handling them. Protection and security issues - access lists, capabilities, cryptographic techniques - introduction to distributed systems.

Syllabus for Desired Course Outcomes (If any): NIL

Text Books

T1. Silberschatz, A., Galvin, P.B. and Gagne, G., Operating System Concepts, 8th ed., Wiley, 2014.

T2. Stallings, W., Operating Systems: Internals and Design Principles, 7th ed., Pearson, 2012.

Reference Books

R1. Crowley, C., Operating Systems: A Design-Oriented Approach, Tata McGraw Hill, 2001.

R2. Tanenbaum, A.S., Modern Operating Systems, 3rd ed., Prentice Hall of India, 2014.

R3. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education,3rd Edition.

R4. Maurice J. Bach, "Design of UNIX Operating System", PHI.

Course Code: AIP252
Course Title: OPERATING SYSTEMS LAB
Structure (L-T-P): 0 0 2 1
Course Prerequisite: NIL
Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

Simulate the process synchronization problems, CPU scheduling algorithms, Deadlock avoidance and prevention techniques, memory management and file allocation techniques.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Implement process creation and synchronization.

CO2. Implement programs on CPU scheduling algorithms.

CO3. Simulation of Deadlock Avoidance and prevention algorithms.

CO4. Implement programs on page replacement algorithms.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Basic LINUX commands and system calls for file, directory and process management.
2. Shell scripts to display operating system and processes information.
3. Implementation of one or two Linux basic commands using Kernel APIs.
4. Process Management Commands in Linux.
5. Simulation of Mutex and Semaphores.
6. Implementation of the Process synchronization
7. Simulation of the CPU scheduling algorithms using the concept of pre-emption and non-pre-emption of processes.
8. Simulation of Deadlock Avoidance and Prevention algorithms.
9. Simulation of Paging and Segmentation memory management techniques.

10. Simulation of page replacement algorithms.
11. Simulation of file allocation Strategies.
12. Simulation of file organization techniques.
13. Implementation of disk scheduling strategies.

Experiments for Desired Course Outcomes (If any): NIL

Text Books

T1. Lab Manual

T2. "Advanced Programming in the UNIX environment", 3rd Edition, W. Richard Stevens and Stephen A. Rago, Addison-Wesley, 2013

T3. John Guttag. Introduction to Computation and Programming using Python, MIT Press, 2013.

Reference Books

R1. Modern Operating Systems, Andrew S Tanenbaum, 3rd Edition, PHI.

R2. "Beginning Linux Programming", 4th Edition by Richard Stones, Neil Matthew, Wiley Publishing, Inc.

R3. Sumitabha Das, "UNIX: Concepts and Applications", McGraw Hill, 4thEdition.

R4. Arnold Robbins, Nelson H. F. Beebe, Classic Shell Scripting, O'Reilly Media 2005

Course Code: AIL253
Course Title: OBJECT ORIENTED PROGRAMMING
Structure (L-T-P): 3-0-0
Prerequisite: NIL
Course Objective:
To familiarize the object-oriented concepts and their uses in real life applications along with introduction to Java programming.
Course Outcomes
Essential:
CO1. Understand and explain the fundamental concepts and features of object-oriented programming languages such as data encapsulation, inheritance, polymorphism and late binding.
CO2. Design, develop and implement Java programs that use classes, interfaces, static and non-static members, and method overloading.
CO3. Comprehend the abstract class and interfaces and apply to design solution prototypes by proposing customized and extending interfaces. Analyze programs against run-time errors and apply exception handling.
CO4. Develop Java programs that implement data structures like linked lists, stacks, queues, and hash tables using object-oriented programming principles.
CO5. Implementation of input/output, networking and database connectivity using Java

Desirable/Advanced (If any): NIL
Contents for Essential Course Outcomes:
Object Oriented Programming, Features of object-oriented programming languages like data encapsulation, inheritance, polymorphism and late binding. Introduction to Java language, Concept of a class, Access control of members of a class, instantiating a class, static and non-static members, overloading a method, Deriving a class from another class, access control of members under derivation, different ways of class derivation, overriding of a method, runtime polymorphism, Concept of an abstract class. Concept of an interface. Implementation of an interface, Exception and exception handling mechanisms, Study of exception handling mechanisms in object-oriented languages, Introduction to streams, use of stream classes, serialization and deserialization of objects. Templates, Implementation of data structures like linked lists, stacks, queues, trees, graphs, hash tables etc. using object-oriented programming languages. Java Database connectivity and networking
Contents for Desired Course Outcomes (If any): NIL
Text Books:

T1: Arnold K., Gosling J. and Holmes, D., The Java Programming Language, 3rd ed., Pearson Education, 2013.
T2: Weisfeld, M.A.,The Object-Oriented Thought Process, 3rd ed., Pearson, 2013.
Additional Books:

R1: Dietel H.M, Dietel P.J, "Java: How to Program", Prentice-Hall, 11th Edition, 2017.

R2: Schildt, H., Java: The Complete Reference, 12th ed., McGraw-Hill, 2021.

Course Code: AIP253
Course Title: OBJECT ORIENTED PROGRAMMING LAB
Structure (L-T-P): 0-0-2
Prerequisite: NIL
Course Objectives:
Programming Lab course aims at the following educational objectives:
· To become familiar with the Object Oriented Programming paradigm.
· To use object oriented features to solve real life problems.
· To enhance logical and problem solving skills using Java programming.
· To impart hands-on experience in Java language
Course Outcomes
Course Outcomes (COs): At the end of this lab course, students will be able to-
Essential:
CO1: Understand the Object Oriented paradigm and use it to solve problems related to real world applications.
CO2: Develop proficiency in the Java programming language, including its syntax and basic data types.
CO3: Implement and use classes and objects to solve problems in various domains, including data structures and algorithms.
CO4: Implement concepts of multithreading, files, and abstraction in java.
Desirable/Advanced (If any): NIL
Experiments for Essential Course Outcomes
1. Demonstrate object oriented programming features using Java language.
2. Implement a java program to demonstrate working of conditional statements and loops.
3. Implement a java program to show working of access modifiers.
4. Write a java program to show use of static and non-static members of a class.
5. Implement Java program to show the concept of Inheritance and demonstrate the concept of Run time Polymorphism and Compile time Polymorphism.
6. Use String Class to demonstrate all the functionality available in Java for string manipulation.

7. STACK_EMPTY and STACK_FULL as methods of inner class and remaining methods should be implemented in outer class STACK.
8. Write a program to implement the concept of Queue and Implement Insert, Delete, Traverse, Queue Empty, Queue Full operations. Queue Empty, Queue Full methods should be private methods.
9. Define outer class STACK. Demonstrate the concept of inner class and implement Java programs for Linkedlist, stack, queue and arraylist using Collection Framework.
10. Write programs to demonstrate exception handling mechanisms in java.
11. Implement input/ output operations and file handling concepts in java.
12. Write a java program to implement networking in java.
13. Write a java program to connect to the database and read and write in the database.

Experiments for Desired Course Outcomes (If any): NIL
Textbooks/Materials:

T1. Xavier C, "Java Programming - A Practical Approach", Tata McGraw-Hill, 2011.

T2. Dietel H.M, Dietel P.J, "Java: How to Program", Prentice-Hall, 11th Edition, 2017.

Reference Books:

R1 Dietel H.M, Dietel P.J, "Java: How to Program", Prentice-Hall, 11th Edition, 2017.

R2:Schildt, H., Java: The Complete Reference, 12th ed., McGraw-Hill, 2021.

Course Code: AIL254
Course Title: DESIGN AND ANALYSIS OF ALGORITHMS
Structure (L-T-P): 3-0-0
Prerequisite: Data Structures
Course Objectives:
Analyze algorithms for time and space complexities. Develop algorithms for various problems by applying various algorithms design strategies. To study divide & conquer, a greedy and dynamic approach to solve various problems.
Course Outcomes
Essential:
CO1. Understand and apply mathematical foundations for analyzing algorithms, including summations, recurrence relations, and asymptotic notations.
CO2. Describe the divide-and-conquer paradigm. Derive and solve recurrence relations of various divide and conquer algorithms and analyze their best and worst case complexities.
CO3. Usage of greedy algorithms to solve problems requiring optimal solutions.
CO4. Apply a dynamic programming approach to solve problems and analyze them. Use of a backtracking approach to solve graph problems.
CO5. Understand the significance of NP-hard and NP-complete problems and be able to apply polynomial reduction to demonstrate NP-hardness.
Desirable/Advanced (If any): NIL
Contents for Essential Course Outcomes (If any)
Asymptotic notations of analysis of algorithms, analyzing control structures, worst case and average case analysis, amortized analysis. sorting algorithms such as selection sort, insertion sort, bubble sort, heap sort, lower bound proof, elementary and advanced data structures with operations on them and their time complexity. Divide and conquer basic strategy, binary search, quick sort, merge sort, etc. Greedy method - basic strategy, application to job sequencing with deadlines problem, minimum cost spanning trees, single source shortest path etc. Dynamic Programming basic strategy, multistage graphs, all pairs shortest path, single source shortest paths, optimal binary search trees, traveling salesman problem. Basic Traversal and Search Techniques, breadth first search and depth first search, connected components. Backtracking basic strategy, 8-Queens problem, graph coloring, Hamiltonian cycles etc. NP-hard and NP-complete problems, basic concepts, nondeterministic algorithms, NP-hard and NP-complete, Cook's Theorem, decision and optimization problems, polynomial reduction.

Contents for Desired Course Outcomes (If any): NIL
Text Books:

T1.Cormen, T.H., Leiserson, C.E. and Rivest, R.L., Stein, C., Introduction to Algorithms, 4th ed., The MIT Press, 2022.

T2.Horowitz, E., Sahni, S. and Rajasekaran, S., Fundamentals of ComputerAlgorithms, 2nd ed., University Press, 2012.
Reference Books:
R1. Brassard, G. and Bratley, P., Fundamentals of Algorithmics, PHI Learning Private Limited, 2008.
R2. S. Sridhar, Design And Analysis Of Algorithms, Oxford University Press, 2014.

Course Code: AIP254
Course Title: DESIGN AND ANALYSIS OF ALGORITHMS LAB
Structure (L-T-P): 0-0-2
Prerequisite:
Course Objectives:
To Analyze the asymptotic performance of algorithms and learn the importance of designing an algorithm in an effective way by considering space and time complexity. Selection of appropriate data structures while developing algorithms to reduce the complexity.
Course Outcomes:
Essential:
CO1: To implement different types of algorithms and analyze their time and space complexity.
CO2: To understand and implement the divide and conquer strategy to solve the sorting and searching problems.
CO3: Implementation of greedy algorithms to find minimum spanning trees, shortest paths and other optimization problems.
CO4: To implement a dynamic programming approach to solve traveling salesman problems and 0/1 knapsack problems.
CO5: To solve various computational problems, such as graph algorithms, optimization problems, using appropriate algorithms.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Implement sorting algorithms to analyze their time and space complexity.
2. Perform operations on heap data structure.
3. To implement maximum and minimum problems using divide and conquer strategy.
4. To implement binary search using divide and conquer strategy.
5. Implement greedy algorithms to solve optimization problems.
6. Write programs to find minimum spanning trees and shortest paths.
7. Use a dynamic programming approach to solve problems like 0/1 knapsack, traveling salesman problem etc.
8. Implement graph traversal and search techniques.
9. Implement N Queens problem using Backtracking

Experiments for Desired Course Outcomes (If any): NIL

Text Books:

T1. Cormen, T.H., Leiserson, C.E. and Rivest, R.L., Stein, C., Introduction to Algorithms, 3rd ed., PHI Learning Private Ltd., 2013.

T2. Horowitz, E., Sahni, S. and Rajasekaran, S., Fundamentals of ComputerAlgorithms, 2nd ed., University Press, 2012.

Reference Books:

R1. Brassard, G. and Bratley, P., Fundamentals of Algorithmics,PHI Learning Private Limited, 2008.

R2. S. Sridhar, Design And Analysis Of Algorithms, Oxford University Press, 2014.

Course Code: AIL255

Course Title: COMPUTER NETWORKS

Structure (L-T-P): 3-0-0

Course Prerequisite: Data Communications CSL-257

Course Objectives:

Computer Networks course aims at the following educational objectives:

To become familiar with the Computer Networks.

To understand the fundamental principles of Networking and other related equipment.

To understand application of Networking Protocols and its applications

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Describe the terminology of computer networks and core concepts of open system interconnection (OSI) and TCP/IP reference models.

CO2. Compare the working of protocols, network interface and design/performance issues in local area networks, metropolitan area networks, and wide area networks.

CO3. Solve and analyze the data link layer, network layer, transport layer and application layer protocols.

CO4. Analyze the basic concepts of wireless networking.

CO5. Design network socket programming and networker simulator using NS-2 and NS-3.

Desirable (if any): NIL

Contents:

Introduction to Network Architecture, Layering and Protocols, Internet Architecture Topologies, Transmission Media (Guided and Unguided), Performance, Bandwidth and Latency, Encoding (Unipolar, Polar, Bipolar), Data Transmission, Multiplexing and De-Multiplexing, Framing, Error Detection and Correction Techniques, Line Discipline, Flow Control, and Error Control, Bit stuffing and Corrector Stuffing, Byte-Oriented Protocols (PPP), Bit-Oriented Protocols (HDLC), internetworking (IEEE 802.1), LLC (IEEE 802.2), MAC (IEEE 802.3), Token Bus (IEEE 802.4) and Token Ring (IEEE 802.5), FDDI, Switching (Circuit Switching and Packet Switching), Point-to-Point Protocol(PPP), Link Control Protocol(LCP). Routing, Bridging, Gateway, Brouters, Routing Protocols (Distance Vector (RIP), Link State (OSPF). IP Addressing (Classful and Classless), Masking, Subneting and Superneting, ARP and RARP, Host Configuration (DHCP), 1Pv4, IPv6, UDP, TCP. Connection Establishment and Termination, Triggering Transmission, Adaptive Retransmission Error Reporting (ICMP, IGMP), Presentation layer functions, Electronic Mail (SMTP, MIME, 1MAP), World Wide, Web(HTTP), Web services multimedia applications, Session control and call control, SDP, SIP, H.323, Name service (DNS), Network Management(SNMP).

Text Books:

T1. Peterson, L.L. and Davie, B.S., Computers Networks: A Systems Approach, 5th ed., Elsevier, 2013.

T2. Forouzan, B.A., Data Communications and Networking, 5thed.Tata McGraw- Hill, 2013.

Reference Books:

R1. Tanenbaum, A. S. and Wetherall, D., Computer Networks, 5th ed., Pearson, 2014.

R2. Haykin, S.S. and Moher, M., Communication Systems, 5th ed., John Wiley and Sons, 2012.

R3. Comer, D., Computer Networks and Internets, 6th ed., Pearson, 2014.

R4. Kurose, J.F. and Ross, K.W., Computer Networking: A Top-Down Approach, 6th ed., Pearson Education, 2013.

R5. Stallings, W., Data and Computer Communications, 10th ed., Pearson Education, 2014.

Course Code: AIP255

Course Title: COMPUTER NETWORKS LAB

Structure (L-T-P): 0-0-2

Course Prerequisite: Data Structures and Computer Programming

Course Objectives:

Computer Networks Lab course aims at the following educational objectives:

To become familiar with Socket Programming.

To understand the fundamental principles of client server programming.

To understand the application of Networking Protocols and its applications through programming.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Describe the terminology of computer networks and core concepts of open system interconnection (OSI) and TCP/IP reference models.

CO2. Compare the working of protocols, network interface and design/performance issues in local area networks, metropolitan area networks, and wide area networks.

CO3. Solve and analyze the data link layer, network layer, transport layer and application layer protocols.

CO4. Analyze the basic concepts of wireless networking.

CO5.Design network socket programming and networker simulator using NS-2 and 3.

Desirable (if any): NIL

Experiments for Essential Course Outcomes

1. Using TCP sockets or network socket programming.
2. Client server application for chat.
3. PC to PC file transfer using serial port.
4. Implementation of shortest path routing.
5. Implementation of Sliding window protocol.
6. Implementation of open shortest path first protocol.
7. Using n/w simulation like NS2, DLC/DLL simulator.
8. Implementation of TCP/IP echo.
9. Using simple UDP protocol.
10. Implementation of a packet analyzer for traffic classification and protocol information.

Experiments for Desirable Course Outcomes (if any): NIL

Text Books:

T1: Peterson, L.L. and Davie, B.S., Computers Networks: A Systems Approach, 5th ed., Elsevier, 2013.

T2: Forouzan, B.A., Data Communications and Networking, 4th and 5th edition of Tata McGraw-Hill, 2013.

Reference Books:

R1: Tanenbaum, A. S. and Wetherall, D., Computer Networks, 5th ed., Pearson, 2014.

R2: Stallings, W., Data and Computer Communications, 10th ed., Pearson Education, 2014.

Course Code: AIL256

Course Title: ARTIFICIAL INTELLIGENCE

Structure (L-T-P): 3 0 0

Course Prerequisite: Data Structures

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, students are expected to: Understand the AI Paradigm as an alternate problem solving paradigm. Able to Scrutiny the particular AI approach applicable for problem solving in real time.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: To be able understand the basics of various modeling and their artifacts.

CO2: To be able to understand the concepts of classical and modern AI.

CO3: To be able to analyze the problem and solve using the most suitable model.

CO4: To be able to design the solution for naïve problems.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction: What is AI?, History, Overview, Intelligent Agents, Performance Measure, Rationality, Structure of Agents, Problem-solving agents, Problem Formulation, Uninformed Search Strategies, Informed (Heuristic) Search and Exploration, Greedy best first search, A* search, Memory bounded heuristic search, Heuristic functions, inventing admissible heuristic functions, Local Search algorithms, Hill-climbing, Simulated Annealing, Genetic Algorithms, Online search, Constraint Satisfaction Problems, Backtracking Search, variable and value ordering, constraint propagation, intelligent backtracking, local search for CSPs, Adversarial Search, Games, The minimax algorithm, Alpha-Beta pruning, Imperfect Real-Time Decisions, Games that include an Element of Chance Knowledge Based Agents, Logic, Propositional Logic, Inference, Equivalence, Validity and Satisfiability, Resolution, Forward and Backward Chaining, DPLL algorithm, Local search algorithms, First Order Logic, Models for first order logic, Symbols and Interpretations, Terms, Atomic sentences, complex sentences, Quantifiers, Inference in FOL, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution Planning, Language of planning problems, planning with state-space search, forward and backward state-space search, Heuristics for state-space search, partial order planning, planning graphs, planning with propositional logic. Uncertainty, Handling uncertain knowledge, rational decisions, basics of probability, axioms of probability, inference using full joint distributions, independence, Baye's Rule and conditional independence, Bayesian networks, Semantics of Bayesian networks, Exact and Approximate inference in Bayesian Networks.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, 3rd edition, Pearson Education, 2014.

T2. Kevin Knight, Elaine Rich, B. Nair, Artificial Intelligence, 2010, Tata McGraw-Hill Education Pvt. Ltd.

Reference Books:

R1. Nilsson, N.J. Artificial Intelligence and New Systems, 1st ed., Elsevier, 2011.

R2. Patterson, D. W. Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India, 2012

Course Code: AIP256

Course Title: ARTIFICIAL INTELLIGENCE LAB

Structure (L-T-P): 0 0 2

Course Prerequisite: Data Structures

Course Outcome

Essential:

CO1: To be able understand the basics of various modeling and their artifacts.

CO2: To be able to understand the concepts of classical and modern AI.

CO3: To be able to analyze the problem and solve using the most suitable model.

CO4: To be able to design the solution for naïve problems.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Implement Bidirectional Search on any map of cities in Uttarakhand with the State Dehradun and Goal State Rudrapur. Provide a map to students.
2. Implementation of 4 Queen Solution and generate at all intermediate states from some given random initial state.
3. Implementation of A* Algorithm on Uttarakhand Map with start state Dehradun and Goal State Rudrapur. Provide a map to students.
4. Implement the CSP paradigm based upon the concepts such as Backtracking, Ordering of Variables and Value heuristics to solve the N-Queen Problem or N-Puzzle. Display the positions of Queens/Tiles on the board.

5. Implement one AI Agent based upon Proposition Logic which can draw conclusions on the basis of a. Forward Chaining, b. Backward Chaining c. Resolution
6. Implement the algorithm to implement the conversion of Predicates to Clausal Form.
7. Implement the algorithm to implement the concept of Unification in Predicate Logic.
8. Implement one AI Agent based upon Predicate Logic which can draw conclusions on the basis of a. Backward Chaining b. Resolution
9. Identify a model for the given wffs using DPLL.
10. Implementation of Route Planner for Autonomous Cars using Google Maps API.

Experiments for Desired Course Outcomes (If any) NIL

Text Book:

T1. Russell, S.J. and Norvig, P., Artificial Intelligence: A Modern Approach, 3rd edition, Pearson Education, 2014.

T2. Kevin Knight, Elaine Rich, B. Nair, Artificial Intelligence, 2010, Tata McGraw-Hill Education Pvt. Ltd.

Reference Books:

R1. Nilsson, N.J. Artificial Intelligence and New Systems, 1st ed., Elsevier, 2011.

R2. Patterson, D. W. Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India, 2012.

Course Code: AIL257

Course Title: MACHINE LEARNING

Structure (L-T-P): 3-0-0

Course Prerequisite: NIL

Course Objectives

After completing the above course, student is expected to:

To understand the basic theory underlying machine learning.

To be able to formulate machine learning problems corresponding to different applications.

To understand a range of machine learning algorithms along with their strengths and weaknesses.

To be able to apply machine learning algorithms to solve problems of moderate complexity.

To apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: To familiarize with the mathematical and statistical techniques used in machine learning.

CO2: Understand the fundamental concepts of supervised learning algorithms and analyze the different supervised learning algorithms.

CO3: Understand the fundamental concepts of unsupervised learning algorithms and analyze the different unsupervised learning algorithms.

CO4: Understand and apply the different performance metrics on supervised and unsupervised learning algorithms.

CO5: Design the learning algorithm models to real world problems, optimize the models and evaluate the models using different performance metrics.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction: Mathematics, Applications, Current technologies, platforms used in ML. Supervised learning: Introduction, Nearest Neighbor, Naive Bayes, Decision Trees, Random Forest, Rule-based classification, Support Vector Machine (SVM), Artificial Neural Network, Bagging, Boosting, Improving classification algorithms, Performance metrics for supervised classification. Unsupervised learning: Introduction, Centroid-based Clustering, Density-based clustering, Distribution-based Clustering, Hierarchical clustering, Connectivity based clustering, Performance metrics for unsupervised classification. Regression: Introduction, Linear regression, Multiple regression, Polynomial regression, Logistics regression, Performance metrics for regression. Reinforcement learning: Introduction, Applications, Markov decision process, Q-learning, SARSA, DQN.

Text Books:

T1. Ethem Alpaydin, Introduction to Machine Learning, Second Edition, PHI, 2010 2. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.

T2. Tom.M.Mitchell, Machine Learning, McGraw Hill International Edition.

Additional Book:

R1. C. M. Bishop. *Pattern Recognition and Machine Learning.* 2nd Edition. Springer, 2015.

R2. Miroslav Kubat, An Introduction to Machine Learning, 2nd ed., Springer, 2017

Course Code: AIP257

Course Title: MACHINE LEARNING LAB

Structure (L-T-P): 0-0-2

Course Prerequisite NIL

Course Objectives

After completing the above course, student is expected to:

Understand the basic concepts, mathematics, and applications of machine learning. Develop and implement machine learning algorithms for real-world problems. Gain proficiency in Python programming language and its application in machine learning. Learn about data preprocessing, feature engineering, and model selection techniques. Evaluate and optimize machine learning models for better accuracy and efficiency. Understand the ethical considerations and limitations of machine learning.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: Develop and implement machine learning algorithms such as Nearest Neighbor, Naive Bayes, Decision Trees, Random Forest, Rule-based classification, Support Vector Machine (SVM), Artificial Neural Network

CO2: Apply regression techniques such as Linear regression, Multiple regression, Polynomial regression, and Logistics regression.

CO3: Understand and implement reinforcement learning algorithms such as Q-learning, SARSA, and DQN.

CO4: Apply data preprocessing, feature engineering, and model selection techniques to improve model performance.

CO5: Evaluate and optimize machine learning models.

Desirable/Advanced (If any):

CO 6. Apply machine learning models in real-time applications.

Experiments for Essential Course Outcomes

1. Implement supervised learning algorithms such as Nearest Neighbor, Naive Bayes, Decision Trees, Random Forest, Rule-based classification, Support Vector Machine (SVM),
2. Implement a single layer perceptron learning rule.
3. Implement a multilayer neural network.

4. Implement Centroid-based Clustering algorithms.
5. Implement Distribution-based Clustering algorithms
6. Implement Hierarchical clustering algorithms
7. Write a program to implement linear regression.
8. Write a program to implement multiple regression.
9. Write a program to implement Polynomial regression.
10. Write a program to implement Logistics regression.
11. Implement Reinforcement learning algorithms such as Q-learning, SARSA, and DQN.
12. Write a program to check the performance of the model using evaluation metrics.
13. Group project: designing, implementing, and presenting a machine learning application.

Experiments for Desired Course Outcomes (If any) NIL

Books/Material

T1. Ethem Alpaydin, Introduction to Machine Learning, Second Edition, PHI, 2010 2. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.

T2. Tom.M.Mitchell, Machine Learning, McGraw Hill International Edition.

Reference Books

R1. C. M. Bishop. *Pattern Recognition and Machine Learning.* 2nd Edition. Springer, 2015.

R2. Miroslav Kubat, An Introduction to Machine Learning, 2nd ed., Springer, 2017

Course Code: AIL258

Course Title: COMPUTER ORGANIZATION AND ARCHITECTURE

Structure (L-T-P): 3 0 0

Course Prerequisite:-Digital Circuits

Course Objectives

The objective of the course is to present an understanding of the basic principles on which computers work. To know about the various components and their organization.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Understand the structure, function and characteristics of computer systems.

CO2. Understand the design of the various functional units and components of computers.

CO3. Identify the elements of modern instruction sets and their impact on processor design.

CO4. Understand the function of each element of a memory hierarchy.

CO5. Identify and compare different methods for computer I/O

CO6. Be able to write assembly language code.

Desirable/Advanced (If any): NIL

Overview of Computer Architecture and Organization: Fundamentals of computer architecture, Organization of von Neumann machine, Basic operation concepts and performance equation.

Computer Arithmetic and Machine Instruction: Representation of integers and real numbers algorithm for carrying out common integer and floating-point operations: Integer Addition and Subtraction, Ripple carry adder, carry look-ahead adder, etc. Multiplication - Shift-and-Add, Booth algorithm, bit pair recording, etc. Division - non-restoring and restoring technique, Floating point arithmetic, Memory Locations and Addresses, Memory operations, Instruction format, execution cycle, Instruction types and addressing modes. Assembly Language program,

Memory Organization: Memory system hierarchy, main memory organization, cache memory, auxiliary memory. Mapping, Replacement, Writing policies, Input-Output Organization: Input-output subsystems, I/O transfers-Program controlled, Interrupt driven and DMA, Privileged and non-privileged instructions, Introduction to Peripheral Devices and their Characteristics, Control Unit Design: Instruction sequencing, Instruction interpretation, control memory, Hardwired Control, Micro programmed Control, Microprogrammed Computers, Organization of CPU: Single vs multiple data path ISA Control unit Instruction, pipelining, Trends in computer architecture: CISC, RISC, VLIW, Introduction to ILP Pipeline Hazards: Structural, data and control. Reducing the effects of hazards, Multiprocessors Architectures.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Hamacher, V.C., Vranesic, Z.G. and Zaky, S.G., Computer Organization, 5th ed., Tata McGraw Hill, 2013.

T2. Computer System Architecture", by M. Morris Mano (PHI).

Reference Books:

R1. Patterson, D.A.and Hennessy, J.L., Computer Organization and Design: The Hardware/Software Interface, 5th ed., Morgan Kaufmann, Amsterdam, 2014.

R2. Stallings, W., Computer Organization and Architecture: Designing for Performance, 9th ed., Pearson Education, Boston, 2013.

R3. Tanenbaum, A.S. and Austin, T., Structured Computer Organization, 6th ed., Pearson Education, 2013.

R4. Computer Architecture and Organization", by John P. Hayes (McGraw Hill)

Course Code: AIL351

Course Title: DATABASE MANAGEMENT SYSTEMS

Structure (L-T-P): 3-0-0

Course Prerequisite: NIL

Course Objectives

After completing the above course, student is expected to:

1. The objective of the course is to present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from a DBMS.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: Understand the fundamental concepts, principles and applications of DBMS.

CO2: Apply the different SQL queries on relations.

CO3: Analyze the ER diagram and produce the relations from the ER diagram.

CO4: Design and implement a database project, considering the issues like normalization, concurrency control, recovery and security.
CO5: Understand the storage structure in DBMS.
Desirable outcomes (If any): NIL
Contents for Essential Course Outcomes (If any)
Introduction: Overview of a DBMS, File processing system, Advantages of a DBMS, Applications, Recent advances in database technology, Database system architecture, Query Languages: Relational algebra, Relational calculus, SQL, Data Models: Relational model, ER model, EER model, Object relational data model, Hierarchical data model, Network data model, ER model to relation model conversion, Database Design: Types of keys, Functional dependencies, Normal forms, Relation decomposition, Denormalization, Data Storage & Indexing: File organization overview, Storage structures, B and B+ tree, Indexing overview, Dense and Sparse index, Transaction management and Concurrency control: Transaction management overview, ACID properties, Serial and Concurrent schedules, Serializability and Recoverability of schedule, Concurrency control mechanisms, Locking and Timestamp based protocol, Query Processing & Optimization: Overview, Relational operator's evaluation, Techniques for query optimization, strong and weak equivalence, cost base optimization, Heuristic-based optimization.
Contents for Desired Course Outcomes (If any): NIL
Text Book:
T1: Silberschatz A., Korth H.F., and Sudarshan S. Database System Concepts, 7th Edition, McGraw-Hill Education, 2020.
T2: Elmasri Ramez, Navathe Shamkant. Fundamentals of Database Systems, 7th Edition, Pearson Education, 2017.
Reference Books:
R1: Ullman, J.D.. Principles of Database Systems, 3rd Edition, Galgotia Publications, 1994.
R2: Ramakrishnan, and Gehrke. Database Management Systems, 3rd Edition, McGraw-Hill, 2003.

Course Code: AIP351
Course Title: DATABASE MANAGEMENT SYSTEMS LAB
Structure (L-T-P): 0-0-2
Course Prerequisite: NIL
Course Objectives
After completing the above course, student is expected to:
1. Understand the basics of database management systems and their applications.
2. Gain proficiency in SQL programming language and its application in manipulating data.
3. Develop skills in designing, implementing and maintaining a database.
4. Understand how database management systems can be used to solve real-world problems.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: Students get practical knowledge on designing and creating relational database systems.
CO2: Design, create and manipulate databases using SQL.
CO3: Create backups and recovery plans for a database.
CO4: Use database management systems to solve real-world problems.
CO5: Understand various advanced queries execution such as relational constraints, joins, set operations, aggregate functions, triggers, views and embedded SQL.
CO6: Use of various software to design and build ER Diagrams, UML, Flow charts for related database systems.
Desirable/Advanced (If any):
CO1: Evaluate the performance of a database management system.
CO2: Students will be able to design and implement database applications on their own.
Experiments for Essential Course Outcomes
1. Design and create a relational database system for a real-world scenario by identifying key entities, attributes, and relationships and designing necessary tables, fields, and constraints.
2. Use SQL to manipulate the database by performing tasks such as adding, deleting, updating records, and performing joins.
3. Create a backup and recovery plan for the database system to understand the importance of data backup and recovery in maintaining the integrity of a database.
4. Use advanced SQL queries such as relational constraints, set operations, aggregate functions, triggers, and views to manipulate and analyze data in a database.
5. Solve real-world problems using front and back end with database management systems: finding books (SQL aggregate), tracking patients (SQL queries with joins), managing inventory (SQL operations), analyzing sales data (SQL subqueries and joins), building recommendation systems (SQL queries and ML algorithms), detecting fraud (SQL queries and data analysis).
6. Use software tools to design and build ER diagrams, UML diagrams, and flowcharts for database systems to develop skills in using software tools to visualize and plan a database system.
7. Write a program to identify the highest normal form.
8. Write a program to check if the decomposed relations are loss or lossless.
9. Write a program to check if the decomposed relations preserve dependency or not.
10. Write a program to execute DML, DDL sql queries by using mysql database through front end.
11. Write a program to implement B and B+ tree storage structure.
12. Write a program to implement a dense and sparse index.
13. Implementation of query optimization techniques.
14. Implementation of locking protocol in concurrency control.
15. Implementation of timestamp based protocol in concurrency control.

Experiments for Desired Course Outcomes (If any)
1. Students can design and implement web applications that interact with databases using web frameworks.

Books/Material
T1. Silberschatz, A.,Korth, H.F. and Sudarshan, S.Database System Concepts, 6th ed., Tata McGraw-Hill, 2011.

T2. Elmasri Ramez, Navathe Shamkant. Fundamentals of Database Systems, 7th Edition, Pearson Education, 2017.

Reference Books

R1. Ullman, J.D.. Principles of Database Systems, 3rd Edition, Galgotia Publications, 1994.

R2. Ramakrishnan, and Gehrke. Database Management Systems, 3rd Edition, McGraw-Hill, 2003.

Course Code: AIL352

Course Title: ADVANCES IN MACHINE LEARNING

Structure (L-T-P): 3-0-0

Course Prerequisite: AIL257

Course Objectives

After completing the above course, student is expected to: Learn and understand recent advances in evolved machine learning such as VAEs, GANs and their applications in representative applications.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: Understand the range of neural network models.

CO2: Understand neural implementations of attention mechanisms and sequence embedding models and how these modular components can be combined to build NLP systems.

CO3: To choose a model to describe a particular type of data.

CO4: Be able to design and implement various machine learning algorithms in a range of real world applications.

Desirable outcomes (If any):

Contents for Essential Course Outcomes (If any)

Mathematics of machine learning, Overview of supervised, unsupervised, and multi-task techniques, Bayesian modelling and Gaussian processes, randomised methods, Bayesian neural networks, approximate inference, variational autoencoders, generative models, applications, Applications of machine learning in natural language processing: recurrent neural networks, backpropagation through time, long short term memory, attention networks, memory networks, neural Turing machines, machine translation, question answering, speech recognition, syntactic and semantic parsing, GPU optimisation for neural networks.

Contents for Desired Course Outcomes (If any):

Text Book:

T1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press 2012

T2. Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press 2016

Reference Books:

R1. Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. New York: springer, 2009.

R2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010.

Course Code: AIP352

Course Title: ADVANCES IN MACHINE LEARNING LAB

Structure (L-T-P): 0-0-2

Course Prerequisite: AIL257

Course Objectives

After completing the above course, student is expected to: Learn and understand recent advances in evolved machine learning such as VAEs, GANs and their applications in representative applications.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: Understand the range of neural network models.

CO2: Understand neural implementations of attention mechanisms and sequence embedding models and how these modular components can be combined to build NLP systems.

CO3: To choose a model to describe a particular type of data.

CO4: Be able to design and implement various machine learning algorithms in a range of real world applications.

Desirable outcomes (If any):

Experiments for Essential Course Outcomes (If any)

1. Implementation of Baysian Neural Networks for Domain Problems.
2. Implementation of Variational Autoencoders for Generation of Texts.
3. Implementation of Attention Mechanism for Object Classifications.
4. Demystifying ChatGPT for creating plugins in word processors or any similar applications.

Experiments for Desired Course Outcomes (If any):

Text Book:

T1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press 2012

T2. Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press 2016

Reference Books:

R1. Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. New York: springer, 2009.

R2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010.

Course Code: AIL353

Course Title: DATA SCIENCE

Structure (L-T-P): 3 0 0

Course Prerequisite: NIL

Students should have completed at least Computer Programming and Problem Solving.

Course Objectives:

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

1. Analyze a problem and Datasets for the domain under consideration.
2. Devise appropriate Data Science technique for solving the problem at hand.

Course Outcomes:

At the end of the course, students will be able to-

Essential:

CO1: To be able understand the basics of various Linear Algebra and Probabilities.

CO2: To be able to understand the concepts of Exploratory Data Analysis and Visualization

CO3: To be able to understand the concepts of Clustering and Classifications

CO4: To be able to analyze the problem and draw inferences for naïve problems.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction: Importance of Data Science, Data Science and Ethical Issues: Discussions on privacy, security, ethics., probabilistic distributions, univariate and multivariate normal distributions, Central Limit Theorem, hypothesis testing, confidence interval, Statistical modeling, Exploratory Data Analysis, Data Visualization, Basics of Learning, Gradient Descent, Regressions, Classification, Clustering, Testing-Evaluation-Validation of Models. Learning Networks: Perceptron, Multi-Layered Perceptrons(MLP), L1 and L2 Regularization, Cross Validation, Data Science vs Data Analytics.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.

T2. Christopher M. Bishop F.R.Eng., Pattern Recognition and Machine Learning, Springer.

Reference Books:

R1. Gilbert Strang, Introduction To Linear Algebra, WellesleyCambridge Press and SIAM, Fifth Edition (2016).

R2. Douglas Montgomery, Applied Statistic And Probability For Engineers, John Wiley & Sons, Inc., Third Edition.

R3. Deep Learning, An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville (http://www.deeplearningbook.org.)

R4. Jure Leskovec, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014. (free online)

Course Code: AIP353

Course Title: DATA SCIENCE LAB

Structure (L-T-P): 0 0 2

Course Prerequisite: Computer Programming and Problem Solving.

Course Objectives:

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

1. Analyze a problem and Datasets for the domain under consideration.
2. Devise appropriate Data Science technique for solving the problem at hand.

Course Outcomes:

At the end of the course, students will be able to-

Essential:

CO1: To be able to understand the concepts of Exploratory Data Analysis and Visualization

CO2: To be able to understand the concepts of Clustering and Classifications

CO3: To be able to analyze the problem and draw inferences for naïve problems.

CO4: To be able to implement Real time Classification using Anomaly Detection

Desirable/Advanced (If any):

CO5: To be able to analyze generic problems in Data Science and Implement a Solution.

Experiments for Essential Course Outcomes

1. Working with Numpy arrays and Pandas data frames
2. Develop Basic plots using Matplotlib
3. Develop Frequency distributions, Variability and Averages
4. Develop program for Normal Curves
5. Develop program for Correlation and scatter plots
6. Develop program for Correlation coefficient
7. Develop program Regression Techniques
8. Develop program for Clustering Techniques
9. Develop a python program for Decision Tree and Ensemble Trees.

Experiments for Desired Course Outcomes (If any)

10. Implementation of Fraud Detection through Anomaly Detection in Financial Data Sets
11. Implementation of Fraud Detection through Anomaly Detection in IDS

Books/Material

T1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from the Frontline. O'Reilly. 2014.

T2. Christopher M. Bishop F.R.Eng., Pattern Recognition and Machine Learning, Springer.

Reference Books

R1. Gilbert Strang, Introduction to Linear Algebra, WellesleyCambridge Press and SIAM, Fifth Edition (2016).

R2. Douglas Montgomery, Applied Statistic and Probability For Engineers, John Wiley & Sons, Inc., Third Edition.

R3. Deep Learning, An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville (http://www.deeplearningbook.org.)

R4. Jure Leskovec, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014. (free online)

Course Code: AIL354

Course Title: INFORMATION AND NETWORK SECURITY

Structure (L-T-P): 3-0-0

Course Prerequisite: CSL 255, CSL252

Course Objectives

To develop an ability to learn underlying principles of cryptography and network security by developing the mathematical tools required to understand the topic of cryptography to design and analyze cryptographic protocols to ensure a secure computing environment.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: Understand the basic concepts of cryptography and network security paradigm.

CO2: Analyze the vulnerabilities in the computing system and apply the security solution.

CO3: Compare and analyze different symmetric and asymmetric encryption algorithms.

CO4: Understand and comprehend the basis of hashing algorithms and requirements.

CO5: Design and implement the algorithm, considering the issues like confidentiality, integrity, authentication, non-repudiation, security and privacy.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction: Introduction to information security, network security model, security attacks, security services and mechanism. Introduction to cryptography, role of cryptography in information and network security, Number theory for cryptography: prime numbers and modular arithmetic, algebraic structures like group, ring and field, polynomial arithmetic over GF(), Euclidean algorithm, Euler's phi function, Fermat's and Euler's theorems, Chinese remainder theorem and Discrete logarithms. Classical Ciphers: monoalphabetic, polyalphabetic and transposition ciphers. Security analysis of Classical ciphers. Modern stream and block

ciphers: design principles of stream and block ciphers, block mode of operations, Feistel network and modern block ciphers. Pseudorandom number generations and stream ciphers, Asymmetric Key Cryptosystems: Introduction to public key cryptography, mathematical intractable problems, RSA cryptosystem, discrete logarithm problem and Diffie-Hellman key exchange, ElGamal cryptosystem, cryptanalysis of public key cryptosystems, Cryptographic Hash Functions: Introduction, random oracle model, security of hash functions, Merkle–Damgard construction and iterative hash functions, message authentication codes and digital signature schemes, Key Management and Distribution: Symmetric key distribution using symmetric & asymmetric encryption, distribution of public Keys, Kerberos, digital certificate and Public Key Infrastructure, Network and Transport-level Security: IPSec, Web security considerations, Secure Socket Layer and Transport Layer Security, HTTPS, Secure Shell (SSH), Wireless Network Security: Wireless Security, Mobile Device Security, IEEE 802.11 Wireless LAN, IEEE 802.11i Wireless LAN Security, EMail Security: Pretty Good Privacy, S/MIME.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Forouzan, B.A. and Mukhopadhyay, Debdeep, Cryptography and Network Security, 2nd ed., Tata McGraw Hill, 2013.

T2. Stallings, W., Cryptography and Network Security: Principles and Practice, 7th ed., Pearson, 2017.

Reference Book:

R1. Mao W., Modern Cryptography Theory and Practice, 3rd ed., Prentice Hall PTR, 2003.

R2. Stinson, D.R., Cryptography: Theory and Practice, 4rd ed., Chapman and Hal CRC Press, 2019.

R3. Menezes, A.J., Oorschot, P.C.V. and Vanstone, S.A., Handbook of Applied Cryptography, 5th ed., CRC Press, 2001.

R4. Kaufman, C., Perlman, R. and Speciner, M., Network Security: Private Communication in a Public World, 2nd ed. Prentice Hall, 2010.

Course Code: AIP354

Course Title: INFORMATION AND NETWORK SECURITY LAB

Structure (L-T-P): 0-0-2

Course Prerequisite: Nil.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to: Identify the security issues in the network and resolve it. Analyze the vulnerabilities in any computing system and hence be able to design a security solution. To have the ability to compare merits and demerits of different cryptographic techniques and take decision while securing a network.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Implement and validate number theoretic algorithms and classical cryptosystem.

CO 2.Use number theoretic algorithms in design and implementation of cryptographic protocols.

CO 3.Implement symmetric and asymmetric cryptographic algorithms.

CO 4.Design and implement authentication and key exchange protocols.

CO 5.Design and Implement cryptographic tools

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Implement various number theory algorithms like Euclidean and extended, Euclidean algorithms, modular arithmetic over, Polynomial arithmetic over GF(), Chinese Remainder Theorem (CRT), etc.
2. Implementation, testing and finding attacks on various classical ciphers like Affine, Playfair, Hill Cipher, etc.
3. Implementation of various modern block ciphers and stream ciphers like DES, AES, RC4, A5/1, etc.
4. Implementation of cryptographic hash functions.
5. Implementation of public key cryptosystems and digital signature algorithms like RSA, ElGamal, DSS, etc.
6. Implementation of Diffie-Helman key exchange, station to station key agreement and MAC protocols.
10. Other experiments related to the course content of CSL354- Information and Network Security.

Experiments for Desired Course Outcomes (If any)

1. Experiments to extend the existing tow party Diffie-Hellman protocol for multiparty.
2. Implementation of Shamir Secret Sharing Scheme.

Book/Material

T1. Forouzan, B.A. and Mukhopadhyay, Debdeep, Cryptography and Network Security, 2nd ed., Tata McGraw Hill, 2013.

T2. Stallings, W., Cryptography and Network Security: Principles and Practice, 6th ed. Pearson, 2014.

Reference Books

R1. Schneier, B., Applied Cryptography: Protocols, Algorithms and Source Code in C, 2nd ed., Wiley-India, 2007.

R2. Stinson, D.R., Cryptography: Theory and Practice, 3rd ed., Chapman and Hal CRC Press, 2006.

R3. Menezes, A.J., Oorschot, P.C.V. and Vanstone, S.A., Handbook of Applied Cryptography, 5th ed., CRC Press, 2001.

R4. Kaufman, C., Perlman, R. and Speciner, M., Network Security: Private Communication in a Public World, 2nd ed., Prentice Hall, 2010.

Course Code: AIL355

Course Title: FUNDAMENTALS OF DATA ANALYTICS

Structure (L-T-P): 3-0-0

Course Prerequisite: NIL

Course Objectives

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Understand the basic concepts of the Statistics

CO2. Understand Classification, Clustering and Regression

CO3. Understand the applications data science concepts in Big Data

CO4. Able to perform data analytics using models in Machine Learning

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Descriptive and Inferential Statistics: Introduction, Descriptive

Plotting tools for displaying and visualizing data; advanced programming tools such as Perl and Python, Probability recap, Data quality, data cleaning, Relational data, No SQL, regression, SVD and PCA, Clustering,

Classification, Support Vector Machines model, non-linear classification, Weka toolkit, Bloom Filters, Sketches, Summaries, Data Sharing, Privacy, Anonymization and Risks, k-anonymity, and differential privacy, Social Network Analysis, metrics, relational learning, Measurements of centrality and importance, Recommendations in social networks, and inference via relational learning, Challenges for big data analytics Prescriptive analytics: Creating data for analytics through designed experiments, creating data for analytics through Active learning, creating data for analytics through Reinforcement learning.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. New York: springer, 2009.

T2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010.

Reference Books

R1: Storytelling with Data: A Data Visualization Guide for Business Professionals by Cole Nussbaumer Knaflic

R2: Python for Everybody: Exploring Data in Python by Dr. Charles Russell Severance

Course Code: AIP355

Course Title: DATA ANALYTICS USING R

Structure (L-T-P): 3-0-0

Course Prerequisite: NIL

Course Objectives

Students should be able to exploit optimizations in unconstrained and constrained contexts. He should be able to apply game theory and queuing theory for problems in AI.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: To be able to understand LP paradigm and applications of Solution approaches to LP problem

CO2: To be able to understand Network Models and solve basic network problems

CO3: To be able to understand pure and mixed Integer Problems

CO4: To be able to understand Queuing Theory and Game Theory

Desirable/Advanced (If any):

Experiments for Essential Course Outcomes

6. To Work in the Console and perform basic operations such as Arithmetic Operators - Logical Operations - Using Functions - Getting Help in R and Quitting R Studio Installing and loading packages. Data structures, variables, and data types in R: Creating Variables - Numeric, Character and Logical Data - Vectors - Data Frames - Factors -Sorting Numeric, Character, and Factor Vectors - Special Values
7. Implementing Data Visualization using R: Scatter Plots - Box Plots - Scatter Plots and Box and-Whisker Plots Together -Customize plot axes, labels, add legends, and add colors.
8. Implementing Descriptive statistics in R: Measures of central tendency - Measures of variability - Skewness and kurtosis - Summary functions, describe functions, and descriptive statistics by group.
9. Testing of Hypothesis using R: T-test, Paired Test, correlation, Chi Square test, Analysis of Variance and Correlation
10. Predictive Analytics: linear Regression model, Non-Linear Least Square, multiple regression analysis, Logistic Regression, Panel Regression Analysis, ARCH Model, GARCH models, VIF model
11. Implementation of Reinforcement Learning using packages of R.

Experiments for Desired Course Outcomes (If any): NIL

Text Books

T1: Taha, H.A. Operations Research, 5th ed., Macmillan Publishing Company, 1992.

T2: Kanth, K. Introduction to Computer System Performance Evaluation, McGraw Hill, 1992

Reference Books

R1: Mustafi, C. K. Operations Research, 4th ed., New Age International, 2009

R2: Hadley G. Linear Programming, Narosa Publishers, 1997

R3: Hillier F. and G. J. Liebermann. Operations Research, Holder Day Inc, 1974.

R4: Mohapatra, P.K.J. Introduction to System Dynamics Modelling, 1st ed., Universities Press, 1994.

R5: Schaum Outline Series. Operations Research, 2nd ed., Tata McGraw Hill, 2003.

R6: Smith, David K. Network Optimization in Practice. Ellis Harwood Publications, 1982.

Course Code: AIL356

Course Title: INTRODUCTION TO DEEP LEARNING

Structure (L-T-P): 3-0-0

Course Prerequisite: NIL

Course Objectives

After completing the above course, student is expected to: Learn Deep

Learning Models and application perspectives of Deep Learning to varied Applications.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: To understand the Neural Networks

CO2: To understand the Neural Network architectures such as CNNs

CO3: To understand the Popular RNNs

CO4: To understand the GANs

Desirable outcomes (If any):

Contents for Essential Course Outcomes (If any)

Introduction to Deep Learning, Neural Networks, building blocks of deep learning, Training of Neural Networks, Deep learning models vs machine learning models, Convolutional Neural Networks, building blocks of CNNs, CNN architecture, Example CNN architectures, Recurrent Neural Networks (RNNs), building blocks of RNNs and other architectural details, special RNN architectures: GRU, LSTM, Seq2Seq models, Attention mechanism, Adversarial Learning Models, Generative Models vs discriminative models, Architecture and training of Generative Adversarial Networks (GANs), Adversarial attacks on Neural Networks

Contents for Desired Course Outcomes (If any):

Text Book:

T1: Deep Learning, An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville (http://www.deeplearningbook.org.)

T2: Deep Learning From Scratch: Building with Python from First Principles by Seth Weidman published by O`Reilley

Reference Books:

R1: Hands-on machine learning with Scikit-learn Keras and TensorFlow by Aurelion Geron published by O` Reilley

R2: Grokking Deep Reinforcement Learning, by Miguel Morales

Course Code: AIL357
Course Title: DIGITAL IMAGE PROCESSING
Structure (L-T-P): 3 0 0
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course:
The objective of the course is to provide the knowledge about the digital image processing concepts, image enhancement techniques, filtering operations on image in spatial and frequency domain, image morphology, image segmentation & color image processing.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Understand the fundamental concepts of a digital image processing system.
CO2. Apply and evaluate the techniques for image enhancement in the spatial and frequency domain.
CO3. Students will have the knowledge about image restoration and morphology.
CO4. Students will learn about image segmentation and color image processing techniques.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
DIGITAL IMAGE FUNDAMENTALS: Overview of Image Processing, Digital Image Representation, Sampling, Quantization, Basic relationships between pixels, Labeling of connected components. IMAGE ENHANCEMENT IN SPATIAL DOMAIN: Some basic gray level transformations, Histogram processing, Smoothing and sharpening spatial filters. IMAGE ENHANCEMENT IN FREQUENCY DOMAIN: Smoothing and Sharpening frequency domain filters, Homomorphic filtering. IMAGE RESTORATION: Noise models, Restoration in the presence of noise only-spatial filtering, Estimating the degradation functions, Inverse filtering. MORPHOLOGICAL IMAGE PROCESSING: Dilation and erosion, Opening and closing, Some basic morphological algorithms. IMAGE SEGMENTATION: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation. COLOR IMAGE PROCESSING FUNDAMENTALS: Color fundamentals and models, pseudo color image processing, basics of full color image processing, color transformations, smoothing and sharpening.
Syllabus for Desired Course Outcomes (If any): NIL
Text Books
T1. Gonzalez and Woods. Digital Image Processing, Pearson, Fourth Edition.
T2. A. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1st Edition, 1988.
Reference Books
R1. J.C. Russ," The Image Processing Handbook", (5/e), CRC, 2006.
R2. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", 2nd Edition, Thomson, 2007.2010.
R3. S. Sridhar, Digital Image Processing', Oxford University Press, Second Edition, 2012.
R4. Sanjit Mitra, Digital Signal Processing: A Computer Based Approach', TataMcGraw Hill, 3rd Edition.

Course Code: AIP357
Course Title: DIGITAL IMAGE PROCESSING LAB
Structure (L-T-P): 0 0 2 1
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, students are expected to: Work on gray scale and color images for image enhancement, restoration and segmentation.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Understand the representation, manipulation, and use of histograms in digital images.
CO2. Able to apply the various transforms on the image to convert it into frequency domain.
CO3. Able to utilize and compare various linear and nonlinear filters in spatial and frequency domain.
CO4. Understand the basics of working with color images.
CO5. Understand the various segmentation techniques.
Desirable/Advanced (If any): NIL
Experiments for Essential Course Outcomes
1. Implementation of pixel wise transformation of given image using image negative, logarithmic transformation and gray level slicing.
2. Display the bit planes of an image.
3. Use of histogram equalization for contrast enhancement of a given image.
4. Apply low pass filters for Image smoothing.
5. Apply High pass filters for Image sharpening.
6. Conversion of image from spatial domain to frequency domain by applying the Discrete Cosine Transform (DCT).
7. Implementation of image smoothing using low pass frequency domain filters.
8. Implementation of image smoothing using high pass frequency domain filters.
9. Apply the image morphological operations on binary and gray scale images.
10. Apply the edge detection techniques like canny edge detection on the given image.
11. Conversion of image from one color space to another.
12. Histogram equalization of color image.
13. Noise removal from gray scale and color images.
Experiments for Desired Course Outcomes (If any): NIL
Text Books
T1. Lab Manual
T2. Digital Image Processing using Matlab, Rafeal C.Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson Education.
T3. Digital Image Processing, Rafeal C.Gonzalez, Richard E.Woods, Second Edition, Pearson Education/PHI.
Reference Books

R1. Image Processing, Analysis, and Machine Vision, Milan Sonka, Vaclav Hlavac and Roger Boyle, Second Edition, Thomson Learning.
R2. A. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1st Edition, 1988.
R3. S. Sridhar, Digital Image Processing', Oxford University Press, Second Edition, 2012.
R4. A. Anand Kumar, Digital Signal Processing', PHI Learning Pvt. Ltd. 2013.

Course Code: AIL358
Course Title: WEB TECHNOLOGIES
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, students are expected to: Implement a website or portal with optimal selection of component technologies for both, frontends and backends.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To understand the web fundamentals
CO2: To understand web services and technologies
CO3: To understand various tools for components and functionalities in websites
CO4: To optimize the basic functionality and diversify the application domain
Desirable outcome (if any)
Syllabus for Essential Course Outcomes
Planning and designing a website, maintaining view state, connecting and hosting database, choosing a web server for hosting, domain name registration, configuration and optimization settings, promotion and maintenance of website Uniform Resource Locators (URLs) & Web Browser, Semantic Web applications and services, Semantic Search, e-learning, Semantic Bioinformatics, Knowledge Base, XML Based Web Services, Creating an OWL-S Ontology for Web Services, Semantic Search Technology, Web Search Agents and Semantic Method, Web technologies: Terminology & Applications; Active X Components, XML, Chat applets, Ajax, Servlet, Java Beans, J2ME, SQL, Ftp Android: Ice cream Sandwich, Jellybean Peer to Peer and Cloud Network, Social Network Analysis, development of the social networks analysis, Electronic Sources for Network Analysis –Electronic Discussion networks, Blogs and Online Communities, Web Based Networks. Building Semantic Web Applications with social network features.
Text Books:
T1.J .Davies, R.Studer, P.Warren. Semantic Web Technologies, Trends and Research in Ontology Based Systems, John Wiley & Sons, 2006.
T2. Liyang Yu. Introduction to Semantic Web and Semantic Web Services, CRC Press, 2007.
Reference Books:
R1. Heiner Stuckenschmidt, Frank Van Harmelen. Information Sharing on the semantic Web, Springer Publications, 2005.
R2.T. Segaran, C.Evans, J.Taylor. Programming the Semantic Web, O"Reilly, 2009.

Course Code: AIL359
Course Title: INFORMATION RETRIEVAL
Structure (L-T-P): 3 0 0 3
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course:
Students will be able to use the data structures like inverted indices to develop the IR system. Learn techniques for compression of index, dictionary and its posting. Will be able to analyze the performance of IR systems.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Students will know the fundamentals of Information Retrieval.
CO2. Understand and be able to use the data structures, such as inverted indices, used in information retrieval systems.
CO3. Understand the various methods for compressing an index, dictionary and its posting lists.
CO4. Learn how to compute scores in a complete search system and measure the effectiveness of the IR systems.
CO5. Learn the probabilistic model, language model and various machine learning approaches in Information retrieval systems.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Boolean retrieval, the term vocabulary and postings lists, Dictionaries and tolerant retrieval, Introduction to index-construction and index-compression. Scoring, term weighting and the vector space model, Computing scores in a complete search system, Evaluation in information retrieval, Introduction to Relevance feedback and query expansion. Probabilistic information retrieval, review of basic probability theory, the probability ranking principle, the binary independence model, Language models for information retrieval, Language modeling versus other approaches to IR, Text classification and Naive Bayes, Bayesian Network approaches to IR. Vector space classification, Support vector machines and machine learning on documents, Flat clustering, Hierarchical clustering, Matrix decomposition and latent semantic indexing. Introduction to Web search basics, Web crawling and indexes, Link analysis.
Syllabus for Desired Course Outcomes (If any): NIL
Text Books
T1. Manning, C.D., Raghavan, P. and Schutze, H.,Introduction to Information Retrieval, Cambridge University Press, England, 2012.
T2. Buttcher, S., Clarke, C.L.A. and Gordon V Cormack, Information Retrieval: Implementing and Evaluating Search Engines, MIT Press, 2010.
Reference Books
R1. Grossman, D.A. and Ophir, F.,Information Retrieval: Algorithms and Heuristics, Springer, 2013.
R2. Frakes, W.B., Pearson, Information Retrieval: Data Structures and Algorithms, Prentice Hall, 2002.
R3. Soumen Chakrabarti, Mining the Web, Morgan-Kaufmann Publishers, 2002
R4. Bing Liu, Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, Springer, Corr. 2nd printing edition, 2009

Course Code: AIL360

Course Title: NEURO-FUZZY TECHNIQUES
Structure (L-T-P): 3-0-0-3
Course Prerequisite: NIL
Course Objectives
After completing the above course, student is expected to:
The main objective of this course is to provide the student with the basic understanding of neural networks and fuzzy logic fundamentals.
Course Outcomes
At the end of the course, students will be able to-
Essential
CO1. Identify different neural network architectures, their limitations and appropriate learning rules for each of the architectures.
CO2. Demonstrate knowledge and understanding of fuzzy systems as they apply in engineering and science.
CO3. Identify and Apply Artificial Neural Network & Fuzzy Logic models in building intelligent machines to handle uncertainty and solve engineering problems.
CO4. Integrate neural network and fuzzy logic to extend the capabilities for efficient and effective problem solving methodologies.
Desirable Outcomes (if any): NIL
Syllabus for Essential Course Outcomes
Neural Networks: History, overview of biological Neural-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks. Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Application of Fuzzy Logic: Medicine, Economics etc. Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks Genetic Algorithm: An Overview of GA, GA operators, GA in problem solving, Implementation of GA.
Syllabus for Desirable Course Outcomes
Text Books:

T1. Haykin, S.S., Neural Networks and Learning Machines, 3rd ed., PHI Learning, 2013.

T2. Ross, T.J., Fuzzy Logic with Engineering Applications, 3rd ed., John Wiley & Sons, 2013.

Reference Books:

R1. Aliev, R.A. and Aliev, R.R., Soft Computing and its Applications, World Scientific, 2001.

R2. Kosko, B., Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence, Prentice-Hall of India, 1994.
R3. Yegnanarayana, B., Artificial Neural Networks, Prentice Hall of India, 2006.

R4. Jang, J-S.R., Sun, C-T. and Mizutani, E., Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, PHI Learning, 2010.

R5. Hertz, J.A., Krogh, A. and Palmer, R.G., Introduction to the Theory of Neural Computation, Addison Wesley, 1999.Mehrotra, K., Mohan, C. K. and Ranka, S., Elements of Artificial Neural Networks, Penram International Publishing,1997.

Course Code: AIL451
Course Title: REAL-TIME SYSTEMS
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives
The objective of the course is to provide the student with the basic understanding of Real-Time Systems and various Job Scheduling fundamentals.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Identify different types of real-time systems, timing constraints, and reference models of real-time systems.
CO2. Demonstrate knowledge and understanding of precedence constraints & dependencies, scheduling Hierarchy, various scheduling approaches, and Optimality of EDF and LST.
CO3. Identify and Apply various real-time scheduling approaches in building various kinds of real-time systems to handle uncertainty and solve engineering problems.
CO4. Demonstrate knowledge and understanding of multiprocessor scheduling including job priority scheduling.

Desirable outcome (if any)
Syllabus for Essential Course Outcomes
Real time applications: Hard and soft real time systems, timing constraints, A Reference model of Real-time systems, temporal parameters, precedence constraints & dependencies, scheduling Hierarchy, Commonly used approaches to scheduling, cyclic and priority drive approaches, Optimality of EDF and LST. Clock Driven Scheduling: Static timer driven scheduler, Cyclic Executives, Improving Average Response times of Aperiodic Jobs, Scheduling Sporadic jobs, Practical Considerations, Pros and Cons of Clock Driven Scheduling Priority-driven scheduling of periodic tasks: Fixed Priority vs Dynamic Priority schemes, Maximum schedulable Utilization, Optimality of the RM and DM algorithms, As Schedulable Test for Fixed Priority Tasks, Practical Factors. Scheduling Aperiodic and Sporadic Jobs in Priority-driven scheduling: Deferrable Servers, Sporadic Servers, Constant Utilization. Total Bandwidth, and Weighted Fair-Queuing Servers, multiprocessor scheduling, Scheduling of Sporadic Jobs.

Text Book:

T1. Liu, J.W.S., Real-Time Systems, Pearson Education, 2013.
Reference Book:

R1. Krishna, C.M. and Shin, K.G., Real Time Systems, 3rd ed.,Tata McGraw Hill, 2010

Course Code: AIL361

Course Title: THEORY OF COMPUTATIONS
Structure (L-T-P): 3 0 0
Course Prerequisite: - Data Structures
Course Objectives
The objective of the course is to provide fundamental knowledge about how to solve various computational problems using Automaton.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. Outline the concept of Finite Automata and Regular Expression.
CO2. To understand Context-Free Grammars (CFG) and their different forms of representation.
CO3. Demonstrate the push down automaton model for the given language.
CO4. Make use of the Turing machine concept to solve the simple problems.
CO5. Explain decidability or undecidability of various problems.
Desirable/Advanced (If any): NIL
Contents for Essential Course Outcomes (If any)
Introduction: Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.
Regular languages and finite automata: Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions, nondeterministic finite automata (NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages, pumping lemma for regular languages, minimization of finite automata.
Context-free languages and pushdown automata: Context-free grammars (CFG) and languages (CFL), Chomsky and Greibach normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, parse trees, ambiguity in CFG, pumping lemma for context-free languages, deterministic pushdown automata, closure properties of CFLs.
Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.
Turing machines: The basic model for Turing machines (TM), Turing-recognizable (recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines, TMs as enumerators.
Undecidability: Overview of Church-Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice s theorem, undecidable problems about languages.
Contents for Desired Course Outcomes (If any): NIL
Text Book:
T1. Martin, J.C., Introduction to Languages and the Theory of Computation, 3rded., Tata McGraw Hill, 2014.
T2. Michael Sipser, Introduction to the Theory of Computation. Cengage Learning, 2013.
Reference Book:
R1. Hopcroft, J.E., Motwani, R. and Ullman, J.D., Introduction to Automata Theory, Languages and Computation, 3rd ed., Pearson Education, 2014.
R2. K. L. P. Mishra, N. CHANDRASEKARAN, Theory of Computer Science Automata, Languages and Computations.

Course Code: AIL362
Course Title: DATA COMMUNICATION
Structure (L-T-P): 3-0-0

Course Prerequisite: CSL151
Course Objective
Data Communication course aims at the following educational objectives:
To become familiar with the fundamental concepts of data communication as well as the relevant state-of-the-art.
Able to analyze concepts of error detection in data communication, encoding, modulation and transmission of data through various modems, clock-based framing, integrated services digital network (ISDN).
To understand the basics of Networking Protocols.
Course Outcomes (COs): At the end of the course, students will be able to-
CO1: Ability to analyze data communication and core concepts of open system interconnection (OSI) and TCP/IP reference models.
CO2: Ability to demonstrate knowledge on Analog and Digital signals, Digital transmission, Analog transmission, Multiplexing, and Transmission Media.
CO3: Ability to analyze the concept of Error Detection and Correction, DTE-DCE Communication, DTE-DCE Interface, Modems, and various Encoding Processes.
CO4: Ability to use the basic concepts of Data Communication.
Desirable/Advanced (If any): NIL
Contents:
Introduction to data communication and networking, OSI and TCP/IP protocol suit, Analog and Digital signals, Digital transmission, Analog transmission, Multiplexing (Frequency division Multiplexing, Wavelength division Multiplexing, Time division Multiplexing, Multiplexing applications), transmission media (Guided Media, Unguided Media, Transmission Impairments, Performance Wavelength , Shannon Capacity , Media Comparison, PSTN , Switching), Error Detection and Correction, DTE-DCE Communication (Digital data transmission, DTE-DCE Interface, Modems, 56K Modems , Cable Modems), Encoding (NRZ, NRZI, Manchester, Differential Manchester, 4B/5B), Clock based framing, Integrated services digital network (ISDN), Introduction to networks.
Syllabus for Desired Course Outcomes (If any): NIL
Text Books:
T1. Data communication & Networking by Bahrouz Forouzan.
T2. Computer Networks by Andrew S. Tanenbaum.
T3. Forouzan, B.A., Data Communications and Networking, 5thed.Tata
McGraw- Hill, 2013.
Reference Books:
R1. Stallings, W., Data and Computer Communications, 10th ed., Pearson
Education, 2014.

Course Code: AIL363
Course Title: SOFTWARE ENGINEERING
Structure (L-T-P): 3 0 0 3

Course Prerequisite: CSL256

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

Understand the Software Engineering Practices for software Design, development and testing along with Software Project Management.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Understand the software development life cycle and Prepare SRS document for a project.

CO2. Able to apply software design and development techniques to construct the various software systems.

CO3. Able to implement the various testing methods at each phase of SDLC.

CO4. Analyze and Apply project management techniques for a software solution.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction to Software Engineering, software Characteristics, software life-cycle models, process models, software project management, software configuration management, software requirements specifications, software architecture, software design, function-oriented software design, object-oriented design, UML modeling, user interface design, software implementation, software testing, verification and validation, Software Quality Frameworks, ISO 9001 Model, SEI-CMM Model, Software reliability and fault tolerance, software metrics.

Syllabus for Desired Course Outcomes (If any): NIL

Text Books

T1. Roger Pressman, Software Engineering: A Practitioner‘s Approach", McGraw-Hill Publications

T2. Sommerville, I., Software Engineering, 9thed.,Pearson Education 2013

Reference Books

R1. Singh,Y.,Software Testing, Cambridge University Press, 2013.

R2. Aho, A.V., and Ullman, J.D., Principles of Compiler Design, Narosa Publishing House, 2002

R3. Pankaj Jalote, "An integrated approach to Software Engineering", Springer/Narosa.

R4. Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall India.

Course Code: AIP364

Course Title: SOFTWARE ENGINEERING LAB

Structure (L-T-P): 0 0 2 1

Course Prerequisite: NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

Develop the well documented software by working in a team and using the principles of software engineering in a phased manner like SRS document preparation, design, coding, testing and Maintenance.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Preparation of Software Requirement Specification document

CO2. Preparation of Design Document using UML

CO3. Implementation of Design document to executable programs using coding techniques

CO4. Preparation of test cases to perform testing

CO5. A well-documented Software

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. A project group with 2-3 students is formed and a small Software Project is assigned to the group.
2. Group is required to prepare a thorough problem statement for the assigned project and find a suitable process model for developing the software. The output of each phase has to be submitted by the students in the form of a phase outcome/deliverables after performing the required activities in each phase within a given time line.
3. Software Requirement Specification (SRS) document is required to be prepared for the project.
4. Utilize a project management tool to create a project schedule.
5. Use the UML to develop the use case and class diagram after identifying potential scenarios for the project.
6. Prepare the activity and state transition diagram.
7. Prepare sequence and collaboration diagram.
8. Write the code using proper coding standards and guidelines.
9. Develop the test cases to perform the White box and Black box testing.
10. Prepare the software usage manual as an external document.
11. After completion of the project, each group has to submit the project report.

Experiments for Desired Course Outcomes (If any): NIL

Text Books

T1. Roger Pressman, Software Engineering: A Practitioner‘s Approach", McGraw-Hill Publications.

T2. Martin Fowler, UML Distilled: A Brief Guide To The Standard Object Modeling Language, 3rd Edition, Pearson.

Reference Books

R1. Singh,Y.,Software Testing, Cambridge University Press, 2013.

R2. Jibitesh Mishra and Ashok Mohanty, Software Engineering, Pearson.

Course Code: AIL365

Course Title: COMPILER DESIGN

Structure (L-T-P): 3 0 0

Course Prerequisite: Theory of Computation

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

1. Students should be able to understand the need and concepts behind Compilers.
2. Students should be able to understand the implementation details of a Compiler.

Course Outcomes:
At the end of the course, students will be able to-
Essential:
CO1: To be able understand the basics of Lexical and Syntactical Analysis in a Compiler Design.
CO2: To be able to Symbol Table, Semantic Analysis and Error Handling Concepts in Compilers.
CO3: To be able to understand code optimization and generation in the context of underlying Hardware Machine.
CO4: To be able to analyze the recent requirements and implement new improvements.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Introduction to compilers, compilers and translators, phase structure of a typical compiler, Number of passes, ideas about lexical analysis, syntax analysis, code optimization and code generation, design of lexical analyzer. Syntax specification of programming languages**,** Design of top-down parser, bottom up parsing technique, LR parsing algorithm, Design of SLR, LALR,LR parsers. Dealing with ambiguity of the grammar. Study of syntax directed definitions and syntax directed translation schemes as notational framework to specify the translations. Using syntax directed translation schemes for translation of expressions, controls structures, declarations, procedure calls. Symbol table management, Error detection and recovery, error recovery in LR parsing, error recovery in LL parsing, Automatic error recovery in YACC Introduction to Important code optimization techniques, loop optimization, control flow analysis, data flow analysis, setting up data flow equations to compute reaching definitions, available expressions, Live variables. Problems in code generation, simple code generator code generation from DAG, Peephole optimization.
Contents for Desired Course Outcomes (If any): NIL
Text Book:

T1: Aho, A.V., and Ullman, J.D., Principles of Compiler Design, Narosa Publishing House, 2002.
T2: Modern Compiler Implementation in C/Java" by Andrew W Appel, 2004
Additional Books:
R1: Holub, A.I., Compiler Design in C, Prentice-Hall of India, 2006.

R2: Fischer, C.N., Cytron, R.K. and LeBlanc, R.J., Crafting a Compiler, Addison Wesley, 2010.

Course Code: AIL451
Course Title: GEO INFORMATICS
Structure (L-T-P): 3 0 0 3
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, students are expected to: Understand the Important Geographical Aspects that need IT support for easy availability and support Geotagging, Navigation. Able to make informed decisions with reference to Geographical Concepts in Applications.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To introduce use of computer in mapping, GIS, components, data structure, modeling, DBMS
CO2: To learn about encoding methods and editing of data
CO3: To know various capabilities of GIS
CO4: To study about various models of GIS
CO5: To understand working GIS and SDSS
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Basic Concepts about spatial information, Philosophy and definition of GIS, features, pictures, variables: points, lines, areas, Position on the earth; Basics of map. Fundamentals of Data Storage, Information Organization and Data Structure Basic File Structures; Tabular Databases; Advantages of Databases, Types of Databases- hierarchical systems, network systems, relational systems and Object-oriented database systems (OODS), Data Models-Entity Relationship model, Relational Model, Data Structures; Raster Structures, Vector Structures, GIS Data Requirement, sources and collection, Methods of data capture-scanning, digitization and associated errors, Conversion from Other Digital Sources, Attribute data input and management, Edge matching, creating digital data -remote sensing; generating data from existing data ; Metadata ;Different Kinds of geospatial data, Detecting and Evaluating Errors, Data Quality Measurement and Assessment, digital output options.Image storage formats, Data retrieval, Data compression, NSDI,GSDI; geographic information in decision making; human resources and education; Interactive data exploration, Vector & Raster data query, Geographic visualization; Raster data and structure, Local operations, Neighborhood operations, Zonal operations, Distance measure operations, Spatial auto correlations, DEM generation, Spatial Modeling, combining data; terrain mapping finding and quantifying relationships; spatial interpolation; Vector database, Topological Relationships; Creation of Topology and Error Correction; Accuracy and Precision; The Importance of Error, Accuracy, and Precision, types of error, sources of error, data quality, Spatial interpolation, Overlay Operations and Buffering, Neighborhood functions Distant Measurement , Map Manipulation, Network analyses, GIS and Remote Sensing data Integration, Thematic Mapping , GIS and Integration of other types of data, Virtual GIS and SDSS, Project design and management, need assessment
Text Books:
T1. Kang-tsung Chang 2002, 'Introduction to Geographic Information Systems' Tata McGraw Hill, New Delhi.
T2. C.P.Lo and Albert K.W.Yeung 2005 "Concepts and Techniques of Geographic Information Systems" **Prentice Hall of India,New Delhi.**
Reference Books:
R1. Burrough, Peter A. and Rachael McDonnell,1998, ' Principles of Geographical Information Systems' Oxford University Press, New York.
R2. Magwire, D. J., Goodchild, M.F. and Rhind, D. M. Ed. 1991,'Geographical Information Systems: Principles and Applications, Longman Group, U.K.

Course Code: AIL452
Course Title: CLOUD COMPUTING
Structure (L-T-P): 3 0 0 3
Course Prerequisite: NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

Understand the benefits of migrations to Cloud Service Providers

Able to make informed decisions with reference to Cloud Computing adoption

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1: To be able understand basics of virtualization, Services and Deployment Models

CO2: To be able to understand Cloud Enabling Technologies such as Map Reduce, Hadoop etc.

CO3: To be able to analyze the small and large industry's perspective and their cloud requirement

CO4: To be able to propose industry grade solutions for small and large industries using available cloud standards such as MongoDB, AWS, Azure etc.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Contents: Overview of Computing Paradigm- Recent trends in Computing: Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud computing; Evolution of cloud computing Business driver for adopting cloud computing Cloud Computing Architecture- Cloud computing stack: Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services; Service Models (XaaS), Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Deployment Models: Public cloud, Private cloud, Hybrid cloud, Community cloud Service Management in Cloud Computing: Service Level Agreements (SLAs), Billing and Accounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling: Benefitting Enormously, Managing Data: Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing. Cloud Security- Infrastructure Security, Network level security, Host level security, Application level security, Data security and Storage, Data privacy and security Issues, Jurisdictional issues raised by Data location, Identity & Access Management, Access Control, Trust, Reputation, Risk Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations Introduction to Big Data- Distributed file system–Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce. Introduction to Hadoop and Hadoop Architecture: Data – Apache Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce -Data Serialization NoSQL- What is it?, SQL vs NoSQL, NewSQL Data Base for the Modern Web- Introduction to MongoDB key features, Core Server tools, MongoDB through the JavaScript's Shell, Creating and Querying through Indexes, DocumentOriented, principles of schema design, Constructing queries on Databases, collections and Documents , MongoDB Query Language.

Contents for Desired Course Outcomes (If any)

Text Books

T1: Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010 2.

T2: Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley, 2011

T3: Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012

T4: Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India, 2010

Reference Book:

R1: Boris Iublinsky, Kevin t. Smith, AlexeyYakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.

R2: Chris Eaton,Dirk derooset al. , "Understanding Big data ", McGraw Hill, 2012.

R3: BIG Data and Analytics , Sima Acharya, Subhashini Chhellappan, Willey

Course Code: AIL453

Course Title: PUBLIC KEY INFRASTRUCTURE AND TRUST MANAGEMENT

Structure (L-T-P): 3-0-0

Course Prerequisite: CSL354

Course Objectives

The objective of the course is to provide fundamental knowledge about the role of PKI in secure digital communication.

Course Outcomes

At the end of the course, students will be able to-

CO1: Understand the working constraints of public key cryptosystems and their limitations.

CO2: Distinguish between public key technology and a public key infrastructure.

CO3: Understand the relationship of identity management to PKI.

CO4: Understand the different components of a public key infrastructure and their usage.

CO5: Understand the issues related to Trust management mechanisms.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction to the need of PKI, overview of asymmetric key cryptography like RSA cryptosystem, RABIN Cryptosystem ElGamal Cryptosystem and their weaknesses, message Integrity & Authentication; Random Oracle model, message authentication, Cryptographic hash functions; MD hash families, Whirlpool, SHA-512.

Digital Signature; Process and services, attacks on digital signatures, Digital Signature Schemes; Digital certificates and PKIs; Different PKIs: PGP (Pretty Good Privacy): Web of trust, applications; X.509: X.500, Certification Authority (CA), Registration Authority (RA), Root-CA, X.509 Protocols, Simple PKI (SPKI)

Entity Authentication; Passwords and Challenge Response, zero-knowledge and biometrics, Key management; security key distribution, Kerberos, Symmetric Key agreement, Public Key Distribution and Hi-jacking, Issues of revocation, Anonymity and Privacy Smart Card integration with PKIs, Trust management systems, Email Security, PGP and S-MIME, Cloud security through PKI, Application in e-commerce, e-business, e-payment, e-health and mobile applications.

Syllabus for Desirable Course Outcomes (if any)

Text Book:

T1. Cryptography and Network Security by Behrouz Forouzan and D. Mukhopadhyay
T2. Public Key Infrastructure Overview by Joel Weise, Sun BluePrints
Reference Book:
R1. Stallings, W., Cryptography and Network Security: Principles and Practice, 7th ed., Pearson, 2017.

Course Code: AIL454
Course Title: PARALLEL AND DISTRIBUTED COMPUTING
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives:
Parallel and Distributed Computing course aims at the following educational objectives:
To become familiar with the Distributed and Centralized computing concepts.
To understand the fundamental principles of GPU architecture, and Memory Hierarchies.
To understand the concepts and application of Message Passing Interface (MPI), Multithreaded Programming,.
TO understand the basic concepts of parallel task, process centric, and shared/distributed memory.
To understand the working/programming of distributed and parallel application tools.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: Describe the terminology of Asynchronous/synchronous computation/communication.
CO2: Compare the working of GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies.
CO3: Solve and analyze the concepts of Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, and parallel I/O.
CO4: Analyze the basic concepts of parallel task, process centric, and shared/distributed memory.
CO5: Design and analyze the concepts of distributed and parallel application tools.
Desirable Outcome (if any)
Syllabus for Essential Course Outcomes
Asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).
Syllabus for Desirable Course Outcomes
Text Books:
T1: Distributed and Cloud Computing: Clusters, Grids, Clouds, and the
Future Internet (DCC) by Kai Hwang, Jack Dongarra & Geoffrey C. Fox (Required).
T2: Andrew S. Tanenbaum and Maarten van Steen. "Distributed Systems:
Principles and Paradigms" (DSPD), Prentice Hall, 2nd Edition, 2007.
Reference Book:
Course Code: AIP454
Course Title: LINUX LAB
Structure (L-T-P): 0-0-2
Course Prerequisite: NIL
Course Objectives: The objective of the course is to provide the foundations of the practical implementation and usage of enormous capabilities of the Linux Ecosystem.
Course Outcomes:
At the end of the course, students will be able to-
Essential:
CO1: To be able to understand the basics of Linux Programming Basics, administration, directory structure and files handling.
CO2: To be able to exploit I/O, Hardware Interfacing and Networking Capabilities of Linux
CO3: To be able to maintain Databases and Security systems in Linux Ecosystem
CO4: To be able to develop smart surveillance, Microcontroller Interfacing and Chat-bots like advanced applications
Desirable Outcomes (if any): NIL
List of Experiments for Essential Outcomes:
1. Build a Clustering Server with Linux
2. Build Your Own Operating System with Linux
3. Build a Linux Web Server
4. Build GPS Location Tracker
5. Build a Weather Monitoring with Raspberry Pi
6. Build a Wireless Surveillance with Raspberry Pi
7. Build a Cloud Service with Raspberry Pi
8. Build a Surveillance Robot

List of Experiments for Desirable Outcomes (If any): NIL
Books/Material:
T1. Richard Blum, Linux Command Line and Shell Scripting Bible, 3rd edition, Wiley
T2: Jason Cannon, Linux Administration, Independently Published.
Reference Books:
R1: Richard Petersen, Linux: The Complete Reference Independently Published.
R2: W. Stevens Advanced Programming in the UNIX Environment, 3rd Edition, Addison-Wesley.

Course Code: AIL455
Course Title: CONCEPTS IN BLOCKCHAINING
Structure (L-T-P): 3-0-0

Course Prerequisite: NIL
Course Objectives
After completing the above course, students are expected to: To give students the understanding of emerging abstract models for Blockchain Technology and to familiarize with the functional/operational aspects of the cryptocurrency ecosystem. Develop familiarity of current technologies, tools, and implementation strategies of blockchain. Introduce application areas, current practices, and research activity.
Course Outcomes
At the end of the course, students will be able to:

Essential

CO1: Understand the fundamentals of block chain technology: validation, verification, and consensus.

CO2: Understand distributed systems basics and challenges, and different paradigms of distributed computing.

CO3: Knowledge of cryptographic techniques and their applications.

CO4: Ability to analyze blockchain use cases in different domains, and understanding of distributed consensus algorithms and crypto currency protocols and vulnerabilities**.**

Desirable Course outcome (If any): NIL

Syllabus for Essential Course Outcomes

Contents: Basics: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. Cryptography: Hash functions, Digital Signature ECDSA, Memory Hard Algorithm, Zero Knowledge Proof. Blockchain: Introduction, History, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain. Distributed Consensus: Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate. Cryptocurrency: History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin. Cryptocurrency Regulation: Stakeholders, Roots of Bitcoin, Legal Aspects – Cryptocurrency Exchange, Black Market and Global Economy Blockchain Applications: Internet of Things, Medical Record Management System, Smart contracts, future of Blockchain etc. The use cases from different application domains.

Text Books:

T1: Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press, 2016.

T2: Roger Wattenhofer, The Science of the Blockchain, 2016.

Reference Books:

R1: Don Tapscott, Alex Tapscott. Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies is Changing the World, 2018.

R2: Melanie Swan. Blockchain: Blueprint for a New Economy, 2015.

Course Code: AIL456

Course Title: CYBER SECURITY AND FORENSIC

Structure (L-T-P): 3-0-0

Course Prerequisite: CSL354-Information and Network Security

Course Objectives

The objective of the course is to contribute to securing corrupted systems, protect personal data, and secure computer networks in an organization. Correctly collect and analyze computer forensic evidence.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Understand the threats in networks and security concepts.

CO2: Apply authentication applications in different networks.

CO3: Understand essential methodology of cyber forensics.

CO4: Correctly define and cite appropriate instances for the application of cyber forensics.

Desirable outcome (if any): NIL

Syllabus for Essential Course Outcomes

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

Introduction to computer and cyber forensics basics like Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues. Types of cybercrime and cyber laws, Understanding Computing Investigations – Procedure for corporate High-Tech investigations, understanding data recovery workstation and software, conducting and investigations. Data and Evidence Recovery, Deleted file recovery, recovery Tools, Forensics Tools. Data acquisition- understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisitions tools. Introduction to IT laws and Cyber Crimes, Security Attacks, Digital Evidence collection, preservation and investigation. Current computer forensics tools- software, hardware tools, Incidence response, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions, E-Mail investigations investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool. Processing crimes and incident scenes, securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case. Methodologies of forensics: Case Studies.

Syllabus for Desirable Course Outcomes

Text Book:

T1: Warren G. Kruse II and Jay G. Heiser, ―Computer Forensics: Incident Response Essentials‖, Addison Wesley, 2002.

T2: Nelson, B, Phillips, A, Enfinger, F, Stuart, C., ―Guide to Computer Forensics and Investigations, 2nd ed., Thomson Course Technology, 2006, ISBN: 0-619-21706-5. **Reference Book:**

R1: Vacca, J, Computer Forensics, Computer Crime Scene Investigation, 2nd Ed, Charles River Media, 2005, ISBN: 1- 58450-389.

R2. Charles P. Fleeger, "Security in Computing", Prentice Hall, New Delhi, 2009.

R3. Stallings William. Cryptography and Network Security, Pearson Education, 7th Edition, 2017.

R4. C. Altheide & H. Carvey Digital Forensics with Open Source Tools, Syngress, 2011. ISBN: 9781597495868.

Course Code: AIL457

Course Title: SYSTEM PROGRAMMING
Structure (L-T-P): 3-0-0
Course Prerequisites: Data Structures
Course Objectives
The objective of the course is to
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: Able to understand the macros and designing a macro processors
CO2: Able to understand the loaders and linkers as system softwares and their functionalities
CO3: Exposure to popular scripting utilities such as grep, awk with understanding of shell programming
CO4: Able to understand the know-how of device drivers
Desirable outcome (if any)
Syllabus for Essential Course Outcomes
Assembler, Macro processor - Concept of assembler, design of single pass and two pass assembler, forward reference, design of output file of assembler, concept of macro, macro call within macro, macro definition within macro, recursive macro calls, design of macro processor.

Linker and Loader - Concept of static and dynamic relocation, external symbols, design of linker, design of object file for different loading schemes.

Common Object file format - Structure of object file and executable file, section or segment headers, symbol table, concept of storage class.

System utilities –Shell programming, make, link editor, symbolic debugger, pattern matching language like awk.

Device Drivers - Incorporation of driver routines, Basic device driver operation, character and block drivers.
Syllabus for Desirable Course Outcomes: NIL
Text Books:

T1: Beck, L.L. and Manjula, D., System Software: An Introduction to Systems Programming, 3rd ed., Pearson Education, 2013.

T2: Gorsline, G.W, Assembly and Assemblers: The Motorola MC68000 Family, Prentice Hall, 1988.
Reference Books:

R1: Dhamdhere, D.M., Systems Programming, Tata McGraw Hill Education, 2011.

R2: Kernighan, B.W. and Pike, R.,The Unix programming Environment, Prentice Hall of India, 1993.

R3: Egan, J.I. and Teixeira, T.J., Writing a UNIXDevice Driver, 2nd ed., John Wiley and Sons, 1992.
R4: Norton, D.A., Writing Windows Device Drivers, Addison Wesley, 1996.

Course Code: AIL458
Course Title: FUNDAMENTAL ALGORITHMS IN COMPUTATIONAL BIOLOGY
Structure (L-T-P): 3 0 0 3
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course:
Students will be able to obtain the information from large biological databases and will be able to apply the computational algorithms on the extracted information for biological analysis.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: Knowledge of sequence alignment and analysis including pairwise sequence alignment , algorithms and tools for pairwise alignment, Multiple Sequence Alignment, its significance, algorithms and tools used for MSA.
CO2: Students will learn about the various techniques, algorithms and tools used for Phylogenetic Analysis.
CO3: Understand the structural organization, structural properties and various techniques employed in the structure determination of Biological macromolecules – DNA, Protein and Carbohydrates. Ability to apply various computational methods and tools used for protein structure prediction and genome analysis.
CO4: Knowledge about the different types of Biological databases.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
DNA and Sequence Alignment – KMP algorithm, BLAST and FASTA, Sorting by Reversals, Biological Databases – formats, downloading and using data, Phylogeny – Distance based algorithms (Hamming /Euclidean distance), Suffix Trees, Prediction of RNA secondary structure, Gene Prediction using Bayesian Methods and Markov Chains/HMMs, Modeling-Based on Cellular Automata, Based on Agent Based Modeling Techniques, Based on Partial Differential Equations, Single Nucleotide Polymorphism and algorithms for their identification, Microarray Data and Clustering – Hierarchical/K-Means, Pathway Data and their analysis, Protein Folding and Docking based on Entropy Calculation.
Syllabus for Desired Course Outcomes (If any): NIL
Text Books
T1. Ellner, S. P. and Guckenheimer, J., Dynamic Models in Biology, New Age International, 2010.
T2. Murray, J. D., Mathematical Biology: An Introduction, 3rd ed.Springer, 2002.
Reference Books
R1. Mandoiu, I.and Zelikovsky, A., Bioinformatics Algorithms: Techniques and Applications. Wiley Series on Bioinformatics: Computational Techniques and Engineering, John Wiley & Sons, 2008.
R2. Introduction to Bioinformatics – T.K. Attwood and Parry Smith.

Course Code: AIL459
Course Title: WIRELESS SENSOR AND ADHOC NETWORKS
Structure (L-T-P): 3 0 0 3
Course Prerequisite: Data Communication
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To understand the working of MAC and Routing Protocols for ad hoc and sensor networks

CO2: To understand the working of Transport Layers in Ad Hoc and Sensor Networks.
CO3: To understand and analyze the QoS for ad hoc and sensor networks.
CO4: To understand various security issues in ad hoc and sensor networks and the corresponding solutions.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Ad Hoc Networks: Issues and challenges in ad hoc networks, MAC Layer Protocols for wireless ad hoc networks, Contention-Based MAC protocols, MAC Protocols Using Directional Antennas, Multiple-Channel MAC Protocols, Power-Aware MAC Protocols, Routing in Ad hoc Networks, Design Issues, Proactive, Reactive and Hybrid Routing Protocols, TCP's challenges and Design Issues in Ad Hoc Networks – Transport protocols for ad hoc networks – Issues and Challenges in providing, MAC Layer QoS solutions, Network Layer QoS solutions, QoS Model, Sensor Networks: Introduction, Applications, Challenges, Sensor network architecture, MAC Protocols for WSNs, Low duty cycle protocols and wakeup concepts, Contention- Based protocols, Schedule-Based protocols, IEEE 802.15.4 Zigbee, Topology Control , Routing Protocols: Data-Centric and Contention-Based Networking, Transport Layer and QoS in WSNs, Congestion Control in network processing, Operating systems for WSNs, Examples, Security Issues: Key Distribution and Management, Intrusion Detection, Software based Anti-tamper techniques, Watermarking techniques, Defense against routing attacks, Secure Ad hoc routing protocols – Broadcast authentication WSN protocols , TESLA, Biba, Sensor Network Security Protocols, SPINS
Contents for Desired Course Outcomes (If any)
Text Books:
T1. C.Siva Ram Murthy and B.S.Manoj, ―Ad Hoc Wireless Networks – Architectures and 2 Protocols‖, Pearson Education, 2006.
T2. Holger Karl, Andreas Willing, ―Protocols and Architectures for Wireless Sensor Networks‖, John Wiley & Sons, Inc., 2005.
Reference Books:
R1. Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, ―Ad Hoc Mobile Wireless Networks‖, Auerbach Publications, 2008.
R2. Carlos De Morais Cordeiro, Dharma Prakash Agrawal, ―Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition)‖, World Scientific Publishing, 2011.
R3. Waltenegus Dargie, Christian Poellabauer, ―Fundamentals of Wireless Sensor Networks Theory and Practice‖, John Wiley and Sons, 2010
R4. Xiang-Yang Li , "Wireless Ad Hoc and Sensor Networks: Theory and Applications‖, 1227 th edition, Cambridge university Press,2008.

Course Code: AIL460
Course Title: 5G NETWORKS
Structure (L-T-P): 3 0 0 3
Prerequisite: Data Communications
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to: Understand the benefits of 4G, LTE and 5G. He should be able to make informed decisions with reference to Network Technology Requirements.
Course Outcome:
Essential:
CO1: To acquaint with basics of 5G Networks
CO2: To acquaint with basics of Device to Device Communications
CO3: To acquaint with Multiple Access Technologies for 5G
CO4: To acquaint with Types of 5G Networks, Mobility and Handovers in 5G
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
5GModeling requirements and scenarios, Channel mode requirements, Propagation scenarios, Relaying multi-hop and cooperative communications: Principles of relaying, fundamentals of relaying, Cognitive radio: Architecture, spectrum sensing, Software Defined Radio (SDR). Multiple-input multiple-output (MIMO) systems, Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems, Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, NFV and SDN, RAN architecture, 5G architecture, Functional architecture and 5G flexibility, Integration of LTE and new air interface to fulfill 5G, Requirements, Enhanced Multi-RAT coordination features, Physical architecture and 5G deployment. Device-to-device (D2D) communications, Device to Device: from 4G to 5G, D2D standardization, Radio resource management for mobile, broadband D2D, RRM techniques for mobile broadband D2D, RRM and system design for D2D, 5G D2D, 5G radio-access technologies, design principles for multi-user communications, Orthogonal multiple-access systems, Spread spectrum multiple access systems, Capacity limits of multiple-access methods, Sparse code multiple access (SCMA), Interleave division multiple access (IDMA), Radio access for dense deployments, non-orthogonal multiple access (NOMA), OFDM numerology for small-cell deployments, Small-cell sub-frame structure, Radio access for V2X communication, Medium access control for nodes on the move, Radio access for massive machine type communication. Interference, mobility and security management in 5G Network
Contents for Desired Course Outcomes (If any)
Text Books
T1. Osseiran, A., Monserrat, J.F. and Marsch, P. eds., 2016. 5G mobile and wireless communications technology. Cambridge University Press.
T2. Dahlman, E., Parkvall, S. and Skold, J., 2020. 5G NR: The next generation wireless access technology. Academic Press.
Reference Books
R1. Rodriguez, J., 2015. Fundamentals of 5G mobile networks. John Wiley & Sons.
R2. Hu, F. ed., 2016. Opportunities in 5G networks: A research and development perspective. CRC press.
R3. Chen, W., Gaal, P., Montojo, J. and Zisimopoulos, H., 2021. Fundamentals of 5G Communications: Connectivity for enhanced mobile broadband and beyond. McGraw-Hill Education.
R4. Wong, V.W., Schober, R., Ng, D.W.K. and Wang, L.C. eds., 2017. Key technologies for 5G wireless systems. Cambridge university press.

Course Code: AIL461
Course Title: NATURAL LANGUAGE PROCESSING
Structure (L-T-P): 3 0 0 3
Course Prerequisite: NIL
Course Objectives: The course objectives define the student learning outcome for the course. After completing the above course, student is expected to: Learn the fundamentals of natural language processing, understand the use of CFG and PCFG in NLP, understand the role of semantics of sentences and pragmatics and apply the NLP techniques to IR applications
Course Outcomes
Essential:
CO1: To tag a given text with basic Language features
CO2: To design an innovative application using NLP components
CO3: To implement a rule based system to tackle morphology/syntax of a language
CO4: To design a tag set to be used for statistical processing for real-time applications
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Origins and challenges of NLP, Language Modeling, English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance, Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models, CFG, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs - Feature structures, Unification of feature structures, Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods, Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC).
Contents for Desired Course Outcomes (If any)
Text Books:
T1. Daniel Jurafsky, James H. Martin—Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.
T2. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Pythonǁ, First Edition, O_Reilly Media, 2009.
Reference Books:
R1.Breck Baldwin, —Language Processing with Java and LingPipe Cookbook, Atlantic Publisher, 2015.
R2. Richard M Reese, —Natural Language Processing with Javaǁ, O_Reilly Media, 2015.
R3. Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.

Course Code: AIL462
Course Title: MOBILE APPLICATIONS
Structure (L-T-P): 3 0 0 3
Course Prerequisite: NIL
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to: understanding of Android application development working knowledge of Android Studio development tool.
Course Outcomes
Essential:
CO1: Identify various concepts of mobile programming that make it unique from programming for other platforms,
CO2: Critique mobile applications on their design pros and cons,
CO3: Utilize rapid prototyping techniques to design and develop sophisticated mobile interfaces,
CO4: Program mobile applications for the Android operating system that use basic and advanced phone features, and
CO5: Deploy applications to the Android marketplace for distribution.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
The Android Platform, Android SDK, Eclipse Installation, Android Installation, Building you First Android application, Understanding Anatomy of Android Application, Android Manifest file, Android Application Design Essentials, Anatomy of an Android applications, Android terminologies, Application Context, Activities, Services, Intents, Receiving and Broadcasting Intents, Android Manifest File and its common settings, Using Intent Filter, Permissions, Android User Interface Design Essentials: User Interface Screen elements, Designing User Interfaces with Layouts, Drawing and Working with Animation, Testing Android applications, Publishing Android application, Using Android preferences, Managing Application resources in a hierarchy, working with different types of resources, Using Common Android APIs: Using Android Data and Storage APIs, Managing data using Sqlite, Sharing Data between Applications with Content Providers, Using Android Networking APIs, Using Android Web APIs, Using Android Telephony APIs, Deploying Android Application to the World.
Text Books:
T1. Lauren Darcey and Shane Conder, "Android Wireless Application Development", Pearson Education, 2nd ed. (2011)
T2. Reto Meier, "Professional Android 2 Application Development", Wiley India Pvt Ltd
Reference Books:
R1. Mark L Murphy, "Beginning Android", Wiley India Pvt Ltd
R2. Android Application Development All in one for Dummies by Barry Burd, Edition: I

Course Code: AIL463
Course Title: MULTIMEDIA TECHNOLOGY AND VIRTUAL REALITY
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives
After completing the above course, students are expected to: Work in virtual reality and augmented reality domain with basic knowledge of multimedia technologies.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To give each student a firm grounding in the fundamentals of the underpinning technologies in graphics, distributed systems and multimedia
CO2: To teach students about the principled design of effective media for entertainment, communication, training and education
CO3: To provide each student with experience in the generation of animations, virtual environments and multimedia applications, allowing the expression of creativity
CO4: To provide each student with a portfolio of their own completed work at the end of the programme
Desirable outcome (if any)
Syllabus for Essential Course Outcomes
Concept of Non- Temporal and Temporal Media, Hypertext and Hypermedia, Presentations, Synchronization, Events, Scripts and Interactivity, Authoring Systems, Compression, Video Compression: MPEG- 1&2 Compression Schemes, MPEG-4 Natural Video Compression. Audio Compression: Introduction to Speech and Audio Compression, Video Compression, Introduction to Multimedia PC/Workstation Architecture, Characteristics of MMX instruction set, I/O systems, Operating System Support for Multimedia Dat, Multimedia Database Design, Content Based Information Retrieval, MPEG-7, Video-on-Demand Systems, Virtual Reality and Virtual Reality Systems, Teleoperation and Augmented Reality, Interface to the Virtual World, Interface to the Virtual World, haptic and force feedback, VRML Programming
Syllabus for Desirable Course Outcomes (if any)
Text Books:
T1: Ralf Steinmetz and Klara Nahrstedt , Multimedia: Computing, Communications & Applications , Pearson Ed.
T2: Nalin K. Sharda , Multimedia Information System , PHI.
Reference Books:
R1. Fred Halsall, Multimedia Communications, Pearson Ed.
R2. Koegel Buford, Multimedia Systems, Pearson Ed.
R3: Fred Hoffstetter, Multimedia Literacy, McGraw Hill.
R4. Ralf Steinmetz and Klara Nahrstedt, Multimedia Fundamentals: Vol. 1- Media Coding and Content Processing, PHI

Course Code: CSL525
Course Title: STATISTICAL MODELS FOR COMPUTER SCIENCE
Structure (L-T-P): 3 0 0
Course Prerequisites: NIL
Course Objectives
The objective of the course is to introduce the students with fundamental concepts of probability, statistics, probability distributions, stochastic processes and Markov models. These fundamental concepts help the student to understand how the real-world processes can be modeled with the help of concepts discussed in this course. In addition, several examples from the computer science domain such as reliability, computer networks, and statistical pattern recognition have also been included.
Course Outcomes:
At the end of the course, students will be able to
Essential:
CO1. Understand the fundamentals of probability and random variables
CO2. Explain various discrete and continuous probability distributions
CO3. Illustrate expectation, moments and different types of stochastic processes
CO4. Apply Markov models for problem solving
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Probability, Random Variables: Random variables, and their event spaces, Probability mass function, Distribution functions, Discrete distributions, Probability Generating Function, Discrete random vectors, Continuous random variables, Functions of random variables, jointly distributed random variables. Expectation: Introduction, Moments, Expectation of functions of more than one random variable, Brief introduction to Conditional pmf, pdf and expectation, Moments and transforms of some distributions (Uniform, Bernoulli, Binomial, Geometric, Poisson, Exponential, Gamma, Normal), Computation of mean time to failure. Stochastic Processes: Classification of stochastic processes, The Bernoulli process, The Poisson process, renewal process, renewal model of program behavior. Markov Chains: Computation of n-step transition probabilities, State classification and limiting distributions, Distribution of times between state changes, Irreducible finite chains with aperiodic states, M/G/1 queuing system, Discrete parameter Birth-Death processes, Analysis of program execution time. Continuous parameter Markov Chains, Birth-Death process with special cases, Non-Birth-Death Processes.
Contents for Desired Course Outcomes (If any)
Text Books
T1. Trivedi, Kishor S. Probability, Statistics with Reliability, Queuing and Computer science Applications. Wiley-India, 2008.
T2. Feller, W. An Introduction to Probability Theory and its applications, 2 vols., Wiley Eastern, 1975
Reference Books
R1. Ross, Sheldon M. Introduction to Probability Models. 11th ed. Academic Press Inc, 2014.
R2. Kleinrock, L. Queuing Systems, 2 vols, John Wiley, 1976.

Course Code: CSL524
Course Title: OPERATION RESEARCH
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives
Students should be able to exploit optimizations in unconstrained and constrained contexts. He should be able to apply game theory and queuing theory for problems in AI.
Course Outcomes
At the end of the course, students will be able to-
Essential:

CO1: To be able to understand LP paradigm and applications of Solution approaches to LP problem
CO2: To be able to understand Network Models and solve basic network problems
CO3: To be able to understand pure and mixed Integer Problems
CO4: To be able to understand Queuing Theory and Game Theory
Desirable/Advanced (If any):
Syllabus for Essential Course Outcomes
Linear Programming Problems (LPP): Basic LPP and Applications; Components of LP Problem Formulation, Simplex Duality Theory; Duality in linear programming, Charnes Big – M Method. Network Models: Shortest Path Problems, Maximum Flow Problems, CPM and PERT, Minimum Cost Network Flow Problems, Minimum Spanning Tree Problems, local and global optima. Integer Programming: Formulating Integer Programming Problems, Branch-and-Bound Method: Solving Pure and mixed Integer Programming Problems and Knapsack problems, unconstrained optimization techniques, constrained optimization. Queuing Network Models: Poisson distributions, wait time, server utilization, SRPT, Pure Birth and Death Models; M/M/1 queue, ∞ /FIFO, N/ FIFO. Game Theory: 2- person Zero – sum Game; Saddle Point; Mini-Max and Maxi-Min Theorems, Inventory Control: EOQ Models ; Deterministic and probabilistic Models; Optimization and Performance in Web Computing, Internet Application, Curse of dimensionality.
Contents for Desired Course Outcomes (If any): NIL
Text Books
T1: Taha, H.A. Operations Research, 5th ed., Macmillan Publishing Company, 1992.
T2: Kanth, K. Introduction to Computer System Performance Evaluation, McGraw Hill, 1992
Reference Books
R1: Mustafi, C. K. Operations Research, 4th ed., New Age International, 2009
R2: Hadley G. Linear Programming, Narosa Publishers, 1997
R3: Hillier F. and G. J. Liebermann. Operations Research, Holder Day Inc, 1974.
R4: Mohapatra, P.K.J. Introduction to System Dynamics Modelling, 1st ed., Universities Press, 1994.
R5: Schaum Outline Series. Operations Research, 2nd ed., Tata McGraw Hill, 2003.
R6: Smith, David K. Network Optimization in Practice. Ellis Harwood Publications, 1982.

Course Code: CSL527
Course Title: DATA MINING
Structure (L-T-P): 3-0-0
Course Prerequisite: NIL
Course Objectives
After completing the above course, students are expected to: understand the fundamental data mining concepts and techniques for discovering interesting patterns from data in various applications. Emphasizes techniques for developing effective, efficient, and scalable data mining tools.
Course Outcomes
At the end of the course, students will be able to:
Essential:
CO1. Understanding of the basic concepts and techniques of data mining and knowledge discovery in databases.
CO2. Ability to perform data pre-processing, cleaning, integration, transformation, and reduction as part of the data mining process.
CO3. Familiarity with various data mining tasks and algorithms, such as association rule mining, classification, and clustering, and ability to apply them to real-world problems in different domains.
CO4. Proficiency in data analysis and visualization, and use of appropriate data mining tools for scientific and real-time applications.
CO5. Exposure to advanced concepts in data mining, such as sequential pattern mining, mining text and web data, graph mining, spatiotemporal and trajectory pattern mining, and multivariate time series mining.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Data Mining: Introduction, Data analysis like Data visualization, probability, histograms, multinomial distributions. Data Mining and Knowledge Discovery in Databases, Data Mining Functionalities, Data Pre-processing, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization and Concept Hierarchy Generation. Overview of data mining, data mining tasks, data mining tools. Processing and visualizing data: Data types, Data quality, Data pre-processing, Measures of similarity, Visualization. Association Rule Mining: Frequent itemset generation algorithms, Rule generation algorithms, Compact representation, Evaluation measures. Algorithms: Introduction to Supervised and unsupervised classification. Advanced Concepts: Introduction, Sequential Pattern Mining, Mining Text and Web data, Graph mining, Mining Spatiotemporal and Trajectory Patterns, Multivariate Time Series (MVTS) Mining, Complex data mining. Applications: Healthcare, Fraud detection, Intrusion detection, Market basket analysis, Banking and Finance.
Desired Course Outcomes (If any): NIL
Text Book:
T1. Jiawei Han, Micheline Kamber, Jian Pei. Data Mining: Concepts and Techniques, 3rd Edition, MK publisher, 2011.
T2. Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar. Introduction to Data Mining, 2nd ed., Pearson Education, 2021.
Reference Books:
R1: Ian H., Eibe Frank, Mark A. Hall. Data Mining: Practical Machine Learning Tools and Techniques, 3rd Edition, MK publisher, 2011.

Course Code: CSL531
Course Title: INTERNET OF THINGS
Structure (L-T-P): 3-0-0
Course Prerequisite: Computer Networks CSL255
Course Objectives
The course Internet of Things (IoT) aims at the following educational objectives:
To become familiar with the IoT architecture. To understand the fundamental principles of various kinds of IoT platforms, like IoT in Health, IoT in Agriculture, IoT in E-Commerce, IoT in Smart Cities, IoE, IIoT, etc.To understand various protocols used in data link layer and network layer of IoT.
Course Outcomes
At the end of the course, students will be able to-

Essential:

CO1. Describe the terminology of architecture of IoT reference model.

CO2. Compare the working of protocols used for M2M communication, business process in IoT, and IoE.

CO3. Solve and analyze the data link layer, network layer, transport layer and application layer protocols.

CO4. Analyze the basic concepts of IoT used for real world design constraints.

CO5. Analyze and Design protocols used in data link layer and networks layer of IoT model.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

IoT-An Architectural Overview– building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, IoT Reference Model - IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views, Data Link Layer & Network Layer Protocols: PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), WirelessHART, Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP, Upper Layer Protocols: Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS), Session Layer: HTTP, CoAP, XMPP, AMQP, MQTT, M2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4, 6LoWPAN, RPL, Application Layer.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.

T2. Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI

Reference Books:

R1. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2,Springer.

R2. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118- 47347-4, Willy Publications.

R3. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands- onApproach)", 1st Edition, VPT, 2014.

R4. Waltenegus Dargie, Christian Poellabauer , "Fundamentals of Wireless Sensor Networks, Theory and Practice", Wiley Series on wireless Communication and Mobile Computing, 2011.

R5. Kazem Sohraby, Daniel manoli , "Wireless Sensor networks Technology, Protocols and Applications", Wiley InterScience Publications 2010.

R6. Bhaskar Krishnamachari " Networking Wireless Sensors", Cambridge University Press, 2005.

R7. C.S Raghavendra, Krishna M.Sivalingam, Taiebznati , "Wireless Sensor Networks", Springer Science 2004.

Course Code: CSL532

Course Title: ADVANCED COMPUTER NETWORKS

Structure (L-T-P): 3-0-0

Course Prerequisite: Computer Networks

Course Objectives

Advanced Computer Networks course aims at the following educational objectives: To become familiar with the concepts of Computer Networks and MAC layer issues. To understand the fundamental principles of IEEE 802.3, 802.4, and 802.5 Networking protocols To understand the concepts of subnet masking and End to End protocol To understand the basic concepts of Routing, Multicasting, Peer to Peer and overlay Networking protocols.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO1. Describe the terminology of advanced computer networks and concepts of MAC layer issues.

CO2. Compare the working of protocols, network interface and design/performance issues in End to End protocols.

CO3. Solve and analyze the data link layer, network layer, transport layer and application layer protocols.

CO4. Analyze the concepts of Routing, Multicasting protocols.

CO5. Analyze the concept of Peer to Peer and overlay networks.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Review of Networking Concepts, MAC layer issues, Ethernet 802.3, ARP, IP addressing and Subnetting, NAT and PAT, Variable Length Subnet Masking, CIDR, End to End protocols, TCP connection establishment and termination, Sliding window concepts, other issues: wraparound, silly window syndrome, Nagle's algorithm, adaptive retransmission, TCP extensions. Congestion and flow control, Queuing theory, TCP flavors: Tahoe, Reno, New-Reno, TCP-SACK, TCP-RED and TCP-Vegas. Transport protocol for real time (RTP), Integrated Services, Differentiated services, Routing and Multicast, Structure of internet: Autonomous systems, Intra-domain routing: OSPF and RIP, Inter-domain routing: BGP. Multicasting: Group Management (IGMP), Internet scale multicasting: Reverse path broadcast, MOSPF, DVMPRP, PIM, Peer to peer and overlay networks: Concept of overlays, Unstructured Overlays: Gnutella, Concepts of Distributed Hash Table, Structured Overlays: Chord, CAN, Pastry.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Computer Networks: A Systems Approach, by Peterson and Davie, 5th Ed. Morgan Kauffman, 2011

T2. Computer Networking: Top Down Approach, by Kurose and Ross, 6th Ed. Pearson, 2011

Reference Books:

R1: V. Paxson. "End-to-end Internet packet dynamics," in IEEE/ACM Transactions on Networking, Vol 7, No 3, June, 1999.

R2: W. Stevens, "TCP Slow Start, Congestion Avoidance, Fast Retransmit, and Fast Recovery Algorithms," RFC2001

R3: K. Fall and S. Floyd, "Simulation-based comparison of Tahoe, Reno, and SACK TCP," Computer Communication Review, vol. 26, pp. 5--21, July 1996.

R4: L. Brakmo and L. Peterson, "TCP Vegas: End-to-End Congestion Avoidance on a Global Internet," IEEE Journal on Selected Areas in Communications, 13(8), October 1995, 1465--1480.
R5: Stoica, I., Morris, R., Karger, D., Kaashoek, F., Balakrishnan, H.: Chord: A scalable peer-to-peer lookup service for Internet applications.
R6: Rowstron, A., Druschel, P.: Pastry: Scalable, decentralized object location and routing for large-scale peer-to-peer systems.

Course Code: CSL534
Course Title: ADVANCED CRYPTOGRAPHY
Structure (L-T-P): 3-0-0
Course Prerequisite: Cryptography
Course Objectives
After completing the above course, student is expected to:
To make the student learn different cryptology techniques along with hash functions, MAC, digital signatures and their use in various protocols for security domain. To design and develop the security solutions to the formulated problems
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1. To understand the mathematical background of the advanced cryptography paradigm.
CO2. Understand and analyze the different symmetric and asymmetric encryption algorithms.
CO3. To understand how to maintain Confidentiality, Integrity, Availability, Authentication, Non-repudiation.
CO4. To understand the basics of advanced topics like secret sharing, steganography, watermarking, attribute and identity based cryptography.
CO5. To design and develop solutions to the formulated problems in the field of cryptography.
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
Number Theory: Probability and information theory, Provable security, Shannon's theory, Computational complexity. Symmetric key cryptography: Introduction, Classical and Modern ciphers, S-box: Overview, Design principles and security analysis, Asymmetric key cryptography: Introduction, RSA algorithm, Rabin cryptosystem, ElGamal cryptography, Elliptic curve cryptography, Key management: Design principles, Key establishment and Group key establishment protocols, Complexity and Security Analysis, Hash functions: Overview of cryptographic hash functions, Security requirements, Random Oracle Model, Analysis of hash functions, Message Authentication and Digital Signature: Importance, Digital signature schemes, security analysis, Message Authentication Codes (MAC), Other advanced topics: Identity based cryptosystem, Attribute based cryptography, Secure multiparty computation, Visual cryptography, Threshold cryptography, Secret sharing schemes, Steganography, Watermarking.
Contents for Desired Course Outcomes (If any): NIL
Text Book:
T1: Douglas R. Stinson. Cryptography: Theory and Practice, CRC publisher, 4th Edition, 2019.
T2: Behrouz A. Forouzan, Debdeep Mukhopadhyay. Cryptography and Network Security, McGraw Hill Education, 2nd Edition, 2010.
Reference Books:
R1: Stallings William. Cryptography and Network Security, Pearson Education, 7th Edition, 2017.
R2: Dominic Welsh. Codes and Cryptography, Oxford University Press, 1988.
R3: Bruce Schneier. Applied Cryptography: Protocols, Algorithms and Source Code in C, Wiley, 2007.
R4: Cox, Ingemar, et al. Digital watermarking and steganography, MK publisher, 2007.
R5: Cimato, Stelvio, and Ching-Nung Yang, eds. Visual cryptography and secret image sharing. CRC press, 2017.

Course Code: CSL535
Course Title: EDGE COMPUTING
Structure (L-T-P): 3 0 0
Course Prerequisite: Cloud Computing
Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, students are expected to: Establish EDGE computing implementation for real life data collection, routing and finally processing at the EDGE devices.
Course Outcomes
At the end of the course, students will be able to-
Essential:
CO1: To understand the basic concepts of EDGE Computing vis-à-vis fog and cloud computing
CO2: To understand the IoT Architecture and Requirements
CO3: To learn the implementation of IoT and WSNs using RaspberryPi
CO4: To implement MQTT with reference to EDGE Computing using RaspberryPi
Desirable/Advanced (If any): NIL
Syllabus for Essential Course Outcomes
IoT and Edge Computing Definition and Use Cases Introduction to Edge Computing Scenarios and Use cases - Edge computing purpose and definition, Edge computing use cases, Edge computing hardware architectures, Edge platforms, Edge vs Fog Computing, Communication Models - Edge, Fog and M2M. IoT Architecture and Core IoT Modules-A connected ecosystem, IoT versus machine-to-machine versus, SCADA, The value of a network and Metcalfe's and Beckstrom's laws, IoT and edge architecture, Role of an architect, Understanding Implementations with examples-Example use case and deployment, Case study – Telemedicine palliative care, Requirements, Implementation, Use case retrospective. RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout and Pinouts, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi, Connecting Raspberry Pi via SSH, Remote access tools, Interfacing DHT Sensor with Pi, Pi as Webserver, Pi Camera, Image & Video Processing using Pi. Implementation of Microcomputer RaspberryPi and device Interfacing, Edge to Cloud Protocols Protocols, MQTT, MQTT publish-subscribe, MQTT architecture details, MQTT state transitions, MQTT packet structure, MQTT data types, MQTT communication formats, MQTT 3.1.1 working example. Edge computing with RaspberryPi, Industrial and Commercial IoT and Edge, Edge computing and solutions.
Contents for Desired Course Outcomes (If any): NIL
Text Books:

T1. IoT and Edge Computing for Architects - Second Edition, by Perry Lea, Publisher: Packt Publishing, 2020, ISBN: 9781839214806

T2. Raspberry Pi Cookbook, 3rd Edition, by Simon Monk, Publisher: O'Reilly Media, Inc., 2019, ISBN: 978149204322.

Reference Books:

R1. Fog and Edge Computing: Principles and Paradigms by Rajkumar Buyya, Satish Narayana Srirama, wiley publication, 2019, ISBN: 9781119524984.

R2. David Jensen, "Beginning Azure IoT Edge Computing: Extending the Cloud to the Intelligent Edge, MICROSOFT AZURE

B.Tech. (Civil Engineering)
Overall Credit Structure

Undergraduate Core(UC)		Undergraduate Elective (UE)	
Category	*Credit*	*Category*	*Credit*
DC	67	**DE**	23 (minimum)
BS	19	**HM**	06 (minimum)
ES	22	**OC**	18 (Balance)
HM	05	**UN**	0 (03 Courses)
Total	**113**	**Total**	47
Grand Total (UC + UE)			**160**

Basic Science (BS)			
Course Code	**Course**	**L-T-P**	**Credit**
MAL102	Applied Mathematics-I	3-2-0	04
MAL103	Applied Mathematics-II	3-2-0	04
MAL201	Applied Mathematics-III*	3-0-0	03
PHL151	Applied Physics	3-0-0	03
PHP151	Applied Physics Lab	0-0-2	01
CYL101	Applied Chemistry	3-0-0	03
CYP101	Applied Chemistry Lab	0-0-2	01
Grand Total			**19**

Humanities and Management (Core) (HM)			
Course Code	**Course**	**L-T-P**	**Credit**
HSP152	Technical Communication	1-2-2	03
HSL151	Social Science	2-0-0	02
Grand Total			**05**

Engineering Arts and Science (ES)			
Course Code	**Course**	**L-T-P**	**Credit**
MEL152	Elementary Mechanical Engineering	3-0-0	03
EEL151	Elementary Electrical Engineering	3-0-0	03
EEP151	Elementary Electrical Engineering Lab	0-0-2	01
ECL151	Basic Electronics Engineering	3-0-0	03
ECP151	Basic Electronics Engineering Lab	0-0-2	01
MEL151	Engineering Drawing	3-0-0	03
MEP151	Engineering Drawing Lab	0-0-2	01
CSL151	Computer Programming and Problem Solving	3-0-0	03
CSP151	Computer Programming and Problem Solving Lab	0-0-2	01
MEP152	Mechanical Workshop	0-0-2	01
CEL151	Environmental Science	2-0-0	02
Grand Total			**22**

Non-Credit Requirement (UN)			
Course Code	**Course**	**L-T-P**	**Credit**
NCN101	NCC#	-	0
NSS152	NSS-I#	-	0
NSS153	NSS-II#	-	0
NCN103	NSO#	-	0
SPB151	Sports-I#	0-0-4	0
SPB152	Sports-II#	0-0-4	0
HSD251	Community Project	-	0
CET251	Practical Training	-	0

#A student has to opt at least one from NCC, NSS, NSO and Sports (I & II both).

Departmental Core Courses		L-T-P	Credit
CEL251	Fluid Mechanics	3-0-0	3
CEL252	Engineering Geology	2-0-0	2
CEL253	Building Materials and Construction Technology	3-0-0	3
CEL256	Surveying	3-0-0	3
CEL257	Strength of Materials	3-2-0	4
CEL281	Water Supply Engineering	3-0-0	3
CEL282	Highway Engineering	3-0-0	3
CEL357	Reinforced Concrete Structures	3-2-0	4
CEL358	Steel Structures	3-2-0	4
CEL359	Railway and Airport Engineering	3-0-0	3
CEL360	Estimation and Costing	3-0-0	3
CEL381	Hydrology and Irrigation Engineering	3-0-0	3
CEL382	Concrete Technology	3-0-0	3
CEL383	Soil Mechanics	3-0-0	3
CEL384	Wastewater Engineering and Pollution	3-0-0	3
CEL385	Structural Analysis	3-2-0	4
CEL386	Geotechnical Engineering	3-2-0	4
CEP251	Fluid Mechanics Lab	0-0-2	1
CEP252	Engineering Geology Lab	0-0-2	1
CEP256	Surveying Lab	0-0-2	1
CEP257	Strength of Materials Lab	0-0-2	1
CEP282	Highway Engineering Lab	0-0-2	1
CEP381	Hydrology and Irrigation Engineering Lab	0-0-2	1
CEP382	Materials Testing Lab	0-0-2	1
CEP383	Soil Mechanics Lab	0-0-2	1
CEP384	Environmental Engineering Lab	0-0-2	1
CED351	Minor Project	-	1
CED451	Major Project	-	2

Departmental Elective Courses Title		L-T-P	Credit
SCL453	Probability and Statistics	3-0-0	3
CEL451	Geomatics Engineering	3-0-0	3
CEL452	Non-Destructive Testing of Materials	3-0-0	3
CEL455	Rock Engineering	3-0-0	3
CEL456	Industrial Waste Management	3-0-0	3
CEL457	Environmental Impact and Risk Assessment	3-0-0	3
CEL459	River Mechanics	3-0-0	3
CEL460	Traffic Engineering	3-0-0	3
CEL461	Construction Planning and management	3-0-0	3
CEL464	Urban Water and Environmental Management	3-0-0	3
CEL466	Advanced Highway Engineering	3-0-0	3
CEL467	Groundwater Engineering	3-0-0	3
CEL468	Hydraulic and Hydraulic Machines	3-0-0	3
CEL471	Architectural Planning and Design of Buildings	2-2-0	3
CEL481	Hydraulic Structures	3-2-0	4
CEL482	Advanced Foundation Engineering	3-1-0	4
CEL483	Earth Retaining Structures	3-0-0	3
CEL484	Machine Learning and Data Analytics for Civil Engineering Applications	3-0-0	3
CEL485	Harbours and Tunneling	3-0-0	3
CEL486	Earth and Rockfill Dams	3-0-0	3
CEL487	Concepts of Green Building Design	3-0-0	3
CEL488	Advanced Structural Analysis	3-0-0	3
CEL502	Earthquake Resistance Design of Structures	3-0-0	3
CEL519	Geometric Design of Transportation Facilities	3-0-0	3
CEL525	Traffic Engineering Design and Management	3-0-0	3
CEL527	Ground Improvement Techniques	3-0-0	3
CEL528	Advanced Soil Mechanics	3-0-0	3
CEL540	Environmental Geotechnology	3-0-0	3
CEL552	Advanced Concrete Structures	3-2-0	4
CEL553	Prestressed Concrete Structures	3-0-0	3
CEL554	Bridge Engineering	3-0-0	3
CEL555	Advanced Steel Structures	3-2-0	4
CEL556	Geotechnical Earthquake Engineering	3-2-0	4
CEL557	Water Storage Structures	3-0-0	3
CEL558	Structural Dynamics	3-0-0	3
CEP451	Geomatics Engineering Lab	0-0-2	1
CEP452	Non-Destructive Testing of Materials Lab	0-0-2	1
CEP455	Rock Engineering Lab	0-0-2	1
CEP484	Machine Learning and Data Analytics for Civil Engineering Applications- Lab	0-0-2	1
CEP507	Geotechnical Design Studio	1-0-4	3
CEP508	RCC Structures Detailing Lab	0-0-2	1
CEP509	Structural Dynamics Lab	0-0-2	1

Course Syllabi
(Under Graduate)
Department of Civil Engineering

Fluid Mechanics | CEL251 | 3 Credits | 3 0 0 3
Course Prerequisite
NIL

Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:
- Understanding the fundamental concepts and principles of fluid mechanics.
- Developing the ability to solve problems in fluid mechanics, and to interpret fluid flow behavior.
- Developing the ability to use software tools and laboratory equipment to investigate fluid mechanics phenomena.
- Developing critical thinking and problem-solving skills, including the ability to identify and analyze real-world fluid mechanics problems.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO 1.Understand the properties of the fluid, concepts of pressure measurement, and fundamental Laws governing fluid flows.
CO 2.Apply different principles of fluid mechanics in civil engineering.
CO 3.Apply the concept of dimensional analysis and similitude in defining physical phenomena.
CO 4.Predict the behavior of fluid in open channel and pipe flow.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes
Flow and fluid properties, Hydrostatic forces on submerged bodies, Fundamentals of fluid flow, principle of conservation of mass, momentum, energy and corresponding equations, potential flow, applications of momentum and Bernoulli's equation, Empirical relations for laminar and turbulent flow, flow in pipes, pipe networks, flow measurement devices. Types of open channels, Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, Reynolds number for Dimensional analysis, Dimensional analysis and modeling similitude. Kinematics of flow. Concepts of boundary layer, flow separation, Circulation, Drag and lift on immersed bodies.

Contents for Desired Course Outcomes (If any): NIL

Text Books:
T1. Fox, R.W. and McDonald, A.T., Introduction to Fluid Mechanics, John Wiley and
Sons, 2013.
T2. Subramanya, K., Flow in Open Channels, Tata McGraw Hill, 2008.
T3. White F. M., Fluid Mechanics, 7th edition, Tata McGraw Hill, 2013.

Reference Books:
R1. Som, S.K. and Biswas, G., Fluid Mechanics and Fluid Mechanics, Tata McGraw Hill, 2013.
R2. Garde, R.J. and Mirajgaoker, A.G., Engineering Fluid Mechanics, NemChand and Bros, 2002.
R3. Srivastava, R., Flow through Open Channels, Oxford University Press, 2010
R4. Steeter, V.L., Wylie E.B. and Bedford, K.W., Fluid Mechanics, 9th edition., Tata McGraw Hill Education, 2011.

Engineering Geology | CEL252 | 2 Credits | 2 0 0 2
Course Prerequisite
NIL

Course Objectives
The course objectives define the student learning outcome for the course. The main focus of the course is highlighted below:
- Learn about basics of engineering geology along with its role in different civil engineering projects.
- To develop awareness about the environmental problems, besides discussing the steps being taken to tackle them.
- To inspire students to come up with possible solutions to deal with various environmental problems.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO 1.Identify as well as apprehend different minerals, rocks and geological features important in planning for civil structures.
CO 2.Understand the process of weathering and soil formation along with its influence on the behavior of soil.

CO 3.Familiarize with the severity of geological hazards like Earthquake and Landslides.
CO 4.Understand the role of engineering geology in planning, design construction and post construction aspects of various civil engineering projects.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes
Introduction: Importance of Engineering Geology, Geological environment and its relation with engineering; Minerology and Petrology; Rock Mass Properties: Types of rocks, texture and structure, Physical and mechanical properties, Introduction to rock mechanics, rock mass classification;Geological structures: Strike and dip of beds, Description and types of folds, joints, faults and shear zones as well as their importance in planning for civil structures; Applications: Foundations, slopes, tunnels, dams and reserviors, River Valley Projects, Roads and bridges in hills; Geological hazards: Earthquake and Landslides .

Contents for Desired Course Outcomes (If any): NIL

Text Books
T1.De Vallejo, L. G., and Ferrer, M. Geological engineering. CRC press, 2011.
T2.Nagarajan, R., Parthasarathy, A., and Panchapakesan, V., Engineering Geology, 1st Edition, 2019.

Reference Books
R1. Waltham, T., Foundations of engineering geology, CRC press, 2009.
R2. Anbalagam, R., Singh B., Chakarborthy, D. and Kohli, A., A Field Manual for Landslide Investigation, DST, Government of India, New Delhi, 2007.
R3. Singh, P., Engineering and General Geology, S.K. Kataria and Sons, 2012.
R4. Krynine, D.P. and Judd, W.R., Principles of Engineering Geology and Geotechnics, Tata McGraw Hill, 2001.
R5. Bell, F. G., Fundamentals of Engineering Geology, Elsevier, 2007.

Building Materials and Construction Technology | CEL253 |3 Credits |3 0 0 3

Course Prerequisite
NIL

Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Overview of the various materials used in Building construction.
- Basic knowledge about material and product manufacturing techniques and how they relate to mechanical and non-mechanical properties of the various materials.
- The basic building materials and systems used in constructing buildings, bridges, and infrastructure projects.
- Gain a comparative knowledge of material properties and possible applications in construction and architecture.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO 1.Develop understanding of basic properties of construction materials.
CO 2.Develop understanding about origin, manufacturing processes, properties, design, and application of commonly used building construction materials.
CO 3.Develop ability to choose appropriate type of construction materials suiting to the functional requirements and cost of the project.
CO 4.Develop awareness of various commonly used construction techniques and apply suitably in the civil engineering practice.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes
Properties of construction materials and their evaluation (creep, elastic modulus, fatigue, impact, etc.); test methods and specifications; Cement: chemical composition, properties such as setting, strength, fineness, hydration; Aggregates: sources, properties, chemical reactivity; Steel : properties, types of steel, steel in civil engineering; Bricks: manufacture, properties and classification; masonry bonds; Brick masonry; bonds, stone masonry, types of walls, stairs, staircases, lifts and escalators. Shuttering, Scaffolding and Centering; Expansion and construction joints, sound and fire proof construction; Introduction to applications of Aluminum, glass and nano-materials in civil engineering; Buildings and its components: footing, column, beam, slab, lintel etc.

Contents for Desired Course Outcomes (If any): NIL

Text Books
T1.Taylor, G.D., Materials of Construction, Prentice Hall, 2012.
T2.Kumar, S., Building Construction, Standard Publishers, 2010.

Reference Books

R1. Neville, A.M. and Brooks, J.J., Concrete Technology, ELBS Ed., Longman Ltd., 2013.
R2. Gambhir, M.L., Concrete Technology, Tata McGraw Hill, 2013.
R3. Dayaratnam, P., Brick and Reinforced Brick Structures, Oxford and IBH Publication, 2012.
R4. Khanna, P.N., Indian Practical Civil Engineering Handbook, Engineers Publishers, 1988.

Surveying| CEL256 | 3 Credits | 3 0 0 3

Course Prerequisite

NIL

Course Objectives

After completing the above course, the key concepts, and skills that students should be able to demonstrate by the end of the course are:

- To gain the practical knowledge in the field-measuring distances, directions, angles, reduced levels.
- Apply the principle of surveying for civil engineering applications to develop the capability to design the facilities.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Understand the basic principles of surveying for vertical, horizontal, linear, and angular measurements to arrive at solutions to basic surveying problems.
CO 2.Understanding leveling (auto level, theodolite) and using it in field of construction. Further draw contours to represent 3D data on plane figures.
CO 3.Capture geodetic data to process and perform analysis for survey problems with the use of electronic instruments.
CO 4.Design and implement different types of curves for deviating type of alignments and applying surveying techniques to align highway and railway curves.
CO 5.Analyze type of survey operation required for problem solving in field.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Importance of Surveying to engineering projects, basic principles; Type of maps, scales and uses, Plotting accuracy, map sheet numbering, Coordinate and map projection; Surveying equipment: levels, compass, theodolites, tachometer, EDM, Total Stations and other instruments; Measurement of angles, directions and distance; Determination of elevation: Spirit leveling, trigonometrical leveling, and tachometric surveying, Contouring; Methods of control establishment, Traversing, triangulation, trilateration; Adjustment of survey measurements, computation of coordinates; Plane table surveys and mapping; Curve layout, Horizontal, transition and vertical curves. Introduction to Hydrographic Surveying, Photogrammetry, remote sensing, GIS and GPS.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.Arora, K.R., Surveying, Vols. I, II and III, Standard Book House, 2013.
T2.Chandra, A.M., Surveying, New Age International Publishers, 2010.

Reference Books

R1. Anderson, J.M. and Mikhail, E.M., Surveying: Theory and Practice, McGrawHill, 1988.
R2. Schofield, W. and Breach M., Engineering Surveying, 6th ed., Butterworth- Heineman, 2007.
R3. Duggal SK., Surveying Vol. I & II McGraw Hill India Private Limited, New Delhi, 4th ed. 2013.

Strength of Materials | CEL257 | 4 Credits | 3 2 0 4

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Define and calculate stress and strain in one and two dimensions for various load conditions and geometries.
- Apply the principles of stress analysis and stress transformations to analyze complex stress states using Mohr's circle method.
- Analyze bending moment and shear force diagrams for various types of beams to determine internal forces and moments at any point.
- Calculate flexural and shear stresses in beams subjected to bending loads using the principles of simple bending theory.
- Analyze the behavior of structural elements subjected to uniform torsion and calculate the associated stresses.
- Understand the concept of buckling and calculate the critical buckling load for different types of columns.

Course Outcomes

At the end of the course, students will be able to

Essential:

CO 1.Apply stress analysis principles to predict material failure under different loading conditions.
CO 2.Gain knowledge of the behavior of thin-walled pressure vessels and understand their failure mechanisms.
CO 3.Develop the ability to analyze unsymmetrical bending and determine the location of the shear center.
CO 4.Calculate combined and direct bending stresses in beams subjected to multiple loading conditions.
CO 5.Learn the double integration method to determine the deflection of statically determinate beams under various loading conditions.
CO 6.Understand the concept of buckling and be able to calculate the critical buckling load for different types of columns.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Simple stress and strain relationship: Stress and strain in one and two dimensions, principal stresses, stress transformation, Introduction to theories of failures, Mohr's circle. Bending moment and shear force diagrams for beams. Simple bending theory, flexural and shear stresses, unsymmetrical bending, shear center. Combined and direct bending stresses, Deflection of statically determinate Beams: Double integration Method, introduction to graphical methods. Thin-walled pressure vessels, uniform torsion, buckling of column.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.Gere, James M., and Timoshenko, Stephen. Mechanics of Materials. United Kingdom, PWS Publishing Company, 2004.
T2.Gere, James M., and Goodno, Barry J., Mechanics of Materials. 9th Ed., Cengage Learning, 2021.
T3.Popov, Egor Paul, Balan, Toader A., Engineering Mechanics of Solids. India, Prentice Hall, 1998.

Reference Books

R1. Beer, F.P., Johnston, E.R., Dewolf, J.T. and Mazurek, D.F., Mechanics of Materials, 5th ed., Tata McGraw Hill, 2011.
R2. Shames, I.H., Introduction to Solid Mechanics, 3rd Ed., Prentice Hall India, 2006.
R3. Crandall, S. H., Dahl, N.C., and Lardner. J., An introduction to the Mechanics of Solids., Tata McGraw Hill, 1978.

Water Supply Engineering | CEL281 | 3 Credits | 3 0 0 3

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understanding the basic principles of water supply engineering, including the importance of water quality, pollution control, and sustainability.
- Developing an understanding of the principles of water and wastewater treatment, including the physical, chemical, and biological processes involved.
- Developing the ability to apply engineering principles and quantitative methods to develop models, and design systems.
- Understanding the responsible use of resources and the impact of water quality on society and the environment.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Describe the principles of water and wastewater treatment, including the physical, chemical, and biological processes involved.
CO 2. Apply engineering principles and quantitative methods to solve environmental engineering problems.
CO 3. Identify and analyze real-world environmental engineering problems and to develop effective solutions.
CO 4. Understand the impact of environmental engineering on society and the environment.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Sources of Water, Water Quality, Water Demand: Types of demand and their contribution, rate of consumption, population forecasting, variation in demand pattern. Intakes structures for surface water source. Systems and unit processes of water Purification: Aeration, sedimentation, Coagulation and flocculation, filtration, Disinfection, Softening, Introduction to advanced water treatment methods. Conveyance of water: pipe materials, corrosion, laying of pipes, pumps for water supply, distribution system, planning of water supply projects. Rural water supply.

Contents for Desired Course Outcomes (If any): NIL

Text books:

T1.Peavy, H.S., Rowe D.R. and Tchobanoglous, G., Environmental Engineering, McGraw Hill, 1985.

T2. Masters, G., Introduction to Environmental Engineering and Science, Prentice Hall, 2004.

Reference books:

R1. Davis, M.L. and Cornwell, D.A., Introduction to Environmental Engineering, McGraw Hill, 2012.

R2. Kenneth, W., Warner, F.C. and Davis, W.T., Air Pollution its Origin and Control, Prentice Hall, 1997.

R3. S. K. Garg., Water supply engineering: Environmental Engineering, Volume 1, Khanna Publications, 2018.

R4. P.N Modi., Water supply engineering, Volume 1, Standard Publications, 2018.

R5. McGhee, T.J., Water Supply and Sewerage, McGraw Hill, 1991.

Highway Engineering | CEL282 | 3 Credits | 3 0 0 3

Course Prerequisite

NIL

Course Objectives

After completing the above course, the key concepts, and skills that students should be able to demonstrate by the end of the course are:

- Basic knowledge on various highway developmental engineering surveys and drawings and reports.
- Knowledge of conducting various tests on bitumen & aggregate.
- Knowledge on designing geometry of highways.
- Knowledge on conducting traffic surveys traffic signs, markings and design of traffic signal.
- Design and Construction of flexible and rigid Pavements as per latest guidelines.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand various engineering surveys for construction of highways.

CO 2. Understand the procedure of conducting tests on bitumen and aggregate.

CO 3. Design geometries like sight distance, super elevation, extra widening, transition curves and vertical curves.

CO 4. Understand design and construction of flexible and rigid Pavements.

CO 5. Understand the procedure of conducting various traffic surveys and traffic regulations by sign boards, markings and signals.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Transportation modes and comparison, Role of transportation: Economic, Social, Political, Environmental; Historical Development, road patterns, master plans, road development plans, engineering survey for highway projects; Testing of road materials like soil, aggregates and bitumen; Highway Cross section elements, camber, super elevation, sight distances, horizontal and vertical alignment, summit and valley curves; Type of pavements, Flexible pavements and their design as per IRC 37, review of old methods, CBR method, equivalent single wheel load factor, rigid pavements, stress in rigid pavement, IRC 58 design method for rigid pavement; Construction of various layers, earthwork, WBM, GSB, WMM, various types of bituminous layers, joints in rigid pavements, Construction of Rigid Pavements; Types of defects in Flexible and Rigid pavements, their Symptoms, Causes and Treatments, Special Repairs. Pavement Evaluation: Pavement Surface Conditions and Structural Evaluation, Evaluation of pavement Failure and strengthening - Overlay design by Benkelman Beam Method; Traffic characteristics, road user and vehicular characteristics, traffic studies, introduction to intelligent transport systems.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Khanna, S.K. and Justo, C.E.G., Highway Engineering, NemChand and Bros, 2011.

T2. Kadiyali, L.R., Traffic Engineering and Transportation Planning, Khanna Publishers, 2012.

Reference Books

R1. Sharma, S.K., Principles and Design of Highway Engineering, S. Chand and Co., 2012.

R2. Papacostas, C.S. and Prevedouros, P.D., Transportation Engineering and Planning, Prentice Hall,2008.

R3. JotinKhisty, C. and Kent Lall, B., Transportation Engineering: An Introduction, Prentice Hall, 2008.

R4. Khanna, S.K. and Justo, C.E.G., Highway Material Pavement Testing Manual, NemChand and Bros., 2013.

R5. Roess, R.P., Prassas, E.S. and McShane, W.R., Traffic Engineering, Pearson, 2013.

Reinforced Concrete Structures | CEL357 | 4 Credits | 3 0 2 4

Course Prerequisite

The student should have studied the course CEL353.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Gain knowledge about the analysis, behaviour, and design of simple structural elements.
- Understand fundamental concepts of design and detailing in Reinforced Cement Concrete.
- Understand the importance of design and detailing.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Analyse the safety of structural components based on Indian standard codal provisions.

CO 2. Apply limit state design principles to analyze and design reinforced concrete beams and compression members.

CO 3. Read and draft the structural drawings of reinforced concrete Beams and Columns.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction to Reinforced Concrete structures, loading and idealization, Load Combinations. Design Consideration: Safety, Stability, Serviceability, Durability; Limit state design of R.C. beam Sections in flexure, shear, torsion and bond; Design for serviceability: Deflection and Crack Control; Earthquake Considerations; Design of compression members: Effective length calculation, short and long columns, Columns with uniaxial and biaxial Moments.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Pillai, S.U. and Menon, D., Reinforced Concrete Design, Tata McGraw Hill, 2013.

T2. Subramanian, N., Design of Reinforced concrete Structures, Oxford Higher Education, 2014.

Reference Books

R1. Sinha, S.N., Reinforced Concrete Design, Tata McGraw Hill, 2013.

R2. Jain, A.K., Reinforced Concrete, NemChand, and Bros, 2012.

R3. Shah, V.L. et. al., Limit State Theory and Design of Reinforced Concrete Structures, 2007.

R4. Varghese, P.C., Limit State Design of Reinforced Concrete, Prentice-Hall, 2011.

R5. Park, R. and Pauley, T., Reinforced Concrete Structures, John Wiley and Sons, 2010.

Steel Structures | CEL358 | 4 Credits | 3 2 0 4

Course Prerequisite

The student should have studied the courses CEL257, CEL353, CEL356.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the properties of structural steel and its application in design and construction.
- Familiarize with the Indian Standard (I.S.) specifications for rolled sections and their usage in structural design.
- Introduce the concept of plastic analysis and its importance in structural design.
- Apply the elastic method and limit state design approach for the design of structural elements.
- Analyze and design simple and moment resistant bolted and welded connections in steel structures.
- Design tension members, compression members, struts, columns, and built-up sections with considerations for stability and strength.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Gain proficiency in applying plastic analysis techniques to assess the load-carrying capacity and behavior of structures.

CO 2. Design and analyses steel connections.

CO 3. Design and analyses tension members, compression members, and flexural members.

CO 4. Understand the principles of designing column bases.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction, properties of structural steel, I.S. rolled sections, I.S. specifications. Introduction to plastic Analysis and design. Design approach, elastic method, limit state design. Connections, simple and moment resistant bolted and welded connections. Tension members. Compression members, struts and columns. Built-up columns, beams, stability of flange and web, built-up sections, plated I-sections with splices and curtailment of flange plates, column bases.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Duggal, S.K., Limit State Design of Steel Structures, Tata McGraw-Hill, 2012.

T2.Subramanian, N. Design of Steel Structures, Oxford University Press, 2012.

Reference Books

R1. Arya, A.S. and Ajmani, J.L., Design of Steel Structures, NemChand and Bros, 2007.
R2. Gaylord, E. H., Design of Steel Structures, Tata McGraw Hill India, 2008.
R3. Dayaratnam, P., Design of Steel Structures, S. Chand Publisher, 1998.

Railway and Airport Engineering | CEL359| 3 Credits | 3 0 0 3

Course Prerequisite

NIL

Course Objectives

After completing the above course, the key concepts, and skills that students should be able to demonstrate by the end of the course are:

- To expose the students to Railway planning, design, construction and maintenance and planning and design principles of Airports.
- Illustrate the basic procedure of railway construction and its maintenance.
- To impart knowledge to students the airport design and understand the basic needs in airport construction.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Understand the history and development, role of railways, railway planning and development based on essential criteria.
CO 2.Learn different types of structural components, engineering properties of the materials, to calculate the material quantities required for construction.
CO 3.Understand various aspects of geometrical elements, points and crossings, significance of maintenance of tracks.
CO 4.Design and plan airport layout, design facilities required for runway, taxiway and impart knowledge about visual aids.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

History of Indian Railways, universal scenario and Indian railways, railway track development, component parts, gauge, wheel and axle arrangement. Various resistances and their evaluation, hauling capacity, tractive effort, locomotives and their classification, stresses in the track and its components. Rails and their requirements, creep and wear in rails, rail joints, long welding rails and short welded rails, types of sleepers and their merits and demerits, requirements of ballast, design of ballast section, track fastenings, check rails and guard rails, railway cross-section, various types of gradients, design of horizontal curves, transition curves and vertical curves, existing provisions on IR. Working and design of a turnout, types of track junctions, design of crossover and diamond crossing, types of signals and their functions, interlocking, advanced methods of train control. High speed rails. Scenario of air transport in India, national and international agencies, aircraft characteristics, site selection, airport obstructions, imaginary surfaces. Runway orientation, geometric design of runway, taxiway, exit taxiway, apron, holding apron, runway configuration, visual aids.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Chandra, S. and Agarwal, M.M., Railway Engineering, Oxford University Press, New Delhi, 2013.
T2. Arora, S. P. and Saxena, S.C, A Text book on Railway Engineering, Dhanpatrai Publications Pvt. Ltd., New Delhi, 2006.
T3. Saxena, S. C., Airport Engineering: Planning and Design, CBS Publishers and Distributors Pvt.Ltd., New Delhi, 2008.

Reference Books

R1. Mundrey, J. S., Railway Track Engineering, Tata McGraw Hill Publishing, 2009.
R2. Khanna, S. K., Arora, S. P. and Jain, S. S., Airport Planning and Design, NemChand and Bros, Roorkee, 1999.

Estimation and Costing | CEL360 | 3 Credits | 3 0 0 3

Course Prerequisite

NIL.

Course Objectives

- To develop the techniques required to measure, quantify and cost of the construction works.
- To understand various professional practice issues including contract, tendering process, departmental procedure and related legal issues.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Understand civil engineering drawing and estimate contracts and other legal requirements in construction.
CO 2.Compute approximate and detailed quantity estimate of any buildings, RCC works,
road works or irrigation works.

CO 3.Analyse rates of various items related to different civil engineering structures.
CO 4.Understand and define the detailed specifications for various Civil Engineering Works.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Building Drawing: Plan, Elevation, Section Views; Estimates: Types, complete set of estimates, working drawings, site plan, layout plan, index plan, plinth area, administrative approval and Technical Sanction, Measurement book. Estimate of buildings, Estimate of R.C.C. works, Estimate of sloped roof and steel structures, Estimate of water supply and sanitary works, Estimates of roads (a) Earthwork (b) Bridges and culverts c) Pavement, Estimate of Irrigation works. Analysis of Rates: For earthwork, concrete works, D. P. C., Brickwork, stone masonry, plastering, pointing, road work, carriage of materials. Specifications: General specification for different classes of building, detailed specifications for various Civil Engineering Works. Introduction on schedule of rates.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.Dutta, B. N. Estimating and Costing in Civil Engineering: Theory and Practice: including Specifications and Valuation., UBS Publishers and Distributors Ltd., New Delhi, 2022.
T2.Chakraborti, M., Estimating, Costing, Specification & Valuation in Civil Engineering, 2006.

Reference Books

R1. Birdie, G.S., Textbook of Estimating and Costing (Civil Engineering), Dhanpatrai Publishing Company, 2014.
R2. Kohli, D. D., Kohli, R.C., A Textbook of Estimating and Costing (civil), S. Chand and Company, New Delhi, 2013.

Hydrology and Irrigation Engineering | CEL381 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL 251.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an understanding of the principles and processes of hydrology, including precipitation, evapotranspiration, and runoff, and their applications.
- Gain knowledge of different irrigation techniques and their design principles, including surface irrigation, and impact on crop production and water use efficiency.
- Learn how to use hydrological and irrigation models and tools to analyze and interpret data, and to design and evaluate irrigation systems.
- Understand the environmental, economic, and social implications of water resources management and irrigation schemes.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Analyze and interpret hydrological data, including precipitation, evapotranspiration, and streamflow, using appropriate statistical and modeling tools.
CO 2. Design and evaluate irrigation systems based on crop water requirements, soil properties, and climate conditions.
CO 3. Assess the impact of land use, climate change, and human activities on water resources and develop sustainable water use alternatives.
CO 4. Communicate effectively and work collaboratively with stakeholders involved in water resources management and irrigation projects.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes-

Contents:

Hydrologic cycle, rainfall: measurement of precipitation and other meteorological parameters, real time data acquisition system for hydrometeorological observations, Interpretation of precipitation data, estimation of missing data, test for consistency, Depth-Area-Duration analysis, rainfall estimation, methods of precipitation, abstraction from precipitation, evaporation, evapo-transpiration, infiltration: factors affecting infilteration, Horton's infiltration curve, phi-index, W-index, interception and depression storage, stage discharge relationships, flow-mass curve, flow-duration curve, surfacewater flow discharge and estimation of runoff, Hydrographs: Different methods of drawing base-line for hydrographs, unit hydrograph concept, derivation of UH, S-curve, construction of UH, derivation of average UH, flood estimation, reservoir capacity, reservoir and channel routing. Soil-water-plant relationships, wilting point and field efficiency, gross command area, irrigation efficiency, Duty, delta, Crop water requirements, consumptive use of water, land classification for crops. Types of Irrigation system, Irrigation methods.Water logging and drainage, sodic soils.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1. Ojha, C.S.P., Berndtsson, R. and Bhunya, P., Engineering Hydrology, Oxford University Press, 2012.

T2. Asawa, G.L., Irrigation and Water Resources Engineering, New Age International Publishers, 2013.

T3. Subramanya, K., Engineering Hydrology, Tata McGraw Hill, New Delhi, 2013.

Reference Books:

R1. Mysooru R., Yadupathi Putty, Principles of Hydrology, I K international publishing house, 2011.

R2. Chow, V. T., Maidment, D.R. and Mays, L.W., Applied Hydrology, Tata McGraw Hill, 2013.

Concrete Technology | CEL382 | 3 Credits | 3 0 0 3

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the fundamental properties, various types and mix design of concrete.
- Gain knowledge about the working stress design concepts and design for common flexural members.
- Understanding of different techniques used in NDT and evaluating their suitability for engineering applications.

Course Outcomes

At the end of the course, students will be able to

Essential:

CO 1.Determine the properties of fresh and hardened concrete.

CO 2.Design the concrete mix as per Indian (IS) and American Code (ACI).

CO 3.Apply working stress principles for analyzing and designing of reinforced concrete flexural members.

CO 4.Identification of appropriate NDT techniques for the analysis of structures.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Fundamental of concrete : constituents, proportioning, mixing, transportation, placing and curing; Properties in fresh and hardened state, characteristic strength, creep, Shrinkage, quality control (sampling, acceptance, etc.); Admixtures: chemical, mineral; Concrete mix design as per IS: 10262-2019 ; Durability of concrete : alkali aggregate reaction, reinforcement corrosion, freezing and thawing, etc., Special concretes : high strength, low heat of hydration, high early strength, self-compacting, etc., Introduction to non-destructive testing of Concrete, evaluation criteria. Concrete design: basic working stress design concepts, working stress design for common flexural members (Single, Doubly and Flanged beams).

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.Shetty, M.S., Concrete Technology, Theory & Practice, S. Chand and Co, 2004.

T2.Bungey, S., Lillard, G. and Grantham, M.G. Testing of Concret in Structures, 4th Ed., Taylor and Francis, London, 2006,

T3.Subramanian, N., Design of Reinforced concrete Structures, Oxford Higher Education, 2014.

Reference Books

R1. P.K. Mehta and Paulo J.M. Monteiro, Concrete: Microstructure Properties and Materials, 4th edition, Tata McGraw Hill, 2017.

R2. Gambhir, M.L., Concrete Technology, Tata McGraw Hill, 2004.

R3. Neville, Properties of Concrete, Longman Publishers, 2004.

R4. Santakumar A.R., Concrete Technology, Oxford University Press, New Delhi, 2007.

R5. IS 10262: 2019: Concrete Mix Proportioning — Guidelines; Bureau of Indian Standards, New Delhi.

R6. ACI 211.1-22 (2022): Standard practice for selecting proportions for normal, heavyweight, and mass concrete, ACI Committee 211, Farmington Hills, MI, USA.

R7. Park, R. and Pauley, T., Reinforced Concrete Structures, John Wiley and Sons, 2010.

R8. Pillai, S.U. and Menon, D., Reinforced Concrete Design, Tata McGraw Hill, 2013.

Soil Mechanics | CEL383 | 3 Credits | 3 0 0 3

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the origin of soils and the various factors affecting soil formation.
- Learn about different soil classification systems, including the Unified soil classification system and the Indian system of classification.

- Understand the principles of compaction, including the factors affecting compaction and different compaction techniques.
- Learn about capillarity and permeability of soils, including field methods of permeability determination and equivalent permeability in stratified soils.
- Gain knowledge about compressibility and consolidation of soils, including 1-D consolidation, time rate of consolidation, settlement, and secondary consolidation.
- Gain knowledge about various methods of subsurface exploration.

Course Outcomes

At the end of the course, students would be able to-

Essential:

CO 1. Understand significance of various index properties and classify soils.
CO 2. Compute flow of water through soils and related stresses.
CO 3. Evaluate compressibility of soils and correlate it with in-situ settlement problems.
CO 4. Evaluate strength characteristics of soils and apply it to various geotechnical analyses.
CO 5. Understand methods and plan an optimized subsurface exploration programme.

Desirable/Advanced (If any):NIL

Syllabus for Essential Course Outcomes

Origin of soils; soil classification; Three phase system: Physical Properties and their interrelationships, mechanical sieve analysis, consistency of fine grained soils, Atterberg's limits, relative density, Unified soil classification system, Indian system of classification; Compaction: General principles, tests, factors affecting compaction, field compaction, compaction techniques; Capillarity and Permeability: Principles of total, effective and neutral stresses, field methods of permeability determination, equivalent permeability in stratified soils; Seepage Analysis: Darcy's law, 1-D flow, Laplace's equation, flow nets, seepage, uplift pressure, confined and unconfined flows, piping, filter criteria; Compressibility and Consolidation : Fundamentals, 1-D consolidation, normally and over consolidated clays, pressure-void ratio relationships, compressibility characteristics, time rate of consolidation, coefficient of consolidation, curve fitting techniques, settlement, secondary consolidation; Shear Strength of Soil :Mohr stress circle representation, Mohr-Coulomb failure criterion, direct shear test, unconfined compression test, Triaxial compression test: consolidated drained, consolidated undrained, unconsolidated undrained tests, vane shear test, shear strength of clays and sands, critical void ratio, pore-pressure coefficients, sand drains; Sub-surface investigations: scope, soil boring techniques, sampling, penetration tests, plate load test.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.Ranjan, G. and Rao, A.S.R., Basic and Applied Soil Mechanics, New Age International Publishers, 2012.
T2.Gulhati, Shashi K., and Dutta. M, Geotechnical Engineering, Mcgraw Hill, 2015.

Reference Books

R1. Holtz, R.D. and Kovacs, W.D., An Introduction to Geotechnical Engineering, Prentice Hall, 2011.
R2. Couduto, D.P., Geotechnical Engineering: Principles and Practices, Prentice Hall of India, 2007.
R3. Murthy, V.N.S., Text Book of Soil Mechanics and Foundation Engineering, CBS Publishers, 2011.
R4. Lambe, T.W. and Whitman, R.V., Soil Mechanics, John Wiley and Sons, 2008.
R5. Craig, RF., Craig's Soil Mechanics, Taylor and Francis, 2010.

Wastewater Engineering and Pollution | CEL384 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL 281.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the advanced treatment processes for drinking water and wastewater, including membrane filtration, ion exchange, and disinfection.
- Understand about the sources, characteristics, and management of hazardous wastes, including the design and operation of hazardous waste treatment facilities.
- Assessment and management of environmental risks associated with chemicals, waste disposal, and industrial activities.
- Learn about the legal and regulatory framework for environmental protection, including federal and state laws and regulations, as well as international treaties and agreements.
- Learn about the design, implementation, and auditing of environmental management systems

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Apply advanced knowledge of environmental engineering principles and technologies to solve complex environmental problems.

CO 2.Design and conduct experiments, analyze data, and interpret results related to water and wastewater treatment, and pollution control and management .
CO 3.Apply principles of environmental law, policy, and regulation to the design and operation of environmental engineering systems.
CO 4.Develop and implement strategies for managing environmental risks associated with chemical, waste disposal, and industrial activities.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Sources of wastewater, Estimation of sanitary sewage flow, Estimation of storm runoff, Characteristics of wastewater and their significance, disposal standards, treatment of wastewater; On-site systems, Sludge digestion, disposal of sludge; Disposal standards of effluents, self-purification of rivers; Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits; Noise pollution: Types of noise pollution, sources and impacts, assessment and control, permissible limits. Management of solid wastes: Characteristics, generation, collection and transportation of solid wastes, engineered system of solid waste management, waste utilization and beneficial aspects.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1.Syed R. Qasim., Wastewater Treatment Plants: Planning, Design, and Operation, Second Edition CRC press, 1995.
T2.P.N Modi., Sewage disposal and waste water engineering, 4th edition, Standard Publications, 2020.

Reference Books:

R1. Metcalf., and Eddy., Waste Water Engineering: Treatment and Reuse, T.M.H. Publication, 2017.
R2. Kenneth, W., Warner, F.C. and Davis, W.T., Air Pollution its Origin and Control, Prentice Hall, 1997.
R3. S. K Garg, Sewage disposal and Air pollution engineering, Volume II, Khanna Publications.
R4. Masters, G., Introduction to Environmental Engineering and Science, Prentice Hall, 2004.

Structural Analysis | CEL385 | 4 Credits | 3 2 0 4

Course Prerequisite

The student should have studied the course CEL257.

Course Objectives

After completing the above course, the key concepts, and skills that students should be able to:

- Understand the concept of determinate and indeterminate structures,
- Understand analysis of statically determinate structures.
- Understand energy methods for determining deflection in statically determinate structures.
- Understand analysis of statically indeterminate structures.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Develop aptitude to determine the degree of indeterminacy and stability structures.
CO 2. Analyse statically determinate structures like beams, truss, cable arches and frames.
CO 3. Analyse and determine the deflection in the beam, trusses and frames using different energy methods.
CO 4. Analyze the statically indeterminate structure using force and displacement methods

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction to structures, loading and idealization. Internal forces in statically determinate structures– arches and cables. Static and Kinematic indeterminacy of structures. Deflection of statically determinate structure using energy method, unit load method, Castigliano's theorems; Analysis of rolling loads. Influence lines for statically determinate structures. Force method of analysis; Displacement approach: basic principles; Slope deflection method; Moment distribution method; Introduction to Matrix method: Flexibility and stiffness approach.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Hibbeler, R.C., Structural Analysis, Pearson Press, 2013.
T2. Wang, C.K., Intermediate Structural Analysis, McGraw Hill, 2012.

Additional Books:

R1. Pandit, G.,and Gupta, S., Theory of Structures (Vol. I & II), McGraw Hill, 1999.
R2. Wang, C.K., Intermediate Structural Analysis, McGraw Hill, 2012.
R3. Weaver, W. Jr. and Gere, J.M., Matrix Analysis of Framed Structures, Springer, 2012.
R4. William, F. R. et al., Mechanics of Materials, John Wiley and Sons. 2006.
R5. Negi, L. S., and Jangid, R. S., Structural Analysis, Tata McGraw Hill Publication, 2004.
R6. Reddy, C.S., Basic Structural Analysis, Tata McGraw Hill, 2012.

Geotechnical Engineering | CEL386 | 4 Credits | 3 2 0 4

Course Prerequisite

The student should have studied the course CEL383.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Study stress distribution in soils using Boussinesq's theory.
- Learn about analyses and design of various types of shallow foundations.
- Understand analyses and design of pile foundations.
- Understand and apply various methods of stability analysis of soil slopes.
- Learn about methods to compute lateral earth pressure.

Course Outcomes

At the end of the course, students would be able to-

Essential:

CO 1. Compute stresses in soils subjected to different types of external loadings.
CO 2. Analyze and design different types of shallow and deep foundations.
CO 3. Perform slope stability analysis using various popular methods.
CO 4. Understand earth pressure and its significance for geotechnical structures.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Stress distribution in soils: Boussinesq's theory; Pressure bulbs, Foundation types: type, Foundation selection and design requirements; Shallow Foundations: bearing capacity, effect of shape, size, water table and other factors, contact pressure, settlement analysis in sands and clays, plate load test; Deep foundations: pile types, dynamic and static formulae, load capacity of piles in sands and clays, negative skin friction, pile group capacity, Methods of Stability of slopes: infinite slopes, finite slopes, method of slices, Swedish circle method, Friction circle method, Bishop's method; Earth pressure theories, effect of water table, layered soils; Pseudo-static analyses; Intoduction to retaining walls.

Contents for Desired Course Outcomes (If any): NA

Text Books

T1. Ranjan, G. and Rao, A.S.R., Basic and Applied Soil Mechanics, New Age International Publishers, 2012.
T2. Gulhati, Shashi K., and Dutta. M, Geotechnical Engineering, Mcgraw Hill, 2015.

Reference Books

R1. Das, B.M., Principles of Geotechnical Engineering, Thomson, India, 2007.
R2. Som, N.N. and Das, S.C., Theory and Practice of Foundation Design, Prentice-Hall, 2009.
R3. Couduto, D.P., Geotechnical Engineering: Principles and Practices, Prentice Hall of India, 2007.
R4. P Murthy, V.N.S., Textbook of Soil Mechanics and Foundation Engineering, CBS publishers, 2013.
R5. Bowles, J.E., Foundation Analysis and Design, Tata McGraw Hill, 2013.

Geomatics Engineering | CEL451| 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL256.

Course Objectives

After completing the above course, the key concepts, and skills that students should be able to demonstrate by the end of the course are:

- To prepare the student to plan and conduct field work and application of scientific methodology in handling field samples.
- To equip the student with the art, science and technology of remote sensing and applications of GIS in Mapping Resources.
- To develop skills in surveying and thematic mapping.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the basic concepts of photogrammetry and stereoscopy.
CO 2. Apply the knowledge of remote sensing and visual data interpretation to various applications.
CO 3. Understand the methods of digital image processing.
CO 4. Understand the Geographic Information System (GIS) and GPS surveys.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction of Geomatics Engineering; Photogrammetry, types and geometry of aerial photograph, flying height and scale, relief (elevation) displacement, Stereoscopy, Measurement of parallax and height determination; Basic remote sensing, interaction mechanism with atmospheric and earth

surface, platforms and sensors, remote sensing data products, visual data interpretation for information extraction; Digital Image, introduction to digital image processing, pre-processing, enhancement, classification; Introduction of Geographic Information System (GIS), GIS database, raster and vector data structure, digital elevation model; Introduction to GPS surveys, space, control and user segments, GPS receivers; Applications of Geomatics to various projects.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Agarwal, C.S. and Garg, P.K. Remote Sensing in Natural Resources Monitoring and Management, Wheeler Publishing House, New Delhi, 2000.

T2. Lillesand, T.L., and Kiefer, R.W., Remote Sensing and Image Interpretation, 4th ed., John eyand Sons, 2005.

Reference Books

R1. Ghilani, C.D. and Wolf, P.R. Elementary Surveying: An Introduction to Geomatics, Pearson, 2012.

R2. Bossler, J.D. Manual of Geospatial Science and Technology, Taylor and Francis, London, 2002.

R3. Burrough, P.A. and McDonnell, R.A. Principles of Geographic Information System, Oxford University Press, 2000.

R4. Chandra, A.M. and Ghosh, S.K. Remote Sensing and Geographical Information Systems, Alpha Science, Oxford U.K., 2005.

R5. Gopi, S. Global Positioning System: Principles and Applications, Tata McGraw Hill, 2005.

R6. Lo, C.P. and Yeung, A.K.W., Concepts and Techniques of Geographical Information System, Prentice Hall, India, 2002.

Non Destructive Testing of Materials | CEL452 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL253.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Introduce students to the different types of distresses in concrete.
- Explain the principles and concepts of destructive and non-destructive testing methods and their correlation with material properties.
- Familiarize students with the different techniques used in NDT.
- Provide students with practical knowledge and skills to apply NDT methods for testing materials and evaluating their suitability for engineering applications.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the different types of distresses and tests involved.

CO 2. Identification of appropriate NDT techniques for the analysis of structures.

CO 3. Perform the NDT equipment's and understanding of interpretation of results.

CO 4. Confirm the application of NDT techniques for actual practical issues.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Planning and interpretation of in-situ testing: Test methods available, Test programme planning, In-situ concrete variability, Interpretation; Surface hardness methods: Rebound test equipment and operation, Procedure, Theory, Calibration and interpretation; Ultrasonic pulse velocity methods: Theory, equipment and use, Test calibration and interpretation of results, Applications, Reliability and limitations; Partially destructive strength tests: Windsor probe test, Pin penetration test, Pull-out Testing. Cores: Procedures for core cutting and testing, Interpretation of results. Durability Tests: Electromagnetic cover measurement, Half-cell or rest-potential measurement, Resistivity measurements, Direct measurement of corrosion rate, Tests for alkali–aggregate reaction, Tests for freeze–thaw resistance, Abrasion resistance testing; Chemical testing and allied techniques: Sulfate determination, Chloride determination, Alkali reactivity tests, carbonation test.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Bungey, S., Lillard, G. and Grantham, M.G. Testing of Concrete in Structures, 4th Ed., Taylor and Francis, London, 2006,

T2. Malhotra, V.M. and Carino, N.J., Handbook on Non-Destructive Testing of Concrete, 2nd Ed.,
Taylor and Francis, London, 2003.

Reference Books

R1. Krautkramer, H., Ultrasonic Testing of Materials, Springer Verlag, 1969.

R2. Novgoresky, M.A., Testing of Building Materials and Structures, Mir Publishers, 1973.

R3. American Society of Metals: Handbook, Vol. II, Destructive Inspection and Quality Control, 1976.

Rock Engineering | CEL455 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL252.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the formation of rock, properties and behavior under different field situations.
- Able to conduct various lab tests on rock samples and specimens.
- Develop an understanding of the engineering properties of rocks, geological and engineering rock classifications.
- Understand rock failure theories, in-situ stresses in rock, and the fundamental concepts and principles of rock mechanics.
- Apply the concept of rock engineering in design of foundations, slope stability and support system around tunnels.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Familiarize with the measurement of in-situ stresses through laboratory and field testing of rocks.

CO 2.Identify as well as apprehend classification systems for rocks and rock masses.

CO 3.Understand the strength and failure criteria for rocks and rock masses along with its influence on the engineering behaviour of rocks.

CO 4.Understand the role of rock engineering in design of foundations, slope stability and support system around tunnels.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Rock forming minerals and rock types: rock mass; classification systems for rocks and rock masses: RMR, Q system, strength and deformation behavior of rocks, strength and failure criteria for rocks and rock masses, strength of rock joints, laboratory and field testing of rocks, measurement of in-situ stresses; Foundations on rocks: bearing capacity theories, IS code methods, Foundation treatment for dams, barrages, bridge piers etc; Stability of rock slopes: Stereographic projections, modes of failure, stability of plane, wedge and toppling failures, Ground conditions in tunneling, Stress distribution around circular tunnels, various support systems, tunnel orientation.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1.Hudson, J.A. and Harrison, John P., Engineering Rock Mechanics- An Introduction to the Principles, Elsevier Publication, 2001.

T2. Jaeger, J.C. and Cook, N.G.W., Fundamentals of Rock Mechanics, Mathew & Co.Ltd, 1979.

T3.Goodman P.E., Introduction to Rock Mechanics, John Wiley and Sons, 2010.

Reference Books:

R1. Ramamurthy, T., Engineering for rocks: Foundations, Slopes and Tunnels, IBH publication, 2003.

R2. Singh, B. and Goel, R.K., Rock Mass Classification- A Practical Engineering Approach, Elsevier Publication, 2006.

R3. Hoek, E., Practical Rock Engineering, Rock Science, 2000.

Industrial Waste Management|CEL456| 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the courses CEL254 & CEL352.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an understanding of the principles of industrial waste generation and its impact on the environment and public health.
- Learn about the regulatory framework and environmental laws governing industrial waste management.
- Familiarize oneself with the different types of industrial waste and their sources, characteristics, and potential hazards.
- Develop skills and knowledge to design and implement effective industrial waste management strategies, including reduction, reuse, recycling, and disposal.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Ability to identify and assess potential environmental and public health impacts of industrial waste.

CO 2.Understanding of the regulatory framework and environmental laws governing industrial waste management.

CO 3.Capacity to analyze and characterize different types of industrial waste and evaluate potential hazards.

CO 4.Competency to design and implement effective industrial waste management strategies.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Industrial Wastewater nature and characteristics, Environmental Impacts, Regulatory Requirements, Prevention vs Control of Industrial Pollution, Source Reduction Techniques , Waste Minimization, Equalization, Neutralization, Adsorption, Aerobic and Anaerobic Biological Treatment, Sequencing Batch Reactors, Chemical Oxidation, Ozonation, Photo catalysis, Ion Exchange, Membrane Technologies, Zero Effluent Discharge Systems, Wastewater Reuse, Disposal of Effluent on Land, Wastewater Characteristics and Wastewater Treatment for Textiles, Tanneries, Pulp and Paper, Pharmaceuticals, Food Processing and Dairy industries. Solid Waste Management: Characteristics, generation, collection and transportation of wastes, reuse/recycle, energy recovery, treatment and disposal standards as per ISI recommendations.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1. Rao, M.N. and Dutta, A.K., Wastewater Treatment II, Oxford IBH Publication, 1995.

T2. Freeman, H.M., Industrial Pollution Prevention Hand Book II, McGraw Hill Inc., New Delhi,1995.

Reference Books:

R1. Eckenfelder, W.W., Industrial Water Pollution Control II, McGraw Hill Book Company, New Delhi, 2000.

R2. Shen, T.T., Industrial Pollution Prevention, Springer, 1999.

R3. Stephenson, R.L. and Blackburn, J.B., Industrial Wastewater Systems Hand Book, Lewis publishers, New York, 1998.

R4. Bishop, P.L., Pollution Prevention: Fundamental and Practice, Tata McGraw Hill, 2000.

R5. Peavy, H.S., Rowe D.R. and Tchobanoglous, G., Environmental Engineering II, McGraw Hill 1985.

Environmental Impact and Risk Assessment | CEL457 | 3 Credits| 3 0 0 3

Course Prerequisite

The student should have studied the courses CEL254 & CEL352.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an understanding of the concepts and principles of environmental impact assessment (EIA) and risk assessment (RA).
- Learn about the regulatory framework and guidelines for conducting EIA and RA.
- Familiarize oneself with the various methods, techniques, and tools used for conducting EIA and RA.
- Develop skills and knowledge to design, implement, and evaluate EIA and RA studies for different types of projects and activities.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Analyze and assess potential environmental impacts and risks of projects and activities.

CO 2. Understanding of the regulatory framework and guidelines for conducting EIA and RA.

CO 3. Capacity to apply different methods, techniques, and tools for conducting EIA and RA.

CO 4. Competency to design, implement, and evaluate EIA and RA studies for different types of projects and activities.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction and scope, utility of the EIA Process, expended and narrowed scope of EIA, Impacts of development activities, planning and management of impact studies. Environment attributes, environmental indices and indicators, environmental assessment, methods and techniques, matrices, network and checklist methods. Prediction technique for quality of environmental attributes. Impact evaluation, assessment of impact on air, water, soil and ground water, noise, biological environment. Assessment of impact on socio-economic environment, evaluation methods, mitigation measures. Health risk assessment, hazard identification toxicology and dose response characterization, exposure characterization, risk characterization, uncertainty in estimates. Risk evaluation, risk acceptance, basic principles of health risk management, preparation of environmental risk assessment report.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1. Jain, P. K., Environment Impact Assessment, John Wiley and Sons, 1978.

T2. Paustenbach, D.A., Risk Assessment: A Text Book of Case Studies, John Wiley and Sons, 1992.

Reference Books:

R1. Kenneth, W., Warner, F.C. and Davis, W.T., Air Pollution its Origin and Control, Prentice Hall, 1997.

R2. Mishra, P.C., Fundamental of Air and Water Pollution, South Asia Books, 1990.

R3. Masters, G., Introduction to Environmental Engineering and Science, Prentice Hall, 2004.

River Mechanics | CEL459 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL 251.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an understanding of the basic principles of river mechanics, including river morphology, sediment transport, and flow dynamics.
- Learn about the various factors that influence river behavior, such as climate, geology, and human activities.
- Familiarize oneself with the methods and tools used for measuring and analyzing river characteristics and behavior.
- Develop skills and knowledge to design and implement river management and restoration strategies that balance ecological, social, and economic needs.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Ability to analyze and assess river morphology, sediment transport, and flow dynamics.

CO 2.Understanding of the factors that influence river behavior, such as climate, geology, and human activities.

CO 3.Capacity to apply methods and tools for measuring and analyzing river characteristics and behavior.

CO 4.Competency to design and implement river management and restoration strategies that consider ecological, social, and economic factors, and balance the needs of different stakeholders.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction, River morphology, drainage patterns, stream order. Properties of mixture of sediment and water, incipient motion and quantitative approach to incipient motion, channel degradation and armoring. Bed forms and resistance to flow, various approaches for bed load transport, suspended load profile and suspended load equations, total load transport including total load transport equations. Scour, its imporatnce and characteristics, local scour, control of scour; limiting capacity of wash load transport and sediment load transport. Comparison and evaluation of sediment transport equations. Stable Channel design with critical tractive force theory, bank protection.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1. Garde, R.J. and Ranga, Raju K., Mechanics of Sediment Transportation and Alluvial Stream Problems, New Age International Publishers, 2000.

Reference Books:

R1. Yang, C. T., Sediment Transport: Theory and Practice, Tata McGraw Hill, New Delhi, 1996.

R2. Henderson, F. M., Open Channel Flow, MacMillan, New York, 1996.

R3. Chang, H. H., Fluvial Processes in River Engineering, John Wiley and Sons, 1988.

R4. Simons, D. B. and Senturk, F., Sediment Transport Technology, Water Resources Publications, Fort Collins, Colorado, 1977.

Traffic Engineering | CEL460 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL282.

Course Objectives

After completing the above course, the key concepts, and skills that students should be able to demonstrate by the end of the course are:

- To have an overall knowledge of the traffic components and assess the traffic characteristics and related problems.
- To develop a strong knowledge base of traffic planning and its management in any transportation area.
- To provide knowledge of traffic control devices and its techniques in transportation interaction.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Understand the various traffic characteristics and fundamental of traffic flow.

CO 2.Understand traffic surveys and evaluate traffic data.

CO 3.Analyse various traffic control measures and design traffic engineering facilities.

CO 4.Evaluate traffic safety and understand impact of traffic on the environment.

CO 5.Evaluate the traffic calming measures and understand the regulations related to road users.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Traffic Engineering and Characteristics- Importance and scope of traffic engineering, traffic characteristics, human factors governing road user characteristics,

vehicular characteristics; Fundamentals of Traffic Flow: Traffic flow elements, time-space diagram, flow-density relationship, gap and gap acceptance. Traffic Studies: Type of studies, Traffic Volume Study –Applications, Methods of data collection, Volume data analysis, Peak Hour concept, Volume to capacity ratio, concepts and application of AADT, DDHV, Temporal expansion factors, Passenger Car Units, Volume data presentation; Traffic Speed Study - Applications, Methods of data collection, Time and Space Mean Speeds, Speed characteristics based on frequency and density functions, Fit of Normal distribution to the data, Before and After study; Capacity Analysis – Service volumes and saturation flows, Factors affecting lane capacity. Parking Study – Parking characteristics, Parking Accumulation analysis, Parking demand and supply analysis, Parking Duration analysis, Parking angles and estimation of parking spaces; Accident Study and Analysis – Causes of accidents, Collision and Condition diagrams, Safety Audit and Remedial measures. Traffic Calming Techniques, Traffic Volume and Speed calming, Road pricing, Regulations related to road users.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Kadiyali, L.R., Traffic Engineering and Transport Planning, 6th ed., Khanna Publishers, 2012.

Reference Books

R1. McShane, W.R. and Roess, R.P.,Traffic Engineering, Prentice Hall, 2010.

R2. Papacostas, C. S. and Prevedouros, P.D., Fundamentals of Transportation Engineering, Prentice Hall, 2001.

Construction Planning and Management | CEL461 | 3 Credits | 3 0 0 3

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop fundamental knowledge and skills in engineering economics and cost analysis.
- Understand the principles and methods of construction project planning and management.
- Gain expertise in selecting, operating, and maintaining construction equipment.
- Learn the production processes and quality control of aggregate, cement, concrete, and asphalt concrete plants.
- Acquire the ability to effectively manage personnel, material, finance, and safety in construction projects.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Apply cash flow diagram and time value of money concept.

CO 2.Develop construction project plan and schedules using network- based methods.

CO 3.Evaluate the cost-effectiveness of different construction equipment and select the appropriate equipment.

CO 4.Understand the quality control measures in aggregate, cement concrete and asphalt concrete plant.

CO 5.Develop skills in personnel management, material management, financial planning and safety in construction projects.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Engineering Economics: Cash flow diagram, Time value of money, Inflation, Interest, Depreciation, Present worth and capitalized cost, Equivalent uniform annual cost and rate of return evaluations, Benefit cost analysis, Analysis of variable costs, Types of capital financing, Valuation. Tendering and Contract: Organizational structure, Methods of tendering, Specifications, Conditions of contract, Contract law, Disputes and Arbitrations. Construction Planning and Management: Time, Cost and Research management of projects for planning, Scheduling, Control, and forecasting using networks with CPM/PERT. Personnel, Material and Finance Management, Safety Engineering. Construction Equipments: Selection, Planning and Cost, Equipments, Earthmoving, Excavating, Hauling, Compacting, Drilling and Blasting, Grouting, Conveying and Dewatering Equipments. Aggregate Cement Concrete and Asphalt Concrete Plants.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.Srinath, L.S., PERT and CPM: Principles and Applications, East West Press, New Delhi, 2013.

T2.Sengupta, B. and Guha, H., Construction Management and Planning, Tata McGraw Hill, New Delhi, 1998.

Reference Books

R1. Moder, J.J. and Phillips, C.R., Project Management with CPM and PERT, Van Nostrand Reinhold, 1983. Pilcher, R., Appraisal and Control of Project Cost, 1973.

R2. Kenneth King Humphreys, Jelen's Cost and Optimization Engineering. United Kingdom, McGraw-Hill, 1991.

Urban Water and Environmental Management | CEL464 | 3 Credits | 3 0 0 3

Course Prerequisite : NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- To develop an understanding of the challenges associated with urban water management, including water supply, wastewater treatment, stormwater management, and flood control.
- To learn about the regulatory framework, policies, and institutional arrangements related to urban water management.
- To familiarize oneself with the various technologies and management practices used for urban water and environmental management, including green infrastructure.
- To develop skills and knowledge to design and implement integrated urban water and environmental management strategies.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Ability to identify and assess the challenges associated with urban water management, including water supply, wastewater treatment, stormwater management, and flood control.

CO 2.Understanding of the regulatory framework, policies, and institutional arrangements related to urban water management.

CO 3.Capacity to apply various technologies and management practices for urban water and environmental management, including green infrastructure, water reuse, and low impact development.

CO 4.Competency to design and implement integrated urban water and environmental management strategies that promote sustainability, resilience, and public health, while considering social and economic factors.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Review of Hydrologic and Hydraulic Principles: hydrologic cycle, rainfall analysis and design storm, hydraulic and hydrodynamic principles Introduction to Drainage Problems : Urbanization - its effects and consequences for drainage, Interaction between urban and peri-urban areas. Planning concepts and System Planning: Objectives of urban drainage and planning criteria, drainage option and system layout, Planning tools and data requirement, Drainage master plan, Drainage structures Calculation Methods and Mathematical Tools: Modeling formulas, Hydrologic models, Hydrodynamic models, Regression analysis, Urban runoff and water quality models Design of Drainage System Elements: Hydraulic fundamentals, Infiltration and on-site detention of storm water, Design of sewerage and stormwater channels, design of appurtenances and pumping stations Control of Storm water Pollution: Pollution bid-up and wash off process with reference to urban drainage systems, Source control in commercial and Industrial complexes, Biological and chemical treatment of waste water, Best management practices Operation and Maintenance of Urban Drainage Systems: Maintenance requirements and planning, Cleansing of sewers and drains, repair options Administrative and Legal Aspects and Financing.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1. Akan, A.O., Urban Storm water Hydrology: A Guide to Engineering Calculations II, Lancaster Technomic, 1993.

T2. Larry, W.M, Storm water Collection Systems Design Handbook II, Tata McGraw Hill, New York, 2001.

Reference Books:

R1. Strickland, G., Urban Hydrology for Small Watersheds, NTIS, Springfield, 1975.

R2. Deb, R., Municipal Storm water Management, Lewis Publishers, 1995.

R3. Hittman Associates, Approaches to Storm water Management, NTIS, Springer, 1973.

R4. Hall, M.J., Urban Hydrology, Elsevier, London, 1984.

Advanced Highway Engineering | CEL466 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL282.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Basic knowledge on construction procedures for different layers of flexible and rigid pavements.
- Knowledge of Construction Project Management for highways.
- Knowledge of Pavement Evaluation Techniques for Functional and Structural Evaluation.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Develop construction procedures for subgrade, unbound, and bound granular layers.

CO 2. Formulate strategies to produce optimal bituminous mixes.

CO 3. Propose appropriate construction procedures for bituminous and concrete layers.

CO 4. Choose appropriate pavement quality control test, and quantify construction variability.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction: National road development programmes, IRC Vision-2021 and Rural Road Vision-225,New Road Materials : Alternate forms of aggregates, theory and specifications of fillers, additives, emulsions, cutbacks and modified binder, Mix designs - Marshall, Hubbard Field and Hveem Method, requirement of a mix, Cold mix design. Design of Flexible and Rigid Pavements: Design factors, empirical, semi-empirical and analytical design methods, California bearing ratio, triaxial, Mcleod and, design considerations for expressways. Rigid Pavements : Design factors, load and temperature stresses, load transfer devices, design of Dowel and Tie bars, joint requirement and working, IRC methods of design of pavements. Stabilized Roads: Aggregate mixtures, proportioning, types of stabilizations, advantages and limitation, special problems related to drainage, control of seepage and capillary rise, importance and functions of each layer of pavement and subgrade. Pavement Evaluation Techniques for Functional and Structural Evaluation: Benkalman beam deflection method, flexible and rigid overlays. Maintenance of Pavements: Routine and periodic maintenance, special repairs, maintenance management system, case study of failure of flexible and rigid pavements cracking, settlement, frost heaving and mud pumping in pavements. Construction Project Management: Construction industry; construction project; product development process; project management ; main causes of project failure; BOT, BOOT, BORT and other variants of BOT. causes of introducing this system, Liberalization policies of GOI for these system; GOI, state governments, other local bodies, board, corporation etc. are adopting these system for construction project management.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Khanna, S.K. and Justo, C.E.G., Highway Engineering, NemChand and Bros, 2011.

T2. Kadiyali, L.R., Traffic Engineering and Transportation Planning, Khanna Publishers, 2012

Reference Books

R1. Sharma, S.K., Principles and Design of Highway Engineering, S. Chand and Co., 2012.

R2. Papacostas, C.S. and Prevedouros, P.D., Transportation Engineering and Planning, Prentice Hall, 2008.

R3. JotinKhisty, C. and Kent Lall, B., Transportation Engineering: An Introduction, Prentice Hall, 2008.

R4. Khanna, S.K. and Justo, C.E.G., Highway Material Pavement Testing Manual, NemChand and Bros., 2013.

R5. Roess, R.P., Prassas, E.S. and McShane, W.R., Traffic Engineering, Pearson, 2013.

Groundwater Engineering| CEL467 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL 251.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an understanding of the fundamental principles of groundwater hydrology, including groundwater flow, aquifer properties, and well hydraulics.
- Learn about the various technologies and methods used for groundwater exploration, development, and management.
- Familiarize oneself with the regulatory framework and environmental laws governing groundwater resources.
- Develop skills and knowledge to design and implement sustainable and efficient groundwater engineering solutions for various applications, including water supply, irrigation, and environmental remediation.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Ability to analyze and evaluate groundwater flow, aquifer properties, and well hydraulics.

CO 2.Understanding of the various technologies and methods used for groundwater exploration, development, and management.

CO 3.Capacity to apply the regulatory framework and environmental laws governing groundwater resources.
CO 4.Efficient groundwater engineering solutions for various applications, including water supply, irrigation, and environmental remediation.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes
Aquifer: various types, properties, permeability, specific yield, transmissivity , storage coefficient and methods of estimation, Introduction to Well hydraulics, objectives of Groundwater hydraulics, Darcy's Law, Groundwater equation, steady state flow, Dupuit-Forchheimer's assumption, groundwater quality management and its development, recharge techniques and groundwater conservation, pump test analysis, Groundwater pollution modeling.

Contents for Desired Course Outcomes (If any): NIL

Text Books:
T1. Groundwater Manual, United States Bureau of Reclamation, 2nd edition, 1995.
T2. Bear J. and Alexander Cheng, Modeling groundwater flow and contaminant transport, Springer Publishers, Volume 23, 2010.
T3. Todd D. K., Groundwater Hydrology, John Wiley and Sons, 2005.
T4. Ramakrishnan, S, Ground Water, K.J. Graph arts, Chennai, 1998.

Reference Books:
R1. Agarwal V. C., Groundwater hydrology, Prentice Hall Publisher, 2012.
R2. William C. Walton, Principles of Groundwater engineering, Lewis, 1st edition, 1990.

Hydraulic and Hydraulic Machines CEL468 | 3 Credits | 3 0 0 3

Course Prerequisite
The student should have studied the course CEL251.

Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:
- Develop an understanding of the principles and concepts of fluid mechanics, including fluid properties, flow characteristics, and energy transfer.
- Learn about the various types of hydraulic machines and their applications, including pumps, turbines, and hydraulic actuators.
- Familiarize oneself with the principles and practices of hydraulic system design and analysis.
- Develop skills and knowledge to design and analyze hydraulic systems and machines for various applications, including water supply, power generation, and industrial processes.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO 1.Analyze and evaluate fluid properties, flow characteristics, and energy transfer in hydraulic systems.
CO 2.Understanding of the principles and applications of various types of hydraulic machines, including pumps, turbines, and hydraulic actuators.
CO 3.Capacity to design and analyze hydraulic systems using appropriate principles, methods, and tools.
CO 4.Competency to design and analyze hydraulic machines for various applications, including water supply, power generation, and industrial processes.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes
Hydraulics: Introduction to open channel flow, laminar flow, Turbulent flow: velocity distribution, turbulent flow in circular pipes, resistance of smooth and artificially roughened pipes, resistance diagram. Hydraulic Machines: Introduction to hydraulic machineries, installation and working principle, Turbines: classification of turbines: Pelton, Francis and Kaplan turbines, effective head and water power, jet ratios and bucket dimensions, velocity triangles, characteristic curves, draft tubes, efficiency of turbines, unit and specific speeds, performance curves of turbines, Pumps: classification, centrifugal and reciprocating pump, cavitation, velocity triangles, unit and specific speeds, characteristics curves, , performance curves, efficiency and power generation, Multiple-stage pumps.

Contents for Desired Course Outcomes (If any): NIL

Text Books:
T1.Rajput R. K., A textbook of Hydraulic Machines, S Chand, 6th edition, 2016.
T2.Pati S., Textbook of Fluid mechanics and hydraulic machines, Tata McGraw Hill, 2017.

Reference Books:
R1. Som, S.K. and Biswas, G., Fluid Mechanics and Fluid Mechanics, Tata McGraw Hill, 2013.
R2. Fox, R.W. and McDonald, A.T., Introduction to Fluid Mechanics, John Wiley and Sons, 2013.

Architectural Planning and Design of Buildings | CEL471 | 3 Credits | 2 2 0 3

Course Prerequisite : NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the concept of building planning and architecture.
- Understand the various building codes to be followed while planning a building.
- Have the knowledge of various building components.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Understand Building Byelaws as per National Building Code and others

CO 2.Understanding of building planning, and orientation.

CO 3.Understanding of building drawing and architectural aspects.

CO 4.Understand the representation of a building on Paper.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Planning principles of buildings, Typical Building Byelaws as per National Building Code and General Development Control Regulation, Planning of residential building, Planning of public buildings, and industrial building, Orientation of buildings, Built Environment, Functional planning: lightning, heating, ventilation, climate factors. Building services, circulation, plumbing, electrification and sanitation. Layout: residential, auditoria, cinema hall, studio etc. Introduction to town planning. Computer aided small and full-fledged architectural design works

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.Singh, G., Building Planning Designing and Scheduling, Standard Publishers Distributors, 2009.

T2.Spence, W.P., Architectural Working Drawings: Residential and Commercial Buildings, John Wiley & Sons, 1993.

Reference Books

R1. Kaleem, S., Zaidi A. & Siddiqui S., Drawing & Design of Residential & Commercial Buildings, Standard Publishers Distributors, 2nd Edition, 2013.

R2. SP 7: Group 1: National Building Code of India (Group 1), 2005.

Hydraulic Structures | CEL481 | 4 Credits | 3 2 0 4

Course Prerequisite

The student should have studied the course CEL 251.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the principles of fluid mechanics and hydraulics as they relate to the design of hydraulic structures.
- Learn about the different types of hydraulic structures and their design considerations.
- Familiarize oneself with the various forces acting on hydraulic structures and how to calculate and mitigate them.
- Develop practical design skills through case studies, design projects, and field visits to hydraulic structures.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Ability to apply principles of fluid mechanics and hydraulics to the design of hydraulic structures.

CO 2. Capacity to identify and analyze design considerations for various types of hydraulic structures.

CO 3. Skill in calculating and mitigating forces acting on hydraulic structures.

CO 4. Competency in developing design solutions for hydraulic structures through practical design projects and case studies.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Dams, Types of dams, Gravity dam: various forces, site selection, modes of failure, stresses, design, elementary and practical profile, low and high gravity dams, construction methods. Arch dams. Spillways: Types and classification of spillways, selection of spillways, special types of spillways, Canal: Design of lined and unlined canals, Kennedy and Lacey theory, Canal Regulation structures, canal fall and its types, design of Sarda type canal falls, Canal Outlets and regulation works, types of outlet, criteria for outlet behavior, flexibility, sensitivity, setting. Cross drainage structures. Diversion headworks.Design of weirs on permeable foundation. Introduction to hydromechanical and electro-mechanical structures.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1. Fuentes C., Chavez C., Irrigation engineering and hydraulic structures, Magnum publishers, 2016.

T2. Sharma S. K., Irrigation engineering and hydraulic structures, S. Chand, 2016.

Reference Books:

R1. Modi, P.N., Irrigation Water Resources and Water Power Engineering (SI Units) Standard Publication, Delhi 10th Edition 2019.

R2. Garg, S.K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2013.

R3. Asawa, G. L., Irrigation and Water Resources Engineering, New Age International Publishers, 2013.

R4. Varshney, R. S., Gupta S.C. and Gupta R.L., Theory and Design of Irrigation Structures, Vol. I and II, NemChand and Bros. 2007.

Advanced Foundation Engineering | CEL482 | 4 Credits | 3 1 0 4

Course Prerequisite

The student should have studied the courses CEL351 and CEL354.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an understanding of the different type of foundations as per their suitability for different soil condition.
- Understand the construction methods and design methodology involved in foundation design.
- Understand the design of machine foundation and pressure acting on retaining structure.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Analyze and design shallow foundations in different types of soils.

CO 2.Analyze and design deep foundations under various in-situ conditions.

CO 3.Perform seismic design and understand soil-structure interaction. An Assess liquefaction potential of soils.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Shallow Foundations: Empirical methods, Layered soils, Foundations under eccentric and inclined loads, Foundations on or near slopes; Pile Foundations: Pile load tests, load capacity of laterally loaded piles, Settlement of piles in cohesion-less soils; Caissons/Well foundations: Types and components, Various loads and load combinations, Methods of stability analysis, Codal provisions, Construction methods; Raft and piled raft foundation; Foundation on expansive soils; Seismic design of foundation; Soil-structure interaction; Liquefaction analysis.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1.Bowles, Joseph E., Foundation Analysis and Design, Mc-Graw Hill, 1996.

T2.Das, Braja M., Principles of Foundation Engineering, PWS Publishing, 1998.

Reference Books:

R1. Som, N, N. and Das S. C., Theory and Practice of Foundation Design, Prentice Hall, 2003.

R2. Poulos, H. G. and Davis, F. H., Pile Foundation Analysis and Design, Wiley and Sons, 1980.

R3. Saran, S., Analysis and Design of Substructures, Oxford and IBH, 2006.

Earth Retaining Structures | CEL483 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the courses CEL383 and CEL386.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Gain general understanding of earth retaining structures including types, material, method of construction, forces acting including earth pressure, stability analysis and design aspects.
- Understand various aspects of reinforced soil retaining walls and perform design and analysis for external and internal stability using various methods.
- Understand various types of sheet pile walls and design of cantilever and anchored sheet pile walls, dead man and continuous anchor, diaphragm and bored pile walls.
- Learn about braced excavations and compute earth pressure against bracings in cuts, heave of the bottom of cut in soft clays.
- Understand design of earth embankments and slopes, and concept of arching & open cuts.
- Gain knowledge and develop awareness about recent advances in earth retaining structures.

Course Outcomes

At the end of the course, students would have-

Essential:

CO 1. Knowledge for recommending suitable earth retaining technique for specific project requirement.

CO 2. Ability to analyze and design reinforced earth structures for earth retaining applications.

CO 3. Competence in analysis and design of various types of sheet pile walls.

CO 4. Ability to analyze and design braced cuts for geotechnical engineering projects.

CO 5. Understanding and awareness of the recent advances in earth retaining structures.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Earth retaining structures: Types, material, method of construction, nature of forces acting including seismic loading, comparison of different earth pressure theories and application in retaining wall, stability analysis and design aspects; Reinforced soil retaining walls: General aspects, Design and analysis: External stability of vertically faced reinforced soil retaining wall. Internal stability, Tie back wedge analysis or coherent gravity analysis or reinforced soil retaining walls with metallic strip and continuous geosynthetic reinforcements; Sheet Pile wall: Types, materials used in construction, free earth system, fixed earth system, selection of soil parameters, analysis and design of cantilever and anchored sheet pile walls, dead man and continuous anchor, diaphragm and bored pile walls; Braced excavations: Earth pressure against bracings in cuts, heave of the bottom of cut in soft clays; reinforced earth retaining structures, arching and open cuts, recent advances in Earth retaining structures.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.Militisky, J. and Woods, R., Earth and Earth retaining structures, Routledge, 1992.

T2.Koerner, R.M., Designing with Geosynthetics, Prentice Hall, New Jersey, USA, 4th edition, 1999.

Reference Books

R1. Das, B. M., Principles of Foundation Engineering, Thomson, Indian Edition, 2003.

R2. Bowles, J. E., Foundation Analysis and Design. McGraw-Hill International Edition, 1997.

R3. Jones, C.J.F.P., Earth reinforcement and soil structures. Butterworth, London, 1985.

R4. Sivakumar Babu, G.L., An introduction to Soil reinforcement and geosynthetics. United Press (India) Pvt. Ltd. 2006.

Machine Learning and Data Analytics for Civil Engineering Applications | CEL484 | 3 Credits | 3 0 0 3

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the basics of probability and statistics for civil engineering applications.
- Gain proficiency in linear algebra and programming skills in Python.
- Develop knowledge in supervised and unsupervised machine learning algorithms.
- Explore the use of directed and undirected generative models and genetic algorithms.
- Learn to apply data statistics and analytics to real-world civil engineering problems.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Apply basic probability and statistics concepts to analyze civil engineering data.

CO 2.Use machine learning techniques to solve real-world civil engineering problems.

CO 3.Implement supervised and unsupervised learning algorithms for clustering and classification tasks.

CO 4.Demonstrate proficiency in programming with Python for data analysis.

CO 5.Apply genetic algorithms for optimization and hybrid systems design in civil engineering.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction, Historical context, Basic Probability and Statistics, Linear Algebra, ML in modern civil engineering, Real-world application examples. Recapitulation of Basic Probability and Statistics, linear regression. Logistic regression, Basic Programming Skills in Python. Supervised Learning: K-Nearest Neighbor, Neural Networks Learning, Back propagation, Support Vector Machines. Unsupervised Clustering: K-means clustering, Density based clustering. Directed Generative Models, Undirected Generative Models, Discriminative Models Genetic Algorithm. Hybrid Systems, Data Statistics and Analytics, Application to Civil Engineering.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Deka, P.C., O. A Primer on Machine Learning Applications in Civil Engineering, CRC Press,2020.

Reference Books

R1. Bishop, C. M. Pattern Recognition and Machine Learning. Switzerland: Springer, 2007.

R2. Lutz, M. Learning Python: Powerful Object-Oriented Programming. United States: O'Reilly Media, 2013.

R3. Simeone, O. A Brief Introduction to Machine Learning for Engineers. Germany: Now Publishers, 2018.

Harbours and Tunneling | CEL485 | 3 Credits | 3 0 0 3

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Apply design features of tunnels, harbors, dock and necessary navigational aids.
- Expose students to various methods of tunneling and tunnel accessories.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Classify the types of water transportation and understand the requirements ports and harbours.

CO 2.Understand planning and design of docks and harbours.

CO 3.Design and construction of backwaters and other navigational aids.

CO 4.Gain the knowledge of dock and repair facilities.

CO 5.Understand the planning, design and construction of tunnels.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Harbour Planning: Types of water transportation, water transportation in India, requirements of ports and harbors, classification of harbors, selection of site and planning of harbors, location of harbor, traffic estimation, master plan, ship characteristics, harbor design, turning basin, harbor entrances, type of docks, its location and number, Site investigations – hydrographic survey, topographic survey, soil investigations, current observations, tidal observations.

Harbour Works: Design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, navigational aids, requirements of signals, fixed navigation structures, the necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar.

Docks and Repair Facilities: Harbor docks, use of wet docks, design of wet docks, repair docks, lift docks, dry docks, keel and bilge blocking, construction of dry docks, gates for dry docks, pumping plant, floating docks, slipways, locks, size of the lock, lock gates, types of gates.

Tunneling: Alignment, disposal of muck, drainage, lighting and ventilation.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.A Course in Docks and Harbour Engineering, Bindra, S.P., DhanpatRai and Sons, Ninth Edition, 2012.

T2.Harbour, Dock and Tunnel Engineering, Srinivasan R. and Rangwala S.C., Charotar Publishing House, Twenty-Ninth Edition, 2018.

Reference Books

R1. Design and Construction of Ports and Marine Structures, Alonzo Def. Quinn, McGraw Hill Book Company, New York, 1997.

R2. Dock and Harbour Engineering, Hasmukh P. Oza and Gautam H. Oza, Charotar Publishing House Pvt. Ltd, 2012.

R3. Dock and Harbour Engineering, Seetharaman, S., Umesh Publications, New Delhi, India, 1999.

Earth and Rockfill Dams | CEL486 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL383.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand and apply various methods of stability analysis of slopes.
- Perform seepage analysis through dam section and its control measures.
- Develop an understanding of earth dams, components design and construction methods.
- Develop an understanding of rockfill dams, nature of failure and damages.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Perform slope stability analysis using various popular methods.

CO 2.Develop an understand of the application of seepage analysis for it through dam sections and its control measures.

CO 3.Develop a knowledge of earth dams, its components and design criterion.

CO 4.Develop an understanding of rockfill dams and nature of failure.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Stability analysis: critical slip surfaces, test conditions, strength parameters, pore pressures, methods of stability analysis; Seepage through dam section and its control: fundamentals of seepage flow, flownets, seepage through dam section and foundation, seepage control filters, Impervious core, drainage; Control of seepage through foundations: types of foundations trench cutoff, upstream impervious blanket, horizontal drainage blanket, relief wells, drainage trenches, cutoff walls, downstream loading berm; Introduction: Classification of dams, Selection of Site, Basic design requirements, Preliminary section; Construction of earth dams: construction equipment, procedures for pervious, semi-pervious, impervious and rockfill sections, construction supervision; Failures and damages of earth dams: nature of failures, piping, settlement cracks, slides, earthquake and miscellaneous damages, case studies; Rock fill dams: general characteristics, rock fill materials, foundation, construction, deformations, types of dams; Design of Rockfill dams: design of dam section, concrete face and earth core, Nature of failures and damages, case studies and layered media.

Contents for Desired Course Outcomes (If any): NIL.

Text Books

T1. Singh, B. and Varshney, R.S., Embankment Dam Engineering, Nem Chand & Bros; First Edition, 2004.

T2. Sherard, J.L., Woodward, R.J., and Gizienski, S.F., Earth and Earth Rock Dams: Engineering Problems of Design and Construction, Jhon Wiley & Sons, 1967.

Reference Books

R1. Creager, W.P., Justin, J.D. and Hinds, J. Engineering for Dams [Vol. I, II & III]. John Wiley & Sons.

R2. Peter P. Canal and river levees. Elsevier; 2014.

Concepts of Green Building Design | CEL487 | 3 Credits | 3 0 0 3

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Evaluate and compare green building programs and rating systems.
- Analyze and design renewable energy systems for heating and electricity.
- Apply sustainable building design principles to building envelopes and materials.
- Evaluate and implement building systems and operations for energy efficiency.
- Develop strategies for solar gain optimization, heating and cooling design, and energy-efficient remodeling.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Understand the principles and goals of green building and renewable energy systems.

CO 2.Analyze and evaluate sustainable building design elements and materials.

CO 3.Develop proficiency in building systems and operations, including HVAC, lighting, and water supply.

CO 4.Apply principles of solar gain and energy-efficient remodeling strategies.

CO 5.Explore and implement solutions for water harvesting, storage, and distribution.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction to Green Building: issues and goals in the green building field, including energy efficiency, LEED, Build Green and Energy. Star programs, the HERS Energy Rating System. Introduction to Renewable Energy: an introduction to several Renewable Energy systems for heating or generating electricity, including Solar Electric, Solar Thermal, “Small Wind”, Geo-Thermal Heat Pumps and Passive Solar. Design Elements: fundamentals of sustainable and energy efficient building design, by focusing on Building envelopes, Alternative Building Materials: pros and cons of different building methods and materials used for wall systems, and relation to green building and energy efficiency, focusing on five “alternative” building systems. Building systems and operations (HVAC, lighting, water supply, sewage, garbage disposal, recycling, and composting) strategies, solutions, and systems for harvesting the water, active and passive

systems, storage, and distribution. Principles of solar gain, design for optimal heating and cooling, and common mistakes, Solar Thermal or "Hydronics" systems, Energy Efficient Re-modeling: strategies for energy efficient re-modeling with economic efficiency, key components of building systems, new technology, and materials.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Keeler, Marian and Burke, Bill. Fundamentals of Integrated Design for Sustainable Building. John Wiley & Sons, 2009.

Reference Books

R1. Mendler, Sandra F., Odell, William, and Lazarus, Mary Ann., The HOK Guidebook to Sustainable Design, Second Edition, John Wiley & Sons, 2005

R2. Snell, Clarke and Callahan, Tim. Building Green: A Complete How to Guide to Alternative Building Methods Earth Plaster, Straw Bale, Cordwood, Cob, Living Roofs. Lark Crafts, 2009

R3. Yudelson, Jerry. Green Building A to Z: Understanding the Language of Green Building. New Society Publishers, 2007

R4. Kibert, Charles J. Sustainable Construction: Green Building Design and Delivery. John Wiley & Sons.

R5. McHarg, Ian L. Design with Nature. First edition. John Wiley & Sons, 2005.

R6. Mazria, Edward. The Passive Solar Energy Book. Rodale Press, 1980.

R7. Kwok, Alison and Grondzik, Walter. The Green Studio Handbook: Environmental Strategies for Schematic Design. Second edition, Architectural Press, 2011.

R8. Indian Green Building Council: www.igbc.inIGBC Green Homes Abridged Reference Guide.

Advanced Structural Analysis|CEL488 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL385.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Review of basic concepts of structural analysis.
- Analysis of indeterminate frame.
- Extend displacement method to generalized stiffness method.
- Gain basics understating of finite element method.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Analyze the space truss and frame structures.

CO 2.Analyze indeterminate frame using displacement methods.

CO 3.Analyze the truss beams and frames using stiffness approach.

CO 4.Understand basic concept of finite element method.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Review of basic concepts of structural analysis; Analysis of Space truss and space frames; Analysis of indeterminate frames, with/without sway, use of symmetry and anti-symmetry, support settlement; Flexibility and Stiffness method of analysis: Truss, beams and frames; Introduction to finite element method.

Contents for Desired Course Outcomes (If any): NIL

Text Book:

T1. Hibbeler, R.C., Structural Analysis, Pearson Press, 2013.

T2. Kanchi, M.B. Matrix Methods of Structural Analysis, John Wiley & Sons, 1982.

Additional Books:

R1. Wang, C.K., Intermediate Structural Analysis, McGraw Hill, 2012.

R2. Weaver, W. Jr. and Gere, J.M., Matrix Analysis of Framed Structures, Springer 2012.

R3. William, F. R. et al., Mechanics of Materials, John Wiley and Sons. 2006.

R4. Negi, L. S., and Jangid, R. S., Structural Analysis, Tata McGraw Hill Publication, 2004.

R5. Reddy, C.S., Basic Structural Analysis, Tata McGraw Hill, 2012.

Earthquake Resistance Design of Structures | CEL502 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL357.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop the concept of strength, over-strength, and ductility, and ductile detailing of reinforced concrete

structures to enhance the earthquake resistance of structures.

- Introduce the concept of equal displacement and equal energy principles, capacity design, and codal provisions for earthquake-resistant design.
- Teach seismic design considerations and the use of different analysis methods, including equivalent static analysis, response spectrum analysis, mode superposition method, and time history analysis.
- Develop knowledge of the seismic behavior and design of linear and planar reinforced concrete elements, including ordinary, intermediate, and special moment resisting frames, concentrically and eccentrically braced frames, and masonry structures.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Understanding of seismic design principles and hazard assessment, including ground motion and response spectrum.

CO 2.Evaluate the reinforced concrete structures' seismic performance and components, such as linear and planar elements, frames, and bracing.

CO 3.Apply knowledge of structural strength, over-strength, and ductility to design reinforced concrete structures with ductile detailing.

CO 4.Analyse seismic design considerations and codal provisions, including analysis methods such as static, response spectrum, and time history.

CO 5.Demonstrate understanding of seismic-resistant masonry structure properties and earthquake-resistant design principles.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Seismic performance of structures and structural components during earthquakes, Ground motion parameters, Response spectrum, design Spectrum; Concept of strength, over-strength and ductility, ductile detailing of reinforced concrete structures; Concept of equal displacement and equal energy principles, capacity design, Codal provisions, seismic design consideration; Equivalent static analysis, response spectrum analysis, mode superposition method, Time history analysis; modelling concept of reinforced concrete building; Seismic resistant properties of reinforced concrete, Seismic behaviour and design of linear reinforced concrete elements, Seismic behavior of planar reinforced concrete elements, ordinary, intermediate and special moment resisting frame; concentrically and eccentrically braced frames; Introduction to earthquake resistant design of masonry structure.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Agrawal, Pankaj, and Shrikhande, Manish; Earthquake resistance design of structures, Prentice Hall India, 2011.

T2. IS1893, Criteria for Earthquake Resistant Design of Structures (General provisions and buildings), 2016.

Reference Books

R1. IS 13920, Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, 2016.

R2. Pauley, T. and Priestley, M.J.N. Seismic Design of Reinforced Concrete and Masonry Buildings, John-Wiley & Sons, 1992

R3. Penelis, George G., and Kappos, Andreas J. Earthquake Resistant Concrete Structure, Taylor& Francis, 2019.

R4. Drysdale, R.G., Hamid, A. H. and Baker, L.R. Masonry Structure: Behaviour and Design. Pearson College Div; 2nd edition, 1993,

R5. Booth, Edmund. Concrete Structure in earthquake regions: Design & Analysis. Longman Scientific & Technical, 1994.

Geometric Design of Transportation Facilities | CEL519 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the courses CEL282.

Course Objectives

After completing the above course, the key concepts, and skills that students should be able to demonstrate by the end of the course are:

- To develop an understanding of the principles of geometric design in the context of transportation planning and traffic design.
- To understand the design criteria for geometric design of highways.
- To develop the capability to design highways.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Examine geometric characteristics and design elements of highways.

CO 2. Analyze and design at grade and grade separated intersections.

CO 3. Plan and Design parking facilities.

CO 4. Plan and design bus lay bye, truck lay bye and bus terminals.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Geometric design of highways: Design controls - Topography and physical features, traffic, vehicular characteristics, speed and safety ; Design Elements; Space standards for urban, rural and hill roads, Sight distance requirements, Access controls; Geometric standards for Mobility and Accessibility; Cross section Elements- Single lane, Two lane, Multi-lane highways, Expressways, Urban roads; Street design concepts, bicycle tracks, pedestrian facilities- Pedestrian q-k-v Relationships – Walkway Widths – LOS for Walkways – Subways and Over Bridges – Pedestrian Precincts – Passenger Conveyors., bikeway facilities, Street furniture, Design of Speed Breaker; Alignment : Horizontal Alignment - Curve design, Super-elevation design, Transition curve design, Attainment of super-elevation, Pavement widening, Sight distance on horizontal curves; Vertical Alignment - Gradients, Grade compensation, Design of vertical curves, Combination of horizontal and vertical alignment, vertical clearance for underpasses and elevated structures; Intersection Geometry: Visibility requirements, Principles of channelization, Layout design for types of intersections, on-ramps and off-ramps (flyovers and access controlled facilities), Acceleration and deceleration lanes, Two-way turn lanes; Design of Facilities: Design of on-street and off-street parking facilities, multi-storied Parking; Design of bus shelters and bus lay-bye, Bus terminal, Truck terminals and truck lay-bye, Foot-over bridge and sky-walk.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.Veeraragavan, Khanna, S.K and Justo, C.E.G. Highway Engineering. Nem Chand & Brothers, 2014

Reference Books

R1. Wright, P. H. Highway Engineering. John Wiley & Sons, 1996.

R2. Rogers, M. Highway Engineering. Blackwell Publishing, 2003.

R3. May, A.D. Traffic Flow Fundamentals. Prentice Hall, 1st Edition, 1989.

R4. Mannering, Fred L., Washburn, Scott S., and P., Kilareski Walter. Principles of Highway Engineering and Traffic Analysis. Wiley India Pvt Ltd., 4th Edition, 2011.

R5. Institute of Transportation Engineers, Traffic Engineering Hand Book. 4th Edition, Prentice Hall., 1991.

R6. Fruin, Pedestrian Planning and Design, McGraw Hill Publication, 1987.

Traffic Engineering Design and Management |CEL525| 3 Credits| 3 0 0 3

Course Prerequisite

The student should have studied the CEL282.

Course Objectives

After completing the above course, the key concepts, and skills that students should be able to demonstrate by the end of the course are:

- To have an overall knowledge of the traffic components and assess the traffic characteristics and related problems.
- To develop a strong knowledge base of traffic planning and its management in any transportation area.
- To provide knowledge of traffic control devices and its techniques in transportation interaction.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Understand the various traffic characteristics and fundamental of traffic flow.

CO 2.Understand traffic surveys and evaluate traffic data.

CO 3.Analyse various traffic control measures and design traffic engineering facilities.

CO 4.Evaluate traffic safety and understand impact of traffic on the environment.

CO 5.Evaluate the traffic system management techniques and understand the regulations related to road users

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Traffic Engineering: Definition, Elements of traffic engineering, traffic engineering problems, Issues for traffic engineer, Components of traffic system – Road User and vehicle characteristics, travel demand and patterns. Traffic Stream Characteristics: Lane and directional systems, Traffic flow characteristics - Speed, Flow and Density, Other flow characteristics – Headways, Occupancy, Flow rate, Capacity, traffic demand v/s volume v/s capacity, Relationships of flow characteristics-Greenshield's, Greenburg, Underwood, Edie, multi-regime relationships. Traffic speed study and volume study. Capacity Analysis: HCM 2010 and IRC guidelines, two-lane highway, multilane highway, basic freeway sections, Service volumes of urban and rural roads, Design of Intersections, Parking Areas and Terminals: Design of at-grade intersection, roundabout, grade-separated intersection, on-street parking, off-street parking, parking for disabled, truck terminal, container terminal. Road Safety Engineering: Statistical analysis of accidents, accident modelling, remedial

measures, road safety audit, transportation system management (TSM) techniques, traffic sign, road marking, signal control, traffic calming techniques, achievable speed reductions, estimate of accident reductions and benefits. Traffic Forecasting: Forecast based on past trends and extrapolation, forecasts and mathematical models, period for forecasting, time series approach. Traffic Forecasting: Forecast based on past trends and extrapolation, forecasts and mathematical models, period for forecasting, time series approach. Planning for Public Transport: Selection of public transport technology, MRTS, LRTS, BRTS, ITS Modules, driver information and guidance, public transport travel information and ticketing, freight and fleet management, system integration.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Kadiyali, L.R., Traffic Engineering and Transport Planning, 6th ed., Khanna Publishers, 2012.
T2. McShane, W.R. and Roess, R.P., Traffic Engineering, Prentice Hall, 2010.
T3. Pignataro, L. J. Traffic Engineering: Theory and Practice. Prentice hall, Inc, 1973

Reference Books

R1. Papacostas, C. S. and Prevedouros, P.D., Fundamentals of Transportation Engineering, Prentice Hall, 2001.
R2. Kerner, Boris S. Introduction to Modern Traffic Flow Theory and Control. Springer, 1st Edition.Edition, 2009.
R3. Drew, D.R. Traffic flow theory and control. McGraw Hill Book Company, 1976.
R4. Highway Capacity Manual, Transportation Research Board, Washington, D.C., 2010.
R5. Currin, T.R. Introduction to Traffic Engineering: A Manual for Data Collection and Analysis, Cengage Learning, 2nd Edition, 2012.

Ground Improvement Techniques | CEL527 | 3 Credits | 3 0 03

Course Prerequisite

The student should have studied the courses CEL383, CEL386.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the principles and techniques of ground improvement.
- Gain knowledge of various methods of ground improvement, including their principles, limitations, and applications.
- Acquire skills in analyzing soil conditions and selecting appropriate ground improvement techniques based on site-specific requirements.
- Develop an understanding of the design process for ground improvement techniques.

Course Outcomes

At the end of the course, students would have-

Essential:

CO 1. Ability to identify and evaluate different ground improvement techniques for specific soil conditions and project requirements.
CO 2. Proficiency in designing and implementing ground improvement techniques, including soil stabilization with chemicals, compaction, consolidation, drainage, grouting, and reinforcement.
CO 3. Understanding of the applications, advantages, and limitations of different ground improvement methods in various geotechnical engineering projects.
CO 4. Knowledge of geosynthetics and their applications in filtration, drainage, and separation in road and other construction works.
CO 5. Ability to analyze and design ground anchors and soil nails, including estimating pull-out capacity, designing anchored walls, and nailed soil-retaining structures.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction to ground improvement, overview of various techniques; Shallow compaction, soil stabilization: principle, method, stabilization with chemicals, cement, lime, ash, bitumen; In-situ densification of cohesionless soils and consolidation of cohesive soils: Dynamic compaction and consolidation, Vibrofloation, Sand pile compaction, Preloading withsand drains and fabric drains, Stone columns, Lime piles, relative merits of various methods and their limitations; Drainage techniques: Well points, Vaccum and electro-osmotic methods; Grouting: principles, types of grouts, grouting equipments and machinery, injection methods, grout operation and monitoring, applications; Reinforcement methods: Types of reinforcement material and specification, Geosynthetics: types, use of Geotextiles for filtration, drainage and separation in road and other works; Ground anchors and soil nails.

Contents for Desired Course Outcomes (If any): NA

Text Books

T1. Koerner, R.M., Design with Geosynthetics, 3rd ed. Prentice Hall, New Jersey, 2002.

T2. Hausmann, M.R., Engineering Principles of Ground Modification, McGraw Hill Education, 2013.

Reference Books

R1. Jewell, R.A., Soil Reinforcement with Geotextiles, CIRIA special publication, London, 1996.

R2. Jones J.E.P., Earth Reinforcement and Soil Structure, Butterworths,1995.

R3. Moseley, M.P., Ground Improvement Blackie Academic and Professional, Chapman and Hall, Glasgow, 1993.

R4. Raj P.P., Ground improvement techniques, Laxmi Publications.

Advanced Soil Mechanics | CEL528 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL 383.

Course Objectives

The course objectives define the student learning outcome for the course. The main focus of the course is to

- Understand soil mechanics through analysis of the stress-strain-strength behaviour of soil in drained and undrained conditions, as well as numerous failure criteria related to it.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Recognize the behaviour of coarse and fine grained soil with the help of index properties and mineralogy.

CO 2.Comprehend stress-strain and seepage behaviour of soil in dry as well as saturated conditions.

CO 3.Analysis of Shear Strength and study of various failure criterion of soils.

CO 4.Evaluate the time dependent behaviour of clays.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Clay mineralogy; Soil-air-water interaction; Consistency; Soil compaction; Concept of effective stress. Elastic theories of stress distributions in soils: Boussinesq's equation, Westergaard, Burmister Theories, Different conditions of loads, Constitutive relationship for soils; Shear strength: stresses in soils, failure criterions, Mohr's circle, stress paths, UU, CU, CD tests, drained and undrained stress-strain relationships, Stress- Strain relationship, Skempton's Pore pressure coefficients, Critical state theory, normal consolidation line, critical state line, Roscoe surface, Hvorslev surface, no tension line, effect of over consolidation on shear parameters; Introduction to partially saturated soil.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.Das, B. M. Advanced Soil Mechanics. CRC Press, 2013.

T2.Lambe, T. W. and Whitman, R.V., Soil Mechanics, Wiley India Pvt. Ltd., 2012

Reference Books

R1. Taylor, D.W. Fundamental of soil Mechanics. John Wiley and Sons, 1955.

R2. Holtz, R.D., Kovacs, W.D., and Sheahan, T.C. An Introduction to Geotechnical Engineering 2nd edition, Pearson, 2011.

R3. R3.Mitchell, J.K. and Soga, K. Fundamentals of Soil Behaviour. 3rd edition, John Wiley & Sons, 2005.

R4. Kurian, N. P. Modern Foundations – Introduction to Advanced Techniques. Tata McGraw-Hill Publishing Company Limited, New Delhi, 1984.

Environmental Geotechnology |CEL540| 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL 383.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the scope and importance of environmental geotechnics, including the role of geotechnical engineering in addressing environmental issues.
- Gain knowledge of waste containment techniques, including solid waste disposal and stabilization, remediation of contaminants.
- Learn about planning and design aspects related to waste disposal in engineered landfills.
- Explore the engineering properties of waste materials and their geotechnical reuse in sustainable and environmentally-friendly ways.

Course Outcomes

At the end of the course, students would have-

Essential:

CO 1. Ability to apply geotechnical engineering principles in addressing environmental issues.

CO 2. Knowledge of waste containment techniques and their design principles.

CO 3. Competence in planning and designing waste disposal systems.
CO 4. Understanding of the engineering properties of waste materials and their geotechnical reuse.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes
Introduction: Scope and importance of environmental geotechnics; Integrated solid waste management, Contaminant transport: basics of infiltration, percolation and retention, hydraulic conductivity and mass transport phenomena; Planning and design aspects relating to waste disposal in engineered landfills: Types of barrier materials, liners and caps systems, environmental monitoring around landfills; Engineering Properties of Waste materials and their geotechnical reuse: coal ash, mining waste, demolition waste.

Contents for Desired Course Outcomes (If any): NIL

Text Books
T1.Chaney, R.C. and Fang,H. Y., Introduction to Environmental Geotechnology, Second Edition, CRC Press, 2016.
T2.Qian, X., Koerner, R., and Gray, D.H., Geotechnical aspects of landfill design and construction, Prentice Hall, 2002.

Reference Books
R1. Daniel, D. E. and Koerner, R. M., Waste containment facilities: Guidance for construction quality assurance and construction quality control of liner and cover systems, ASCE press, 2007.
R2. Daniel, D.E., Geotechnical Practice for waste disposal, Chapman and Hall, London,1993. Koerner, R. M., Designing with geosynthetics, Pearson Education Inc., 2005.

Advanced Concrete Structures|CEL552| 3 Credits | 3 0 0 3

Course Prerequisite
The student should have studied the courses CEL357.

Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:
- Gain knowledge about the analysis, behavior, and design of advanced structural elements.
- Provide an understanding of the seismic performance of structures and its design, including understanding of structural detailing.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO 1.Design the Slabs, footing and staircase.
CO 2.Analyze the building frames for static and dynamic loads.
CO 3.Understand the ductile detailing of the structures.
CO 4.Design the RC walls, beam column joints, curved and annular members.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes
Design of Reinforced Cement Concrete Structures: Design of one-way and two-way R.C. Slabs; Flat slabs, Cantilever and Continuous slabs; Design of R.C. footings: isolated, Combined, Raft, pile and Pile Caps; Design of staircase; Building frames, static and dynamic load analysis and component design, provisions of ductile detailing (IS13920); Design of RC walls and beam column Joints; Analysis and design of curved and annular members.

Contents for Desired Course Outcomes (If any): NIL

Text Books
T1. Raju, N. Krishna, Advanced Reinforced Concrete Design, CBS Publishers and Distributors, 2013.
T2. Agrawal, Pankaj. andShrikhande, Manish; Earthquake resistance design of structures, Prentice Hall India, 2011.
T3. Subramanian, N., Design of Reinforced concrete Structures, Oxford Higher Education, 2014.

Reference Books
R1. Sinha, S.N., Reinforced Concrete Design, Tata McGraw Hill, 2013.
R2. Shah, V.L. et.al., Limit State Theory and Design of Reinforced Concrete, Structures Publications, 2007.
R3. Nilson, A.H., and Winter, G., Design of Concrete Structures, McGraw Hill, New Delhi, 1983.
R4. Penelis, George G., and Kappos, Andreas J. Earthquake Resistant Concrete Structure, Taylor & Francis, 2019.
R5. Varghese, P.C., Advanced Reinforced Concrete Design, Prentice Hall, 2nd edition, 2005.
R6. IS 456, Plain and Reinforced Concrete- Code of Practice, 2000.
R7. IS 13920, Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces, 2016.

R8. IS1893, Criteria for Earthquake Resistant Design of Structures (General provisions and buildings), 2016.

Prestressed Concrete Structures | CEL553 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL357.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understanding of the basic concepts and general principles of pre-stressed concrete and pre-stressing systems.
- Analysing of pre-stressed concrete sections for flexure considering loading stages, Use of balancing method of analysis.
- Study the design philosophy and design of pre-stressed concrete sections.
- Provide the design knowledge for actual practical scenarios.

Course Outcomes: At the end of the course, student will be able to:

CO 1. Apply the concepts of pre-stressing in concrete structures and identify the materials for pre-stressing systems.

CO 2. Analyze a Pre-stressed Concrete section, Losses of Prestrss, Pressure line.

CO 3. Identify the cable profile and deflection of pre-stressed concrete sections.

CO 4. Analysis the rectangle and T beam for flexural and shear strength.

CO 5. Design pre-tensioned and post-tensioned beams, girders, slabs, sleepers etc.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction to basic concepts and general principles of pre-stressed concrete, materials used in prestressed concrete and methods and techniques of prestressing, prestressing systems; Analysis of prestressed concrete sections for flexure considering loading stages, computation of sectional properties, critical sections under working loads for pretensioned and post tensioned members, load balancing method of analysis of prestressed concrete beams, losses in prestress, application to simply supported beams and slabs; Design philosophy of prestressed concrete sections, permissible stresses in concrete and steel, design approaches using working stress method as per IS 1343 -1980, limit state of collapse: flexure and shear as applied to prestressed concrete beams, kern points, choice and efficiency of sections, cable profile and layouts, cable zone, deflection of prestressed concrete sections; End zone stresses in prestresses concrete members, pretension transfer bond, transmission length, end block of post tensioned members; Design of simply supported pre-tensioned and post tensioned slabs and beams.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Raju, N. Krishna, Prestressed concrete, CBS Publishers and Distributors, fifth edition, 2017.

Reference Books

R1. Lin, T. Y., & Burns, N. H., Design of Prestressed Concrete Structures, 1981.

R2. Park, R., Design of Prestressed Concrete Structures. University of Canterbury, 1977.

R3. Shamsher Bahadur Singh, Analysis and Design of Prestressed Concrete Structures, Wiley Publisher, Ist Edition, 2023.

Bridge Engineering | CEL554 |3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course**s** CEL357, CEL358.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Define bridge components, classifications, and their importance.
- Conduct investigations for bridge design including site selection and data collection.
- Apply standard specifications for road and railway bridges.
- Design reinforced concrete culverts, T-beam bridges, and pre-stressed concrete bridges.
- Design substructures including types of piers and abutments, design forces, and bearing and joints.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Demonstrate knowledge of bridge components and classifications.

CO 2.Apply investigation techniques for bridge design and site selection.

CO 3.Design reinforced concrete culverts, T-beam bridges, and pre-stressed concrete bridges.
CO 4.Design substructures including piers, abutments, bearings, and joints.
CO 5.Analyze and evaluate different types of bridge designs for suitability and effectiveness.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Introduction: Definition, components of a bridge, classifications, importance of bridge, Investigation of Bridges: Need for investigations, selection of bridge site, preliminary data to be collected, design discharge and its determination, linear waterway, aflux calculation, economical span, vertical clearance above HFL, local scour and computation of scour depth, choice of bridge type. Standard Specifications of road bridges, I.R.C. loadings, code provisions on width of carriage way, clearances, loads considered etc. standard specifications for railway bridges, Railway bridge code, Codal provision of IRC 112 for concrete design, Reinforced Concrete Slab bridge (effective width method), Design of Box Culvert, T-beam bridge (Courbon's theory for load distribution). Sub Structure: Types of piers and abutments, design forces, stability criteria, design of piers and abutments. Bearing and Joints: Various types of expansion bearing and fixed bearings, elastomeric bearings, joints and their types, maintenance of bridges.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Johnson, D. Victor, Essentials of Bridge Engineering. India, CBS Publishers & Distributors, 2017.

Reference Books

R1. Hambly E. C, Bridge Deck Behaviour, E & FN Spon Publications, 2nd edition 1991.
R2. Raina, V. K. Concrete Bridge Practice, Analysis, Design and Economics, Tata McGraw- Hills Publishing Company Limited, 2014.
R3. Ryall M.J., Parke G.A.R, Harding J.E., The Manual of Bridge Engineering, Thomas Telford Publishers, 2000.
R4. Rajagopalan R., Bridge Superstructure, Tata McGraw- Hills Publishing Company Limited, 2nd edition, 2006.

Advanced Steel Structures | CEL555 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL358.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the principles and methods for designing steel structures, including considerations for wind loads and earthquake effects.
- Develop the skills to design various types of beam-column joints, plate girders, gantry girders, and column bases.
- Gain knowledge of the design principles for industrial structures and stack-like structures as per IS 1893 part - IV.
- Introduce the design concepts and considerations for chimneys and silos.
- Develop proficiency in designing building frames and pre-engineered buildings (PEB).

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Apply wind load calculations and earthquake considerations to design steel structures with proper safety and stability.
CO 2.Design beam-column joints, plate girders, gantry girders, and column bases that meet structural integrity and load-carrying requirements.
CO 3.Design industrial structures and stack-like structures in compliance with IS 1893 part - IV, considering the dynamic effects of seismic forces.
CO 4.Apply appropriate design principles to design chimneys and silos, considering their unique structural requirements.
CO 5.Design building frames and pre-engineered buildings (PEB) with considerations for efficiency, durability, and ease of construction.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Design of steel Structures; Wind load calculation, Earthquake Considerations; Design of Beam Column Joints, Plate Girders, Gantry Girders, Column Bases: Slab Base, Gusseted Base, and Grillage footing; Design of Industrial structures and stack like structures (IS 1893 part -IV), Introduction to chimney & silos; Design of Building frames and Pre-Engineered Buildings (PEB).

Contents for Desired Course Outcomes (If any): NIL.

Text Books

T1.Duggal, S.K., Limit State Design of Steel Structures, Tata McGraw-Hill, 2012.

T2. Subramanian, N. Design of Steel Structures, Oxford University Press, 2012.

Reference Books

R1. Dayaratnam, P., Design of Steel Structures, S. Chand Publisher, 1998.

R2. Gaylord, E. H., Design of Steel Structures, Tata McGraw Hill India, 2008

R3. Malhas, Faris Amin, et al. Steel Structures: Design and Behavior: Emphasizing Load and Resistance Factor Design. United Kingdom, Pearson/Prentice Hall, 2009.

R4. Gaylord, E. H., Design of Steel Structures, Tata McGraw Hill India, 2008.

R5. Negi, L. S.. Design of Steel Structures. India, Tata McGraw Hill Publishing Company Limited, 2005.

Geotechnical Earthquake Engineering | CEL556 | 4 Credits | 3 2 0 4

Course Prerequisite

The student should have studied the course CEL383, CEL 386.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Acquire a comprehensive understanding of the fundamental concepts of seismology, plate tectonics, earthquake loading, and geotechnical earthquake engineering.
- Familiarize with the different types of earthquakes and their characteristics, as well as the factors influencing seismic hazard and ground motion.
- Develop knowledge of the methods used in seismic hazard analysis, site response analysis, and liquefaction mitigation techniques in geotechnical earthquake engineering.
- Performthe pseudo-static seismic analysis and design of various geotechnical structures. Understand fundamentals of vibration theory and dynamic soil properties

Course Outcomes

At the end of the course, students would have-

Essential:

CO 1. Ability to comprehend and apply the fundamental concepts of geotechnical earthquake engineering.

CO 2. Competence in analyzing and predicting the behavior of different types of earthquakes and their effects on soil and structures.

CO 3. Proficiency in applying methods for seismic hazard analysis, site response analysis, and liquefaction mitigation techniques in geotechnical earthquake engineering projects.

CO 4. Ability to analyze vibrating systems under free and forced vibration conditions.

CO 5. Proficiency in conducting and interpreting dynamic property tests on soils.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Basic seismology, Plate Tectonics, Nature and types of earthquake loading; Importance of geotechnical earthquake engineering. Strong ground motion: Size of earthquake, Seismic energy, Correlations, Spectral parameters, Wave propagation. Seismic hazard analysis – deterministic and probablistic, Site response analysis, Liquefaction of soils and its mitigation, Case histories, Psuedo static analysis of slopes, retaining walls and foundations. . Theory of vibrations: Free vibration, Forced vibration, Single degree and multi-degree of freedom system, Effect of damping. Dynamic properties of soils: In-situ and laboratory methods, Block vibration tests, Cyclic plate load test, Cyclic resonant column test, Cyclic triaxial test, Cyclic simple shear test, Wave propagation tests, Interpretation of test results.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1.Kramer, S.L., Geotechnical Earthquake Engineering, Pearson Education, 2003.

T2.Prasad, B.B., Fundamentals of Soil Dynamics and Earthquake Engineering, PHI Learning Private Ltd., 2009.

Reference Books

R1. Day, R.W., Geotechnical Earthquake Engineering Handbook, McGraw-Hill Education, 2002.

R2. Towhata, I., Geotechnical Earthquake Engineering, Springer, 2008.

R3. IS 1893, Indian Standard Criteria for Earthquake Resistant Design of Structures, BIS, 2016.

R4. Prakash, S., Soil Dynamics, McGraw Hill International Edition, New York Publishing, New Delhi, 1994.

R5. Saran, S., Soil Dynamics and Machine Foundations, Galgotia, New Delhi, 2010.

Water Storage Structures | CEL557 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the courses CEL382, CEL357.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to understand the planning, behavior, analysis and design of water retaining structures

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Design and detailing of circular GSR and underground tank.

CO 2. Design and detailing of rectangular GSR and underground tank.

CO 3. Design and detailing of Elevated Service Reservoir of various capacities and column configurations.

CO 4. Design and detailing of Approach Bridge, Jack well.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Study of Codal Requirements IS 3370 part I-IV, IS 1893 part-III, analysis of circular water tanks with various boundary conditions at base slab, variation of hoop tension, moment, and deflection of wall with various H/RT ratios, deep and shallow tanks. Analysis of tanks using beam on elastic foundation analogy.

Analysis of rectangular water tanks with various boundary conditions at base slab, variation of moments with respect to height/span ratio. Design (un-cracked and cracked design) of water tank sections subjected to moment, Moment and compression, moment and tension.

Earthquake Analysis of water tanks on ground and overhead tanks (SDOF and MDOF model) Analysis and design of jack well, approach bridge and WTP units etc. Analysis and design of ESR (container and staging). Introduction to other liquid retaining structures.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1. Rajagopalan K., Storage Structures, Tata McGraw-Hill, New Delhi, 1998.

T2. Krishna Raju N., Advanced Reinforced Concrete Design, CBS Publishers and Distributors, New Delhi, 1998.

References :

R1. Jaiswal, O. R., Rai, D. C., & Jain, S. K. Review of seismic codes on liquid-containing tanks. Earthquake Spectra, 23(1), 239-260, 2007.

R2. BIS IS 1893-2 Criteria for Earthquake Resistant Design of Structures – Part 2: Liquid retaining tanks, Bureau of Indian Standards, New Delhi, India, 2014.

R3. BIS IS 1168 Criteria for design of RCC staging for overhead water tanks, Bureau of Indian Standards, New Delhi, India, (2011)

R4. Anchor, R. D. Design of liquid-retaining concrete structures. Halsted Press, 1981.

R5. IS 3370(Part-I). Concrete structures for storage of liquids - code of practice, 2009.

R6. IS 3370(Part-II). Concrete structures for storage of liquids - code of practice, 2009.

R7. IS 3370(Part-III). Code of practice for concrete structures for the storage of liquids, 1967.

R8. IS 3370(Part-IV). Code of practice for concrete structures for the storage of liquids. Design Tables, 1967.

R9. IS BIS IS 13920 Ductile design and detailing of reinforced concrete structures subjected to seismic forces – code of practice (first revision), Bureau of Indian Standards, New Delhi, India, 2016.

R10. Ghali, A. Circular storage tanks and silos. CRC Press, 2014.

Structural Dynamics | CEL558 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course CEL353.

Course Objectives

After completing the above course, the key concepts, and skills that students should be able to demonstrate by the end of the course are:

- Develop an understanding of the fundamental principles of single-degree-of-freedom (SDOF) systems.
- Gain the ability to evaluate damping in SDOF systems.
- Learn how to analyze SDOF systems subjected to different Loads.
- Develop an understanding of the matrix formulation of multiple-degree-of-freedom (MDOF) systems and the concept of structural damping.
- Gain the ability to analyze MDOF systems.
- Learn how to generate the damping matrix using the Rayleigh damping model and how to perform mode superposition analysis on MDOF systems.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Demonstrate an understanding of the fundamental principles of single-degree-of-freedom (SDOF) systems.

CO 2. Evaluate damping in SDOF systems.

CO 3.Analyze SDOF systems subjected to various types of loads.
CO 4.Describe the matrix formulation of multiple-degree-of-freedom (MDOF) systems.
CO 5.Analyze MDOF systems subjected to various loading.
CO 6.Generate the damping matrix using the Rayleigh damping model and perform mode superposition analysis on MDOF systems.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

SDOF System: Equation of motion; Free vibration; Harmonic load; Evaluation of damping, Periodic load; General load (time domain, frequency domain); Response spectrum load, Transmissibility and base isolation. MDOF Systems: Structural matrices; Un-damped free vibration; damped free vibration, undamped forced vibration and damped force vibration. Generation of damping matrix Rayleigh damping model, Mode superposition analysis; Practical considerations. Introduction to earthquake resistant design.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Chopra, A. K., Dynamics of Structures, Applications to Earthquake Engineering, Prentice Hall, 2000.
T2. Clough, R. W. and Penzien, J., Dynamics of Structures, 2nd ed., Tata McGraw Hill, Singapore, 1993.

Reference Books

R1. Meirovitch, L., Elements of Vibration Analysis, 2nd edition, Tata McGraw Hill, Singapore, 1986.
R2. Agarwal, P. and Shrikhande, M., Earthquake Resistant Design of Structures, PHI Learning Pvt. Ltd., 2006.
R3. James, L.S, Manual of Seismic Design, Pearson Education, 2004.

Fluid Mechanics Lab | CEP251 | 1 Credit | 0 0 2 1

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the fundamental principles of fluid mechanics and their applications in real-world problems.
- Gain practical experience using fluid mechanics equipment and learn how to properly set up and calibrate it.
- Design and conduct experiments to test hypotheses, collect and analyze data, and evaluate the accuracy and reliability of results.
- Develop communication skills by preparing lab reports, to understand safety and ethical considerations associated with fluid mechanics research.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Ability to apply fundamental fluid mechanics principles to real-world problems.
CO 2.Proficiency in using fluid mechanics equipment and accurately setting it up and calibrating it.
CO 3.Skill in designing and conducting experiments, collecting and analyzing data, and evaluating the accuracy and reliability of results.
CO 4.Understanding safety and ethical considerations when conducting experiments.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. To verify Bernoulli's equation and understanding its importance.
2. To determine the Metacentric height of a floating body (i.e. a model of ship) and to locate the center of Buoyancy, metacenter and center of gravity and also understanding its importance.
3. To reproduce the dye line experiment as performed by Reynolds and to obtain the criteria for Laminar and Turbulent flow.
4. Determination of coefficient of discharge, coefficient of contraction, coefficient of velocity of orifice & mouthpiece.
5. To calculate coefficient of discharge of Venturimeter.
6. To calculate coefficient of discharge of Orifice meter.
7. To determine the percentage error in discharge computation by using rotameter.
8. To determine the friction factor of a given pipe of circular cross section.
9. To compare theoretical and actual value of flow over notch.
10. To determine the flow characteristics and elements of hydraulic jump in open channel.
11. Impact of jet on the hemispherical shell and horizontal flat plate.
12. Verification of vortex shredding.

Experiments for Desired Course Outcomes (If any): NIL

Books/Material:

T1. Fox, R.W. and McDonald, A.T., Introduction to Fluid Mechanics, John Wiley and Sons, 2013.
T2. Subramanya, K., Flow in Open Channels, Tata McGraw Hill, 2008.
T3. White F. M., Fluid Mechanics, 7th edition, Tata McGraw Hill, 2013.

Reference Books:
R1. Som, S.K. and Biswas, G., Fluid Mechanics and Fluid Mechanics, Tata McGraw Hill, 2013.
R2. Garde, R.J. and Mirajgaoker, A.G., Engineering Fluid Mechanics, NemChand and Bros, 2002.
R3. Srivastava, R., Flow through Open Channels, Oxford University Press, 2010.
R4. Steeter, V.L., Wylie E.B. and Bedford, K.W., Fluid Mechanics, 9th edition., Tata McGraw Hill education, 2011.

Engineering Geology Lab | CEP252 | 1 Credit | 0 0 2 1

Course Prerequisite
NIL

Course Objectives
The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:
- Identify rocks and rock forming minerals used in civil construction.
- Recognize geological features using essential tools during field investigation.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO 1. Understand various megascopic properties of minerals.
CO 2. Identify rock forming minerals based on the physical properties.
CO 3. Classification and identification of rock specimens.
CO 4. Filed identification of geological features.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes
1. Physical properties of minerals by observation of various collection boxes.
2. Identification of common rock forming minerals (Hand specimen).
3. Description of physical properties of 20 minerals used in civil construction.
4. Textures of common rocks.
5. Identification of rock type (Igneous, Sedimentary, Metamorphic).
6. Field identification of geological features using Brunton's Compass.
7. Identification of common geological discontinuity: Bedding plane, Folds, Faults, Joints, Foliation Plane.
8. Measurement and plotting of geological structures.
9. Extracting information from geological maps: Introduction to topographic sheets.

Experiments for Desired Course Outcomes (If any): NIL

Books/Material
T1. Nagarajan, R.Parthasarathy, A., and Panchapakesan V., Engineering Geology, 1st Edition, 2019.

Reference Books
R1. Pollard D., Pollard, D. D., Fletcher R. C., & Fletcher, R. C. Fundamentals of structural geology Cambridge University Press, 2005.
R2. Allmendinger, R. W., Cardozo, N. C., and Fisher, D., Structural Geology Algorithms: Vectors & Tensors: Cambridge, England, Cambridge University Press, 2012.

Surveying Lab |CEP256|1 Credit|0 0 2 1

Course Prerequisite
NIL

Course Objectives
After completing the above course, the key concepts, and skills that students should be able to demonstrate by the end of the course are:
- Gain the practical knowledge on calculation of an area, volume of an irregular and regular land surface using chains and tapes.
- Operate different types of instruments in surveying and perform leveling and contouring of ground surfaces.
- Apply knowledge of mathematics in surveying field to calculate areas and volumes for different projects.
- Utilize total station and other modern survey instruments.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO 1. Carry out field survey using various equipment and perform office works.
CO 2. Plot the physical points from the field to map and vice versa.
CO 3. Calculate areas, drawing plans and contour maps using different measuring equipment at field level.
CO 4. Apply the principle of surveying for civil engineering projects.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Construction of Plain Scale and Diagonal Scale.
2. Measurement of distance by ranging and chaining.
3. Determination of area of polygon by chain and cross staff survey.
4. Measurement of bearings of sides of traverse with prismatic compass and computation of correct included angle.
5. Locating given building by chain and compass traversing.
6. Determination of elevation of various points with dumpy level by collimation plane method and rise & fall method.
7. L-Section and cross section of road.
8. Measurement of horizontal angles and vertical angles theodolite by method of repetition.
9. Determination of horizontal distance between two inaccessible points with theodolite.
10. Determination of elevation of point by trigonometric levelling.
11. Drawing of Contour plan of given area.
12. Constructing of map of a given area using Plane Table Surveying.
13. Horizontal Curve Layout using linear and angular methods.
14. Measurement of area by planimeter.

Experiments for Desired Course Outcomes (If any): NIL.

Text Books

T1. Arora, K.R., Surveying, Vols. I, II and III, Standard Book House, 2013.
T2. Chandra, A.M., Surveying, New Age International Publishers, 2010.

Reference Books

R1. Anderson, J.M. and Mikhail, E.M., Surveying: Theory and Practice, McGrawHill, 1988.
R2. Schofield, W. and Breach M., Engineering Surveying, 6th ed., Butterworth- Heineman, 2007.

Strength of Materials Lab | CEP257 | 1 Credit | 0 0 2 1

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Define and calculate stress and strain in one and two dimensions for various load conditions and geometries.
- Apply the principles of stress analysis and stress transformations to analyze complex stress states using Mohr's circle method.
- Analyze bending moment and shear force diagrams for various types of beams to determine internal forces and moments at any point.
- Calculate flexural and shear stresses in beams subjected to bending loads using the principles of simple bending theory.
- Analyze the behavior of structural elements subjected to uniform torsion and calculate the associated stresses.
- Understand the concept of buckling and calculate the critical buckling load for different types of columns.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Apply stress analysis principles to predict material failure under different loading conditions.
CO 2.Gain knowledge of the behavior of thin-walled pressure vessels and understand their failure mechanisms.
CO 3.Analyze unsymmetrical bending and determine the location of the shear center.
CO 4.Calculate combined and direct bending stresses in beams subjected to multiple loading conditions.
CO 5.Learn and apply the double integration method to determine the deflection of statically determinate beams under various loading conditions.
CO 6.Understand the concept of buckling and be able to calculate the critical buckling load for different types of columns.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Measurement of Stress and Strain in One-Dimensional Axial Loading.
2. Measurement of Stress and Strain in Bending.
3. Tensile Testing of Materials.
4. Shear Testing of Materials.
5. Compression Testing of Materials (Cast Iron, Mild Steel).
6 Bending Test on Materials (Mild Steel).
7. Hardness Testing of Materials.
8. Failure Analysis of Specimens under Different Loading Conditions.
9. Shear Center Determination of an Unsymmetrical Beam.
10. Beam Deflection.
11. Graphical Analysis of Beam Deflection using Moment-Area Method.
12. Buckling Test for Columns.
13. Thin-Walled Pressure Vessel Analysis.

14. Torsion Testing of Circular Shafts (Mild Steel).

Experiments for Desired Course Outcomes (If any): NIL

Books/Material

T1.Gere, James M., and Goodno, Barry J., Mechanics of Materials. 9th Ed., Cengage Learning, 2021.

Reference Books

R1. Philpot, Timothy A., and Thomas, Jeffery S., Mechanics of Materials: An Integrated Learning System, United Kingdom, Wiley, 2020.

R2. Gere, James M., and Timoshenko, Stephen, Mechanics of Materials. United Kingdom, PWS Publishing Company, 2004.

R3. Shames, I.H., Introduction to Solid Mechanics, 3rd Ed., Prentice Hall India, 2006.

R4. Crandall, S. H., Dahl, N.C., and Lardner. J., An introduction to the Mechanics of Solids., Tata McGraw Hill, 1978.

Highway Engineering Lab | CEP282 | 1 Credit | 0 0 2 1

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Give an overview of road construction materials.
- Give complete knowledge of test procedure as per Indian standard practices.
- Provide knowledge of accepting criteria of materials, suitable for road construction.
- Provide knowledge of Traffic Data Collection.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Basic characterize the pavement materials.

CO 2.Understand material behavior for pavement construction.

CO 3.Conduct basic test on aggregate, soil and bitumen for pavement construction.

CO 4.Obtain and analyze the limiting value of test samples.

CO 5.Understand the procedure of traffic data collection.

Desirable/Advanced (If any):NIL

Experiments for Essential Course Outcomes

(A) Tests on Aggregates

1. To determine the water absorption of aggregate.
2. To determine fineness modulus and grain size distribution of fine aggregate.
3. To determine grain size distribution and fineness modulus of coarse aggregate.
4. To determine specific gravity of a given sample of fine aggregate.
5. To determine the Aggregate Crushing Value of coarse aggregate.
6. To access the resistance of an aggregate to mechanical degradation by the Aggregate Impact Value.
7. To determine Los Angeles Abrasion Value.
8. To determine the Flakiness Index and Elongation Index of aggregates. (Shape Test)
9. To determine the Specific Gravity and Water Absorption of aggregates.

(B) Tests on Bituminous Materials.

10. To determine the Softening Point of bitumen.
11. To determine the Flash Point and Fire Point of a bitumen.
12. To determine the Specific Gravity of given sample of bitumen.
13. To determine the stripping value of road aggregates.

(C) Traffic Engineering

14. To determine the Traffic Volume at a given section of highway.
15. To determine the Traffic Capacity at a given section of highway.

Experiments for Desired Course Outcomes (If any): NIL

Text Books

T1.Khanna, S.K. and Justo, C.E.G., Highway Material Pavement Testing Manual, NemChandand Bros., 2013.

Reference Books

R1. Papacostas, C.S. and Prevedouros, P.D., Transportation Engineering and Planning, Prentice Hall, 2008.

R2. JotinKhisty, C. and Kent Lall, B., Transportation Engineering: An Introduction, Prentice Hall, 2008.

R3. Roess, R.P., Prassas, E.S. and McShane, W.R., Traffic Engineering, Pearson, 2013.

Hydrology and Irrigation Engineering Lab | CEP381 | 1 Credit | 0 0 2 1

Course Prerequisite

The student should have studied the course CEP251.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop skills in using modern techniques and equipment for hydrological data collection, analysis, and interpretation.
- Acquire knowledge of irrigation system design and the principles of irrigation scheduling, and apply this knowledge to practical situations.
- Gain hands-on experience in analyzing hydrological and agronomic data to design effective irrigation and drainage systems.
- Learn to assess and mitigate environmental impacts of irrigation projects and apply sustainability principles in water resource management.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Ability to apply fundamental principles of hydrology to real-world problems in water resource management.

CO 2.Proficiency in using a range of equipment and techniques for measuring and analyzing hydrological data, such as rainfall, runoff, and evapotranspiration.

CO 3.Ability to design and analyze irrigation systems based on soil and crop characteristics, climate conditions, and water availability.

CO 4.Understanding of the environmental and social impacts of water management practices.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes:

1. Determination of rainfall by automatic rainguages.
2. Determination of hydrometeorological parameters including silt carrying by streams.
3. Determination of hydraulic parameters for river discharge sites.
4. Determination of pH ,electrical conductivity and other associated parameters of the soil sample.
5. Determination and construction of unit hydrographs and S-Curve.
6. Reservoir Routing for steams by help of software.
7. Construction of Horton's Infiltration Curve and Horton's Parameters.
8. Introduction and use of HEC software.

Experiments for Desired Course Outcomes (If any): NIL

Books/Material

T1. Ojha, C.S.P., Berndtsson, R. and Bhunya, P., Engineering Hydrology, Oxford University Press, 2012.

T2.Asawa, G.L., Irrigation and Water Resources Engineering, New Age International Publishers, 2013.

T3.Subramanya, K., Engineering Hydrology, Tata McGraw Hill, New Delhi, 2013.

Reference Books:

R1. Mysooru R., Yadupathi Putty, Principles of Hydrology, I K international publishing house, 2011.

R2. Chow, V. T., Maidment, D.R. and Mays, L.W., Applied Hydrology, Tata McGraw Hill, 2013.

Materials Testing Lab | CEP382 | 1 Credit | 0 0 2 1

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Impart knowledge of engineering properties of various types of building materials.
- Understand and apply the knowledge to select appropriate and suitable materials for building construction.
- Understand the mix design of concrete.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Understand various types building materials for construction.

CO 2.Conduct the test on aggregate, brick and cement as per IS specification.

CO 3.Understand the limitations and accepting criteria of building materials.

CO 4.Design the concrete for civil infrastructure.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. To determine the fineness of the cement a) Using 90-micron IS sieve b) Blaine's air permeability method.
2. To determine the standard consistency, initial setting and final setting time of cement.
3. To determine the specific gravity of a cement using:
(a) specific gravity bottle. (b) Le-Chatelier Flask.
4. To determine the soundness of cement.
5. To determine the compressive strength of cement (using mortar cubes).
6. To test the shape, size and water absorption of standard brick.
7. To determine the compressive strength of bricks.

8. To determine the mix proportional for M20 Grade of concrete.
9. To design a concret mix as per IS10262-2019.
10. To determine the compressive strength of concrete using a) UTM / CTM b) Rebound Hammer c) Ultrasonic Pulse Velocity (UPV) Tester.
11. To determine workability of concrete using a) Slump Cone Test b) Compaction factor test.
12. To determine the flexural strength of concrete.
13. To determine the splitting tensile strength of concrete.

Experiments for Desired Course Outcomes (If any): NIL

Books/Material

T1. Gambhir, M.L., Concrete Technology, Tata McGraw Hill, 2013.

Reference Books

R1. Kumar, S., Building Construction, Standard Publishers, 2010.
R2. Neville, A.M. and Brooks, J.J., Concrete Technology, ELBS Ed., Longman Ltd., 2013.
R3. Khanna, P.N., Indian Practical Civil Engineering Handbook, Engineers Publishers, 1988.
R4. IS 10262, Mix design & concrete, 2019.

Soil Mechanics Lab | CEP383 | 1 Credit | 0 0 2 1

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to

- Understand sampling and testing techniques for determination of engineering properties of soil.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Determine index properties of soil.
CO 2. Classification and identification of soil specimens.
CO 3. Investigate in details the permeability and compaction behaviour of soil.
CO 4. Analyse and interpret consolidation as well as shear strength properties of soil

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Liquid limit, plastic limit and shrinkage limit.
2. Field density by (a) core cutter method and (b) sand replacement method.
3. Grain size analysis by (a) mechanical method and (b) hydrometer method.
4. Specific gravity by pycnometer.
5. Compaction properties of soil using Proctor compaction test.
6. Permeability by (a) constant head method and (b) variable head method.
7. Shear strength of cohesive soil using unconfined compression test.
8. Shear strength of cohesion-less soil using direct shear test.
9. Consolidation properties of clayey soils.
10. Demonstration of tri-axial test set-up.
11. Plate load Test.
12. Standard Penetration Test

Experiments for Desired Course Outcomes (If any): NIL

Books/Material

T1. Head, K. H., Manual of Soil Laboratory Testing, Vol. I, II, and III, 3rd Edition, Whittles Publishing, 2006.
T2. Lambe, T. W., Soil Testing for Engineers, Wiley, 1st Edition, 1951.

Reference Books

R1. Ranjan G. and Rao A.S.R., Basic and Applied Soil Mechanics, New Age Publishers, 2004.
R2. Shamsher P. and Jain P.K., Engineering Soil Testing, 4th Edition, NemChand and Bros, 2013.

Environmental Engineering Lab | CEP384|1 Credit| 0 0 2 1

Course Prerequisite

The student should have studied the course CEL 281.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Applying basic concepts in environmental engineering to practical problems through hands-on experimentation.
- Developing skills in the design, operation, and optimization of advanced treatment systems for water and air pollution control.
- Understanding the use of analytical instruments and laboratory techniques in environmental analysis.
- Learning about emerging technologies and their application in environmental engineering, and how to evaluate their effectiveness through experimentation.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Ability to design and optimize treatment systems for water and air pollution control using analytical and experimental methods.
CO 2.Proficiency in using analytical instruments and laboratory techniques for environmental analysis and effective communication of results.
CO 3.Ability to apply advanced concepts in environmental engineering to solve practical problems.
CO 4.Understanding of the ethical and safety considerations, including governing environmental engineering experimentation.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes:

1. Understanding the IS codes for drinking water specifications.
2. Determination of pH of water/wastewater.
3. Determination of biological oxygen demand (BOD).
4. Determination of chemical oxygen demand (COD).
5. Determination of acidity and alkalinity for wastewater/water.
6. Determination of–

a. Total Hardness of water
b. Permanent Hardness of water
c. Temporary Hardness of water

7. Determination of total solids, total dissolved solids, suspended solids and settleable solids in water/wastewater.
8. Collection of air samples and their analysis.
9. Determination of dissolved oxygen in water/wastewater.
10. Determination of heavy metal ions in drinking water.
11. Determination of chloride concentration in water.
12. To determine the optimum dosage of coagulant to remove small or charged particles present in water/wastewater.
13. Determination of turbidity for water/wastewater.
14. Determination of chlorine demand and residual chlorine water.

Experiments for Desired Course Outcomes (If any): NIL

Books/Material:

T1.Syed R. Qasim., Wastewater Treatment Plants: Planning, Design, and Operation, Second Edition CRC press, 1998.
T2.P.N Modi., Sewage disposal and waste water engineering, 4th edition, Standard Publications, 2020.

Reference Books

R1. AWWA, WEF, APHA, Standard Methods for the Examination of Water and Wastewater, 1998.
R2. Sawyer, C.N., McCarty, P.L., and Parkin, G.F. Chemistry for Environmental Engineering, 4th Edition, Tata McGraw-Hill Publishing Company Limited, 2000.
R3. AQ-5000, Indoor Air Quality Monitor Manual, QUEST technology USA, 2003.
R4. IS 4209. Code of safety in chemical laboratories, 1987.

Geomatics Engineering Lab | CEP451 | 1 Credit | 0 0 2 1

Course Prerequisite

NIL

Course Objectives

After completing the above course, the key concepts, and skills that students should be able to demonstrate by the end of the course are:

- Apply geometric principles to arrive at solutions to surveying problems.
- Analyze spatial data using appropriate computational and analytical techniques.
- Design proper types of curves for deviating type of alignments.
- Use the concepts of advanced data capturing methods necessary for engineering practice.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Apply the knowledge of geometric principles to arrive at surveying problems.
CO 2. Use modern instruments to obtain geo-spatial data and analyze the same to appropriate engineering problems.
CO 3. Capture geodetic data to process and perform analysis for survey problems with the use of electronic instruments.
CO 4. Design and implement the different types of curves for deviating type of alignments.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Introduction to GIS.
2. Field Practices &Measurements.
3. Measuring Vertical Distances by Leveling.
4. Measuring Horizontals distances.
5. Applications of GIS.
6. Property Layout and USPLSS .
7. Field Traverse and Area Measurements.
8. Location by Resection/Collecting Topographic Data.
9. Topographic Map Compilation.
10. Horizontal and Vertical Curve Design.
11. Horizontal and Vertical Curve Layout.
12. Global Positioning Systems.

13. Final ARCMAP Layout.

Experiments for Desired Course Outcomes (If any): NIL

Text Books

T1. Arora, K.R., Surveying, Vols. I, II and III, Standard Book House, 2013.
T2. Chandra, A.M. Higher Surveying, New Age International (P) Limited, Publishers,New Delhi, 2005.

Reference Books

R1. Ghilani, C.D. and Wolf, P.R. Elementary Surveying: An Introduction to Geomatics, Pearson, 2012.
R2. Bossler, J.D. Manual of Geospatial Science and Technology, Taylor and Francis, London, 2002.
R3. Chandra, A.M. and Ghosh, S.K. Remote Sensing and Geographical Information Systems, Alpha Science, Oxford U.K., 2005.
R4. Gopi, S. Global Positioning System: Principles and Applications, TataMcGraw Hill, 2005.

Non Destructive Testing of Materials Lab | CEP452 | 1 Credit | 0 0 2 1

Course Prerequisite

The student should have studied the course CEL452.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop practical skills in performing conventional and advanced non-destructive testing techniques.
- Learn how to set up and control non-destructive testing parameters to achieve desired output parameters and interpret test results accurately to identify flaws and defects in materials.
- Gain hands-on experience in detecting and analyzing internal flaws in materials using non-destructive testing and develop strategies for defect elimination and prevention.
- Acquire problem-solving and troubleshooting skills by working through common issues encountered during non-destructive testing, such as equipment malfunctions, signal interference, and data interpretation challenges.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understanding of conventional and advanced non-destructive testing techniques used in the industry.
CO 2. Interpreting and analyzing test results to identify internal flaws in materials.
CO 3. Detect and evaluate various types of defects, such as leaks, cracks, and blowholes, and recommend appropriate measures for defect elimination and prevention.
CO 4. Use critical thinking and problem-solving skills to troubleshoot common issues encountered during non-destructive testing and propose solutions to optimize the testing process and ensure quality control.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. To determine Compressive Strength of concrete by using Rebound Hammer.
2. To determine Compressive Strength of concrete by Ultrasonic pulse velocity.
3. To determine the quality of concrete using by Ultrasonic pulse velocity.
4. To determine Location of Rebars, measurement of concrete covers and bar diameter by using Rebar detector.
5. To determine the resistivity of the concrete.
6. To determine the concrete ability to resist chloride ion penetration.
7. To analyze the corrosion in concrete.

Experiments for Desired Course Outcomes (If any): NIL

Books/Material

T1. Bungey, S., Lillard, G. and Grantham, M.G. Testing of Concrete in Structures, 4th Ed., Taylor and Francis, London, 2006.
T2. Malhotra, V.M. and Carino, N.J., Handbook on Non-Destructive Testing of Concrete, 2nd Ed.,Taylor and Francis, London, 2003.

Reference Books

R1. Krautkramer, H., Ultrasonic Testing of Materials, Springer Verlag, 1969
R2. Novgoresky, M.A., Testing of Building Materials and Structures, Mir Publishers, 1973.
R3. American Society of Metals: Handbook, Vol. II, Destructive Inspection and Quality Control, 1976.

Rock Engineering Lab | CEP455 | 1 Credit | 0 0 2 1

Course Prerequisite

The student should have studied the course CEP252.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Determine the rock samples from rock specimen with proper tolerance limit.
- Determine physical, mechanical properties of rock and rock-masses.
- Understand different tests to compute the durability, strength and permeability of rock sample.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Identify the way to prepared different rock samples by coring and cutting.

CO 2.Analyze the various physical and mechanical properties of rocks by conducting different tests.

CO 3.Determine the strength of rock by conducting Uniaxial compression, Point load index and Brazilian strength tests.

CO 4.Analyze the permeability and durability for given rock sample.

Desirable/Advanced (If any): NIL

List of Experiments:

1. Rock samples: specimen preparation, coring, cutting and lapping, tolerance limits.
2. To determine water absorption, density, specific gravity, porosity, void index of rock sample.
3. Electrical resistivity and sonic wave velocity tests.
4. Uniaxial compression test.
5. Point load index test.
6. Brazilian strength tests.
7. Direct shear tests: Single, double, oblique tests, Punch shear.
8. Triaxial compression tests.
9. Field shear test.
10. Permeability tests.
11. Slake durability.

Reference Books:

R1. Hoek, E. and Brown, E., Underground excavations in rock, CRC Press, 1980.

R2. Hoek, E. and Bray, J., Rock Slope Engineering, 4th Ed. Spon Press. 2004.

R3. Goodman, R. E. Introduction to Rock Mechanics, John Wiley and Sons, 2010.

R4. Ulusay R. (eds), The ISRM Suggested Methods for Rock Characterization, Testing and Monitoring:Springer, Cham, 2007-2014.

R5. Hudson, J.A., Rock Testing and Site Characterization: Comprehensive Rock Engineering: Principles, Practice and Projects Kindle Edition, Pergamon, 2014.

Machine Learning and Data Analytics for Civil Engineering Applications Lab | CEP484 | 1 Credit | 0 0 2 1

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the basics of probability and statistics for civil engineering applications.
- Gain proficiency in linear algebra and programming skills in Python.
- Develop knowledge in supervised and unsupervised machine learning algorithms.
- Explore the use of directed and undirected generative models and genetic algorithms.
- Learn to apply data statistics and analytics to real-world civil engineering problems.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Apply basic probability and statistics concepts to analyze civil engineering data.

CO 2.Use machine learning techniques to solve real-world civil engineering problems.

CO 3.Implement supervised and unsupervised learning algorithms for clustering and classification tasks.

CO 4.Demonstrate proficiency in programming with Python for data analysis.

CO 5.Apply genetic algorithms for optimization and hybrid systems design in civil engineering.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Basic Probability and Statistics: Write a Python program to simulate a coin flip and calculate the probability of getting heads or tails. Calculate the mean, median, and mode of a given dataset.
2. Linear Algebra: Write a Python program to perform matrix operations like addition, subtraction, multiplication, and finding the inverse of a matrix.
3. ML in Modern Civil Engineering: Use a machine learning algorithm to predict the strength of concrete based on various inputs like age, cement content, water content, etc.
4. Linear Regression: Use Python to perform linear regression on a given dataset and plot the regression line.
5. Logistic Regression: Write a Python program to classify a given dataset using logistic regression.

6. Programming Skills in Python: Write a Python program to perform basic file operations like reading from and writing to a file.
7. Supervised Learning: Implement a K-Nearest Neighbor algorithm to classify a given dataset.
8. Neural Networks: Build a neural network using Python and train it to recognize handwritten digits from the MNIST dataset.
9. Unsupervised Learning: Implement K-means clustering on a given dataset and visualize the results.
10. Genetic Algorithm: Implement a genetic algorithm to solve the Traveling Salesman Problem.
11. Application to Civil Engineering: Use machine learning to predict the strength of a bridge based on various inputs like weather conditions, traffic load, etc.
12. Data Statistics and Analytics: Write a Python program to perform data analysis on a given dataset and visualize the results using libraries like Matplotlib and Pandas.

Experiments for Desired Course Outcomes (If any): NIL

Text Books

T1.Deka, P.C., O. A Primer on Machine Learning Applications in Civil Engineering, CRC Press, 2020.

Reference Books

R1. Bishop, C. M. Pattern Recognition and Machine Learning. Switzerland: Springer, 2007.
R2. Lutz, M. Learning Python: Powerful Object-Oriented Programming. United States: O'Reilly Media, 2013.
R3. Simeone, O. A Brief Introduction to Machine Learning for Engineers. Germany: Now Publishers, 2018.

Geotechnical Design Studio | CEP507 | 3 Credits | 1 0 4 3

Course Prerequisite

The student should have studied the courses CEL383 and CEL386.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the basic aspects of computational simulation for geotechnical structures.
- Learn the scope, merits, and limitations of computational simulations in geotechnical engineering.
- Gain knowledge about different aspects of modeling, including geometry, in-situ stress conditions, material behavior, and applied loading in computational simulations.
- Learn how to analyze and interpret output data from computational simulations and use spreadsheets and cod for geotechnical analysis.

Course Outcomes

At the end of the course, students would be able to -

Essential:

CO 1. Understand the limitations and uncertainties associated with computational simulations.
CO 2. Develop the ability to create and implement computational models for geotechnical structures.
CO 3. Gain proficiency in computational geotechnical analysis.
CO 4. Analyze and interpret the results of computational simulations for geotechnical case studies / failures.
CO 5. Develop knowledge and skills to effectively communicate the findings of computational geotechnical analysis to stakeholders.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Basic aspects of computational simulation for geotechnical structures such as foundations, earth retaining structures, slopes, tunnels, underground excavations etc.; scope, merits and demrits, modelling of geometry, in-situ stress conditions, material behaviour, applied loading etc., 2D and 3D modelling, Seepage analysis through an earth dam. Slope stability analysis of a dam. Settlement analysis of shallow and deep foundations; Analysis and design of retaining structures; Analysing the structural forces in a tunnel lining. Applications of spreadsheet and programming codes in geotechnical analysis.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Desai, C.S. and Zaman, M., Advanced Geotechnical Engineering: Soil-Structure Interaction using Computer and Material Models, CRC Press/Taylor & Francis Group, 2013.
T2. Hicher, P.Y. and Shao J.F., Constitutive Modeling of Soils and Rocks, John Wiley, 2008.

Reference Books

R1. Bowles, J. E., Analytical & Computer Methods in Foundation Engineering, McGraw-Hill, 1974.
R2. Desai, C.S. and Christian, J. T., Numerical Methods in Geotechnical Engineering, McGraw-Hill, 1977.
R3. Potts, D. M. and Zdravkovic, L., Finite Element Analysis in Geotechnical Engineering: Theory and Applications, Thomas Telford Publishing, 2001.

RCC Structures Detailing Lab | CEP508| 1 Credit | 0 0 2 1

Course Prerequisite

The student should have studied the course CEL357.

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop the knowledge of reinforcement/structural design as per IS 456 and SP 16.
- Design (manual) of the single-story building.
- Understand the importance of reinforcement as per location.
- Draw the structural drawings with all detailing as per IS 456 and SP 16.
- Reading of various structural drawings and its understanding.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Understand the importance and application of design reinforcement.

CO 2.Understand the detailing of reinforcement as per design.

CO 3.Read the structural drawings.

CO 4.Identify the mistake in the structural drawings.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1.Structural Detailing drawing for singly and doubly reinforced rectangular and T beam.

2.Structural Detailing drawing for cantilever beam, chajja and canopy.

3.Structural Detailing drawing for one way simply supported Slab.

4.Structural Detailing drawing for two-way simply supported Slab.

5.Structural Detailing drawing for Cantilever and continuous slab.

6.Structural Detailing drawing for isolated column and footing.

7.Structural Detailing drawing for combined column and footing.

Experiments for Desired Course Outcomes (If any): NIL

Books/Material

T1.Pillai, S.U. and Menon, D., Reinforced Concrete Design, Tata McGraw Hill, 2013.

T2.Jain, A.K., Reinforced Concrete-II, NemChand and Bros, 2012.

T3.Fundamentals of reinforced concrete design by M.L. Gambhir, Prentice-Hall, New Delhi.

Reference Books

R1. Sinha, S.N., Reinforced Concrete Design, Tata McGraw Hill, 2013.

R2. Subramanian, N., Design of Reinforced concrete Structures, Oxford Higher Education, 2014.

R3. Shah, V.L. et. al., Limit State Theory and Design of Reinforced Concrete, Structures Publications, 2007.

R4. Varghese, P.C., Limit State Design of Reinforced Concrete, Prentice-Hall, 2011.

R5. SP-16(S&T), Design Aids for Reinforced Concrete to IS:456, BIS, N.Delhi, 1980.

R6. SP-34(S&T), Handbook on Concrete Reinforcement and Detailing, BIS, N.Delhi, 1987.

Structure Dynamics Lab | CEP509 | 1 Credit | 0 0 2 1

Course Prerequisite

NIL

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Apply principles of vibration analysis to real-world structures.
- Explain the effects of different types of base motion on structures.
- Apply principles of vibration analysis to analyze the response of structures to harmonic and periodic base motions.
- Design a vibration isolation system for a secondary structure.
- Evaluate the dynamic behavior of a vibration absorber and its effectiveness in reducing vibration.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1.Understand the principles of vibration analysis and how they apply to real-world structures.

CO 2.Demonstrate knowledge of different types of base motion and their effects on structures.

CO 3.Analyze and interpret the response of structures to harmonic and periodic base motions.

CO 4.Design and analyze vibration isolation system for secondary structure.

CO 5.Analyze dynamic behavior of vibration absorber and its effectiveness in reducing vibration.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Dynamics of a three storied building frame subjected to harmonic base motion.
2. Dynamics of a one-storied building frame with planar asymmetry subjected to harmonic base motions.
3. Dynamics of a three storied building frame subjected to periodic (non-harmonic) base motion.
4. Vibration isolation of a secondary system.
5. Dynamics of a vibration absorber.
6. Dynamics of a four storied building frame with and without an open ground floor.
7. Dynamics of one-span and two-span beams.
8. Earthquake induced waves in rectangular water tanks.
9. Dynamics of free-standing rigid bodies under base motions.

Experiments for Desired Course Outcomes (If any): NIL

Books/Material

T1. Chopra, A. K., Dynamics of Structures, Applications to Earthquake Engineering, Prentice Hall, 2000.

Reference Books

NIL

B.Tech (Electronics and Communication Engineering)
OVERALL CREDIT STRUCTURE

Undergraduate Core (UG)		Undergraduate Elective (UE)	
Category	**Credit**	**Category**	**Credit**
DC	67	DE	23 (minimum)
BS	19	HM	06 (minimum)
ES	22	OC	18 (Balance)
HM	05	UN	0 (03 Courses)
Total	113	Total	47
Grand Total (UC + UE)			**160**

Basic Science (BS)			
Course Code	**Course**	**L-T-P**	**Credit**
19 CREDITS TO BE OFFERED BY S&H DEPARTMENT			
Total			**19**

Humanities and Management (Core) (HM)			
Course Code	**Course**	**L-T-P**	**Credit**
05 CREDITS TO BE OFFERD BY S&H DEPARTMENT			
Total			**05**

Engineering Arts and Science (ES)			
Course Code	**Course**	**L-T-P**	**Credit**
ECL151	Basic Electronics Engineering	3-0-0	03
ECP151	Basic Electronics Engineering Lab	0-0-2	01
18 CREDITS TO BE OFFERD BY S&H DEPARTMENT			
Total			**22**

Department Core (DC)		L-T-P	Credit

Department Elective (DE)		L-T-P	Credit

B.Tech (Electronics and Communication Engineering)
OVERALL CREDIT STRUCTURE

Undergraduate Core (UG)		Undergraduate Elective (UE)	
Category	**Credit**	**Category**	**Credit**
DC	67	DE	23 (minimum)
BS	19	HM	06 (minimum)
ES	22	OC	18 (Balance)
HM	05	UN	0 (03 Courses)
Total	113	Total	47
Grand Total (UC + UE)			**160**

Engineering Arts and Science (ES)			
Course Code	**Course**	**L-T-P**	**Credit**
ECL151	Basic Electronics Engineering	3-0-0	03
ECP151	Basic Electronics Engineering Lab	0-0-2	01
18 CREDITS TO BE OFFERD BY S&H DEPARTMENT			
Total			**22**

Basic Science (BS)			
Course Code	**Course**	**L-T-P**	**Credit**
19 CREDITS TO BE OFFERED BY S&H DEPARTMENT			
Total			**19**

Humanities and Management (Core) (HM)			
Course Code	**Course**	**L-T-P**	**Credit**
05 CREDITS TO BE OFFERD BY S&H DEPARTMENT			
Total			**05**

ECL359	Microprocessor and Interfacing	3-0-0	03

Department Elective (DE)		**L-T-P**	**Credit**
ECP361	Electronics Workshop and Tinkering Lab	0-0-4	02
ECL462	Electronic System Design	3-0-0	03
ECP462	Electronic System Design Lab	0-0-2	01
ECL466	Finite Automata	3-0-0	03
ECL467	Radio Frequency and Microwave Engineering	3-0-0	03
ECL468	Embedded System Design	3-0-0	03
ECP468	Embedded System Design Lab	0-0-2	01
ECL470	Wireless and Mobile Communications	3-0-0	03
ECP470	Wireless and Mobile Communication Lab	0-0-2	01
ECL471	Radar and Satellite Communication Systems	3-0-0	03
ECL473	FPGA based IC/System Design	3-0-0	03
ECP473	FPGA based IC/System Design Lab	0-0-2	01
ECL474	Data Communication and Networks	3-0-0	03
ECL475	Information Theory & Coding Techniques	3-0-0	03
ECL476	Advanced Analog Circuits	3-0-0	03
ECL477	Intelligent Instrumentation	3-0-0	03
ECL519	VLSI/ULSI Technology	3-0-0	03
ECL531	Advanced Microwave Engineering	3-0-0	03
ECL533	Advanced Digital Communication Systems	3-0-0	03
ECL542	Image Processing	3-0-0	03
ECP542	Image Processing Lab	0-0-2	01
ECL552	Advanced Machine Learning	3-0-0	03
ECP552	Advanced Machine Learning Lab	0-0-2	01
ECL563	Matrix Theory for System Analysis	3-0-0	03
ECL564	Robotics Control and Computer Vision	3-0-0	03
ECL565	Advanced Topics in Semiconductor Devices	3-0-0	03
CSL252	Operating System	3-0-0	03
CSP252	Operating System Lab	0-0-2	01
CSL353	Data Science	3-0-0	03
CSP353	Data Science Lab	0-0-2	01
EEL255	Power Electronics	3-0-0	03
EEP255	Power Electronics Lab	0-0-2	01

Department Core (DC)		**L-T-P**	**Credit**
ECL251	Signals and Systems	3-2-0	04
ECL252	Analog Circuits	3-0-0	03
ECP252	Analog Circuits Lab	0-0-2	01
ECL253	Analog Communication Systems	3-0-0	03
ECP253	Analog Communication Systems Lab	0-0-2	01
ECL254	Engineering Electromagnetics	3-0-0	03
ECL255	Solid State Devices	3-0-0	03
ECL256	Digital Circuits	3-0-0	03
ECP256	Digital Circuits Lab	0-0-2	01
ECL351	Linear Integrated Circuit	3-0-0	03
ECP351	Linear Integrated Circuit Lab	0-0-2	01
ECL352	Digital Signal Processing	3-0-0	03
ECP352	Digital Signal Processing Lab	0-0-2	01
ECL354	Antenna Theory	3-0-0	03
ECL355	Digital Communication Systems	3-0-0	03
ECP355	Digital Communication Systems Lab	0-0-2	01
ECL356	Microwave Theory and Techniques	3-0-0	03
ECP356	Microwave Theory and Techniques Lab	0-0-2	01
ECP359	Microprocessor and Interfacing Lab	0-0-2	01
ECL360	Optical Communication Systems	3-0-0	03
ECP360	Optical Communication Lab	0-0-2	01
EEL251	Basic Electrical Circuits	3-0-0	03
EEP251	Basic Electrical Circuits Lab	0-0-2	01
EEL254	Control System	3-0-0	03
EEP254	Control System Lab	0-0-2	01
CSL251	Data Structures	3-0-0	03
CSP251	Data Structures Lab	0-0-2	01
CSL258	Computer Organization and Architecture	3-0-0	03

Course Syllabi
(Under Graduate)
Department of Electronics Engineering

Course Code: ECL151
Course Title: Basic Electronics Engineering
Structure (L-T-P): 3-0-0
Prerequisite: NIL

Course Objectives:
After completing the course, student is expected to:

- Understand the physics behind the conduction in a semiconductor and the working of a diode
- Analyze diode based circuits such as rectifier clipper, clamper, shunt regulator, multiplier circuits etc.
- Compute different parameters for BJT and MOSFET transistor circuits.
- Apply the knowledge of operational amplifiers in common applications.
- Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.

Course Outcomes
At the end of the course, students will be able to-
Essential:

CO 1. Understand the physics behind the conduction in a semiconductor and the working of a diode.
CO 2. Analyze diode based circuits such as rectifier clipper, clamper, shunt regulator, multiplier circuits etc.
CO 3. Apply the knowledge of operational amplifiers in common applications.
CO 4. Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.
CO 5. Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Basic Semiconductor Physics: temperature effect, intrinsic and extrinsic semiconductor, band diagram, mobility, conductivity hall effect, Diode, Depletion layer, V-I characteristics, ideal and practical, diode resistance, capacitance, Diode Equivalent Circuits, Transition and Diffusion Capacitance, Zener Diodes breakdown mechanism (Zener and avalanche).

Diode Applications: Parallel and Series Diode Configuration, Half and Full Wave rectification,

Clippers, Clampers, Zener diode as shunt regulator, Voltage-Multiplier Circuits. Light-Emitting Diodes, Varactor (Varicap) Diodes, Tunnel Diodes, Liquid-Crystal diodes and displays. Introduction to LASERs

Transistor Theory: Bipolar Junction Transistor, Transistor Construction, Operation, Amplification action, Common Base, Common Emitter, Common Collector Configuration. Amplifiers. Field Effect Transistor:

Construction and I-V Characteristics of JFETs. Construction and I-V Characteristics of MOSFET, CS, CD, CG amplifier and analysis of CS amplifier MOSFET (Depletion and Enhancement) Type.

Digital Electronics: Introduction to digital electronics, Number Systems, Conversion between various number systems, Basic Logic gates.

Operational Amplifiers: Introduction, Differential Amplifier Circuits, Op-Amp Basic, Practical Op-Amp Circuits (Inverting Amplifier, Noninverting Amplifier, Unit Follower, Summing Amplifier, Integrator, Differentiator). Differential and Common-Mode Operation, CMRR, PSRR.

Fundamentals of Communication Engineering: Elements of a Communication System, Need of modulation, electromagnetic spectrum and typical applications, terminologies in communication systems, Basics of signal representation and analysis, Fundamentals of amplitude and angle modulation, modulation and demodulation techniques

Contents for Desired Course Outcomes (If any): Nil

Text Books

T1. Robert L. Boylestad & Louis Nashelsky. Electronic Devices and Circuit Theory, Tenth Edition, Pearson

T2. David A. Bell, Electronics Devices and Circuits, 5th Edition, OXFORD University Press 2008.

T3. George Kennedy, Electronic Communication System, Fifth Edition, TMH Publication, 2012.

Reference Books

R1. Jacob Millman, Christos C. Halkias, Satyabrata Jit, Electronics Devices and Circuits, 3rd Edition, TMH 2008.

R2. H S Kalsi, Electronics Instrumentation, Third Edition, TMH Publication 2012

Course Code: ECP151
Course Title: Basic Electronics Engineering Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL151

Course Objectives

After completing the course, student is expected to:

- Understand the physics behind the conduction in a semiconductor and the working of a diode
- Analyze diode based circuits such as rectifier clipper, clamper, shunt regulator, multiplier circuits etc.
- Compute different parameters for BJT and MOSFET transistor circuits.
- Apply the knowledge of operational amplifiers in common applications.
- Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Analyze diode based circuits such as rectifier clipper, clamper, shunt regulator, multiplier circuits etc.

CO 2. Apply the knowledge of operational amplifiers in common applications.

CO 3. Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.

CO 4. Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.

Desirable/Advanced (If any):

List of Experiments

1. Study of CRO-Applications
2. V-I Characteristics of Silicon & Germanium PN Junction diodes
3. V-I Characteristics of Zener Diode

4. Characteristics of BJT in Common Emitter Configuration
5. Characteristics of JFET in Common Source Configuration
6. Half Wave and Full Wave Rectifier Without Filter
7. Half Wave and Full Wave Rectifier with Filter
8. Common Emitter BJT Amplifier
9. Applications of Operational Amplifier
10. Implementation of Logic Gates
11. Study of communication modulation techniques

Contents for Desired Course Outcomes (If any): Nil

Text Books

T1. Robert L. Boylestad & Louis Nashelsky. Electronic Devices and Circuit Theory, Tenth Edition, Pearson
T2. David A. Bell, Electronics Devices and Circuits, 5th Edition, OXFORD University Press 2008.
T3. George Kennedy, Electronic Communication System, Fifth Edition, TMH Publication, 2012.

Reference Books

R1. Jacob Millman, Christos C. Halkias, Satyabrata Jit, Electronics Devices and Circuits, 3rd Edition, TMH 2008.
R2. H S Kalsi, Electronics Instrumentation, Third Edition, TMH Publication 2012

Course Code: ECL251
Course Title: Signals and Systems
Structure (L-T-P): 3 2 0
Prerequisite: NIL

Course Objectives

After completing the course, student is expected to:

- Represent and Classify signals and systems,
- Employ convolution to obtain the response of a linear time invariant system
- Obtain Fourier Series expansion of a periodic signal
- Obtain Fourier Transform of aperiodic signals
- Use z-Transform method to analyze discrete systems

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Analyze the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.
CO 2. Characterize different types of signals and systems.
CO 3. Analyze system behavior using time and frequency domain techniques.
CO 4. Identify the sources of signals in real life.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

An introduction to signals and systems- Signals and systems as seen in everyday life, and in various branches of engineering and science electrical, mechanical, hydraulic, thermal, biomedical signals and systems as examples. Extracting the common essence and requirements of signal and system

Formalizing signals- energy and power signals, signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. Formalizing systems- system properties: linearity: additivity and homogeneity, shift invariance, causality, stability, realizability.

Continuous time and discrete time linear shift-invariant (LSI) systems in detail-the impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of linear shift invariant systems. System representation through differential equations and difference equations.

Periodic and semi-periodic inputs to an LSI system, the notion of a frequency response and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. The idea of signal space and Orthogonal bases of signals.

The Laplace Transform for continuous time signals and systems- the notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. Generalization of Parseval's Theorem. The z-Transform for discrete time signals and systems- eigen functions, region of convergence, system functions, poles and zeros of systems and sequences, z-domain analysis. Generalization of Parseval's Theorem. Applications of Laplace Transform and z-Transform.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. B. P. Iathi, Oxford, Principles of Linear Systems and Signals, Second edition, 2009.
T2. Oppenheim, A.V., Willsky, A.S., and Nawab, S.H. Signals and Systems. 2nd ed., PHI Learning Private Limited., 2012.

T3. Haykin, S.S. and Veen, B.V. Signals and Systems .2nd ed. Wiley, 2013

Reference Books

R1. Phillips, C.L., Parr, J.M., and Riskin, E.A. Signals, Systems and Transforms.5th ed. Pearson Education, 2014.

R2. Carlson, G.E. Signal and Linear System Analysis. 2nd ed. Allied Publishers Limited, 1993.

Course Code: ECL252
Course Title: Analog Circuits
Structure (L-T-P): 3 0 0
Prerequisite: ECL151
Course Objectives

After completing the course, student is expected to:

- Understand fundamentals of MOSFET and their small and large signal equivalent model.
- Understand the analog integrated circuit and its building blocks.
- Analyze different analog circuits in terms of gain, input resistance and output resistance.
- Solve practical and state of the art analog IC design problems to serve VLSI industries.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the basic of semiconductor device physics & MOS/BJT characteristics.

CO 2. To be well versed with the MOS fundamentals, small signal models and analysis of MOSFET based circuits.

CO 3. Analysis of Single Stage Amplifier such as CE/CS, CB/CG, CC/CD.

CO 4. Able to analyze and design analog circuits such as Differential Amplifier, OP- AMP, Current mirrors, Biasing circuits.

CO 5. Solve practical and state of the art analog IC design problems to serve VLSI industries.

Desirable/Advanced (If any):

CO 6. Analysis of various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues. Feedback topologies.

Syllabus for Essential Course Outcomes

Introduction: Scope and applications of analog electronic circuits. Amplifier models: Voltage amplifier, current amplifier, transconductance amplifier and trans-resistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, various configurations(such as CE/CS, CB/CG, CC/CD) and their features, small signal analysis, low frequency transistor models, estimation of volt-age gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers. High frequency transistor models, frequency response of single stage and multistage amplifiers, cascade amplifier. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin. Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Collpits, Clapp etc.), non-sinusoidal oscillators, Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues.

Contents for Desired Course Outcomes (If any)

Research papers related to the field.

Text Books

T1. Sedra, A.S. and Smith, K.C., Microelectronic Circuits: Theory and Applications, 6th ed., Oxford University Press, 2013.

T2. Boylestad, R.L. and Nashelsky, L., Electronic Devices and Circuit Theory, 10th ed., Pearson Education, 2013

Reference Books/Additional Books:

R1. Bell, D.A., Electronic Devices and Circuits, 4th ed. Prentice Hall of India, 2001.

R2. Meade, R.L., Foundations of Electronics Circuits and Devices, 5 th ed. Delmar Learning, 2007.

R3. Horowitz, P. and Hill, W., The Art of Electronics, 3rd ed., Cambridge University Press, 2011.

R4. Wait, J.V., Huelsman, L. P. and Korn, G.A., Introduction to Operational Amplifier Theory and Applications, 2nd ed., Tata McGraw Hill, 1992.

R5. M]illman, J., Microelectronics, 2nd ed., Tata McGraw Hill, New Delhi, 2003.Gray, P.R.et. al., Analysis and Design of Analog Integrated Circuits, 5th ed., John Wiley, 2010.

Course Code: ECP252
Course Title: Analog Circuits Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL151, ECP151, ECL252
Course Objectives

- The objective of this course is to provide students with hands-on experience in designing, building, testing, and analyzing analog circuits in a laboratory setting.
- Students will learn fundamental principles of analog circuit design, circuit analysis techniques, and practical skills in using laboratory equipment and tools for designing and testing analog circuits.
- Through a series of laboratory experiments, students will gain practical experience in designing and implementing analog circuits, analyzing their performance, and troubleshooting circuit issues.

Course Outcomes

At the end of the course, students will be able to

Essential:

CO 1. Understand the fundamental principles of analog circuit design.
CO 2. Use laboratory equipment and tools for circuit testing and measurement.
CO 3. Design and implement analog circuits such as CE/CS, CB/CG, CC/CD.
CO 4. Design and implement analog circuits such as Differential Amplifier, OP-AMP, Current mirrors, Biasing circuits.

Desirable/Advanced (If any):

CO 5. Apply analog circuit design principles to real-world applications: Students will be able to apply their knowledge of analog circuit design principles to real-world applications. They will understand the practical applications of analog circuits in areas such as communication systems, sensor circuits, audio amplifiers, and other analog signal processing circuits, and develop the skills to design and implement analog circuits for these applications.

Experiments for Essential Course Outcomes:

1. BJT Common Emitter Amplifier: Design and build a BJT common emitter amplifier circuit, measure and analyze its DC operating point, input/output characteristics, voltage gain, and frequency response. Explore the effect of different biasing arrangements and component values on the amplifier performance.
2. BJT Common Source Amplifier: Design and build a BJT common source amplifier circuit using a MOSFET, measure and analyze its DC operating point, input/output characteristics, voltage gain, and frequency response. Explore the effect of different biasing arrangements and component values on the amplifier performance.
3. BJT Differential Amplifier: Design and build a BJT differential amplifier circuit, measure and analyze its DC operating point, input/output characteristics, common mode rejection ratio (CMRR), and differential mode gain. Explore the effect of different biasing arrangements and component values on the differential amplifier performance.
4. MOSFET Common Gate Amplifier: Design and build a MOSFET common gate amplifier circuit, measure and analyze its DC operating point, input/output characteristics, voltage gain, and frequency response. Explore the effect of different biasing arrangements and component values on the amplifier performance.
5.

Course Code: ECL253
Course Title: Analog Communication Systems
Structure (L-T-P): 3 0 0
Prerequisite: ECL251

Course Objectives

After completing the course, student is expected to:

- Learn the importance of analog communication systems.
- Analyze different analog modulation and demodulation techniques
- Design AM/FM transmitters and receivers
- Apply the role of different analog modulation techniques on noise performance.
- Compare different pulse analog modulation techniques.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Apply the theoretical concepts of signal and systems, frequency domain analysis, different communication channels in the field of communication system.
CO 2. To analyze the analog communication systems and compare the performance of different amplitude modulation and demodulation schemes
CO 3. Compare and analyze -NBFM and WBFM schemes, TRF and superheterodyne receivers
CO 4. Solve & analyze the noise performance of analog communication systems
CO 5. Analyze the sampling process and pulse modulation techniques.

Desirable/Advanced (If any):

CO 6. Design an analog communication system using different modulation processes to meet desired needs within realistic constraints.

Syllabus for Essential Course Outcomes

Introduction to Communication systems, Review of Signal Representations, Frequency domain analysis of signals using Fourier Transforms. Concept of bandwidth, Mathematical models for communication channels Linear filter channel, Linear time-invariant channel

Analog Signal Transmission and reception: Modulation, Amplitude Modulation: Equation or AM wave, Modulation Index and Power relationships. AM transmitter: Generation of AM. AM demodulator: Theory and Mathematical analysis of Square Law detector, Envelope detector and synchronous detector. DSB AM: Principle of nonlinear resistance, Balance modulator and Switching Modulator, DSB Demodulation through product modulator, Costas receiver, SSB AM: Time domain representation of SSB signal, Generation methods: Filter, Phase shift method using Hilbert Transformer, SSB demodulator. VSB-AM generation, Demodulation using sideband filters, Quadrature Carrier multiplexing, FDM.

Frequency and phase modulation, NBFM, WBFM, Generation of Frequency Modulation, Reactance modulator and Indirect method, FM receiver: block diagram, FM discriminator: slope detector, balance

slope detector and phase discriminator, Phase locked loop, Multiplexed Stereo FM system Radio receivers: Tuned radio frequency receiver, Superheterodyne receiver Sensitivity and selectivity, selection of IF. Block diagram and features of Communication Receiver.
Noise in Communication Systems: Thermal noise, Shot noise, S/N ratio, noise Equivalent bandwidth, Concept of Random Variables, PDF, CDF, Different types of Pdfs, Gaussian Rayleigh PDF, Noise performance of AM, DSB,SSB, Noise in FM systems under AWGN, Noise in FM, Pre-emphasis & De- emphasis , Capture effect & Threshold effect in FM
Sampling Theorem, Analog Pulse modulation schemes PAM, PPM, PWM. Quantization Process, Quantization Error

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Haykin, S.S. and Moher, M., Introduction to Analog and Digital Communications, 2nd ed., Wiley, 2012.
T2. Lathi, B.P. and Ding, Z., Modern Digital and Analog Communication Systems, 4th ed., Oxford University Press, 2012

Reference Books

R1. Taub, H., Schilling, D.L. and Saha, G., Principles of Communication Systems; 2ndedition, Tata McGraw-Hill, 2008.
R2. Kennedy, G. and Davis, B., Electronic Communication Systems, 4th ed., Tata McGraw Hill, 1999.
R3. Choenbeck, R.J., Electronic Communications: Modulation and Transmission, 2nd ed., Prentice Hall, 1992.

Course Code: ECP253
Course Title: Analog Communication Systems Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL251, ECL253

Course Objectives

After completing the course, student is expected to:

- Apply the knowledge of analog communication systems.
- Analyze the performance of different analog modulation and demodulation techniques
- Design AM/FM transmitters and receivers
- Perform noise performance analysis of different analog modulation techniques.
- Compare the performance of different pulse analog modulation techniques.

Course Outcomes

At the end of the course, students will be able to-
Essential:

CO 1. Measure various performance parameters of a communication system using CRO and Function generator.
CO 2. Analyze various modulation techniques like AM, FM, PM using experimental analysis.
CO 3. Compare the waveform of PAM, PWM, and PPM using experimental analysis.
CO 4. Observe the waveform of modulated signal on CRO/DSO.

Desirable/Advanced (If any):

CO 5. Apply some theoretical concept to design a FM receiver.

Experiments for Essential Course Outcomes

1. To implement simple Amplitude Modulation (AM), demodulation and calculate the modulation index.
2. To implement DSB-SC Modulation (AM) and demodulation using kits.
3. To implement SSB Modulation (AM) and demodulation using kits.
4. To implement Frequency Modulation (FM) and demodulation using kits.
5. To implement Pulse Amplitude Modulation (PAM) and Demodulation.
6. To implement Pulse Position Modulation (PPM).
7. To implement Pulse Width Modulation (PWM).
8. To study and implement Pre-emphasis and De-emphasis circuits.
9. To perform sampling and reconstruction of the analog signal.
10. To determine the performance of PCM.
11. To determine the performance TDM (PAM) and TDM (PCM).
12. To determine the spectrum of AM/FM using a spectrum analyzer.

Experiments for Desired Course Outcomes (If any)

1. To implement Phase Locked Loop (PLL) and find out the lock range and capture range.
2. To design and test the circuit of Voltage to Frequency Converter (VCO) using IC 555.

Books/Material

T1. Lab Manuals
T2. Haykin, S.S. and Moher, M., Introduction to Analog and Digital Communications, 2nd ed., Wiley, 2012.
T3. Lathi, B.P. and Ding, Z., Modern Digital and Analog Communication Systems, 4th ed., Oxford University Press, 2012.

Reference Books

R1. Kennedy, G. and Davis, B., Electronic Communication Systems, 4th ed., Tata McGraw Hill, 1999.
R2. Schoenbeck, R.J., Electronic Communications: Modulation and Transmission, 2nd ed., Prentice Hall, 1992.

R3. Taub, H., Schilling, D.L. and Saha, G., Principles of Communication Systems; 2ndedition, Tata McGraw-Hill, 2008.

Course Code: ECL254
Course Title: Engineering Electromagnetics
Structure (L-T-P): 3 0 0
Prerequisite: NIL

Course Objectives
After completing the course, student is expected to:
- To introduce the basic mathematical concepts related to electromagnetic vector fields.
- To familiarize the students with the different concepts of electrostatic, magneto static and time varying electromagnetic systems.
- To expose the students to the ideas of electromagnetic waves and structure of transmission line.
- To provide the basic skills required to understand, develop, and design various engineering applications involving electromagnetics.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO 1. Illustrate the physical concepts of static, time varying electric and magnetic fields.
CO 2. Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering.
CO 3. Analyze the fundamental characteristics of transmission lines, its matching using various methods.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes
Review of Vector calculus. Review of basic laws of electrostatics: Coulomb's law, Electric field intensity, Field of 'n' point charges, Field of line and sheet of charge. Electric flux density, Gauss's law and it's applications. Divergence and Divergence theorem. Definition of potential difference and potential, Potential of point charge and system of charges. Potential gradient, Energy density in electrostatic field.

Poisson's and Laplace's equations. Current and current density, Continuity of current. Capacitance. Review of basic laws of magneto statics: Biot-Savart and Amperes circuital laws and their applications, Curl, Stoke's theorem. Magnetic flux density, Scalar and Vector magnetic potential. Maxwell's equations in steady electric and magnetic fields. Time varying fields and Maxwell's equations.

Uniform plane waves, wave motion in free space, perfect dielectric, lossy dielectric and good conductor, skin effect. Poynting vector and power considerations. Reflection of uniform plane waves, Standing ratio, boundary conditions.

Transmission lines: S-parameters, telegraphers model of transmission line. Various terminations. Transmission line equations and their solutions. Transmission line parameters, Characteristic impedances, Propagation constant, Attenuation constant, Phase constant, Waveform distortion, Distortion less transmission lines, Loading of transmission lines, Reflection coefficient and VSWR. Equivalent circuits of transmission lines, Transmission lines at radio frequency. Open circuited and short circuited lines, Smith Chart, Stub matching.

Contents for Desired Course Outcomes (If any)
NIL
Text Book/ Material:
T1. Hayt, W.H. and Buck, J.A., *Engineering Electromagnetics*, 7th ed., Tata McGraw Hill, 2013.
T2. Sadiku, M.N.O., *Principles of Electromagnetics*, 4th ed., Oxford University Press, 2013.
T3. Shevgaonkar, R. K. *Electromagnetic waves*. Tata McGraw-Hill Education, 2005.
Reference Books:
R1. Rao, N.N., *Elements of Engineering Electromagnetics*, 6th ed., Prentice Hall of India, 2004.
R2. Elgerd, O. I., *Electric Energy Systems Theory: An Introduction*, 2nd ed., Tata McGraw-Hill, New Delhi, 2007.
R3. Jordan, E.C. and Balmain, K.G., Electromagnetic Waves and Radiating Systems, 2nd ed., Prentice Hall of India, 2013.

Course Code: ECL255
Course Title: Solid State Devices
Structure (L-T-P): 3 0 0
Prerequisite: ECL151, ECP151

Course Objectives
After completing the course, student is expected to:
- To develop an ability to learn fundamentals of semiconductor and its physics.
- To develop the physics and working of different types of transistor action.
- Students would be able to apply the basic fundamentals of semiconductors in analysing the semiconductor based devices and fabrication process flow.

Course Outcomes:
Essential:
CO 1. Able to understand the basics of Quantum Machines Energy band diagram for semiconductors.
CO 2. Able to understand the charge carrier transport phenomenon and recombination-generation

process for semiconductors in P-N junction Diode and Solar Cell.

CO 3. Able to understand the Characteristics & Current flow of semiconductor devices like BJT, JFET, MOSFET & Metal-Semiconductor Junction & Hetero Junction Devices and basic fabrication process flow.

CO 4. Able to analyse the design parameters of MOSFET i.e.,- Channel length & width, depletion width, surface field and potential, ON resistance, transconductance, equivalent circuits, amplification factors, capacitances, noise margins, scaling & short channel effects MOSFET.

Syllabus for Essential Course Outcomes

Introduction to E-K diagram, Introduction: Evolution and uniqueness of Semiconductor Technology, Equilibrium carrier concentration, Thermal Equilibrium and wave-particle duality, intrinsic semiconductor – Bond and band models, Extrinsic semiconductor – Bond and band models

Carrier transport: Random motion Drift and diffusion Excess carriers: Injection level, Lifetime, Direct and indirect semiconductors Procedure for analysing semiconductor devices.

Basic equations and approximations P-N Junction: Device structure and fabrication. Equilibrium picture, DC forward and reverse characteristics, Small-signal equivalent circuit, Switching characteristics, Solar cell, Introduction to Tunnel, IMPATT, TRAPATT diodes.

Bipolar Junction Transistor: Device structures and fabrication, Transistor action and amplification, Common emitter DC characteristics

MOS Junction: C-V characteristics, threshold voltage, body effect Metal Oxide Field Effect Transistor: Device structures and fabrication, Common source DC Characteristics, Small-signal equivalent circuit, Differences between a MOSFET and a BJT Junction FET and MESFET, Recent Developments, Heterojunction FET, Heterojunction bipolar transistor.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1. Streetman, B.G., and Banerjee, S.K. Solid-state Electronics devices. 7th ed. Pearson Education, 2014.

Reference Books:

R1. Bell, David A. Electronics Devices and Circuits. 4th Ed, Prentice Hall India, 2009.

R2. Sedra, A. S., and Smith, K.C. Microelectronics Circuits. 7th ed. Oxford University Press, 2015.

R3. Millman, J., and Halkias, Christos C. Integrated Electronics. Tata McGraw-Hill Education, 1991.

Course Code: ECL256

Course Title: Digital Circuits
Structure (L-T-P): 3 0 0
Prerequisite: NIL

Course Objectives

After completing the course, student is expected to:

- Design & analyze combinational circuits and implementation of minimization techniques.
- Understand and design different arithmetic circuits.
- Design of synchronous and asynchronous sequential circuits using State Diagrams & Tables.
- Design and implement sequential logic function using FSM & ASM.
- Implement & Verify of digital logic circuits & systems using Verilog HDL for enhancing the employability skills in VLSI Domain.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Design & analyze combinational circuits and implementation of minimization techniques.

CO 2. Understand and design different arithmetic circuits.

CO 3. Design of synchronous and asynchronous sequential circuits using State Diagrams & Tables.

CO 4. Design and implement sequential logic function using FSM & ASM.

Desirable/Advanced (If any):

CO 5. Implement & Verify of digital logic circuits & systems using Verilog/VHDL for enhancing the employability skills in VLSI Domain.

Syllabus for Essential Course Outcomes

Number systems and Boolean algebra: Introduction to number systems and Boolean algebra; Boolean identities, basic logic functions, standard forms of logic expressions, simplification of logic expressions.

Combinational logic: Arithmetic circuits, decoders, encoders, multiplexers, de-multiplexers, and their use in logic synthesis; Hazards in combinational circuits.

Sequential logic circuits: Latches and Flip Flops (SR, D, JK, T); Timing in sequential circuits; Shift register; Counters – synchronous, asynchronous; Finite state machines: Basic concepts and design; Moore and Mealy machines examples; State minimization/reduction, state assignment; Finite state machine design case studies

ROM and RAM, PLA, PAL and FPGA

Logic families: Brief overview of Transistor as a switch; Logic gate characteristics – propagation delay, speed, noise margin, fan-out and power dissipation; Standard TTL and static CMOS gates.

Contents for Advanced Course Outcomes (If any)
Introduction to Verilog/VHDL: Behavioral – data flow, and algorithmic and structural description, lexical elements, data objects types, attributes, operators; Verilog/VHDL coding examples, combinational circuit design examples in VHDL and simulation, RTL based design projects and their implementation in FPGA using VHDL, Sequential circuit design examples in Verilog/VHDL and simulation, FSM circuit design examples in VHDL and simulation.

Text Books:
T1. Mano, M.M. and Ciletti, M.D. *Digital Design: With an Introduction to the Verilog HDL*. 5th ed. Pearson Education, 2013.
T2. Kohavi, Z. and Jha, N.K. *Switching and Finite Automata Theory*.3rd ed. Cambridge University Press, 2013.
T3. Thomas L. Floyd ,Pearson Education, Digital Fundamentals,11th ed. , 2014

Reference Books:
R1. Palnitkar, S. *Verilog HDL: A guide to Digital Design a Synthesis.* 2nd ed., Pearson, 2013.
R2. Brown, S.D. and Vranesic, Z.G. *Fundamentals of Digital Logic with Verilog Design*. 3rd ed. McGraw-Hill, 2013.
R3. Bhaskar, J. *VHDL Primer*. 3rd ed. Prentice Hall of India, 2011.
R4. Kumar, A. Anand. *Fundamentals of Digital Circuits*. PHI Learning Pvt. Ltd., 2003

Course Code: ECP256
Course Title: Digital Circuits Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL256

Course Objectives
After completing the course, student is expected to:
- Design & analyze combinational circuits and implementation of minimization techniques.
- Understand and design different arithmetic circuits.
- Design of synchronous and asynchronous sequential circuits using State Diagrams & Tables.
- Design and implement sequential logic function using FSM & ASM.
- Implement & Verify of digital logic circuits & systems using Verilog HDL for enhancing the employability skills in VLSI Domain.

Course Outcomes
Essential:
CO 1. Design & analyze combinational circuits and implementation of minimization techniques.
CO 2. Understand and design different arithmetic circuits.
CO 3. Design of synchronous and asynchronous sequential circuits using State Diagrams & Tables.
CO 4. Design and implement sequential logic function using FSM & ASM.
CO 5. Implement & Verify of digital logic circuits & systems using Verilog HDL for enhancing the employability skills in VLSI Domain.

Desirable/Advanced (If any):
CO 6. Apply some additional processes to advance the performance of I C engines.

Experiments for Essential Course Outcomes
1. Familiarization of Digital trainer kit and study of logic gates
2. Realization of Boolean expressions using logic gates
3. Realization of Boolean expressions using universal gates
4. Realization of code converters
5. Design of Adders/ Subtractors
6. Design of Multiplexers/ De-Multiplexers
7. Design of Encoders/ Decoders
8. Study of flip-flops
9. Design of Synchronous counters
10. Design of Asynchronous counters
11. Design basic blocks in Verilog/VHDL

Experiments for Desired Course Outcomes (If any): NIL

Text Books:
T1. Lab Manuals

Reference Books:
R1. Palnitkar, S. *Verilog HDL: A guide to Digital Design and Synthesis.* 2nd ed., Pearson, 2013.
R2. Brown, S.D. and Vranesic, Z.G. *Fundamentals of Digital Logic with Verilog Design*. 3rd ed. McGraw-Hill, 2013
R3. Bhaskar, J. *VHDL Primer*. 3rd ed. Prentice Hall of India, 2011.
R4. Kumar, A. Anand. *Fundamentals of Digital Circuits*. PHI Learning Pvt. Ltd., 2003

Course Code: ECL351
Course Title: Linear Integrated Circuit
Structure (L-T-P): 3 0 0
Prerequisite: ECL252, ECP252

Course Objectives
After completing the course, student is expected to:
- Understand ideal and actual operational amplifier.
- Understand the linear and non-linear applications of the op-amp.
- Gain some knowledge about internal architecture of op-amp.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO.1. To study the basic principles, configurations for ideal and practical Op-amp and finding limitations of Op-amp.

CO.2. To understand the various linear and non-linear applications of Op-amp for negative feedback, open loop and positive feedback conditions.

CO.3. To analyze, design and explain the characteristics and applications of active filters.

CO.4. In-depth knowledge of applying the concepts in real time applications.

CO.5. To understand the operation of the most commonly used D/A & A/D converters and its applications.

CO.6. To design the building blocks of Op-amp i.e. Differential Amplifier, Current Mirror and Two stage CMOS Op-amp.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Differential amplifier and Op-amp design, configurations (FET, BJT).DC & AC analysis, constant current bias, current mirror, cascaded differential amplifier stages, level translator. Review of feedback topologies

OPAMP, inverting, noninverting, differential amplifier configurations, negative feedback, voltage gain, input & output impedance, Bandwidth. Input offset voltage, input bias and offset current, Thermal drift, CMRR, PSRR, Frequency response.

Linear applications, DC, ac amplifiers, summing differential amplifier, instrumentation amplifier, V to I and I to V converters, Integrator, Differentiator. First/second order low/high/ band pass, band reject active filters,

All pass filter Phase shift oscillator, Wein bridge oscillator, Square wave and triangular waveform generators. Nonlinear applications, Comparators, Schmitt Trigger, Clipping and Clamping circuits,

Absolute value circuits, Peak detectors, Sample and hold circuits, Log and antilog amplifiers. Data Converters (ADC and DAC's), 555 Timer, Voltage Regulator, Phase Locked Loops (PLL).

Contents for Desired Course Outcomes (If any): Nil

Text Books

T1. Graeme, J.G., Tobey, G.E., and Huelsman, L.P. Operational Amplifiers: Design and Applications. New Delhi: McGraw Hill, 1986.

T2. R.A. Gayakwad. Op-amps and Linear Integrated Circuits. 4th ed., Prentice Hall of India, 2012.

Reference Books

R1. Franco, S. Design with Operational Amplifiers and Analog Integrated Circuits. 4th ed., McGraw Hill Education, 2014.

R2. Fiore, J.M. Op amps and Linear Integrated Circuits: Theory and Application. Delmar Thomson Learning, 2001.

R3. Choudhury. Roy D. Linear integrated Circuits. 2nd ed. New Age International Publications, 2003.

Course Code: ECP351
Course Title: Linear Integrated Circuit Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL252, ECP252, ECL351

Course Objectives

After completing the course, student is expected to:

- Understand the pin diagram of 741 and 555.
- Able to perform various linear and non-linear applications of analog signal processing using op-amp ICs.

Course Outcomes

Essential:

CO.1. To design and study of various amplifier configurations of Op-amp such Inverting, Non-inverting, differential, adder etc.

CO.2. To design and study of various order filter configuration such as low pass, high pass, band pass etc.

CO.3. To design and study of various waveform generators such as sine wave, square wave, saw-tooth etc.

CO.4. To design and study of various modes of 555 timer IC.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. To design and study of the non-inverting amplifier using operational amplifier.
2. To design and study of the inverting amplifier using operational amplifier.
3. To design and study of the Integrator and Differentiator.
4. To design and study of the second order active low pass filter.
5. To design and study of the second order active high pass filter.
6. To design and study of the second order sine wave oscillator (wein-bridge).
7. To design and study of the second order sine wave oscillator (R-C phase shift).
8. To design and study of the Schmitt Trigger.
9. To design and study of the 555 IC as an astable multivibrator.
10. To design and study of the 555 IC as an mono-stable multivibrator.

Books/Material
T1. Lab Manuals

Course Code: ECL352
Course Title: Digital Signal Processing
Structure (L-T-P): 3 0 0
Prerequisite: ECL251

Course Objectives
After completing the course, student is expected to:
- Demonstrate an understanding of the fundamentals of discrete-time signals and systems
- Be familiar with the techniques of analysis of discrete-time signals and systems using Z-transform
- Derive knowledge of spectral properties of discrete-time systems through the use of Discrete Fourier Transform of sequences
- Design digital filters

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO.1. Interpret and analyze discrete-time signals
CO.2. Identify various types of discrete systems.
CO.3. Compute DFT and apply Fast Fourier Transform algorithms to analyze discrete signals and systems.
CO.4. Design FIR and IIR filters.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes
Discrete time signals Sequences; representation of signals on orthogonal basis; Sampling and reconstruction of signals;

Discrete systems, Classification of LTI, Discrete time systems, Linear convolution, Inverse systems

Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), theorems, DFT symmetry relations, Circular convolution, Linear convolution using DFT, overlap add method, overlap save method.

Fast Fourier Transform (FFT) algorithms, decimation in time and frequency domain and algorithms, Goertzel algorithms

Realization of discrete systems: Signal flow graph representation, Direct Form, parallel cascade and state space representation.

Design of FIR digital filter using window method, Park-McClellans method.

Design of IIR digital filter, Butterworth, Chebyshev and Elliptic Approximations with Bilinear Transformation and Impulse In-variant method. Lowpass, Bandpass, Bandstop and High pass filters

Contents for Desired Course Outcomes (If any): Nil

Text Books
T1. Oppenheim, A.V. and Schafer, R.W., Discrete-Time Signal Processing, 3rd ed., Pearson, 2013.
T2. Proakis, J.G. and Manolakis, D.G., Digital Signal Processing: Principles, Algorithms and Applications, 4th ed., Pearson, 2011.
Reference Books
R1. Phillips, C.L., Parr, J.M., and Riskin, E.A. Signals, Systems and Transforms.5th ed. Pearson Education, 2014.
R2. Carlson, G.E. Signal and Linear System Analysis. 2nd ed. Allied Publishers Limited, 1993.
R3. Mitra S. K., Digital Signal Processing: a Computer based Approach, 3rd ed., Tata McGraw-Hill, 2012.

Course Code: ECP352
Course Title: Digital Signal Processing Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL251, ECL352

Course Objectives
After completing the course, student is expected to:
- Use MATLAB and/or other software to analyze and produce discrete signals
- Obtain outputs of discrete systems by giving suitable inputs to the system
- Design digital filters

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO.1. Use MATLAB and/or other computing software for signal processing
CO.2. Perform analysis of discrete signals and systems
CO.3. Design Digital filters
CO.4. Use DSP kits to verify the simulation results

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes
1. Generate discrete cosine waveforms of varying periods
2. Generate Ramp sequence, unit sample sequence and unit step sequence
3. Obtain the 4-point DFT of a given sequence
4. Using FFT obtain 8-point DFT of a sequence
5. Obtain IDFT of a given sequence
6. Find the Circular convolution of a given sequence
7. Design a Butterworth Filter using Bilinear Transformation
8. Design a Butterworth Filter using Impulse Invariant Technique
9. Design a Chebyschev Filter using Bilinear Transformation
10. Obtain the impulse response of a given system

11. Application of DSP to speech signal processing

Experiments for Desired Course Outcomes (If any): Nil

Books/Material

T1. Vinay K. Ingle, John G. Proakis, Digital Signal Processing using MATLAB, Cengage Learning 2012

Reference Books

R1. L. Milic, Multirate Filtering for Digital Signal Processing: MATLAB Applications, Information Science Reference 2009

Course Code: ECL354
Course Title: Antenna Theory
Structure (L-T-P): 3 0 0
Prerequisite: ECL254

Course Objectives

After completing the course, student is expected to:

- Be proficient in the radiation phenomena associated with various types of antennas and understand basic terminology and concepts of antennas along with emphasis on their applications.
- Analyze radiation characteristics and designing techniques of different antenna structures and hence develop entrepreneurship skills.
- Analyze the real time applications of various modern antenna structures.
- Justify the propagation of the waves at different frequencies through different layers in the existing layered free space environment structure.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO.1. Analyses the radiation phenomena and need of antenna theory for wireless applications to promote sustainable employment in the RF field.

CO.2. Understand the basic concepts and characteristics of antennas and arrays in the transmit and receive mode.

CO.3. Analyze radiation characteristics and designing techniques of various planar and non-planar antenna structures for various applications.

Desirable/Advanced (If any): Nil

CO.1. Analyze the structure of the atmosphere for the wave propagation.

Syllabus for Essential Course Outcomes

Fundamental Concepts: Physical concept of radiation, retarded potentials, Hertzian dipole; Antenna parameters: Radiation pattern, gain, directivity, effective aperture, and reciprocity; Radiation from dipoles of arbitrary length. Introduction of various antenna structures: linear wire and loop antennas, aperture antennas, horn antennas, travelling wave and broadband antennas, broadband dipole antennas.

Planar antennas: Radiation from rectangular and circular patches, feeding techniques.

Antenna arrays: Arrays of point sources, End-fire and broadside Arrays, pattern multiplication, introduction of modern arrays including microstrip patch array.

Modern antenna structures:- reconfigurable antennas, ultra wideband antennas, meta material based antennas, dielectric resonator antennas, substrate integrated waveguide antennas, wearable textile antennas, smart antennas.

Application based antennas:- frequency allocations for various applications, antennas for mobile communication, satellite communication, navigation purposes, radar and remote sensing, Bluetooth antennas, Wi-Fi applications, automobile, defense, biomedical, Tera Hertz applications etc.

Contents for Desired Course Outcomes (If any):

Introduction to microwave communication and wave propagation.

Text Books:

T1. Balanis, C.A., Antenna *Theory and their applications*, 4th Ed., Indian Adaptation, John Wiley & Sons. 2021.

T2. Kraus, J.D. And Fleisch, D.A., *Electromagnetics with Applications*, McGraw-Hill. 1999.

T3. Jordan, E.C. and Balmain, K.G., *Electromagnetic Waves and Radiating Systems*, 2nd Ed., Prentice-Hall of India. 1993.

Reference Books:

R1. Stutzman, W.L. and Thiele, H.A., *Antenna Theory and Design*, 2nd Ed., John Wiley & Sons. 1998

R2. Elliot, R.S., *Antenna Theory and Design*, Revised edition, Wiley IEEE Press. 2003

R3. Garg, R., Bhartia, P., Bahl, I. and Ittipiboon, A., *Microstrip Antenna Design Handbook*, Artech House. 2001

Course Code: ECL355
Course Title: Digital Communication Systems
Structure (L-T-P): 3 0 0
Prerequisite: ECL253

Course Objectives

- This course presents the principles and techniques fundamental to the analysis and design of digital communication systems.
- It focuses on the basic building blocks of a digital communication system (channel encoder/decoder, digital modulator/demodulator and channel characteristics).

- The emphasis is on mathematical underpinnings of communications theory along with practical applications.

Course Outcomes
At the end of the course, students will be able to-

Essential:
CO.1. To apply knowledge of digital modulation techniques to the analysis and design of digital communication systems.
CO.2. Identify and formulate and solve engineering problems in the area of digital communication.
CO.3. Apply the theoretical concepts like random process, error probability, bit error rate, spread spectrum techniques and various digital modulation techniques to efficiently utilize the modern engineering tools such as MATLAB, necessary for engineering practice in the field of communication systems.
CO.4. Apply knowledge of spread spectrum and multiple access techniques to the analysis and design of digital communication systems.
CO.5. Analyze and design a digital communication system using source codin techniques or modulation processes to meet desired needs within realistic constraints.

Desirable/Advanced (If any):
CO.6. Analyze and design a digital communication system using different modulation processes to meet desired needs within realistic constraints.

Syllabus for Essential Course Outcomes
Introduction to digital communication systems: Principles of digital data transmission, Advantages and disadvantages of digital communication, Pulse Code Modulation, Line codes Source Coding of Analog Sources: PCM, DPCM, Delta modulation, Adaptive DM, ADPCM, Introduction to concept of probability, random variable and its characterization, probability density functions, transformations of random variables, statistical averages
Baseband data transmission systems, Error probability, ISI, pulse shaping, Nyquist criterion for Zero ISI, Scrambling. Signal Space Representation: Orthogonal expansion of signals, Gram-Schmidt Procedure, Representation of digitally modulated signals; Digital Transmission over the AWGN Channel.
Passband Transmission: Digital modulation schemes, ASK, FSK, PSK, QPSK, DPSK, GMSK,and QAM systems, Probability of error of each scheme, Matched filter receiver and its characteristics and Implementation, Signal space representation of digital modulation systems, Probability of error in digital modulation schemes under AWGN environment, Performance comparison of various digital modulation schemes. Continuous phase modulation,
Spread spectrum systems: direct sequence modulation and frequency hopping Case study — code division multiple access (CDMA); Multichannel and multicarrier systems: OFDM, Introduction to Information Theory, Channels, Channel Capacity, Shannon channel capacity theorem, Source coding techniques,

Contents for Desired Course Outcomes (If any): Nil

Text Books
T1. Haykin, S.S. and Moher, M., Introduction to Analog and Digital Communications, 2nd ed., Wiley, 2012.
T2. Lathi, B.P. and Ding, Z., Modern Digital and Analog Communication Systems, 4th ed., Oxford University Press, 2012

Reference Books
R1. Proakis, J.G. and Salehi, M., Digital Communications, 5th ed., McGraw Hill, 2010.
R2. Taub, H., Schilling, D.L. and Saha, G., Principles of Communication Systems, 2nd edition, Tata McGraw-Hill, 2008.
R3. M.S. Roden, Digital Communication System Design
R4. M. Rice, Digital Communications - A Discrete-Time Approach, Prentice-Hall, 2009.
R5. B. Sklar, Digital Communications: Fundamentals & Applications, 2nd ed., Prentice Hall, 2001.

Course Code: ECP355
Course Title: Digital Communication Systems Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL253, ECP253, ECL355

Course Objectives
This course presents the principles and techniques fundamental to the analysis and design of digital communication systems. It focuses on the basic building blocks of a digital communication system (channel encoder/decoder, digital modulator/demodulator and channel characteristics). The emphasis is to apply communications theory for practical applications.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO.1. Analyze PCM and Delta modulation using experiments.
CO.2. Analyze and compare digital modulation techniques practically.
CO.3. Implement NRZ and Manchester coding practically.
CO.4. Analyze and compare source coding techniques.
Desirable/Advanced (If any):
CO.5. Perform some additional experiments on some simulation software.

Experiments for Essential Course Outcomes

1. To verify the sampling theorem
2. To perform PCM signal generation and demodulation.
3. To perform DPCM signal generation and demodulation.
4. To perform DM signal generation and demodulation.
5. To perform ADM signal generation and demodulation.
6. To perform Amplitude Shift Keying (ASK) modulation and demodulation
7. To perform Binary-Frequency Shift Keying (B-FSK) modulation and demodulation.
8. To perform Binary-Phase Shift Keying (B-PSK) modulation.
9. To perform experiment on Manchester/RZ/NRZ coding and decoding
10. To perform TDM and de-multiplexing.
11. Implementation and analysis of QPSK modulation and demodulation.
12. To perform different source coding techniques using different programming methods.

Experiments for Desired Course Outcomes (If any)

1. To implement source encoding algorithms using simulations.

Books/Material

T1. Lab Manuals
T2. Haykin, S.S. and Moher, M., Introduction to Analog and Digital Communications 2nd ed., Wiley, 2012.
T3. Lathi, B.P. and Ding, Z., Modern Digital and Analog Communication Systems, 4th ed., Oxford University Press, 2012

Reference Books

R1. Proakis, J.G. and Salehi, M., Digital Communications, 5th ed., McGraw Hill, 2010.
R2. Taub, H., Schilling, D.L. and Saha, G., Principles of Communication Systems, 2nd edition, Tata McGraw-Hill, 2008.
R3. M.S. Roden, Digital Communication System Design
R4. M. Rice, Digital Communications - A Discrete-Time Approach, Prentice-Hall, 2009.
R5. B. Sklar, Digital Communications: Fundamentals & Applications, 2nd ed., Prentice Hall, 2001.

Course Code: ECL356
Course Title: Microwave Theory and Techniques
Structure (L-T-P): 3 0 0
Prerequisite: ECL254
Course Objectives
After completing the course, student is expected to:

- Foster knowledge about electromagnetic waves, transmission lines, their propagation and field patterns to promote sustainable development in high frequency and improvised skill set.
- Skillfully design different waveguide components, their characteristic measurement, hence develop employability skills in high frequency industries.
- Design and implement various microwave components to support entrepreneurship.

Course Outcomes
At the end of the course, students will be able to-
Essential:

CO.1. Describe microwave transmission modes and transmission lines.
CO.2. Analyze microwave networks and measure their measurement parameters.
CO.3. Analyze the working of various microwave devices.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes
Transmission line theory: Lumped element circuit model, field analysis, terminated lossless transmission line, smith chart, quarter wave transformer, generator and load mismatches, lossy transmission lines, transient analysis.
General solutions for TEM, TE and TM waves, parallel plate waveguide, rectangular waveguide, circular wave guide, coaxial line, surface waves on a ground dielectric sheet, stripline, microstripline, transverse resonant techniques, wave velocities and dispersion.
Microwave Network analysis: Equivalent voltages and currents, Impedance and Admittance matrices, scattering matrix, ABCD matrix, signal flow graphs, Excitation of waveguides. Matching with lumped elements, single stub matching, quarter wave transformer, theory of small reflections.
Microwave resonators: series parallel resonator circuits, transmission line resonators, rectangular and circular cavity resonators, excitation of resonators, cavity perturbations. Properties of power dividers and couplers, The T junction power divider, the Wilkinson power divider, wave guide directional couplers, the quadrature hybrid, coupled line directional couplers, lange coupler, 180 degree hybrid.

Contents for Desired Course Outcomes (If any)
NIL

Text Books

T1. Pozar, D.M. *Microwave Engineering Theory and Techniques, Indian adaptation,* Wiley, 2020.
T2. Shevgaonkar, R.K., *Electromagnetic Waves,* 6th ed., Tata McGraw-Hill, 2011.

Reference Books

R1. Jordan, E.C. and Balmain, K.G., *Electromagnetic Waves and Radiating Systems*, 2nd ed., Prentice Hall of India, 2013.
R2. Collin, R.E. *Foundation of Microwave Engineering*. 2nd ed. Wiley India, 2012.

Course Code: ECP356
Course Title: Microwave Theory and Techniques Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL254, ECL356

Course Objectives

On completion of this lab course the students will be able to:

- Able to handle microwave equipment
- Able to understand the characteristics of microwave generators.
- Able to analyze the transmission line characteristics and parameters.
- Able to understand the characteristics of microwave devices and components through various parametric and power measurements.
- Able to understand Waveguide and antenna measurements.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Design test bench for measurement of various microwave parameters and microwave generators.
CO 2. Analyze various characteristics of microwave junctions and design of microwave communication links.
CO 3. Use a microwave test bench in analyzing various types of microwave equipment.

Desirable/Advanced (If any):

CO 4. To analyze the radiation pattern and gain of the various antennas.

Experiments for Essential Course Outcomes

1. Study of Microwave Components and Instruments
2. To verify the relationship between free space wavelength, Guide Wavelength and Cut- off wavelength.
3. To study the V-I characteristics of Gunn Diode.
4. To study the following characteristics of Gunn Diode.
5. Output power and frequency as a function of voltage.
6. To Study of the characteristics of klystron tube and to determine its electronic tuning range.
7. To determine the frequency & wavelength in a rectangular waveguide working on TE10 mode.
8. To determine the standing wave ratio and reflection coefficient.
9. To study the square law behavior of a microwave crystal detector.
10. To study the resonant cavity.
11. To study the variable attenuator.
12. To measure an unknown impedance with Smith Chart.
13. Study of attenuators (fixed and variable type).
14. Study of various Tee like E Plane Tee - H Plane Tee - Magic Tee.
15. Study the function of multi-hole directional coupler by measuring the following parameters.
16. Main line & Auxiliary line VSWR.
17. Coupling factor and directivity and Isolation.
18. Study of Scattering parameters of circulators/Isolator.
19. To study the phase shift measurements by using phase shifter
20. Study of Square wave modulation through Pin Diode.
21. To Measure the Dielectric constant.(Solid and liquid).

Experiments for Desired Course Outcomes (If any)

1. Study of wave guide horn and its radiation pattern and determination of the Beam width.
2. To measure the gain of a waveguide horn antenna.
3. Radiation pattern Measurement of Parabolic Dish Antenna.

Books/Material

T1. Lab Manuals
T2. Pozar, D.M. *Microwave Engineering Theory and Techniques, Indian adaptation,* Wiley, 2020

Reference Books

R1. Jordan, E.C. and Balmain, K.G., *Electromagnetic Waves and Radiating Systems*, 2nd ed., Prentice Hall of India, 2013.
R2. Collin, R.E. *Foundation of Microwave Engineering*. 2nd ed. Wiley India, 2012.
R3. Shushrut Das, Microwave Engineering, Oxford Higher Education, 2014

Course Code: ECL359
Course Title: Microprocessor and Interfacing
Structure (L-T-P): 3 0 0
Prerequisite: ECL256, ECP256

Course Objectives

- After completing the course, student is expected to:
- To introduce students with the architecture and operation of typical and advanced microprocessors.
- To familiarize the students with the programming and interfacing of microprocessors.
- To provide strong foundation for designing real world applications using microprocessors.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO.1. Assess and solve basic binary math operations using the microprocessor and explain the microprocessor's internal architecture and its operation within the area of manufacturing and performance.
CO.2. Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor.
CO.3. Compare and Analyze assembly language programs; select appropriate assemble into machine a cross assembler utility of a microprocessor.
CO.4. Design electrical circuitry to the Microprocessor I/O ports in order to interface the processor to external devices that will provide solutions real-world control problems.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes
Microprocessor based personal computer system, Von Neumann and Harvard architecture. Brief History of Microprocessors. RISC and CISC Architectures.
Intel 8085 Microprocessor: Architecture, Addressing Modes Instruction set, instruction types and formats; Instruction execution, instruction cycles, different types of machine cycles and timing diagram.
Intel 8086 Microprocessor: Programmer's model for 8086. Segmented memory operation. Instruction set of 8086.
Intel 8086/8088 Microprocessor — Architectures, Pin Diagrams and Timing Diagrams, addressing modes supported by 8086 instruction set. 8086/8088 Instruction Set, Assembly language programming.
Memory Basic Peripherals and their Interfacing, Special Purpose Programmable Peripheral Devices and Their Interfacing, Priority Interrupt controller 8259, Interfacing with 8255, RAM, ROM, keyboard etc.
Multimicroprocessor Systems, Introduction to 80286, 80386, and 80486—The 32-Bit Processors, Recent Advances in Microprocessor Architectures—A Journey from Pentium Onwards.

Contents for Desired Course Outcomes (If any): Nil

Text Books
T1. Gaonkar, R. Microprocessor Architecture, Programming and Applications with the 8085. 5th ed., Penram International Publishing, 2011.
T2. K M. Bhurchandi and A. K. Ray, Advanced Microprocessor and Peripherals, 3rd Edition, 2012.

Reference Books
R1. Predko, M. Programming and Customizing the 8051 Microcontroller. McGraw Hill, 1999.
R2. Hall, D.V. Microprocessors & Interfacing. 3rd ed. Tata McGraw-Hill, 2012

Course Code: ECP359
Course Title: Microprocessor and Interfacing Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL256, ECP256, ECL359

Course Objectives

- To provide skills for designing flowcharts and writing algorithms
- To provide skills for writing Embedded programs
- To enable the students to debug programs

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO.1. Write algorithms and programming task involved for a given problem
CO.2. Design and develop modular programming skills
CO.3. Trace and debug a program.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes
1. Write a program using 8085 Microprocessor for Decimal, Hexadecimal addition and subtraction of two Numbers.
2. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers.
3. To perform multiplication and division of two 8 bit numbers using 8085.
4. To find the largest and smallest number in an array of data using 8085 instruction set.
5. To write a program to arrange an array of data in ascending and descending order.
6. To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8085 instruction set.
7. To write a program to initiate 8255 and to check the data transfer using it.
8. To interface 8253 programmable interval timer to 8085 and verify the operation of 8253 in six different modes.

Contents for Desired Course Outcomes (If any): Nil

Text Books
T1. Gaonkar, R. Microprocessor Architecture, Programming and Applications with the 8085.
T2. 5th ed., Penram International Publishing, 2011.

Reference Books
R1. Hall, D.V. Microprocessors & Interfacing. 3rd ed. Tata McGraw-Hill, 2012

Course Code: ECL360
Course Title: Optical Communication Systems
Structure (L-T-P): 3 0 0
Prerequisite: ECL253, ECP253, ECL355

Course Objectives

After completing the course, student is expected to:

- Understand the need of optical communication systems.
- Compare the different types of optical fibers, and losses within fiber
- Learn optical power launching and coupling schemes.
- Analyze different optical sources and detectors.
- Apply the analog & digital modulation schemes to design Optical communication system

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Design test bench for measurement of various optical parameters of optical communication link

CO 2. Classify the structures of Optical fiber and its types.

CO 3. Analyze various coupling losses of optical communication systems.

CO 4. Compare different Optical sources and detectors.

CO 5. Design an efficient fiber optic system.

~~Desirable~~/Advanced (If any):

CO 6. To analyze the characteristics of optical fiber, sources and detectors, design as well as conduct experiments in software and hardware, analyze the results to provide valid conclusions.

Syllabus for Essential Course Outcomes

Overview of optical fiber communication- The general system, advantages of optical fiber communications. Optical fiber waveguides- Introduction, Ray theory transmission, Optical fiber Modes and configuration, Mode theory for circular Waveguides, Step Index fibers, Graded Index fibers. Single mode fibers- Cut off wavelength, Mode Field Diameter, Effective Refractive Index. Fiber Material and its Fabrication Techniques

Signal distortion in optical fibers- Attenuation, Absorption, Scattering and Bending losses, Core and Cladding losses. Information capacity determination, Group delay, Attenuation Measurements Techniques, Types of Dispersion - Material dispersion, Wave-guide dispersion, Polarization mode dispersion, Intermodal dispersion. Pulse broadening. Overall fiber dispersion in Multi mode and Single mode fibers, Special Fibers, Fiber dispersion measurement techniques, Optical fiber Connectors: Joints, Couplers and Isolators.

Optical sources- LEDs, Structures, Materials, Quantum efficiency, Power, Modulation, Power bandwidth product. Laser Diodes- Basic concepts, Classifications, Semiconductor injection Laser: Modes, Threshold conditions, External quantum efficiency, Laser diode rate equations, resonant frequencies, reliability of LED & ILD

Optical detectors- Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors.

Design considerations of fiber optic systems: Analog and digital modulation, Optical receiver operation, Power Budget and Rise time Budget analysis, Introduction to Integrated Photonics

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1. Senior, John M. Optical Fiber Communication. 3rd ed. Pearson Education 2009.

T2. Keiser, G. Optical Fiber Communications .4th ed. TMH, 2013.

Reference Books:

R1. Agrawal, G. P. Fiber Optic Communication Systems.4th ed. Wiley, 2010.

R2. Ramaswami R., Sivarajan K. N. Optical Networks. 3rd ed. Elsevier, 2010.

R3. Fiber Optic Communications, Harold B Killen, Prentice hall, 1991.

Course Code: ECP360
Course Title: Optical Communication Lab
Structure (L-T-P): 0-0-2
Prerequisite: NIL

Course Objectives

After completing the course, student is expected to:

- Learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
- Understand the different kinds of losses, signal distortion, SM fibers.
- Analyze the various optical sources, materials and fiber splicing
- Analyze fiber optical receivers and noise performance in photo detectors.
- Design link budget, WDM

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Apply the Knowledge of optical devices to design a simple optical communication link.

CO 2. Identify, describe and analyze the most important devices like light sources, fibers and detectors from both physical and system point of view.

CO 3. Perform measurements of numerical aperture and fiber losses.

CO 4. Apply knowledge about the measurements done at THz frequencies to conduct experiments.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Setting up a fiber optic digital link.
2. To study the coupling of laser to fiber and measuring the coupling efficiency.
3. To measure fiber losses.
4. Calculation and Measurement of numerical aperture of the fiber.
5. Voltage vs. current (V-I) characteristics of laser diode
6. Voltage vs. current (V-I) characteristics of LED.
7. Characteristics of photodiodes and measure the responsivity.
8. Characteristics of avalanche photodiodes [APD] and measure the responsivity.
9. To perform wavelength division multiplexing /demultiplexing
10. Study of VI and PI Characteristics of LASERS. (1310nm and 1550nm)
11. To design a basic optical fiber communication system using Opti-System software

Experiments for Desired Course Outcomes (If any)

1. Performing experiments using Opti-System simulation software.

Books/Material

T1. Lab Manuals
T2. Senior, John M. Optical Fiber Communication. 3rd ed. Pearson Education 2009.

Reference Books:

R1. Keiser, G. Optical Fiber Communications .4th ed. TMH, 2013.
R2. Agrawal, G. P. Fiber Optic Communication Systems.4th ed. Wiley, 2010.
R3. Ramaswami R., Sivarajan K. N. Optical Networks. 3rd ed. Elsevier, 2010.
R4. Fiber Optic Communications, Harold B Killen, Prentice hall, 1991.
R5. Fiber Optics Communications, Harold B Kolimbiris, United states Edition, Pearson Educational International.

Course Code: ECP361
Course Title: Electronics Workshop and Tinkering Lab
Structure (L-T-P): 0-0-4
Prerequisite: NIL

Course Objectives

After completing the course, student is expected to:

- To make the students familiar to various electronic measuring instruments, devices and using them for developing applications.

Course Outcomes

At the end of the course, students will be able to-
Essential:

CO.1. Use CRO, DSO, Function Generator, Spectrum Analyzer and other measuring instruments.
CO.2. Design PCB on a PCB prototype Machine.
CO.3. Perform soldering operation
CO.4. Design useful projects.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Familiarization to CRO and DSO
2. Familiarization to Spectrum Analyzer, Digital Multimeter and LCR meter.
3. Familiarization to Power supply and Function generator.
4. Identification of basic electronic components, resistor color codes, and ICs
5. Understand the working of a PCB prototype machine
6. Design PCB layouts and generate supporting files for working on a PCB prototype machine.
7. Using multimeter to test the diode and transistor
8. Programming a microcontroller
9. Design a Working project 1
10. Design a Working Project 2

Experiments for Desired Course Outcomes (If any): Nil

Books/Material

T1. K. A. Navas, “Electronics Lab Manual”, Volume I, PHI, 5th Edition, 2015

Reference Books

R1. T.K Hemingway, “Electronic Designer’s Handbook”, Business Books Limited.

Course Code: ECL462
Course Title: Electronics System Design
Structure (L-T-P): 3 0 0
Prerequisite: ECL151, ECP151

Course Objectives

- The objective of the course is to provide students with a comprehensive understanding of the design principles and techniques involved in developing power supply systems, amplifiers, oscillators, and filters. Through theoretical concepts and practical applications, the course aims to equip students with the necessary knowledge and skills to design and analyze various components of power supply systems and amplifiers and filters, ensuring their proper functioning and performance.

Course Outcomes

At the end of the course, students will be able to-
Essential:

CO.1. Analyze and design unregulated DC power supply systems with rectifiers and filters, ensuring stable and smooth output voltages.
CO.2. Develop and design switch-mode power supplies (SMPS) with step-up and step-down capabilities, considering efficiency and voltage regulation.
CO.3. Design class A and class AB audio power amplifiers with appropriate driver circuits, considering power requirements and fidelity.
CO.4. Evaluate the figure of merit for various oscillator circuits, considering factors like frequency stability, distortion, and signal purity.
CO.5. Design Butterworth and Chebyshev filters using voltage-controlled voltage sources (VCVS) and inverting-gain multiple feedback (IGMF) configurations for achieving desired frequency response characteristics.

~~Desirable~~/Advanced (If any): Nil

Syllabus for Essential Course Outcomes
Design of Power supply system: Unregulated D.C.. power supply system with rectifiers and filters. Design of emitter follower regulator, series regulators, overload protection circuits for regulators. Design of SMPS: Step up and step down.
Design of class A small signal amplifiers: Emitter follower, Darlington pair amplifiers with and without Bootstrapping, Two stage direct coupled amplifier. Design of class A, Class AB audio power amplifier with drivers.
Design of sinusoidal oscillators: OPAMP based Wein bridge and Phase Shift oscillators with AGC circuits, Transistor based Hartley, Colpits and Crystal oscillators, Evaluation of figure of merit for all above oscillator circuits.
Design of constant current sources, Design of function generators, Design of tuned amplifiers. Design of Butterworth, Chebyshev filters upto sixth order with VCVS and IGMF configuration.

Contents for Desired Course Outcomes (If any): NIL

Text Books:
T1. Regulated Power supply Handbook. Texas Instruments.
T2. Electronics : BJT's, FETS and Microcircuits – Anielo.
T3. Monograph on Electronic circuit Design : Goyal & Khetan.

Reference Books:
R1. Kim R. Fowler, Electronic Instrument Design, Oxford University Press.
R2. Henry W. Ott, Noise Reduction Techniques in Electronic Systems, Wiley Publications.
R3. John F. Wakerly, Digital Design Principles and Practices, Prentice-Hall International.
R4. Robert F. Coughlin, Operational Amplifiers and Linear Integrated Circuits, Prentice-Hall.
R5. Walter C. Bosshart, Printed Circuit Boards-Design and Technology, TMH.

Course Code: ECP462
Course Title: Electronics System Design Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL151, ECP151, ECL462

Course Objectives
- The objective of the course is to provide students with a comprehensive understanding of the design principles and techniques involved in developing power supply systems, amplifiers, oscillators, and filters.
- Through theoretical concepts and practical applications, the course aims to equip students with the necessary knowledge and skills to design and analyze various components of power supply systems and amplifiers and filters, ensuring their proper functioning and performance.

Course Outcomes
Essential:
CO.1. To understand the principles and techniques involved in designing unregulated DC power supply systems using rectifiers and filters.
CO.2. Able to develop an understanding of the design and simulation of switch-mode power supplies (SMPS), including step-up and step-down configurations, while evaluating efficiency, voltage regulation, and transient response.
CO.3. Able to design two-stage direct-coupled amplifiers, and sinusoidal oscillators.
CO.4. Develop the skills to design and build function generators capable of generating square, triangle, and sine waveforms, and evaluate their frequency range, amplitude control, and waveform quality.
CO.5. Able to design and simulate Butterworth and Chebyshev filters up to the sixth order using VCVS and IGMF configurations, and measure and compare their frequency response, gain, and filter characteristics.

~~Desirable~~/Advanced (If any): Nil

Experiments for Essential Course Outcomes
1) Unregulated DC Power Supply System
a. Design and construct an unregulated DC power supply system using rectifiers and filters.
b. Measure and analyze the output voltage waveform under different load conditions.
c. Evaluate the ripple voltage and its effect on the system performance.
2) Emitter Follower Regulator
a. Design and build an emitter follower regulator circuit.

b. Measure and analyze the output voltage regulation characteristics.
c. Investigate the effect of varying input voltage and load conditions on the regulator performance.

3) Series Regulator and Overload Protection Circuit
a. Design and implement a series regulator circuit with overload protection.
b. Analyze the voltage regulation and the response of the overload protection circuit.
c. Test the circuit's performance under different load conditions and evaluate its effectiveness.

4) Design of Switch-Mode Power Supplies (SMPS)
a. Design and simulate a step-up and a step-down switch-mode power supply (SMPS).
b. Analyze the efficiency, voltage regulation, and transient response of the SMPS circuits.
c. Compare the performance of the step-up and step-down configurations.

5) Design of Class A Small Signal Amplifiers
a. Construct and analyze an emitter follower amplifier circuit.
b. Build a Darlington pair amplifier circuit with and without bootstrapping.
c. Measure and compare the gain, frequency response, and distortion characteristics of the amplifiers.

6) Two-Stage Direct-Coupled Amplifier
a. Design and assemble a two-stage direct-coupled amplifier.
b. Measure and analyze the voltage gain, frequency response, and distortion characteristics.
c. Evaluate the overall performance of the amplifier circuit.

7) Design of Class A and Class AB Audio Power Amplifiers
a. Design and construct a class A audio power amplifier with appropriate driver circuits.
b. Design and build a class AB audio power amplifier with drivers.
c. Measure and compare the power output, efficiency, and distortion characteristics of both amplifiers.

8) Design of Sinusoidal Oscillators
a. Design and implement an OPAMP-based Wein bridge oscillator with AGC circuits.
b. Build transistor-based Hartley, Colpitts, and Crystal oscillators.
c. Evaluate the frequency stability, distortion, and figure of merit for each oscillator circuit.

9) Design of Constant Current Sources
a. Design and construct a constant current source for biasing amplifier circuits.
b. Analyze the stability and accuracy of the current source under different load conditions.

10) Design of Function Generators
a. Design and build a function generator capable of generating square, triangle, and sine waveforms.
b. Measure and analyze the frequency range, amplitude control, and waveform quality of the function generator.

11) Design of Tuned Amplifiers
a. Design tuned amplifiers for selective frequency amplification.
b. Measure and analyze the frequency response, gain, and bandwidth of the tuned amplifiers.

12) Design of Butterworth and Chebyshev Filters
a. Design and simulate Butterworth and Chebyshev filters up to the sixth order.
b. Implement the filters using VCVS and IGMF configurations.
c. Measure and compare the frequency response, gain, and filter characteristics of the designed filters.

Contents for Desired Course Outcomes (If any): NIL

Text Books:
T1. Regulated Power supply Handbook. Texas Instruments.
T2. Electronics : BJT's, FETS and Microcircuits – Anielo.
T3. Monograph on Electronic circuit Design : Goyal & Khetan.

Course Code: ECL466
Course Title: Finite Automata
Structure (L-T-P): 3 0 0
Prerequisite: ECL256, ECP256

Course Objectives
Course should provide a formal connection between algorithmic problem solving and the theory of languages and automata and develop them into a mathematical (and less magical) view towards algorithmic design and in general computation itself. The course should in addition clarify the practical view towards the applications of these ideas in the engineering part of CS.

Course Outcomes
Essential:
CO 1. Model, compare and analyse different computational models using combinatorial methods.
CO 2. Apply rigorously formal mathematical methods to prove properties of languages, grammars and automata.
CO 3. Construct algorithms for different problems and argue formally about correctness on different restricted machine models of computation.
CO 4. Identify limitations of some computational models and possible methods of proving them.
CO 5. Have an overview of how the theoretical study in this course is applicable to and engineering application like designing the compilers.

Syllabus for Essential Course Outcomes

Brief review of combinational and sequential circuit design and optimization, functional decomposition and symmetric functions, identification of symmetric functions.

Threshold logic, synthesis of threshold networks. Fault detection in combinational circuits, Boolean differences and Path sensitization.

Synchronous sequential circuits and iterative networks, memory elements and their excitation functions, synthesis of synchronous sequential circuits, Moore and Mealy machines,

Applications to controller design, finite state machine flow charts, tables, ASM charts. Machine minimization, Asynchronous Sequential circuits, synthesis, state assignment, minimization.

Contents for Desired Course Outcomes (If any): NIL.

Text Books

T1. Kohavi, Z. and Jha, N. K. *Switching and Finite Automata Theory*, 3rd ed. Cambridge University Press, 2013

T2. Shevgaonkar, R.K., Electromagnetic Waves, 6th ed., Tata McGraw-Hill, 2011.

T3. S.Y. Liao, Microwave Devices and Circuits, 4th edition, Pearson education.

Reference Books

R1. Kohavi, Z. Switching and Finite Automata Theory, 2nd ed. Tata McGraw Hill, 1978.

R2. Taub, H. *Digital Circuits and Microprocessors*. McGraw Hill, 1986.

R3. Mano, M.M. *Digital Logic and Computer Design*. Pearson, 2011.

R4. Lee, S.C. *Modern Switching Theory and Digital Design*. Prentice-Hall, 1978.

Course Code: ECL467

Course Title: Radio Frequency & Microwave Engineering

Structure (L-T-P): 3 0 0

Prerequisite: ECL254, ECL354

Course Objectives

After completing the course, student is expected to:

- Understand the need of radio frequency and microwave engineering through basic and advanced electromagnetic theory.
- Analyze the importance of microwave signal, learn important microwave devices and classify problems related to the communication systems and the prospects of entrepreneurship;
- Analyze the operation of different microwave generators at high microwave frequency.
- Outline the recent trends in advanced microwave communication for future industry applications.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Know about the microwave frequencies and the transmission lines that are used in communication.

CO 2. Assess qualitatively and quantitatively the role of microwave in the application areas of wireless communication.

CO 3. Understand the operation and working of the various tubes or sources for the transmission of the microwave frequencies.

Desirable/Advanced (If any):

CO.4 Analyze the recent trends and techniques pertaining to microwave engineering.

Syllabus for Essential Course Outcomes

Introduction: Microwave frequency bands, microwave engineering applications.

Overview of fundamentals of electromagnetic theory: Maxwell Equations, Poynting's theorem, uniform plane waves, electromagnetic waves and propagation medium, concept of good conductors and dielectrics, concept of wave transmission through wired transmission lines, overview of microwave radiation and microwave antenna theory.

Microwave communication: Friis formula, link budget and margin, radio receiver architecture, microwave propagation, introduction to radar systems, satellite systems, mobile communication system.

Microwave solid state generators: operation, characteristics and application of BJTs and FETs - Principles of tunnel diodes-Varactor, Step recovery diodes, Gunn diode-Avalanche Transit time devices-IMPATT and TRAPATT devices. Parametric devices-Principles of operation- applications of parametric amplifier.

Microwave Tubes:- Classifications:- O type and M type, klystrons, Reflex Klystrons, Travelling wave tube, magnetron.

Contents for Desired Course Outcomes (If any)

Recent Trends:- Microwave monolithic integrated circuit (MMIC) - Materials and fabrication techniques and others.

Text Books

T1. Pozar, D.M. Microwave Engineering Theory and Techniques, Indian adaptation, Wiley, 2020.

T2. Shevgaonkar, R.K., Electromagnetic Waves, 6th ed., Tata McGraw-Hill, 2011.

T3. S.Y. Liao, Microwave Devices and Circuits, 4th edition, Pearson education.

Reference Books

R1. Jordan, E.C. and Balmain, K.G., Electromagnetic Waves and Radiating Systems, 2nd ed., Prentice Hall of India, 2013.

R2. Collin, R.E. Foundation of Microwave Engineering. 2nd ed. Wiley India, 2012.
R3. K. T Mathew, Microwave Engineering, Wiley India, 2012
R4. Sushrut Das, Microwave Engineering, Oxford Higher Education, 2014.

Course Code: ECL468
Course Title: Embedded Systems Design
Structure (L-T-P): 3 0 0
Prerequisite: ECL359, ECP359

Course Objectives

- The objective of this course is to provide a comprehensive introduction to the field of embedded systems, focusing on the fundamental concepts, design principles, and practical applications. Students will learn about the integration of hardware and software in embedded systems, including microcontrollers, and real-time operating systems.
- The course will cover topics such as embedded system architecture, programming, interfacing, and system integration. Students will gain hands-on experience through lab exercises and projects involving embedded system development and programming.

Course Outcomes
Essential:
CO 1. Introduce students to the fundamental concepts and components of embedded systems.
CO 2. Familiarize students with microcontrollers used in embedded systems.
CO 3. Enhance students' ability to interface and integrate hardware and software in embedded systems.
CO 4. Design an embedded system considering the trade-off between designing functionality in hardware versus software.
CO 5. Perform design analysis and modular implementation for a complete system.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes
Microcontroller family: Architecture, basic assembly language programming concepts, The program Counter and ROM Spaces in the 8051, Data types, 8051 Flag Bits ad PSW Register, 8051
Register Banks and Stack Instruction set, Loop and jump instructions, Call Instructions, Time delay generations and calculations, I/O port programming Addressing Modes, accessing memory using various addressing modes, Arithmetic instructions and programs, Logical instructions, BCD and ASCII application programs, Single-bit instruction programming, Reading input pins vs. port Latch, Programming of 8051 Timers, Counter Programming. Communication with 8051: Basics of communication, Overview of RS-232, I2C Bus, UART, USB, 8051 connections to RS-232, 8051 serial communication programming, 8051 interrupts, Programming of timer interrupts, Programming of External hardware interrupts, Programming of the serial communication interrupts, interrupt priority in the 8051
Interfacing with 8051: Interfacing an LCD to the 8051, 8051interfacing to ADC, Sensors, Interfacing a Stepper Motor, 8051 interfacing to the keyboard, Interfacing a DAC to the 8051, 8255 Interfacing with 8031/51, 8051/31 interfacing to external memory
Contents for Desired Course Outcomes (If any): Nil

Text Books:
T1. Raj Kamal, ―Embedded Systems‖, TMH, 2004.
T2. M.A. Mazidi and J.G. Mazidi, ―The 8051 Microcontroller and Embedded Systems‖, PHI, 2004.

Reference Books:
R1. David E.Simon, ―An Embedded Software Primer‖, Pearson Education, 1999.
R2. K.J. Ayala, ―The 8051 Microcontroller‖, Penram International, 1991.
R3. Dr. Rajiv Kapadia, ―8051 Microcontroller & Embedded Systems‖, Jaico Press

Course Code: ECP468
Course Title: Embedded Systems Design Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL359, ECP359, ECL468

Course Objectives
The objective of this course is to provide a comprehensive introduction to the field of embedded systems, focusing on the fundamental concepts, design principles, and practical applications. This practical course covers the fundamentals necessary to take up embedded software development and also students can dive in to the details of embedded software programming by running the applications.

Course Outcomes
Essential:
CO 1. Introduce students to the fundamental concepts and components of embedded systems.
CO 2. Familiarize students with microcontrollers used in embedded systems.
CO 3. Enhance students' ability to interface and integrate hardware and software in embedded systems.
CO 4. Design an embedded system considering the trade-off between designing functionality in hardware versus software.
CO 5. Perform design analysis and modular implementation for a complete system.

Syllabus for Essential Course Outcomes

1. Interfacing of D to A converter using 8051 microcontroller
2. Interfacing of A to D converter using 8051 microcontroller
3. Interfacing of DC motor using 8051 microcontroller
4. Arithmetic and Logical operations using 8051 Trainer Kit Average of N Numbers, Ascending order and Descending order, Palindrome checking
5. Interrupts programming using 8051 Trainer Kit
6. Interfacing Programming using 8051 Trainer Kit: DAC & ADC Interface ,Traffic Lights Interface, Hex Keypad Display, Controlling 8 LEDs using DIP switch, Elevator Interface, 7 Segment Display
7. Arithmetic and logical operations using ARM Trainer Kit: Fibonacci Series, G.C.D Numbers, 2 X 2 Matrix Addition
8. Interrupts Programming using ARM Trainer Kit
9. Interfacing Programs using ARM Trainer Kit: LCD Display, Buzzer, Temperature Sensor, UART, DC Motor

Contents for Desired Course Outcomes (If any)
NIL

Text Books:

T1. Lab Manual
T2. Raj Kamal, —Embedded Systems‖, TMH, 2004.
T3. M.A. Mazidi and J.G. Mazidi, —The 8051 Microcontroller and Embedded Systems‖, PHI, 2004.

Reference Books:

R1. David E.Simon, —An Embedded Software Primer‖, Pearson Education, 1999.
R2. K.J. Ayala, —The 8051 Microcontroller‖, Penram International, 1991.
R3. Dr. Rajiv Kapadia, —8051 Microcontroller & Embedded Systems‖, Jaico Press

Course Code: ECL470
Course Title: Wireless & Mobile Communications
Structure (L-T-P): 3 0 0
Prerequisite: ECL253, ECP253, ECL355, ECP355

Course Objectives
After completing the course, student is expected to:

- Explain the architecture, functioning, capabilities, evolution and applications of various wireless communication networks.
- Understand the concept of multiple access techniques and the cellular systems which are using these techniques.
- Evaluate design challenges, constraints and security issues associated with radio wave and cellular communication networks and standards..
- Foster knowledge about the recent trends in advanced wireless communication for future industry applications.

Course Outcomes
Essential:

CO 1. Discuss the cellular system design and technical challenges.
CO 2. Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling
CO 3. Demonstrate their understanding on functioning of wireless communication system and evolution of different wireless communication systems.
CO 4. Foster knowledge about radio wave communication and cellular communication systems.
CO 5. Analysis of Logical and Conditional methods for wireless communication systems and standards to provide solutions in terms of employability

Desirable/Advanced (If any):

CO 6. Introduction to future trends for wireless communication

Syllabus for Essential Course Outcomes

Introduction to Wireless Systems- Evolution of Wireless Communication Technologies, Modeling Wireless Channel, Wireless Fading Channel Model, Fading Channel Distribution, Rayleigh Fading Channel, Bit Error Rate (BER) Performance, Bit Error Rate (BER) of AWGN Channels, Performance in Fading wireless channels- Bit Error Rate of Rayleigh Fading Wireless Channel, Exact BER Expression for Rayleigh Fading Wireless Channel, Deep Fade Analysis of Wireless Communication, Principle of Diversity, Multiple Antenna Diversity, Maximal-Ratio Combining

Multiple Antenna Wireless Systems and Diversity- BER of Multiple Antenna Wireless Systems, Approximate BER for Multiple Antenna Wireless System, Examples for BER of Wireless Communication, Deep Fade in Multi Antenna Systems, Intuition for Deep Fade in Multi-Antenna System, Definition of Diversity Order

Wireless Channel Characterization Delay Spread and Doppler- Max Delay Spread, RMS Delay Spread, Delay Spread and Inter Symbol Interference, Coherence Bandwidth of Wireless Channel, Mobility and Doppler Effect in Wireless Channels, Impact of Doppler Effect on Wireless Channel

Principles of CDMA Wireless Communication- Introduction to Code Division Multiple Access (CDMA), Chip Time and Bandwidth Expansion in CDMA, Code Generation for CDMA, CDMA Codes: Properties of PN Sequences, BER of CDMA Systems

Principles of OFDM Wireless Communication-Capacity of MIMO Wireless Systems, SVD based MIMO Transmission, Orthogonal Frequency Division Multiplexing (OFDM), Transmission in Multicarrier

Systems, FFT/IFFT Processing in OFDM, Cyclic Prefix in OFDM Systems, Schematic Representation of OFDM Transmitter and Receiver, BER Performance of OFDM Systems

Text Books

T1. T. S. Rappaport, "Wireless Communications: Principles and Practice", second Edition, Pearson Education, 2009.
T2. A. Dornan, "The essential guide to wireless communications applications: from cellular systems to WiFi", second Edition, Prentice Hall, 2002.

Reference Books

R1. W. Stallings, "Wireless communications and networking", Prentice Hall, 2002.
R2. Balanies, C.A., Antenna *Theory and their applications*, 4th Ed., Indian Adaptation, John Wiley & Sons. 2021.
R3. Aditya K Jagannathan, Principles of Modern Wireless Communication Systems Theory & Practice, Mcgraw Hill Education, 2015
R4. Misra, "Wireless Communications and Networks: 3G & Beyond", Tata McGraw-Hill, 2009.

Course Code: ECP470
Course Title: Wireless and Mobile Communication Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL253, ECP253, ECL355, ECP355, ECL470

Course Objectives

The objective of this course is to enable the student to understand the emerging technologies of wireless and mobile communications and simulate them. To develop an ability to compare recent technologies used for wireless communication

Course Outcomes

Essential:

CO 1. Apply the knowledge of cellular system design.
CO 2. Identify, describe and analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling.
CO 3. Perform experiments on the multiple access techniques.
CO 4. Perform experiments on Multiuser Systems, CDMA, and OFDM Concepts.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. To perform the generation of Pseudo Random Binary sequence and determine the chip rate using PN sequence.
2. To test the various AT commands on GSM Evaluation Kit for IMSI Information along with performing basic implementation of GSM based Mobile Phone Kit.
3. To study and perform basic implementation of CDMA (DSSS) on CDMA Evaluation Kit.
4. To study and implement TDM based experiments related to various modulation schemes on Evaluation Kit.
5. To study Spread Spectrum – DSSS Modulation & Demodulation on trainer kit.
6. Analyse the BER for the M-ary PSK Using MATLAB/Simulink for Rayleigh fading with AWGN.
7. To study Gaussian Minimum Shift Keying (GMSK) modulation technique.
8. To write and execute a MATLAB program to calculate the median path loss for the Okumura model for outdoor propagation.
9. To write a MATLAB program to calculate the median path loss for Hata model for outdoor propagation.
10. To determine bit error rate of modulated signal transmitted over Rayleigh fading channel.
11. To determine bit error rate of modulated signal transmitted over Rician fading channel.
12. Analysis of multipath signal reception with equalizer and without equalizer for different path delays.

Experiments for Desired Course Outcomes (If any)

1. Performance analysis of SISO and SIMO using equal gain combining method.
2. To Simulate OFDM and observe bit error rate for given signal to noise ratio.

Text Books:

T1. Lab Manuals
T2. Rappaport, T.S., Wireless Communication: Principles and Practices, 2nd ed., Pearson Education, 2013.

Reference Books:

R1. Mischa Schwartz, Mobile Communication, Cambridge, University Press, 2005.
R2. William Stallings, Wireless Communications and Networks. PHI, 2002.
R3. Feher, K., Wireless Digital Communication, Prentice Hall of India, 2011.
R4. Proakis, J.G. and Salehi, M., Digital Communications, 5th ed., McGraw Hill, 2010.
R5. Haykin, S., Digital Communication, Wiley India, 2012.
R6. Schiller, J., Mobile Communication, 2nd ed., Pearson Education, 2012.

Course Code: ECL471
Course Title: Radar and Satellite Communication Systems
Structure (L-T-P): 3 0 0
Prerequisite: ECL254, ECL354

Course Objectives

After completing the course, student is expected to:

- Understand the need of radio frequency and microwave engineering through basic and advanced electromagnetic theory.
- Understand the basic principle, characteristics and some of the important applications of radio frequency and microwave.
- Analyze the operation of different microwave generators at high microwave frequency.
- Foster knowledge about the recent trends in advanced microwave communication for future industry applications.

Course Outcomes

Essential:

CO 1. Analyze the importance of microwave signal, learn important microwave devices and classify problems related to the communication systems and the prospects of entrepreneurship;

CO 2. Estimate problems and the working principle of different RADAR systems and their applications;

CO 3. Demonstrate knowledge about the Satellite fundamentals and the types of satellite systems to provide solutions in terms of employability;

CO 4. Foster knowledge about working of a Satellite communication system and its other subsystems, highlighting the applications of satellites in different areas for development of skills.

Desirable/Advanced (If any):

CO 5. Designing the uplink and downlink link budget considering the specified CNR and various attenuations.

Syllabus for Essential Course Outcomes

Introduction to Radar, radar parameters: Introduction, block diagram, applications of radar systems, radar frequencies, basic pulsed radar system, system losses, range resolution, cross range resolution, Doppler resolution, pulse repetition frequency, radar accuracy.

Basic Radars:- Principal of operation of basic radar, radar range equation for monostatic and bistatic radar, pulsed radar, continuous wave radar, frequency modulated continuous wave radar, pulsed Doppler radar, surface search and navigation radar, moving target indicator, MST radar, synthetic aperture radar, phased array radar, laser radar.

Radar displays, fundamentals of radar navigation, introduction of radar antennas.

Satellite Communications: The Origin of satellite communications, brief history of satellite communications, advantages and disadvantages of current status of satellite communication, Satellite applications, Kepler's law, satellite orbits, satellite orbit patterns, classifications, spacing and frequency allocation of satellite, satellite antenna radiation, frequency reuse, satellite system parameters, link equations. Satellite Subsystems, Earth Station Technology. Inter-satellite communication.

Contents for Desired Course Outcomes (If any)

Satellite link design: design of Uplink and downlink link budgets.

Text Books

T1. M. I. Skolnik, "*Introduction to Radar Systems*", 3rd Ed., McGraw Hill, 2003. T2.

T2. T. Pratt "Satellite communications", 3rd edition, Indian adaptation, John Wiley and Sons (2021).

Reference Books

R1. G.S.N Raju., "*Radar Engineering and fundamentals of navigation aids",* John Wiley, 2020.

R2. E. Byron, "*Radar: Principles, Technology, Applications",* Prentice- Hall education, 2004.

R3. D. Barton, "Radar system analyses and Modeling", Artech house, 2005.

R4. M. Antonio, "Bistatic radar emerging technology", John Wiley, 2008.

R5. Dennis Roddy, "Satellite communications", McGraw-Hill international edition.

Course Code: ECL473
Course Title: FPGA based IC/System Design
Structure (L-T-P): 3 0 0
Prerequisite: ECL256, ECP256

Course Objectives

- The objective of this course is to provide students with a comprehensive understanding of Field-Programmable Gate Array (FPGA) technology and its application in Very Large Scale Integration (VLSI) design.
- Students will learn the fundamental concepts, design methodologies, and tools used in FPGA-based VLSI design, with a focus on designing digital circuits and systems using FPGA platforms.

Course Outcomes

Essential:

CO 1. Understand the fundamentals of FPGA-based VLSI design: Students will have a strong understanding of the basic concepts, principles, and techniques of FPGA-based VLSI design, including digital logic design, VHDL or Verilog programming, FPGA architecture, and synthesis.

CO 2. Design and implement complex digital systems on FPGAs: Students will be able to design, implement, and verify complex digital systems using FPGA tools and methodologies. This includes creating RTL (Register Transfer Level) designs using VHDL or Verilog, synthesizing the RTL code to generate a bitstream file, and programming the FPGA to implement the designed system.

CO 3. Optimize and debug FPGA-based designs: Students will learn techniques to optimize the performance and area utilization of FPGA-based designs. They will also acquire skills to debug and troubleshoot issues related to timing, routing, and functional correctness in FPGA designs.

CO 4. Design and implement FPGA-based projects: Students will be able to apply their knowledge and skills to design and implement FPGA-based projects, such as digital signal processing (DSP) systems, embedded systems, and system-on-chip (SoC) designs. They will be able to prototype and test their designs on FPGA development boards, and demonstrate their projects with real-world applications.

Desirable/Advanced (If any):

CO 5. Stay updated with the latest trends and advancements in FPGA-based VLSI design.

Syllabus for essential outcome

Different types of VLSI Design style, Modeling digital systems, Finite state machines: Basic concepts and design; Moore and Mealy machines examples; State minimization/reduction, state assignment; Finite state machine design case studies.

Hardware design environment, Design Flow, Hardware description languages, Various design styles. Introduction to Verilog, elements of Verilog, basic concepts in Verilog, simulation, synthesis. Dataflow modeling, Concurrent signal assignment, delays, Behavioral modeling, processes.

Design organization, Structural specification of hardware, parameterization, hierarchy, abstraction, configurations, utilities. Subprogram, packages, libraries, Basic I/O, Programming mechanics Synthesis, RTL description, constraints attributes, FPGA, CPLD structure, technology libraries.

Introduction to VHDL Programming. RTL based design projects and their implementation in FPGA using VHDL, Sequential circuit design examples in Verilog/VHDL and simulation, FSM circuit design examples in VHDL and simulation.

Contents for Desired Course Outcomes (If any)

Latest conferences and Journals related to the field.

Text Books

T1. Palnitkar, S. Verilog HDL: A guide to Digital Design and Synthesis. 2nd ed. Pearson, 2013.

Reference Books/Additional Books:

R1. Bhasker, J. A System Verilog Primer. 1st Indian ed. B.S. Publication, 2013.

R2. Navabi, Z. VHDL: Analysis and Modeling of Digital Systems. 2nd ed. McGraw Hill, 2000.

R3. Weste, N.H.E., Harris, D., and Banerjee, A CMOS VLSI Design: A Circuits and Systems Perspective. 3rd ed. Pearson Education, 2012.

R4. Pucknell, D.A. and Eshraghian, K. Basic VLSI Design. 3rd ed. PHI Learning Private Limited, 2011.

R5. Brown, S.D. and Vranesic, Z.G. Fundamentals of Digital Logic with VHDL/Verilog Design. 3rd ed. McGraw-Hill, 2009.

Course Code: ECP473
Course Title: FPGA based IC/System Design Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL256 , ECP256, ECL473

Course Objectives

- The objective of the Hardware Description Language Lab is to provide hands-on experience to students in designing, implementing, and testing digital circuits using Field-Programmable Gate Arrays (FPGAs) as a key technology in Very Large Scale Integration (VLSI) design.
- The lab aims to develop practical skills in FPGA-based design methodologies, tools, and techniques, and enable students to design and implement complex digital systems using FPGA platforms.

Course Outcomes

Essential:

CO 1. Understand the fundamentals of digital system design and the role of FPGAs in VLSI design.

CO 2. Select and utilize appropriate FPGA development tools, software, and hardware platforms for designing digital circuits.

CO 3. Implement digital circuits using Hardware Description Languages (HDL) such as VHDL or Verilog.

CO 4. Design, simulate, synthesize, and implement digital circuits on FPGA platforms using industry-standard design tools.

CO 5. Develop skills in designing and implementing advanced digital circuits such as arithmetic circuits, memory circuits, and complex control circuits using FPGAs.

Desirable/Advanced (If any):

CO 6. Apply the concepts and techniques learned in the lab to real-world applications and projects involving FPGA-based VLSI design.

Experiments for Essential Course Outcomes:

1. Introduction to FPGA Development Tools and Hardware Platforms: Familiarization with FPGA development tools such as Xilinx Vivado or Intel Quartus, and hardware platforms such as Xilinx FPGA boards or Intel FPGA boards. Understanding the basics of FPGA architectures, FPGA

programming flows, and hardware description languages (HDL) like VHDL or Verilog.

2. Basic Digital Logic Design on FPGA: Implementing and testing basic digital logic circuits such as AND, OR, NOT gates, and their combinations on an FPGA platform. Understanding the concept of combinatorial and sequential logic.
3. Design of Arithmetic Circuits on FPGA: Designing, simulating, synthesizing, and implementing arithmetic circuits such as adders, multipliers, and dividers using FPGA platforms. Analyzing the performance parameters such as speed, area, and power consumption of the circuits.
4. Design of Memory Circuits on FPGA: Designing, simulating, synthesizing, and implementing memory circuits such as SRAM, DRAM, and ROM using FPGA platforms. Understanding the working principles, performance parameters, and trade-offs of different memory types.
5. Design of Complex Control Circuits on FPGA: Designing, simulating, synthesizing, and implementing complex control circuits such as state machines, timers, and counters on an FPGA platform. Understanding the concept of synchronous and asynchronous design, and analyzing the performance parameters of these circuits.
6. Design of Finite State Machines (FSMs) on FPGA: Designing, simulating, synthesizing, and implementing finite state machines using FPGA platforms. Understanding the concept of FSMs, state encoding, state minimization, and state transition diagrams.
7. Design of Digital Signal Processing (DSP) Circuits on FPGA: Designing, simulating, synthesizing, and implementing digital signal processing circuits such as filters, FFT, and PID controllers on an FPGA platform. Analyzing the performance parameters such as signal quality, latency, and throughput of the DSP circuits.
8. Design of Custom IP Cores on FPGA: Designing, integrating, and testing custom Intellectual Property (IP) cores on FPGA platforms. Understanding the concept of IP cores, IP integration, and IP reuse in FPGA-based designs.
9. Design of System-Level Designs on FPGA: Designing, simulating, synthesizing, and implementing system-level designs involving multiple IP cores, interconnects, and peripherals on an FPGA platform. Analyzing the performance,• power consumption, and resource utilization of the system-level designs.
10. Real-time Testing and Validation of FPGA Designs: Implementing real-time testing and validation of FPGA designs using input/output interfaces, sensors, actuators, and communication protocols on FPGA platforms. Analyzing the real-time performance, responsiveness, and reliability of the FPGA-based designs.

Experiments for Desired Course Outcomes (If any)

1. Project: Design and build a FPGA Based projects few examples are as follows-
2. Design of a custom processor or microcontroller on FPGA
3. Implementation of a digital communication system on FPGA
4. Design of a digital image processing system on FPGA
5. Development of a video processing or gaming application on FPGA
6. Design of a digital audio processing system on FPGA
7. Implementation of a cryptographic system or security application on FPGA
8. Design of a sensor interface or control system on FPGA
9. Implementation of a digital control or automation system on FPGA
10. Design of a data acquisition or processing system on FPGA
11. Development of a custom IP core or accelerator for a specific application on FPGA.

Text Books

T1. Palnitkar, S. Verilog HDL: A guide to Digital Design and Synthesis. 2nd ed. Pearson, 2013.

Reference Books/Additional Books:

R1. Bhasker, J. A System Verilog Primer. 1st Indian ed. B.S. Publication, 2013.
R2. Navabi, Z. VHDL: Analysis and Modeling of Digital Systems. 2nd ed. McGraw Hill, 2000.
R3. Weste, N.H.E., Harris, D., and Banerjee, A CMOS VLSI Design: A Circuits and Systems Perspective. 3rd ed. Pearson Education, 2012.
R4. Pucknell, D.A. and Eshraghian, K. Basic VLSI Design. 3rd ed. PHI Learning Private Limited, 2011.
R5. Brown, S.D. and Vranesic, Z.G. Fundamentals of Digital Logic with VHDL/Verilog Design. 3rd ed. McGraw-Hill, 2009.

Course Code: ECL474
Course Title: Data Communication and Networks
Structure (L-T-P): 3 0 0
Prerequisite: ECL253, ECP253, ECL355, ECP355

Course Objectives

To introduce basic concepts of Data communication with different models. Enumerate the physical layer, Data Link Layer, Network Layer, Transport Layer and Application Layer, explanation of the function(s) of each layer. Understanding of switching concept and different types of switching techniques.

Course Outcomes

Essential:

CO 1. Apply knowledge of basic concepts of internet, OSI Model, TCP/IP model to the analysis and design of Data communication and networks.
CO 2. Understand and analyze the various techniques of error correction and detection,switching, switches and functions of the data link layer.
CO 3. Understand Multiple Access techniques like ALOHA, CDMA, CSMA/CD, CSMA/CA,Controlled Access, and Channelization in order to have sustainable development of data communication.
CO 4. Analyse routing algorithm, subnet masks and IP addresses to fulfill networking requirements.
CO 5. Use the concepts and modern engineering tools such as cryptography and network security for secure data communication system

Desirable/Advanced (If any):
CO 6. To analyse and design the recent trends adopted in data communication systems and wireless standards.

Syllabus for essential outcome
Overview of Data Communication and Networking: Data communications, Networks, The Internet, Protocols and standards, Layered tasks, OSI model, TCP/IP protocol Architecture.
Physical layer: Analog and digital, Analog signals, Digital signals, Analog versus digital, Data rate limit, Transmission impairments, Line coding, Block coding, Sampling, Transmission mode, Modulation of digital data, Telephone modems, Modulation of analog signal, FDM, WDM, TDM, Guided media, Unguided media, Circuit switching, Telephone networks, DSL technology, Cable modem, SONET
Data link layer: Types of errors, Detection, Error correction, Flow and error control, Stop and wait ARQ, go back n ARQ, Selective repeat ARQ, HDLC, Point to point protocol, PPP stack, Random access, Controlled access, Channelization, Traditional Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE802.11, Bluetooth, Connecting devices, Backbone network, Virtual LAN, Cellular telephony, Satellite networks, Virtual circuit switching, Frame relay, ATM.
Network layer: Internetworks, Addressing, Routing, ARP, IP, ICMP, IPV6, Unicast routing, Unicast routing protocol, Multicast routing, Multicast routing protocols.
Transport layer: Process to process delivery, User datagram protocol (UDP), Transmission control protocol (TCP), Data traffic, Congestion, Congestion control, Quality of service, Techniques to improve QOS, Integrated services, Differentiated services, QOS in switched networks.
Application layer: Client server model, Socket interface, Name space, Domain name space, Distribution of name space, DNS in the internet, Resolution, DNS messages, DDNS, Encapsulation, Electronic mail, File transfer, HTTP, World wide web (WWW), Digitizing audio and video, Audio and video compression, Streaming stored audio/video, Streaming live audio/video, Real time interactive audio/video, Voice over IP.
Switching: Circuit Switching Networks, Concepts, Control Signaling, Soft switch Architecture, Packet switching, Packet size, X.25, Frame Relay, ATM, Message Switching.

Text Books:
T1. B. A. Forouzan, “Data Communications and Networking”, MGH, 4th ed. 2007
T2. S. Tanenbaum, “Computer Networks”, PHI.
Reference Books:
R1. W. Stallings, “Data and Computer Communication”, PHI.
R2. W. Tomasi, “Introduction to Data Communications and Networking”, Pearson Education.
R3. Williiam J Beyda, “Data Communications: from basics to broadband”, 4 th Ed Pearson Education.

Course Code: ECL475
Course Title: Information Theory Coding
Structure (L-T-P): 3 0 0
Prerequisite: ECL253, ECP253, ECL355, ECP355

Course Objectives
After completing the course, student is expected to:
- Apply information theory concepts for communication systems.
- Apply error control coding techniques to design efficient communication systems.
- Study various data compression methods and describe the most common such methods
- Apply the different source encoding techniques.
- Understand and apply different channel encoding techniques.

Course Outcomes
Essential:
CO 1. Quantify the notion of information, entropy, channel capacity in a mathematically sound way and understand its significance in the communications systems.
CO 2. Differentiate between lossy compression techniques and decide an efficient data compression scheme for a given information source.
CO 3. Differentiate between lossless compression techniques and decide an efficient data compression scheme for a given information source.
CO 4. Apply different channel coding techniques for error detection and correction schemes.
CO 5. Design communication systems with error control capabilities.

Desirable/Advanced (If any):

CO 6. Analyze and design a communication system using different error control capabilities to meet desired needs within realistic constraints.

Syllabus for Essential Course Outcomes

Information Theory and Source Coding: Introduction to Information Theory, Uncertainty and Information, Average Mutual Information and Entropy, Information Measures for Continuous Random Variables, Relative Entropy,

Source Coding Theorem, Huffman Coding, Shannon-Fano-Elias Coding, Arithmetic Coding, The Lempel-Ziv Algorithm, Run Length Encoding, Rate Distortion Function, Optimum Quantizer Design, Entropy Rate of a Stochastic Process

Channel capacity and coding: Channel Models, Channel Capacity, Channel Coding, Information Capacity Theorem, Parallel Gaussian Channels, The Shannon Limit, Channel Capacity for MIMO Systems, Capacity Region for Multiple Access Channel

Error control coding: Linear Block Codes for Error Correction, Cyclic Codes, Perfect Codes, Hamming Codes, Low Density Parity Check (LDPC) Codes, Cyclic codes,

Convolutional codes, Turbo codes, Trellis coded modulation, Coding for secure communication

Contents for Desired Course Outcomes (If any): Nil

Text Books:

T1. Haykin, S.S. and Moher, M., Introduction to Analog and Digital Communications, 2nd
T2. W.E Ryan and S Lin, Channel Codes-Classical and Modern, Cambridge University Press, 2009.
T3. R.W Yeung, Information Theory And Network Coding, Springer, 2008

Reference Books:

R1. F.J. MacWilliams and N.J.A Sloane, The Theory of Error-Correcting Codes, Elsevier Science, 1988.
R2. D Lun and T Ho, Network Coding - An Introduction, Cambridge University Press, 2008
R3. F.J. MacWilliams and N.J.A Sloane, The Theory of Error-Correcting Codes, Elsevier Science, 1988.
R4. D Lun and T Ho, Network Coding - An Introduction, Cambridge University Press, 2008

Course Code: ECL476
Course Title: Advanced Analog Circuits
Structure (L-T-P): 3 0 0
Prerequisite: ECL351, ECP351

Course Objectives

- To understand and analyze second order functions and design op-amp RC and active filters.
- To develop the ability to understand the applications of OTAs and switch capacitors in analog circuits.
- To apply the knowledge of switch capacitors and OTA in designing the filters, PLL and analog building blocks of communication system.
-

Course Outcomes

Essential:

CO.1. Students will be able to identify basic building blocks of OTA as well as its applications in analog multipliers.
CO.2. Students will be able to analyze and design op-amp RC and active filters, admittance converters and inverters, generalized impedance converter, inductance simulation, sinusoidal oscillators, amplitude stabilization and control using Operational Transconductance Amplifier (OTA).
CO.3. Students will gain understanding on voltage controlled filters, phase locked loop operational modes & voltage controlled oscillators.
CO.4. Students will be able to design, analyze and implement Switch Capacitor Filters for various applications.
CO.5. Students will gain an understanding of MOSFET-C filters and techniques used in non-linearity cancellation in MOS circuits.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Review of Opamp, Basics second order functions, op-amp RC and active filter design, admittance converters and inverters, generalized impedance converter, inductance simulation,

Operational Transconductance Amplifier (OTA), Basic building blocks using OTA, Application examples, Operational Transconductance Amplifier (OTA), Basic building blocks using OTA, Application examples Analog Multiplier and its applications: Gilbert multiplier cell 2-quadrant and 4-quadrant operations.

Modulation, demodulation and frequency changing, voltage-controlled filters, phase locked loop, operational modes, voltage-controlled oscillators, IC PLL: basic PLL principle, three modes of operation, PLL as AM detector, FM detector, frequency synthesis, FM demodulator, PLL motor speed control and voltage to frequency converter, Frequency response of bilinear and second order transfer functions,

Filter approximation Functions: Butterworth, Chebyshev, Pole locations, Filter specifications, Comparison of maximally flat and equal ripple response Frequency Transformation: Low pass to High pass, Low pass to band pass, Low pass to band elimination, GIC and optimal design,

Switch capacitor using a MOSFET, SC integrator, Switch capacitor filter, filter, Generations of current Conveyers, MOSFET-C Filters and techniques of non-linearity cancellation in MOS circuit.

Text Books

T1. Rolf Schaumann and Mac E. Van Valkenberg, Design of Analog Filters, Oxford Indian Edition, 2008, CRC, 2ndEditionPrenticehall International (ISBN: 0849337739) 2008
T2. Analysis and Design of Analog Integrated Circuits by, Paul R.Gray/ Robert G.Meyer, Wiley, Third edition 2009

Reference Books/Additional Books:

R1. G. Daryanani, Principles of active network synthesis and design Wiley 2003.
R2. G. Ferri, N. C. Guerrini, Low-Voltage Low-Power CMOS Current Conveyors. Kluwer Academic Publishers 2003,
R3. Design with Operational Amplifiers and Analog Integrated Circuits by Sergio Franco, TMH.

Course Code: ECL477
Course Title: Intelligent Instrumentation
Structure (L-T-P): 3 0 0
Prerequisite: NIL

Course Objectives

After completing the course, student is expected to:

- Demonstrate an understanding of the novel category of Instrumentation Systems with integrated intelligent features and smart sensing technologies.

Course Outcomes

Essential:

CO 1. Classify sensors for various applications.
CO 2. Understand Linearization, calibration and compensation of sensors
CO 3. Apply Artificial Intelligence to sensor signals
CO 4. Work with interfacing protocols in wireless networking platform

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction: Intelligent instrumentation, definition, types of instruments, static and dynamic characteristics of instruments, Historical Perspective, Current status, software based instruments.

Intelligent Sensors: Classification, Smart sensors , Monolithic Integrated Smart Sensors, Hybrid Integrated Smart Sensors, Cogent Sensors, Soft or Virtual sensors, self-adaptive, self-validating sensors, Soft Sensor Secondary Variable Selection, Rough Set Theory , Model Structures. Self-Adaptive Sensors, Self-Validating Sensors, VLSI Sensors, Temperature Compensating Intelligent Sensors, Pressure Sensor.

Linearization, Calibration, and Compensation: Analog Linearization of Positive and Negative Coefficient Resistive Sensors. Higher-Order Linearization , Quadratic Linearization , Third Order Linearization Circuit, Nonlinear ADC- and Amplifier-Based Linearization, Interpolation, Piecewise Linearization, Microcontroller-Based Linearization, Lookup Table Method, Artificial Neural Network–Based Linearization, Nonlinear Adaptive Filter–Based Linearization, Sensor Calibration, Conventional Calibration Circuits , Offset Compensation, Error and Drift Compensation, Lead Wire Compensation.

Sensors with Artificial Intelligence: Artificial Intelligence, Sensors with Artificial Intelligence, Multidimensional Intelligent Sensors, AI for Prognostic Instrumentation, ANN-Based Intelligent Sensors, Fuzzy Logic–Based Intelligent Sensors.

Intelligent Sensor Standards and Protocols: IEEE 1451 Standard, STIM, TEDS, NCAP, Network Technologies, Lon Talk, CEBUS, J1850 Bus, 1 Signal Logic and Format, MI Bus, Plugn-Play Smart Sensor Protocol

Contents for Desired Course Outcomes (If any): Nil

Text Books

T1. Manabendra Bhuyan, ―Intelligent Instrumentation: Principles and Applications‖ CRC Press, 2011.

Reference Books

R1. R1. G. C. Barney, ―Intelligent Instrumentation‖, Prentice Hall, 1995

B.Tech. Electrical & Electronics Engineering
OVERALL CREDIT STRUCTURE

Undergraduate Core(UC)		Undergraduate Elective (UE)	
Category	*Credit*	*Category*	*Credit*
DC	67	**DE**	23 (minimum)
BS	19	**HM**	06 (minimum)
ES	22	**OC**	18 (Balance)
HM	05	**UN**	0 (03 Courses)
Total	**113**	**Total**	47
Grand Total (UC + UE)			**160**

Basic Science (BS)			
Course Code	**Course**	**L-T-P**	**Credit**
MAL102	Applied Mathematics-I	3-2-0	04
MAL103	Applied Mathematics-II	3-2-0	04
MAL201	Applied Mathematics-III	3-0-0	03
PHL151	Applied Physics	3-0-0	03
PHP151	Applied Physics Lab	0-0-2	01
CYL101	Applied Chemistry	3-0-0	03
CYP101	Applied Chemistry Lab	0-0-2	01
Grand Total			**19**

Humanities and Management (Core) (HM)			
Course Code	**Course**	**L-T-P**	**Credit**
HSP152	Technical Communication	1-2-2	03
HSL151	Social Science	2-0-0	02
Grand Total			**05**

Engineering Arts and Science (ES)			
Course Code	**Course**	**L-T-P**	**Credit**
MEL152	Elementary Mechanical Engineering	3-0-0	03
EEL151	Elementary Electrical Engineering	3-0-0	03
EEP151	Elementary Electrical Engineering Lab	0-0-2	01
ECL151	Basic Electronics Engineering	3-0-0	03
ECP151	Basic Electronics Engineering Lab	0-0-2	01
MEL151	Engineering Drawing	3-0-0	03
MEP151	Engineering Drawing Lab	0-0-2	01
CSL151	Computer Programming and Problem Solving	3-0-0	03
CSP151	Computer Programming and Problem Solving Lab	0-0-2	01
MEP152	Mechanical Workshop	0-0-2	01
CEL151	Environmental Science	2-0-0	02
Grand Total			**22**

Non-Credit Requirement (UN)			
Course Code	**Course**	**L-T-P**	**Credit**
NCN101	NCC#	-	0
NSS152	NSS-I#	-	0
NSS153	NSS-II#	-	0
NCN103	NSO#	-	0
SPB151	Sports-I#	0-0-4	0
SPB152	Sports-II#	0-0-4	0
HSD251	Community Project	-	0
EET251	Practical Training	-	0
#A student has to opt at least one from NCC, NSS, NSO and Sports (I & II both).			

Departmental Core (DC)			
Course Code	**Course**	**L-T-P**	**Credit**
EEL251	Basic Electrical Circuits	3-0-0	03
EEP251	Basic Electrical Circuits Lab	0-0-2	01
EEL252	Measurement & Instrumentation	3-0-0	03
EEP252	Measurement & Instrumentation Lab	0-0-2	01
EEL253	Electrical Machines I	3-0-0	03
EEP253	Electrical Machines I Lab	0-0-2	01
EEL254	Control System	3-0-0	03
EEP254	Control System Lab	0-0-2	01
EEL255	Power Electronics	3-0-0	03
EEL256	Power System I	0-0-2	01
ECL251	Signals and Systems	3-2-0	04
ECL252	Analog Circuits	3-0-0	03
ECP252	Analog Circuit Lab	0-0-2	01
ECL254	Engineering Electromagnetics	3-0-0	03
ECL256	Digital Circuits	3-0-0	03
ECP256	Digital Circuits Lab	0-0-2	01
EEL351	Electrical Machines II	3-0-0	03
EEP351	Electrical Machines II Lab	0-0-2	01
EEL352	Electric Drives	3-0-0	03
EEP352	Electric Drives Lab	0-0-2	01
EEL353	Power System II	3-0-0	03
EEL356	Advance Control System	3-0-0	03
EEP255	Power Electronics Engineering Lab	0-0-2	01
EEL355	Switchgear & Protection	3-0-0	03
EEP355	Switchgear & Protection Lab	0-0-2	01
ECL351	Linear Integrated Circuits	3-0-0	03
ECP351	Linear Integrated Circuits Lab	0-0-2	01
ECL359	Microprocessor and Interfacing	3-0-0	03
ECP359	Microprocessor and Interfacing Lab	0-0-2	01
EED351	Minor Project	-	01
EED451	Major Project	-	02

Departmental Elective (DE)			
Course Code	**Course**	**L-T-P**	**Credit**
EEP257	Electrical Workshop	0-0-2	01
EEL 307	Electrical And Industrial Safety	3-0-0	03
EEL 451	Computer Control and Automation of Power Systems	3-0-0	03
EEL 452	Discrete Data and Digital Control	3-2-0	04
EEL 453	Power Plant Engineering	3-0-0	03
EEL 454	HVDC	3-0-0	03
EEL 455	Power System Economics and Management	3-0-0	03
EEL 456	System Engineering	3-2-0	04
EEL 457	Pulse Width Modulation for Power Converters	3-0-0	03
EEL 458	Soft Computing Techniques	3-0-0	03
EEL 459	Commissioning and Testing of Electrical Systems	3-0-0	03
EEL 460	Control System Design	3-2-0	04
EEP460	Control System Design Lab	0-0-2	01
EEL 461	Electrical Energy System	3-0-0	03
EEL 462	Electrical Distribution System	3-0-0	03
EEL 463	High Voltage Engineering	3-0-0	03
EEL 464	Power Quality Issues & Solutions	3-0-0	03
EEL 465	Electrical Engineering Material	3-0-0	03
EEL 466	Power System Operation and Control	3-0-0	03
EEP 467	Soft Computing Techniques Lab	0-0-2	01
ECL352	Digital Signal Processing	3-0-0	03
ECP352	Digital Signal Processing Lab	0-0-2	01
ECL473	FPGA based IC/System Design	3-0-0	03
ECP473	FPGA based IC/System Design Lab	0-0-2	01
MAL401	Linear Algebra	3-0-0	03
MAL402	Probability Theory and Statistics	3-0-0	03
MEL461	Robotics	3-0-0	03
MEP461	Robotics Lab	0-0-2	01
CSL253	Object Oriented Programming	3-0-0	03
CSL251	Data Structures	3-0-0	03
CSP251	Data Structures Lab	0-0-2	01
CSL359	Neuro-Fuzzy Techniques	3-0-0	03

Course Code: EEL151
Course Title: ELEMENTARY ELECTRICAL ENGINEERING
Structure (L-T-P): 3-0-0 Prerequisite: NIL

Contents: Electrical circuit, circuit elements resistance, inductance & capacitance, Kirchhoff‘s laws, voltage source & current source, superposition theorem, Thevenin‘s theorem, norton‘s theorem, duality, star-delta transformation. DC Transients

AC circuits, periodic function, average & r.m.s. values, steady state behavior with sinusoidal excitation, phase representation, reactance & impedance, power and power factor, series & parallel circuit, resonance and quality factor, principle of generation of single phase & three phase voltages, power in balanced three phase ac system.

Power systems: elementary idea about bulk power generation, long distance transmission and distribution, industrial and residential distribution, safety & legal standards.

Magnetic circuit, flux, mmf, reluctance, analogy with electric circuits. Simple calculations for composite magnetic circuits. Magnetic Coupling Coefficient

Measurement of electrical current, voltage and energy in ac & dc systems.

Transformer: introduction, basic principles, construction, phasor diagram for transformer under no load condition, transformer on load, balance of mmf on both sides, phasor diagram, equivalent circuit, open circuit & short circuit test.

Electric Machines:

1. DC shunt and series motor – construction, principle of working and applications, need of starters, torque and speed control.
2. Induction motors – construction, principle of working of single phase and 3-phase motors, torque-slip characteristics.

Text Books:

1. Hughes, E., Electrical and Electronics Technology, 10th ed., Pearson Education, 2013.
2. Toro,V.D., Electrical Engineering Fundamentals, 2nd ed., Prentice Hall of India, 2012.

Reference Books:

1. Kothari D.P., Nagrath I.J, Theory and Problems of Basic Electrical Engineering, Prentice Hall India 2011.
2. Kulshreshtha, D.C., Basic Electrical Engineering, Tata McGraw Hill, 2013.

Course Code: EEL251
Course Title: BASIC ELECTRICAL CIRCUITS
Structure (L-T-P): 3-0-0 Prerequisite: EEL151

Contents: Classification of elements of an electrical circuit, Resistors, Inductors, Capacitors, Controlled sources, Diodes and ideal transformers. Basic circuit analysis methods nodal, Mesh and modified nodal-analysis. Transient analysis of RL, RC and RLC circuits.

Network theorems: Tellegen‘s theorem, Superposition theorem, Thevenin theorem, Norton theorem, Substitution theorem, Reciprocity theorem, Maximum power transfer theorem, Network analysis methods, Poly-phase circuits. Circuits transformers, Laplace transforms and their adaptation to networks. Two port networks, Two-port parameters, Interconnection of two ports and their effect on the parameters.

Tellegen‘s generalized reciprocity theorem, Multiport and multiterminal
networks, their representations and interconnections.

Graphs: paths, connectedness, circuits, cutsets, trees, matrix representation of directed graphs, incidence, cutset and circuit matrices, methods of analysis of linear networks, nodal, cutset, mesh and loop analysis.

Trigonometric and exponential Fourier series, discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and continuous spectra, three phase unbalance circuit and power calculation. Frequency domain approaches to electrical networks. Driving points and transfer functions poles and zeros of immittance function, their properties, sinusoidal response from pole-zero locations, convolution theorem and integral solutions.

Pole-zero concept, network synthesis: Hurwitz polynomial, Properties of Hurwitz polynomial, Positive real functions and their properties, Concepts of network synthesis, Realization of simple R-L, R-C and L-C functions in Cauer-I, Cauer-II, Foster-I and Foster-II forms.

Elements of Filter Theory: introduction, classification of filters, introduction of windows, butter worth filter challenge filter equation of ideal filter, image parameters and characteristics impedance, passive and active filter of various filter, low pass, high pass, constant K type, M derived filters and their design.

Transmission line parameters and performance, operation for maximum power transfer, characteristic impedance.

Text Books:

1. Hayt, W.H. and Kemmerley, J.E. and Durbin, S.N., Engineering Circuit Analysis, 7th ed., McGraw Hill, 2013.
2. Valkenburg, M. E. Van, Network Analysis, 3rd ed. Prentice Hall India, 2011.
3. Hayt, W.H. and Kemmerley, J.E. and Durbin, S.N., Engineering Circuit Analysis, 7th ed., McGraw Hill, 2013.
4. M. E. Van Valkenburg: Network Analysis, 3rd ed., Prentice Hall of
India.
5. Choudhury, D.R., Networks and Systems, 2nd ed., New Age Publication, 2014.

Reference Books:

1. Murthy, K.V.V.and Kamath M.S, Basic Circuit Analysis, 8th ed., Jaico Publishing House, 2010.
2. Choudhury, D.R., Networks and Systems, 2nd ed., New Age Publication, 2014.
3. Chua , L.O., Desoer, C.A. and Kuh, E.S., Linear and Nonlinear Circuits, McGraw Hill, 1991
4. Murthy, K.V.V. and Kamath M.S, Basic Circuit Analysis, 8th ed., Jaico Publishing House, 2010.

Course Code: EEL252
Course Title: MEASUREMENT & INSTRUMENTATION
Structure (L-T-P): 3-0-0 Prerequisite: EEL151, EEL 251

Contents: Classification of measuring instruments, comparison of analog and digital instruments, advantages of digital instruments, classification of analog instruments, absolute and secondary instruments, indicating type, recording type and integrating type instruments, loading effect of instruments.

Measurement of resistance: classification, measurement of low resistance by Kelvins‘ double bridge, measurement of medium resistance by voltmeter-ammeter method, Wheatstone bridge. Measurement of high resistance by Ohmmeter, Megger and loss of charge method, general theory of AC bridges, study of Maxwell, Hay‘s, Owen‘s, De Sauty‘s, Wien and Schering bridges, detectors for AC bridges.

Principles and use of D.C. potentiometer for calibration purposes, principle and applications of A.C. potentiometer. ammeter, voltmeter, principles of moving coil, moving iron and dynamometer type instruments, extension of range using series and shunts, error due to extension of range, digital voltmeter : types of DVM, integrating type DVM. Oscilloscope, working principle and its operations. Measurement of active and reactive power in polyphase circuits using dynamometer type instruments, measurement of energy in single and polyphase circuits using induction type instruments. Errors in power and energy measurements, class of accuracy, maximum demand indicator, trivector meter.

General theory of extension of range using CT and PT, errors in instrument transformers, applications of instrument transformers. Special instruments: power factor meter, frequency meter, synchroscope, rectifier type instrument, measurement of non-electrical quantities, digital frequency meter.

Text Books:

1. Sawhney, A.K., A Course in Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai and Sons, 2013

2. E.W. Golding & F.C. Widdis, ―Electrical Measurement and Measuring Instrumentsǁ, A.W. Wheeler and Co.Pvt. Ltd. India.

Reference Book:

1. E.O. Doebelin and D. N. Manik, ―Measurement systems application and designǁ, TMH, New Delhi.
2. Cooper, W.D. and Helfrick, A.D.,Modern Electronic Instrumentation and Measurement Techniques, 3rd ed., PHI Learning Private Limited, 2012.

Course Code: EEL253
Course Title: ELECTRICAL MACHINES-I
Structure (L-T-P): 3-0-0 Prerequisite: EEL151

Contents: Transformer: Single phase transformer : Phasor diagram for transformer for different loading conditions, equivalent circuit, open circuit & short circuit test , Back to back Test. Voltage regulation, efficiency calculation, parallel operation of transformer, Auto transformer, conversion of two winding transformer to auto transformer. Three Phase Transformer: Connection and phasor groups, effect of phase sequence, inrush current & harmonics, tertiary winding, open delta connection, Scott connection, Applications.

Basic of Rotating Machines: Rotating magnetic field, Induced EMF, Torque developed

DC Machines: Concept of induced emf, Armature winding and field winding, mmf of armature and field winding. Armature reaction, its bad effects and steps to limit the effects of armature reaction, Staring of Motor

DC Motor: Basic principle and operation, classification, torque, power, losses and efficiency, characteristics. Speed control of DC motor, Braking.

DC Generator: Emf equation, shunt and compound generator, losses and efficiency , characteristics & Applications.

Text Books:

1. Fitzgerald, A.E., Kingsley, C. and Umans, S.D., Electric Machinery,6th ed., Tata McGraw Hill, 2014
2. Bhimbhra, P.S., Electrical Machinery, Khanna Publishers, Delhi, 2003.
3. Nagrath, I. J. and Kothari, D. P., Electric Machines, Tata McGraw Hill, 2006.

Reference Books:

1. Bhattacharya, S.K., Electrical Machines, 3rd ed., McGraw Hill Education (India) Private Limited, 2013.

Course Code: EEL254
Course Title: CONTROL SYSTEM
Structure (L-T-P): -0-0 Prerequisite: EEL151, EEL251

Contents: Introduction: Introduction to need for automation and automatic control, Examples of control systems, Basic idea of feedback control systems, Use of feedback, Properties and effect of feedback, Control system component.

Mathematical Modelling: Mathematical modelling of: electrical systems, mechanical systems, electro-mechanical systems. Laplace transforms, transfer functions, electrical analogues of other dynamical systems. Block diagrams, block diagram reductions. Signal flow graph, Mason's gain formula.

Time response of dynamical systems: Time response of first order and second order system, Standard inputs, Poles and zeros and their effects on response, Type of control system, Time-domain specifications and their formulae, Steady state error And its analysis. P, PI, PD, PID controllers

Stability: Definition of stability. Routh-Hurwitz test.

Root-locus technique: Concept of Root Locus, Rules and steps for constructing a root-locus.

Frequency domain analysis: Bode plot, Polar plot, Nyquist plot, Nyquist stability criterion, gain and phase margins, and Robustness.

Text Books:

1. Ogata, K., Modern Control Engineering, 5th ed., Prentice Hall of India, 2012.
2. Nagrath, I.J. and Gopal, M., Control System Engineering, 5th ed., New Age International, 2012.
3. Kuo, B.C. and Golnaraghi F., Automatic Control Systems, 8th ed., Wiley India, 2011.
4. Abbas Emami-Naeini J. Da Powell Gene F. Franklin, Feedback Control of Dynamic Systems, Global Edition 7th Edition.

Reference Books:

1. Dorf R. C. and Bishop R. H., Modern Control Systems, 12th ed., Pearson Education, 2013

Course Code: EEL256
Course Title: POWER SYSTEM-I Structure (L-T-P): 3-2-0
Prerequisite: EEL151, EEL251

Contents: Power system introduction: Introduction, comparison of AC and DC systems, overhead versus underground systems, choice of working voltages for transmission and distribution, cost comparison of overhead and underground systems, Classification of Voltage levels, Introduction to HVDC & basic configuration.

Power factor improvement: Necessity of power factor improvement,
techniques for power factor improvement, Synchronous condenser, economics

Line parameters: Inductance and Capacitance, skin effect, proximity effect, Graphical method for performance of overhead transmission line. Transmission line modeling: Characterization of transmission line on basis of length, modeling of long, short and medium transmission line, ABCD parameters. Derivation for voltage drop and power loss in lines efficiency of short, medium and long transmission lines, Surge impedance, SIL.

Mechanical design: Sag and tention calculation in hilly and plain area, Sag and tension calculation with wind and ice effect. Line support, types of conductors; Overhead line insulators, types of insulator spin,
suspension and strain insulators, insulator materials, insulator string;

Corona: Corona formation, factors affecting corona, calculation of potential gradient, disruptive critical voltage and visual critical voltage, corona power loss, minimizing corona, merits and demerits of corona, skin effect.

Travelling Waves: Introduction and mechanism of traveling waves, wave equation, characteristic impedance of a line, incident and reflected waves, transmission and refraction of waves, velocity of traveling waves, behavior of traveling waves for different terminations: inductor, capacitor, open-end, short-end and over the junction of dissimilar lines, attenuation of traveling waves, lattice diagrams.

Surge Performance and Protection: Switching surges, origin and mechanism of lightening strokes, direct and induced strokes, protection from surges- lightning arrestors (rod gap, horn gap, multigap and expulsion type) and surge diverters, evaluation of surge impedance, energy and power of a surge.

Introduction to cables: Introduction, sheath, amour and covering, Classification of cables, Grading of cables, Underground HVDC cables.

Text Books:

1. Nagrath, I. J. andKothari, D.P., Power System Engineering, 2nd ed., Tata McGraw Hill Publications, 2013.
2. C.L Wadhwa, Electrical Power Systems, 6th ed., New Age international publications.

Reference Books:

1. Elgerd, O.I., Electric Energy Systems Theory: An Introduction, 2nd ed., Tata Mc-Graw Hill Education, 2012.
2. Saadat, H., Power System Analysis, 3rd ed., PSA Publishing, 2010.
3. Grainger, J.J., Stevenson, W.D., Power System Analysis, 22th ed., McGraw Hill Education (India) Private Limited, New Delhi, 2014.

Course Code: EEL254
Course Title: CONTROL SYSTEM Structure (L-T-P): 3-0-0
Prerequisite: EEL151, EEL251

Contents: Introduction: Introduction to need for automation and automatic control, Examples of control systems, Basic idea of feedback control systems, Use of feedback, Properties and effect of feedback, Control system component.

Mathematical Modelling: Mathematical modelling of: electrical systems, mechanical systems, electro-mechanical systems. Laplace transforms, transfer
functions, electrical analogues of other dynamical systems. Block diagrams, block diagram reductions. Signal flow graph, Mason's gain formula.

Time response of dynamical systems: Time response of first order and second order system, Standard inputs, Poles and zeros and

their effects on response, Type of control system, Time-domain specifications and their formulae, Steady state error And its analysis. P, PI, PD, PID controllers
Stability: Definition of stability. Routh-Hurwitz test. Root-locus technique: Concept of Root Locus, Rules and steps for constructing a root-locus.
Frequency domain analysis: Bode plot, Polar plot, Nyquist plot, Nyquist
stability criterion, gain and phase margins, and Robustness

Text Books:
1. Ogata, K., Modern Control Engineering, 5th ed., Prentice Hall of India, 2012.
2. Nagrath, I.J. and Gopal, M., Control System Engineering, 5th ed., New Age International, 2012.
3. Kuo, B.C. and Golnaraghi F., Automatic Control Systems, 8th ed., Wiley India, 2011.
4. Abbas Emami-Naeini J. Da Powell Gene F. Franklin, Feedback Control of Dynamic Systems, Global Edition 7th Edition.
Voltage regulation: Calculation of voltage distribution and string efficiency, methods of equalizing voltages, use of guard rings, sag calculation, factors affecting sag. power-loss calculations, Manual methods of solution for radial networks,

Reference Books:
1. Dorf R. C. and Bishop R. H., Modern Control Systems, 12th Pearson Education, 2013.
2. D'Azzo J. J., Houpis, C.H. and Sheldon, S.N., Linear Control System Analysis and Design with MATLAB, 6th ed., CRC Press, 2014.
3. Nise, N.S., Control Systems Engineering, 6th ed., Wiley, 2013.
4. Gopal, M., Control Systems: Principles and Design, 3rd ed., Tata McGraw Hill Education, 2010.

Course Code: EEL255
Course Title: POWER ELECTRONICS Structure (L-T-P): 3-0-0
Prerequisite: EEL151, EEL251
Contents: Power semiconductors devices and switching circuits: SCR and its characteristics, SCR ratings ,series and parallel operations of SCRs, Triggering circuits, commutating circuits, protection of SCR. Gate circuit protection, over voltage and over current protection, snubber circuit design, converter circuit faults and their protection, Uni-Junction Transistor (UJT), Self Commutating Device: characteristics and working of MOSFET. Gate turn off thyristor and insulated gate bipolar transistor.
AC to DC Converters: working of single pulse and two pulse converters. Three pulse midpoint converter and 3 phase six pulse bridge converter. Effect of source inductance in converters. Effect of freewheeling diode. Speed control of DC motor using converter.
DC to DC Converters: Classification, principles of step down chopper and step up chopper, Buck, Boost, Buck-Boost converter and application to low power circuits.
DC to AC Converters: Single phase and three phase bridge inverters, output voltage control, harmonics in output voltage waveform, harmonics attenuation by filters. Harmonic reduction by pulse width modulation techniques, analysis for single pulse width modulation, working of current source inverters, applications of inverters.
AC to AC Converters: Operation & analysis of single phase integral cycle and phase controlled converters, configuration of three phase controllers, Cycloconverters: Single phase and three phase configurations and operating principle, AC voltage controller Introduction of matrix converter.
Text Books:
1. Mohan, Ned, Undeland, T.M. and Robbins, W.P., Power Electronics, 3rd ed., Wiley India, 2014
2. Rashid, M.H., Power Electronics: Circuits Devices & Applications, 3rd ed., Pearson Education, 2012.
3. Joseph Vithayathil, Power Electronics: Principles and Applications, Tata McGraw-Hill Education.
Reference Books:
1. Singh, M.D. and Khanchandani K.B., Power Electronics, 2nd ed., Tata McGraw Hill Education, 2012.
2. Bose, B.K., Modern Power Electronics and AC Drives, PHI Learning, New Delhi, 2012.
3. Lander, C.W., Power Electronics, 3rd ed., McGraw Hill, 1993.
4. Bimbhra, P.S., Power Electronics, Khanna Publishers, 2012.
5. Dubey, G.K., Fundamentals of Electrical Drives, 2nd ed., Narosa Publication, 2013.

Course Code: EEL307
Course Title: ELECTRICAL AND INDUSTRIAL SAFETY
Structure (L-T-P): 3-0-0
Pre-requisites: EEL203
Contents: Review of electrical concept, Working principle of major electrical equipment, Typical supply situation, Standards and statutory requirements, Indian electricity acts and rules, Indian boiler acts and regulations statutory requirements from electrical inspectorate. International standards of electrical safety, First aid-cardiopulmonary resuscitation (CPR).
Electrical hazards, Effect of electrical shock of human being, Effect of lightening current on installation and buildings, Energy leakage, Clearance and insulation, Excess energy, Current, Surges, Electrical causes of fire and explosion, Importance of earthing in installation. Safety of transmission lines, substations, Transformer, circuit breakers and power control drives. National electrical safety code. General safety rules, Principles, Maintenance, Inspections.

Text Books:
1. Krishnan, N.V., Safety Management in Industry, Jaico Publishing House, 1997.
2. Cooper W.F., Electrical Safety Engineering,3rd ed., Newnes, 2002.
Additional Books:
1. Cadick, J., et. al., Electrical Safety Handbook, 4thed, McGraw Hill, 2013.
2. Bureau of Indian Standards, National Electrical Code 2011, Bureau of Indian Standards, New Delhi, 2011.
3. Manchanda, S.C., Manchanda's the Indian Boilers Regulations, 1950 and the Indian Boilers Act, 1923 (Act No. V of 1923), 2nd ed., Delhi Law House, Delhi, 2009.

Course Code: EEL351
Course Title: ELECTRICAL MACHINES-II
Structure (L-T-P): 3-0-0 Prerequisite: EEL151, EEL253
Contents: Three Phase Induction Motor: principle and operation, types of motors, Three phase speed control of induction motor (V/f control etc.) load torque-speed characteristics, determination of equivalent circuit parameter, circle diagram of induction motor , starting against load, star delta starter, soft starting faults on motor , single phasing & protection. Different types of slots of machines (open, closed, semi closed), Crawling, Cogging, Induction Generator,
Three phase Alternator: constructional features of cylindrical and salient pole rotor machines, steady state operation of three phase synchronous generators, phasor diagram, regulation & efficiency, parallel operation, transient & sub transient reactance's and their measurement, short circuit fault currents. Effects of variable excitation and mechanical power input on generator operation.
Three phase Synchronous Motor: methods of starting, performance and leading power factor operation due to effect of variable excitation and load on motor operation. Study of both cylindrical and salient pole alternator, phasor diagram at various power factor, V curve, capability characteristics etc.
Single phase machines: Induction Motor: principle, equivalent circuit,
characteristics, double field revolving theory, staring methods, Repulsion motor, Reluctance motor, Hysteresis motor, Universal motor, Stepper motor.
Text Books:
1. Fitzgerald, A.E., Kingsley, C. and Umans, S.D., Electric Machinery,6th ed., Tata McGraw Hill, 2014
2. Bhimbhra, P.S., Electrical Machinery, Khanna Publishers, Delhi, 2003.
3. Nagrath, I. J. and Kothari, D. P., Electric Machines, Tata McGraw Hill, 2006.
Reference Books:
1. A.S. Langsdorf: Theory of Alternating Current Machinery, Tata Mc- Graw Hill.
2. I.J. Nagrath, D.P. Kothari: Electrical Machines, Tata McGraw Hill.
3. M. G. Say: The Performance and Design of Alternating Current Machines, III Edition, CBS Publishers & Distributers.
4. Toro, V.D., Electric Machines and Power Systems, Prentice Hall, 1985.

Course Code: EEL352
Course Title: ELECTRIC DRIVES Structure (L-T-P): 3-0-2
Prerequisite: EEL253, EEL255
Contents: Definitions, classification and speed torque characteristics of common industrial loads & drive motors and their characteristics under starting, running, braking and speed control.
Introduction:
Review of power converters used in drives, multi-quadrant operation of electric drive, example of hoist operation in four quadrant.
DC Drives:
Single-phase half controlled and fully controlled converter fed dc motor drives, operation of dc drives with continuous armature current, voltage and current waveforms; Concept of energy utilization and effect of free- wheeling diode;
Operation of drive under discontinuous current, expression for speed- torque characteristic.
Chopper fed DC Drives:
Principle of operation and control techniques, chopper circuit configurations used in dc drives: Type A, B, C, D and E; Motoring operation of chopper fed separately excited dc motor, steady state analysis of drive with time-ratio control.
Closed Loop Control of DC Drives:
Drives with current limit control, single-quadrant closed loop drive with inner current control loop, advantage of inner current control loop in drives.
AC Drives:
Variable voltage, rotor resistance and slip power recovery control of induction motors, torque-speed characteristics under different control schemes; Variable frequency control of induction motor, analysis of induction machine under constant V/f operation, constant flux operation and controlled current operation.
Estimation of Drive Motor Rating:
Selection of motor power capacity for continuous duty at constant load and variable loads; Selection of motor capacity for short time and intermittent periodic
duty, permissible frequency of starting of squirrel cage motor for different duty cycles.
Text Books:
1. Dubey, G.K., Fundamentals of Electrical Drives, 2nd ed., Narosa Publication, 2013.
2. Partab H., Modern Electrical Traction; Dhanpat Rai and Co. Pvt. Ltd, 2014.
3. J. M. D. Murphy & F. G. Turnbull, ―Power Electric Control of AC Motors‖, Pergamon Press.
Reference Books:
1. Subrahmanyam, V., Electric Drives: Concepts and Applications, 2nd ed., Tata McGraw Hill Education, New Delhi, 2011.
2. Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., A Course in Electrical Power, Dhanpat Rai & Sons, New Delhi, 1987
3. Bimal K. Bose, ―Power Electronics and Variable Frequency Drives: Technology and Applications‖.

Course Code: EEL353
Course Title: POWER SYSTEM-II Structure (L-T-P): 3-0-0
Prerequisite: EEL151, EEL251, EEL256
Contents: General concept: Introduction of bus matrix, Ybus formulation, Tap changing transformer formulation in Ybus, Zbus formulation, Single line representation, per unit calculations of parameters.
Load Flow Analysis: Formation of static load flow equations, solution of
decoupled load flow problem by Gauss-Seidel, Newton-Rapson (polar and rectangular) and fast decoupled techniques
Stability of Power system: Introduction, dynamics of synchronous machine, swing equation, swing equation for multi machine system, power angle equation, steady state stability studies.
Transient stability analysis: Swing curve, Swing equations solutions using Runga Kutta method (4th order). Equal area criteria, for transient stability, application of equal area for different disturbance, solution of swing equation point by point methods.
Power System Control: Elementary idea of single area load-frequency control, automatic generation control, Necessity of keeping frequency control, Block diagram representation of an isolated power system, steady state analysis, dynamic response
Voltage control: Equipment for voltage control, Effect of series capacitors, Effect of AVB/AVR, Line drop compensation.
Active power and frequency control: fundamentals of speed governing, control of generating unit power output, composite regulating characteristics of power systems, response rates of turbine governing systems, fundamental of automatic generation control, Implementation of AGC, underfrequency load shedding.
Reactive power and voltage control: Production and absorption of reactive power, method of voltage control,shunt reactors, shunt capacitors, series capacitors, synchronous condensers, static Var system, principle of transmission system compensation, Modelling of reactive compensating devices, Application of tap changing transformers to transmission systems, ULTC control system.
Text Books:
1. Grainger, J.J., Stevenson, W.D., Power System Analysis, 22th ed., McGraw Hill Education (India) Private Limited, New Delhi, 2014.
2. Nagrath, I. J. andKothari, D.P., Power System Engineering, 2nd ed., Tata McGraw Hill Publications, 2013.
Reference Books:
1. Elgerd, O.I., Electric Energy Systems Theory: An Introduction, 2nd ed., Tata Mc-Graw Hill Education, 2012.
2. Saadat, H., Power System Analysis, 3rd ed., PSA Publishing, 2010.

Course Code: EEL355
Course Title: SWITCHGEAR AND PROTECTION
Structure (L-T-P): 3-0-0
Prerequisite: EEL256, EEL253, EEL351
Contents: Faults in Power Supply System: Symmetrical component transformation. Classification of faults, Three phase power in unbalanced circuit in terms of symmetrical component. Sequence impedance of generator. Transformer transmission line & passive loads. Symmetrical fault analysis without & with prefault load currents. Selection of circuit breakers ratings, current limiting reactors.
Unsymmetrical fault analysis L-G, L-L-G-, L-L, open conductors fault using symmetrical components.
General philosophy of protective relaying: protective zones. Primary protection, back up protection, remote and local back up. Medium voltage line protection: overcurrent relay, directional over current relays. High voltage line protection: Distance relays, carrier distance schemes. Unit carrier schemes.
Equipment protection: principles of differential relaying, protection of generator, transformers and busbars by differential relaying and other relays. Phase shift in Y/delta three phase transformer (Yd1, Yd11 connection). Protection of induction motor‘s against overload, short- circuits, thermal release, miniature circuit breaker.
Introduction to numerical relays: Comparison of static and electro-mechanical relays, two input amplitude and phase comparators and their duality. Generation of various distance relay characteristics using above comparators.
Switchgear: circuit breakers, arc interruption theory, recovery and restriking voltages, RRRV, breaking of inductive and capacitive current, different media of arc interruption, SF6 and vacuum breakers. Introduction to Gas Insulated Switchgear and Substation
Text Books:
1. Ram, B. and Vishwakarma, D.N. Power System Protection & Switchgear, 2nded., Tata McGraw Hill, 2013.
2. Paithankar, Y.G. and Bhide, S.R., Fundamentals of Power System Protection, 2nd ed., PHI Learning, 2013
Reference Books:
1. Elmore, W.A, Protective Relaying Theory and Applications, 2nd ed., MarcelDekker, New York, 2004.
2. Mason, C.R., Art and Science of Protective Relaying, Wiley, New York, 1968.
3. Warrington, A.R.V., Protective Relays: Their Theory and Practice (Vol. I & Vol. II), 3rd ed., Chapman and Hall, London, 1978.

Course Code: EEL356
ADVANCED CONTROL SYSTEM
Structure (L-T-P): 3-0-0
Course Prerequisite: EEL151, EEL251, EEL254
Contents: Introduction: Review of classical feedback control, frequency response, Constant M circle and N circle and Nichols chart.

Design of compensators: Lead compensator, Lag compensator, Lead-lag/Lag-lead compensators, their design using root locus and Bode plot.
State Variable: Concepts of state, State variable and state model, State-space modelling of dynamical systems, Diagonalization, Solution of state equations, Controllability and Observability
Control System Design in state space: Pole placement techniques, State Observes, Design of a regulator system with observers, Design of Control system with observers, Design of the observers using MATLAB
Stability: Lyapunov theory, Liapunov's stability criterion, Direct and indirect method of Liapunov and the linear system, Methods of construction Liapunov functions.

Text Books

1. Dubey, G.K., Fundamentals of Electrical Drives, 2nd ed., Narosa Publication, 2013.
2. Partab H., Modern Electrical Traction; Dhanpat Rai and Co. Pvt. Ltd, 2014.
3. J. M. D. Murphy & F. G. Turnbull, ―Power Electric Control of AC Motor, Pergamon Press.

Reference Books

1. Subrahmanyam, V., Electric Drives: Concepts and Applications, 2nd ed., Tata McGraw Hill Education, New Delhi, 2011.
2. Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., A Course in Electrical Power, Dhanpat Rai & Sons, New Delhi, 1987
3. Bimal K. Bose, ―Power Electronics and Variable Frequency Drives: Technology and Application

Course Code: EEL451
Course Title: COMPUTER CONTROL AND AUTOMATION OF POWER SYSTEMS
Structure (L-T-P): 3-0-0 Prerequisite: EEL256

Contents: Energy Management Systems (EMS): Energy Management Centers and Their Functions, Architectures, recent Developments. Characteristics of Power Generating Units and Economic Dispatch. Unit Commitment (Spinning Reserve, Thermal, Hydro and Fuel Constraints); Solution techniques of Unit Commitment. Generation Scheduling with Limited Energy. Energy Production Cost – Cost Models, Budgeting and Planning, Practical Considerations. Interchange Evaluation for Regional Operations, Types of Interchanges. Exchange Costing Techniques.
Supervisory Control and Data Acquisition (SCADA): Introduction to Supervisory Control and Data Acquisition. SCADA Functional requirements and Components. General features, Functions and Applications, Benefits. Configurations of SCADA, RTU (Remote Terminal Units) Connections. Power Systems SCADA and SCADA in Power System Automation. SCADA Communication requirements. SCADACommunication protocols: Past Present and Future. Structure of a SCADA Communications Protocol.

Text Books:

1. Wood, A. J., Wollenberg, B.F. and Sheble, G.B., Power Generation Operation and Control,3rd ed.,Wiley-Interscience, 2014.
2. Green J.N, Wilson, R,Control and Automation of Electric Power Distribution Systems,CRC Press, 2013.
3. M A Pai, Computer Techniques In Power System Analysis, Mc-Graw Hills
4. G.W. Stagg & A.H. El-Abiad, Computer Methods In Power System Analysis, Mc-Graw Hills

Reference Books:

1. Handschin E. and Petroianu, A., Energy Management Systems: Operationand Control of Electric Energy Transmission Systems, Springer Verlag, 1991.
2. Handschin, E., Real-Time Control of Electric Power Systems, Elsevier, 1972. 3. McDonald, J.D., Electric Power Substations Engineering, 3rd ed., CRC Press, 2012.

Course Code: EEL452
Course Title: DISCRETE DATA AND DIGITAL CONTROL
Structure (L-T-P): 3-2-0 Prerequisite: EEL254

Contents: Sampling and data reconstruction processes: sampled, Data control systems, Ideal sampler, Sampling theorem, Sample and hold operations, Frequency domain considerations.
Z-transforms: Properties inverse, Applications to solution of difference equations, Convolution sums.
Stability of discrete systems: Location of poles, Jury's stability criterion, Stability analysis through bilinear transforms.
General procedures for obtaining pulse Transfer functions, Pulse Transfer function of open loop and closed loop systems, Dead beat controller, closed loop digital control systems with time delay systems. Design of digital control systems: PID controllers and frequency domain compensation design.
State variable methods and the discrete linear regulator problem. Deadbeat observer, The Separation Principle, Reduced order observer, Root locus technique.

Text Books:

1. Ogata, K., Discrete Time Control System, 2nd ed., Prentice Hall of India, 2011.
2. Gopal, M., Digital Control Engineering and State Variable Methods:
Conventional and Intelligent Control Systems, 4th ed., Tata McGrawHill, 2012.

Reference Books:

1. Isermann, R., Digital Control Systems, 2nd ed., Springer, 1997.
2. Landau, Y.D. and Zito, G., Digital Control Systems: Design, Identification and Implementation, Springer, 2006

Course Code: EEL453
Course Title: POWER PLANT ENGINEERING
Structure (L-T-P): 3-0-0
Prerequisite: EEL253, EEL256

Contents: Conventional Sources of electrical energy: Steam, hydro, nuclear, diesel and gas, their scope and potentialities for energy conversion.
Generation: Different factors connected with a generating station, load curve, load duration curve, energy load curve, base load and peak load plants.
Thermal stations: Selection of site, size and no. of units, general layout, major parts, auxiliaries, generation costs of steam stations.
Hydro stations: Selection of site, mass curve, flow duration curve, hydrograph, classification of hydro plants, types of hydro turbines, pumped storage plants.
Nuclear stations: Main parts, location, principle of nuclear energy, types of nuclear reactors, reactor control, nuclear waste disposal.
Power station control and interconnection: Excitation systems, excitation
control, automatic voltage regulator action, advantage of interconnection.
Alternate energy sources: Solar, wind, geo-thermal, ocean-thermal, tidal
wave, MHD and biomass.

Text Books:

1. Deshpande, M.V., Elements of Electrical Power Station Design, 5th ed., PHI, 2013.
2. Gupta, B.R., Generation of Electrical Energy, S. Chand, New Delhi, 2013.

Reference Books:

1. Nag, P.K., Power Plant Engineering, 3rd ed., Tata Mc-Graw Hill Education, 2013.
2. Raja, A.K., Srivastava, A.P. and Dwivedi, M., Power Plant Engineering, New Age International Private Limited, New Delhi, 2006.

Course Code: EEL454
Course Title: HVDC Structure (L-T-P): 3-0-0
Prerequisite: EEL255

Contents: Evolution of HVDC Transmission, Comparison of HVAC and HVDC systems, Type of HVDC Transmission systems,
Components of HVDC transmission systems, Analysis of simple rectifier circuits, Required features of rectification circuits for HVDC transmission, Analysis of HVDC converter, Different modes of converter operation, Output voltage waveforms and DC voltage in rectification, Output voltage waveforms and DC in inverter operation, Thyristor voltages, Equivalent electrical circuit, HVDC system control features,Control Modes, Control Schemes, Control comparisons.
Converter mal-operations, Commutation failure, Starting and shutting down the converter bridge, Converter protection.
Smoothing reactor and DC Lines, Reactive power requirements, Harmonic analysis, Filter design.

Component Models for the Analysis of AC DC Systems, Power flow analysis of AC-DC systems, Transient stability analysis, Dynamic stability analysis.
Multi-terminal HVDC system, Advances in HVDC transmission, HVDC
system application in wind power generation.

Text Books:

1. Padiyar, K.R., HVDC Power Transmission Systems, 2nd ed., New Age International, 2013.
2. Kimbark, E.W., Direct Current Transmission, Wiley-Interscience, New York, 1971.

Reference Books:

1. Singh, S.N., Electric Power Generation, Transmission and Distribution, 2nd ed., PHI Learning, New Delhi, 2010.
2. Arrillaga, J., High Voltage Direct Current Transmission, 2nd ed., Institution of Engineering and Technology, London, 2008.

Course Code: EEL 455

Course Title: POWER SYSTEM ECONOMICS & MANAGEMENT

Structure (L-T-P): 3-0-0 Prerequisite: EEL256

Contents: Economic Operation of Power Systems: Optimal operation of Generators in Thermal Power Stations, Heat rate Curve, Cost Curve, Incremental fuel and Production costs, input-output characteristics, Optimum Generation allocation with line losses neglected.
Optimum generation allocation including the effect of transmission line losses – Loss Coefficients, General transmission line loss formula.
Hydrothermal Scheduling: Optimal scheduling of Hydrothermal System: Hydroelectric Power plant models, Scheduling problems-short term Hydrothermal scheduling problem.
Modeling of Turbine, Generator and Automatic Controllers: Modelling of Turbine: First order Turbine, model, Block Diagram representation of Steam Turbines and Approximate Linear Models.
Modelling of Generator (Steady State and Transient Models): Description of Simplified Network Model of a Synchronous Machine (Classical Model), Description of Swing Equation (No Derivation) and State-Space II-Order Mathematical Model of Synchronous Machine.
Modelling of Governor: Mathematical Modelling of Speed Governing
System – Derivation of Small signal transfer function. Modelling of Excitation System: Fundamental Characteristics of an Excitation system, Ttransfer function, Block Diagram Representation of IEEE Type-1 Model Single Area Load Frequency Control: Necessity of keeping frequency constant. Definitions of Control area, Single area control, Block diagram representation of an isolated power system, steady state analysis, Dynamic response, Uncontrolled case.
Two-area load frequency control:
Load frequency control of 2-area system – uncontrolled case and controlled case, tie-line bias control.
Load Frequency Controllers:
Proportional plus Integral control of single area and its block diagram representation, steady state response – Load Frequency Control and Economic, Dispatch control.
Reactive Power Control: Overview of Reactive Power control, Reactive Power compensation in transmission systems, advantages and disadvantages of different types of compensating equipment for transmission systems, load compensation, Specifications of load compensator, Uncompensated and compensated transmission lines, shunt and Series Compensation.
Text Books:
1. Kundur P., Power System Stability and Control, EPRI Series, McGraw-Hill, 1998.
2. Wood A. J. and Wollenberg B. F., Power Generation, Operation and Control, second edition, Willey Publication, 2008.
Reference Books:
1. Nagrath I. J. and Kothari D. P., ―Power System Engineering‖, 2nd
edition, Tata Mc-Graw Hill Publishing Company,2008.
2. Saadat H., Power System Analysis, 1st International Edition, Tata McGraw-Hill Publishing Company Limited, 2008

Course Code: EEL456

Course Title: SYSTEM ENGINEERING Structure (L-T-P): 3-0-0

Prerequisite: NIL

Contents: Introduction to Optimization, Generalized Principles of System Modeling, Engineering Applications of Optimization, Statement of problem, Classification of optimization problem techniques.
Linear programming, introduction, Requirements for a LP Problem,
Graphical solution of 2-variable LP problems, Some exceptional cases, General mathematical formulation for LPP, Canonical and standard forms of LP problem, Simplex method, special cases in simplex method, Big-M method, Concept of duality, Dual simplex method and sensitivity analysis.
Transportation problem, Definition and mathematical representation of transportation model, Formulation and solution of transportation models (basic feasible solution by north-west corner method, Inspection method, Vogell's approximation method).
Network models, Scope and definition of network models, Minimal spanning tree algorithm, Shortest-route problem, Maximal flow model. Goal programming, Formulation of goal programming, Introduction to goal programming algorithms, The weights method, The preemptive method.
Text Book:
1. Hamdy A. Taha, Operations Research: An Introduction, Pearson, 9th Ed., 2014.
Reference Books:
1. S. S. Rao, Engineering Optimization: Theory and Practice, 4th Ed., John Wiley & Sons, 2009.
2. G. Hadley, Linear Algebra, Narosa, 2002.
3. P. K. Gupta and D. S. Hira, Operations Research, S. Chand Publications, 7th Ed., 1976.

Course Code: EEL457

Course Title: Pulse Width Modulation for Power Converters Structure

(L-T-P): 3-0-0

Prerequisite: EEL255

Contents: Introduction: Review of Voltage Source Inverters and Multi-level Inverters.
Harmonic Distortion: Voltage and Current Distortion Factors and Weighted THD calculation by using Fourier series for different level Voltage Source Inverters.
Pulse width modulation (PWM) at low switching frequency: Square wave operation of voltage source inverter; PWM with a few switching angles per quarter cycle; equal voltage contours; selective harmonic elimination.
Triangle-comparison based PWM: Average pole voltages, sinusoidal modulation, third harmonic injection, continuous PWM, bus-clamping or discontinuous PWM; Extensions of sine-triangle PWM to multilevel inverters.
Space Vector Based PWM: Space vector concept and transformation, per-phase methods from a space vector perspective, space vector based modulation, conventional space vector PWM, bus-clamping PWM, advanced PWM, triangle-comparison approach versus space vector approach to PWM, Extensions of space vector based PWM to multilevel inverters.
Inverter loss: Evaluation of conduction loss, Dependence of switching loss on power factor and modulation method, PWM techniques for reduced switching loss.
Effect of inverter dead-time: Effect of dead-time with continuous modulation, Effect of dead-time with discontinuous or bus-clamping PWM.

Text books:

1. Mohan N., Underland T.M., Robbins W.P., ―Power Electronics – Converters, Applications and Design‖, John Wiley & Sons Inc., 2004.
2. Erickson R. W., Maksimovic D., ―Fundamentals of Power Electronics‖, Springer (India) Pvt. Ltd., 2005.
3. Rashid M. H., ―Power Electronics: Circuits, Devices and Applications‖, Third Edition, Pearson, 2009.

Reference books:

1. Choi Byungcho, ―Pulsewidth Modulated DC to DC Power Conversion: Circuits, Dynamics and Control Designs‖, IEEE Press, John Wiley & Sons, Inc., 2013.
2. Holmes D.G., Lipo T.A., ―Pulse Width Modulator for Power Converters – Principles and Practice‖, IEEE Press, John Wiley & Sons, Inc., 2003.

Course Code: EEL458
Course Title: SOFT COMPUTING TECHNIQUES
Structure (L-T-P): 3-0-0 Prerequisite: SCL152, SCL153
Contents: Introduction, brief history of artificial intelligence, comparison with deterministic methods, aims, objectives of artificial intelligence and current state of the art.
Expert systems: introduction to knowledge based systems structure and definitions knowledge acquisition inference engine, forward and backward chaining.
Fuzzy logic: introduction to concepts, fuzzy reasoning, defuzzification, adaptive fuzzy systems.
Artificial neural networks: basic concepts, introduction to various paradigms, learning in neural networks, back-propagation, multi-layer networks,
Evolutionary computing (Genetic algorithms): basic concepts, Genetic algorithms and variants,
Differential evolution, Particle swarm optimization (PSO) and variants, Bacterial foraging optimization (BFO), Ant colony optimization - travelling salesman problem, cat swarm optimization.
Applications of AI in Electrical Engineering like condition monitoring, protective relaying etc.
Text Books:
1. Zurada, J.M., Introduction to Artificial Neural Systems, Jaico Publication House, 2006.
2. Haykin, S.S., Neural Networks and Learning Machines, 3rd ed., PHI Learning, 2013.
3. Lotfi A. Zadeh (Advances in Fuzzy Systems: Application and Theory) First Edition,
Reference Books:
1. Deb, K., Multi-Objective Optimization Using Evolutionary Algorithms, John Wiley and Sons, 2009.
2. Hagan, M.T., Demuth, H.B. and Beale, M.H., Neural Network Design, Vikas Publishing House, New Delhi, 2004.
3. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications Paperback – Import, 8 May 2017
4. Lefteri H. Tsoukalas, Robert E. Uhrig, Lotfi A. Zadeh, Fuzzy And Neural Approaches in Engineering.

Course Code: EEL459
Course Title: COMMISSIONING AND TESTING OF LECTRICAL SYSTEMS Structure (L-T-P): 3-0-0 Prerequisite: EEL151, EEL253, EEL351
Contents: Installation of Electrical Equipment: Inspection of Electrical Equipment at site, Storage Electrical Equipment at site, Foundation of Electrical Equipment at site, Alignment of Electrical Machines, Tools/Instruments necessary for installation, Technical report, Inspection, storage and handling of transformer, switchgear and motors. Testing of Transformer, Plant and Equipment:
General Requirements for Type, Routine and Special Tests, Measurement of winding resistance; Measurement of voltage ratio and check of voltage vector relationship; Measurement of impedance voltage/short-circuit impedance and load loss; Measurement of no-load loss and current; Measurement of insulation resistance; Dielectric tests; Temperature-rise, insulation and HV test, dielectric absorption, switching impulse test. Testing of Current Transformer and Voltage Transformer, power transformer, distribution transformer, CVT and special transformer with reference to Indian Standard (IS). Drying out procedure for transformer. PI index, Commissioning steps for transformer, Troubleshooting &
Maintenance of transformer. [Ref: IS 2026:Part_1-10- Power Transformers: Methods of Test; IS 13956:1994Testing Transformers] Installation and Commissioning of Rotating Electrical Machines: Degree of protection, cooling system, degree of cooling with IP- IC code (brief discussion), enclosures, rating of industrial rotating electric machine, installation, commissioning and protection of induction motor and rotating electric machine, drying out of electric rotating machine, insulation resistance measurement, site testing and checking, care, services and maintenance of motors, commissioning of synchronous generator, protection and automation of synchronous generator, synchronous motor, D.C. generator and motor with reference to Indian Standard (IS). [Ref: IS 4029:2010-Guide for Testing Three Phase Induction Motors; IS 7132:1973-Guide for Testing Synchronous Machines; IS 9320:1979-Guide for Testing of Direct Current (dc) Machines]
Transmission line:
Commissioning of A.C transmission line and HVDC transmission, galvanize steel structure, towers and insulator for transmission and distribution line, tower footing resistance, substation equipment, bus bar system, power cable, low power control cable, Contactor, GIS (gas insulated substation).
SWITCH GEAR & PROTECTIVE DEVICES
Standards, Classification, specification, rating and duties of CB, installation, commissioning tests, maintenance schedule, type & routine tests. Operation of s/s (steps) for line Circuit breaker maintenance. Location of lightening arrester with reasons
Text books:
1. S. Rao, Testing Commissioning Operation & Maintenance of Electrical Equipments , 6th Ed , Khanna Publishers Delhi, 2010.
2. P. Gill, Electrical Power Equipment Maintenance and Testing, 2nd Ed., CRC Press (Taylor & Francis Group), 2009.
Reference Books:
1. T. Singh, Installation commissioning & Maintenance of Electrical Equipments, S. K. Kataria and Sons, New Delhi, 2013.
2. P. Kiameh, Electrical Equipment Handbook: Troubleshooting & Maintenance, 1st Ed., McGraw-Hill Companies, Inc, 2003.

Course Code: EEL460
Course Title: CONTROL SYSTEM DESIGN
Structure (L-T-P): 3-0-0 Prerequisite: NIL
Contents: Introduction: The process of control system design, Control problem, Scaling, Deriving the linear models.
Classical Feedback Control: One degree and two degree of freedom controller, Sensitivity, Loop Shaping Design, IMC Design
Modern Control: Review of State variables, performance measures like ISE, ITAE, Quadratic indices, Uncertainty, robustness and performance analysis for SISO and MIMO system.
Controller Design: Linear Quadratic Regulator (LQR), Optimal control law, Algebraic Riccati equation, Linear Quadratic Gaussian (LQG): statistical descriptions of noise, Kalman filter, stability margins, H design and model-order reduction.
Case studies: Inverted pendulum, Aero etc. and software based design of industrial controllers
Text Books:
1. Ogata, K., Modern Control Engineering, 5th ed., Prentice Hall of India, 2012.
2. Nagrath, I.J. and Gopal, M., Control System Engineering, 5th ed., New Age International, 2012.
3. Kuo, B.C. and Golnaraghi F., Automatic Control Systems, 8th ed., Wiley India, 2011.
4. Abbas Emami-Naeini J. Da Powell Gene F. Franklin, Feedback Control of Dynamic Systems, Global Edition 7th Edition.
Reference Books:
1. Dorf R. C. and Bishop R. H., Modern Control Systems, 12th ed., Pearson Education, 2013.

Course Code: EEL461
Course Title: ELECTRICAL ENERGY SYSTEM
Structure (L-T-P): 3-0-0 Prerequisite: NIL
Contents: Introduction, Fossil fuel based systems, Impact of fossil fuel based systems, Non-conventional energy, seasonal variations and availability, Renewable energy, sources and features, Hybrid energy systems, distributed energy systems and dispersed generation (DG) Solar thermal systems: Solar radiation spectrum, Radiation measurement, Technologies, Applications, Heating, Cooling, Drying, Distillation, Power generation.
Solar Photovoltaic systems: Operating principle, Photovoltaic cell concepts, Cell, module, array, Series and parallel connections, Maximum power point tracking, Applications, Battery charging, Pumping, Lighting, Peltier cooling.
Microhydel: Operating principle, Components of a microhydel power plant, Types and characteristics of turbines, Selection and modification, Load balancing.
Wind: Wind patterns and wind data, Site selection, Types of wind mills, Characteristics of wind generators, Load matching.
Hybrid Systems: Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Diesel-PV, Wind-PV, Microhydel-PV, electric and hybrid electric vehicles.
Tariffs and cost of energy under regulated and de-regulated environment, Energy audit and its methodologies.
Text Books:
1. Rai, G.D., Non-Conventional Energy Sources, 5th ed., New Age International, 2013.

2. Ramesh, R., Renewable Energy Technologies: Ocean Thermal Energy Conversion and other Sustainable Energy Options, Narosa, New Delhi, 1997.

Reference Book:

1. Vanek, F.M., Albright, L.D. and Angenent, L.T., Energy Systems Engineering: Evaluation and Implementation, 2nd ed., Tata McGraw Hill, 2012.

Course Code: **462**
Course Title: **ELECTRICAL DISTRIBUTION SYSTEM**
Structure (L-T-P): **3-0-0**
Prerequisite: **EEL256**

Contents: General concepts: Introduction to distribution systems, Load modeling and characteristics. Coincidence factor, Contribution factor loss factor-relationship between the load factor and loss factor. Classification of loads (Residential, Commercial, Agricultural and industrial) and their characteristics.

Distribution feeders: Design consideration of distribution feeders: Radial and loop types of primary feeders, Voltage levels, Feeder loading; Basic design practice of the secondary distribution system. Substations: location of substation, Rating of distribution substation, Service area within primary feeders. Benefits derived through optimal location of substations.

Underground Cables :Introduction, Insulation, Sheath, Armour and Covering, Classification of Cables, Pressurized Cables, Effective Conductor Resistance, Conductor Inductive Reactance, Parameters of Single Core Cables, Grading of Cables, Capacitance of Three Core Belted Cable, Breakdown of Cables, Cable Installation, Current Rating of Cables, System Operating Problems with Underground Cables, HVDC Cables.

System Analysis: Voltage drop and power-loss calculations, Derivation for voltage drop and power loss in lines, Manual methods of solution for radial networks, Three phase balanced primary lines.

Protection: Objectives of distribution system protection, Types of common faults and procedure for fault calculations. Protective devices: Principle of operation off uses, Circuit re-closures, Line sectionalizes, and Circuit breakers.

Coordination: Coordination of protective devices: General coordination procedure. Compensation for power factor improvement, Capacitive compensation for power-factor control. Different types of power capacitors, Shunt and series capacitors, Effect of shunt capacitors (fixed and switched), Power factor correction, Capacitor allocation-economic justification, Procedure to determine the best capacitor location.

Voltage control: Equipment for voltage control, Effect of series capacitors, Effect of AVB/AVR, Line drop compensation.

Text Books:

1. Gonen, T., Electric Power Distribution System Engineering, 3rd ed., CRC Press 2014.
2. Pabla, A.S., Electric Power Distribution, 6th ed., Tata McGraw Hill, 2012.

Reference Books:

1. Sivanagaraju, S. and Sankar, V., Electrical Power Distribution and Automation, Dhanpat Rai & Co, 2006.
2. Kamaraju, V., Electrical Power Distribution Systems, Tata McGraw Hill Education, New Delhi, 2011.

Course Code: **EEL463**
Course Title: **HIGH VOLTAGE ENGINEERING**
Structure (L-T-P): **3-0-0 Prerequisite: EEL256, EEL353**

Contents: Levels of high voltage, votage levels, electrical insulation and dielectrics, importance of electric field intensity in the dielectrics, types of electric fields and degree of uniformity of fields, utilization of dielectric properties and stress control.

Properties of atmospheric air, SF6 and vacuum, relate dionization process, properties in vacuum, related ionization process, development of electron Avalanche, breakdown mechanisms, Townsend's mechanism, breakdown mechanisms, streamer mechanism, breakdown in uniform fields (Paschen's law), breakdown of gaseous dielectrics in weakly non-uniform and the limiting value of Î, development of PB in extremely non-uniform fields, breakdown characteristics in air with stable PB (corona).

Classification and properties of liquid dielectrics, classification and properties of solid dielectrics, classification and properties of liquid dielectrics, classification and properties of solid dielectrics, insulation resistance, conductivity and losses in dielectrics, partial breakdown phenomenon in dielectrics, partial breakdown phenomenon on the surfaces of solid and liquid dielectrics and degradation due to PB. Definition and measurements of intrinsic and practical breakdown strengths of liquid dielectrics, measurement of intrinsic breakdown in solid dielectrics, thermal and other breakdown mechanisms in extremely non-uniform fields, comparison of the development of breakdown in extremely and weakly non-uniform fields and the requirement of time for breakdown in solid dielectrics.

methods of generation of power frequency high test voltage, transformers in cascade, resonance transformers, g generation of high DC voltage, voltage multiplier circuits and ripple minimization, sources of overvoltages and standard lightning and switching wave shapes, impulse voltage generator, analysis of single stage circuit, multistage impulse generator and their triggering methods.

Peak high voltage measurement techniques, sphere gap, construction, effects of earthed objects and atmospheric conditions, electrostatic voltmeters, principle and construction.

Potential dividers, their types and applications.

Measurable properties of dielectrics, measurement of dielectric properties with Schering bridge and Mega ohm meter, partial breakdown (PB), measurement techniques in dielectrics/ equipment. Over voltages and basic insulation level design systems.

Text Book:

1. Naidu, M. S. and Kamaraju, V., High Voltage Engineering, 4th edition, Tata McGraw-Hill, New Delhi, 2008.

Reference Books:

1. Kuffel J., Kuffel E., and Zaengl W. S., High Voltage Engineering fundamentals, 2nd edition, Newness (Oxford, Boston), 2000.
2. Abdel-salam M., Anis H. and, Abdel-salamani, High Voltage Engineering: Theory and Practice, 2nd edition, CRC Press, 2001.
3. Ray S., An introduction to High Voltage Engineering, Prentice Hall, New Delhi, India, 2004

B.Tech. Mechanical Engineering
OVERALL CREDIT STRUCTURE

Undergraduate Core(UC)		Undergraduate Elective (UE)	
Category	*Credit*	*Category*	*Credit*
DC	67	**DE**	23 (minimum)
BS	19	**HM**	06 (minimum)
ES	22	**OC**	18 (Balance)
HM	05	**UN**	0 (03 Courses)
Total	**113**	**Total**	47
Grand Total (UC + UE)			**160**

Basic Science (BS)			
Course Code	**Course**	**L-T-P**	**Credit**
MAL102	Applied Mathematics-I	3-2-0	04
MAL103	Applied Mathematics-II	3-2-0	04
MAL201	Applied Mathematics-III*	3-0-0	03
PHL151	Applied Physics	3-0-0	03
PHP151	Applied Physics Lab	0-0-2	01
CYL101	Applied Chemistry	3-0-0	03
CYP101	Applied Chemistry Lab	0-0-2	01
Grand Total			**19**

Humanities and Management (Core) (HM)			
Course Code	**Course**	**L-T-P**	**Credit**
HSP152	Technical Communication	1-2-2	03
HSL151	Social Science	2-0-0	02
Grand Total			**05**

Engineering Arts and Science (ES)			
Course Code	**Course**	**L-T-P**	**Credit**
MEL152	Elementary Mechanical Engineering	3-0-0	03
EEL151	Elementary Electrical Engineering	3-0-0	03
EEP151	Elementary Electrical Engineering Lab	0-0-2	01
ECL151	Basic Electronics Engineering	3-0-0	03
ECP151	Basic Electronics Engineering Lab	0-0-2	01
MEL151	Engineering Drawing	3-0-0	03
MEP151	Engineering Drawing Lab	0-0-2	01
CSL151	Computer Programming and Problem Solving	3-0-0	03
CSP151	Computer Programming and Problem Solving Lab	0-0-2	01
MEP152	Mechanical Workshop	0-0-2	01
CEL151	Environmental Science	2-0-0	02
Grand Total			**22**

Non-Credit Requirement (UN)			
Course Code	**Course**	**L-T-P**	**Credit**
NCN101	NCC#	-	0
NSS152	NSS-I#	-	0
NSS153	NSS-II#	-	0
NCN103	NSO#	-	0
SPB151	Sports-I#	0-0-4	0
SPB152	Sports-II#	0-0-4	0
HSD251	Community Project	-	0
MET251	Practical Training	-	0
#A student has to opt at least one from NCC, NSS, NSO and Sports (I & II both).			

Departmental Core (DC)			
Course Code	**Course**	**L-T-P**	**Credit**
MEL251	Mechanical Behaviour of Materials	3-0-0	03
MEL252	Engineering Thermodynamics	3-0-0	03
MEL253	Fluid Mechanics	3-0-0	03
MEP253	Fluid Mechanics Lab	0-0-2	01
MEL254	Solid Mechanics	3-0-0	03
MEP254	Solid Mechanics Lab	0-0-2	01
MEL255	Kinematics of Machines	3-2-0	04
MEL256	Machine Drawing	1-0-0	01
MEP256	Machine Drawing Lab	0-0-4	02
MEL257	Casting Welding and Forming	3-0-0	03
MEP257	Casting Welding and Forming Lab	0-0-2	01
MEL258	Machining and Machine Tools	3-0-0	03
MEP258	Machining and Machine Tools Lab	0-0-2	01
MEL351	Energy Conversion	3-0-0	03
MEP351	Energy Conversion Lab	0-0-2	01
MEL352	Fluid Machines	3-0-0	03
MEP352	Fluid Machines Lab	0-0-2	01
MEL353	Heat and Mass Transfer	3-0-0	03
MEP353	Heat and Mass Transfer Lab	0-0-2	01
MEL354	Dynamics of Machines	3-2-0	04
MEL355	Metrology and SQC	3-0-0	03
MEP355	Metrology and SQC Lab	0-0-2	01
MEL356	Operations Management	3-0-0	03
MEL357	Design of Machine Elements	3-2-0	04
MEL451	Refrigeration & Air Conditioning	3-0-0	03
MEP451	Refrigeration & Air Conditioning Lab	0-0-2	01
MEL452	Mechanical Vibrations	3-0-0	03
MEP452	Mechanical Vibrations Lab	0-0-2	01
MED351	Minor Project	-	01
MED451	Major Project	-	02

Departmental Elective (DE)			
Course Code	**Course**	**L-T-P**	**Credit**
SCL453	Probability Theory and Statistics	3-0-0	03
MEL358	Measurement and Control	3-0-0	03
MEP358	Measurement and Control Lab	0-0-2	01
MEL359	Fundamentals of Electric Vehicles	3-0-0	03
MEL360	Introduction to Data Science for Mechanical Engineers	3-0-0	03
MEL453	Operation Research	3-2-0	04
MEL454	Industrial Engineering	3-0-0	03
MEL455	Compressible and Incompressible Fluid Flow	3-0-0	03
MEL456	Computer Aided Design	3-0-0	03
MEP456	Computer Aided Design Lab	0-0-2	01
MEL457	Computer Integrated Manufacturing	3-0-0	03
MEL458	Mechatronics	3-0-0	03
MEP458	Mechatronics Lab	0-0-2	01
MEL459	Gas Turbine and Compressor	3-0-0	03
MEL460	Quality Assurance	3-0-0	03
MEL461	Robotics	3-0-0	03
MEP461	Robotics Lab	0-0-2	01
MEL462	Automation in Production	3-0-0	03
MEL463	Power Plant Engineering	3-0-0	03
MEL464	Renewable Energy Technology	3-0-0	03
MEL465	Automobile Engineering	3-0-0	03
MEP465	Automobile Engineering Lab	0-0-2	01
MEL466	I. C. Engines and Hybrid Vehicles	3-0-0	03
MEP466	I. C. Engines and Hybrid Vehicles Lab	0-0-2	01
MEL467	Processing of Non-Metals	3-0-0	03
MEL468	Additive Manufacturing Technology	3-0-0	03
MEP468	Additive Manufacturing Technology Lab	0-0-2	01
MEL469	Material Resource Planning	3-0-0	03
MEP471	Machine System Design Lab	0-0-4	02

Course Syllabi
(Under Graduate)
Department of Mechanical Engineering

Engineering Drawing | MEL151 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an ability to understand the basic concepts and to realize the importance of engineering drawing as a medium of communication to convey ideas in engineering fields.
- Develop basic skills in reading and interpretation of engineering drawings.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the concept of projection theory and acquire visualization skills with an emphasis on the use of orthographic projections.

CO 2. Apply orthographic projections on one-dimensional and two-dimensional objects.

CO 3. Apply orthographic projections on three dimensional objects.

CO 4. Understand and apply the concept of sectional views of three-dimensional objects, development of their surfaces and Isometric views.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Scales-concept of representative fraction, importance of scales, Orthographic projections, Projections of points, Projections of Straight lines and practical applications, Projections of planes, Projections of solids (right and regular prisms, pyramids, cones and cylinders), Sections of solids, Development of surfaces of solids, Isometric projections.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Bhatt N.D, Engineering Drawing: Plane and Solid Geometry, 53rd ed., Charotar Publishing House Pvt. Ltd., 2019.

T2. Gill P.S., A Text Book of Engineering Drawing: Geometrical Drawing, 11th ed., S.K. Kataria & Sons, 2009.

Reference Books

R1. Luzadder W. J. and Duff J. M., Fundamentals of Engineering Drawing: With an Introduction to Interactive Computer Graphics for Design and Production, 11th ed., Prentice Hall of India, 2012.

R2. Narayana K.L. and Kannaiah P., Text Book on Engineering Drawing: Engineering Graphics, 2nd ed., SciTech Publications, 2010.

R3. Agrawal B. and Agrawal C.M., Engineering Drawing, 7th ed., Tawala McGraw Hill Education, 2011.

R4. Shah M.B. and Rana B.C., Engineering Drawing, 2nd ed., Pearson Education, 2012.

R5. Jolhe D.A., Engineering Drawing: With an Introduction to AutoCAD, Tata McGraw Hill Education, 2011.

Engineering Drawing Lab| MEP151 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an ability to understand the basic concepts and to realize the importance of engineering drawing as a medium of communication to convey ideas in engineering fields.
- Develop basic skills in reading and interpretation of engineering drawings.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Use the drawing instruments effectively and able to understand concept of dimensioning, free hand lettering skills and scales.

CO 2. Understand the concept of projections and acquire visualization skills, draw orthographic and isometric projections.

CO 3. Draw orthographic projections on one-dimensional and two-dimensional objects.

CO 4. Draw orthographic projections on three dimensional objects.

CO 5. Draw sectional views of solids and development of their surfaces for practical situations.

CO 6. Learn basics of AutoCAD software tool.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Lettering And Dimensioning
2. Orthographic Projections
3. Projections of Points
4. Projections of Straight Lines-1
5. Projections of Straight Lines-2 (Practical applications of lines)
6. Projections of Planes
7. Projections of Solids-1
8. Projections of Solids-2

9. Section of Solids-1
10. Section of Solids-2
11. Development of Surfaces
12. Isometric Projections
13. Introduction to AutoCAD

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.

T2. Bhatt N.D, Engineering Drawing: Plane and Solid Geometry, 53rd ed., Charotar Publishing House Pvt. Ltd., 2019.

T3. Gill P.S., A Text Book of Engineering Drawing: Geometrical Drawing, 11th ed., S.K. Kataria & Sons, 2009.

Reference Books

R1. Luzadder W. J. and Duff J. M., Fundamentals of Engineering Drawing: With an Introduction to Interactive Computer Graphics for Design and Production, 11th ed., Prentice Hall of India, 2012.

R2. Narayana K.L. and Kannaiah P., Text Book on Engineering Drawing: Engineering Graphics, 2nd ed., SciTech Publications, 2010.

R3. Agrawal B. and Agrawal C.M., Engineering Drawing, 7th ed., Tawala McGraw Hill Education, 2011.

R4. Shah M.B. and Rana B.C., Engineering Drawing, 2nd ed., Pearson Education, 2012.

R5. Jolhe D.A., Engineering Drawing: With an Introduction to AutoCAD, Tata McGraw Hill Education, 2011.

Elementary Mechanical Engineering | MEL152 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the fundamental principles governing the equilibrium state of the rigid body under the application of external forces.
- Apply the principles of solid mechanics to predict the resultant or unknown force in a given system of forces and framed structures.
- Learn the concept of centre of gravity and moment of inertia in regular and composite bodies.
- Know the fundamental principles and laws of thermodynamics and fluid mechanics.
- Understand the concept of pressure and learn different techniques of its measurement.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the concept of force systems and fundamental theorems to estimate resultant and unknown forces under the equilibrium of rigid body.

CO 2. Calculate moment, force coupling, torque and friction force in simple geometrical figures.

CO 3. Apply the principles of force to calculate reactions and unknown forces acting on beams, truss, and framed structures.

CO 4. Understand the concept of Centre of gravity and moment of inertia in regular and composite bodies.

CO 5. Know the fundamental principles, laws of thermodynamics and fluid mechanics and pressure and its measurement using different methods.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Mechanics Introduction: System of forces, coplanar concurrent force system, equilibrium of rigid bodies, free body diagram, Lami's theorem, varignon's theorem, Analysis of framed structure: Reaction in beam with different end conditions, determination of reactions in members of trusses. Centre of gravity and moment of inertia: Concept of C.G and centroid, position of centroid, theorem of parallel and
perpendicular axes, moment of inertia of simple geometrical figures. Types of Friction, Introduction to stress and strain, Elastic constants.
Basics of Thermal and Fluid Science: Introduction, thermodynamics properties, forms of energy, thermodynamic systems and control volume, steady flow systems, types of work, thermodynamic processes, Zeroth, first and second law of thermodynamics, Reversible and Irreversible processes, steady-state energy equation and its applications, Heat engine, Heat pump and refrigerator, COP.
Introduction to fluid mechanics, Properties of fluids, surface tension, compressibility, pressure measurement.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Bhavikatti S.S. and Rajashekarappa K.G., Engineering Mechanics, 8th ed., New Age International Limited Publisher, 2022.

T2. Cengel Y. A., Boles M., Thermodynamics: An Engineering Approach, 8th ed. McGraw- Hill, 2006.

Reference Books

R1. Shames I.H., Engineering Mechanics: Statics and Dynamics, 4th ed., Pearson Education, 2011.

R2. Nag P. K., Engineering Thermodynamics, 5th ed., Tata McGraw- Hill, 2005.

R3. Cengel Y. A., Cimbala, J. M., Fluid Mechanics: Fundamentals and Applications, 3rd ed., Tata McGraw- Hill, 2010.

R4. Beer and Johnston, Vector Mechanics for Engineers: Statics and Dynamics, 10th ed., Tata McGraw-Hill, 2013.

R5. Kumar D.S., Mechanical Engineering, 4th ed., S.K. Kataria & Sons Publisher, 2009.

Mechanical Workshop| MEP152 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop general mechanical skills in the students.
- Develop a skill to fabricate components with their own hands.
- Acquire an insight to various types of machine tools, accessories, and attachments.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the use of various mechanical tools and devices used in engineering practice and use of safety equipment during shop floor activities.
CO 2. Acquire practical knowledge in carpentry trade and the welding trade.
CO 3. Acquire practical knowledge in tin smithy trade, fitting shop and machine shop.
CO 4. Design and fabricate different prototypes in the carpentry, welding, tin smithy, fitting and machine shop.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Introduction of various tools and safety equipment used in mechanical workshop
2. To make a Dove tail joint in carpentry trade.
3. To make a T-Lap joint in carpentry trade.
4. To make a Single V-butt joint in welding shop.
5. To make a Lap-joint in welding shop and drilling.
6. To make a square tray in tin smithy shop.
7. To make a V-fitting in fitting shop.
8. To make a Step-fitting in fitting shop.
9. To make a wooden pattern in machine shop.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Kannaiah P. and Narayana K.L., Workshop Manual, 2nd ed., Scitech publishers, 2009.
T3. John K.C., Mechanical Workshop Practice. 2nd ed., PHI, 2010.

Reference Books

R1. Raghuwanshi B.S., Workshop Technology Vol. I & II, Dhanpath Rai & Sons, 2014.
R2. Choudhury S.K. H., Hajra A.K., Roy N., The Elements of Workshop Technology - Vol I & II, 11th ed., Media Promoters and Publishers, Mumbai, 2001.
R3. Bawa H. S., Workshop Technology, Tata McGraw Hill, 2001.
R4. Groover M.P., Fundamentals of Modern Manufacturing: Material Processes and Systems, 3rd ed., Wiley India, 2011.
R5. Kalpakjian S. and Schmid S.R., Manufacturing Engineering and Technology, 7th ed., Pearson Education,

2018.

Mechanical Behaviour of Materials | MEL251 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Attain the knowledge of different crystal structures and constitution of alloys.
- Understand rules to form solid solution and different reactions in a phase diagram.
- Correlate the concepts of phase structures and properties of different types of steels and their heat treatment methods.
- Recognize the microstructure and properties of cast iron and few non-ferrous metal alloys.
- Illustrate different types of ceramics, polymers and composite materials.
- Identify various advanced materials and their designation.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Recognize different structure of metals and the constitution of alloys.

CO 2. Construct different phase diagrams, microstructures and reactions with examples.

CO 3. Acquire the knowledge of engineering materials – steels with iron-carbon phase diagram and various heat treatment properties.

CO 4. Analyse various cast irons and few non-ferrous metals & alloys and their properties.

CO 5. Characterize different non-metals such as ceramics, polymers, and composites for engineering applications.

CO 6. Analyse and recognize the need for some advanced materials, their properties and designations.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Structures of materials – crystal structure, substructure, microstructure, etc. Phase diagram and phase transformation. Diffusion phenomenon, Mechanical behaviour – strength, hardness, deformation creep, fatigue, etc., Mechanisms of strengthening and toughening of materials, Metallic alloys, Ceramics, Polymeric and Composite materials, Non-destructive testing. Standard numbering system including BIS designations of materials.
Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Raghavan V., Materials Science and Engineering: A First Course, 5th ed., Prentice Hall, 2012.

T2. Callister W. D., Rethwisch D. G., Materials science and engineering: An introduction, 7th ed., John Wiley & sons, NY, 2007.

Reference Books

R1. Avner S.H., Introduction to Physical Metallurgy, 2nd ed., Tata McGraw Hill, 2012.
R2. Dieter G.E. and Bacon D., Mechanical Metallurgy, 3rd ed., Tata McGraw Hill, 2001.
R3. Lakhtin Y.M., Engineering Physical Metallurgy and Heat treatment, 6th ed., CBS Publishers, 1998.
R4. Rollason E.C., Metallurgy for Engineers, 4th ed., Edward Arnold Publications, 1982.
R5. Donald R. A, Pradeep P. F, Essentials of Materials Science and Engineering, 2nd ed., Cengage India Private

Limited, 2013.

Engineering Thermodynamics | MEL252 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Present a comprehensive and rigorous treatment of classical thermodynamics while retaining an engineering perspective.
- Lay the groundwork for subsequent studies in such fields as fluid mechanics, heat transfer and to prepare the students to effectively use thermodynamics in the practice of engineering.
- Develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.
- Present a wealth of real-world engineering examples to give students a feel for how thermodynamics is applied in engineering practice.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Know the basic concepts of thermodynamics and thermodynamic properties using tables of thermodynamic properties and analyse the processes to solve advanced engineering problems.

CO 2. State and apply the first law of thermodynamics for closed and open systems.

CO 3. Quantify the second law of thermodynamics for a cycle by establishing the inequality. Derive and apply principle of increase of entropy to evaluate the feasibility of a thermodynamic process.

CO 4. Analyse the performance of vapor power generation and air-standard cycles.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to basic concept of thermodynamics: Types of system, state and properties of system, thermodynamic equilibrium, heat, and thermodynamic work. Laws of thermodynamics. First Law of thermodynamics: Flow and non-flow system, change in internal energy, heat transferred, and work transferred during various thermodynamic processes, P-V diagrams. Applications of steady and unsteady flow processes. Second law of thermodynamics: Kelvin-Plank & Clausius Statement. Heat engine, refrigerator and heat pump, reversible and irreversible processes. Carnot cycle, thermodynamic temperature scale. Entropy: Clausius inequality, entropy principle, change in entropy for closed and open systems. Availability: Reversible work and irreversibility. Properties of Ideal gas, equation of state, internal energy and specific heats of gases. Properties of pure system and use of steam tables, Mollier charts, P-V, T-S and H-S diagrams. Dryness fraction and its measurement. Work and heat transfer during various thermodynamic processes with steam as working fluid. Air standard cycles: Otto, Diesel, Stirling, Ericsson, Atkinson, and Brayton. Vapour power cycles: Simple and Modified Rankine Cycle, combined cycle.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Cengel Y.A. and Boles M.A., Thermodynamics: An Engineering Approach, 8th ed., McGraw Hill, 2015.

T2. Nag P.K., Engineering Thermodynamics, 5th ed., Tata McGraw Hill Education, 2013.

Reference Books

R1. Moran M.J. and Shapiro H.N., Fundamentals of Engineering Thermodynamics, 6th ed., Wiley-India, 2012.

R2. Eastop, T.D. and McConkey, A., Applied Thermodynamics: For Engineering Technologists, 5th ed., Pearson Education, 2013.

R3. Holman J.P., Thermodynamics, 4th ed., Mc-Graw Hill, 1988.

R4. C P Arora, Thermodynamics, McGraw-Hill Education (India) Pvt. Ltd., 2001.

R5. Joel R., Basic Engineering Thermodynamics, 5th ed., Pearson Education, 2014.

Fluid Mechanics| MEL253 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Teach basic fluid properties (density, viscosity, bulk modulus), flow forces (pressure, shear stress, surface tension).
- Teach how force is transmitted in static fluids.
- Teach conservation of mass, momentum, and energy in fixed, deforming, and moving control volumes.
- Teach the use and limitations of steady and unsteady Bernoulli equation along and normal to a streamline.
- Teach conservation of mass and momentum through differential analysis in simple geometries.
- Teach techniques of dimensional analysis, similitude, and modelling, and introduce the important non-dimensional groups in fluid mechanics.
- Teach application of the above concepts to internal and external flows, losses during the fluid flows and introduce the boundary layer concept, lift and drag, flow separation, and drag reduction fundamentals.
- Develop the concept of flow and pressure measurement and to apply the governing equations to estimate associated parameters of flow filed.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Determine the various properties and parameters of the fluids and its significance.

CO 2. Understand and measure the various forces exerted during solid-fluid interaction either in static or dynamic conditions of the fluid.

CO 3. Understand and derive the physical laws governing the fluid motion and types of fluid flows.

CO 4. Solve for internal flow in pipes and channels through simple solutions of the Navier-Stokes equations, the Moody chart, or the head-loss equation.

CO 5. Solve for external flows, evaluate lift, and drag, know when there is possibility of flow separation, apply streamlining concepts for drag reduction by using experimental correlations.

CO 6. Solve the governing equations in non-dimensional form, design experiments, and perform model studies.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to Fluid Mechanics, fluid properties and classification. Fluid statics: Pressure variation in a static fluid, forces on submerged surfaces, stability of floating bodies, rigid body motion. Kinematics of fluid Flow, Ideal Fluid Flow. Inviscid flow: Euler equation, Bernoulli's equation and its applications, Reynold's transport theorem, mass, momentum and energy conservation laws with applications, governing equations for Newtonian fluids, exact solutions of Navier-Stokes Equation, Internal flows: pipe flow, hydraulic diameter, laminar and turbulent flows, friction factor, Moody diagram, minor and major losses, pipe networks, flow measurement, Introduction to open channel flow. External flows: introduction to boundary layer theory, flow over flat and curved surfaces, boundary layer separation. Dimensional analysis and modelling, Buckingham Pi theorem.

Contents for Desired Course Outcomes (If any) Nil

Nil

Text Books

T1. Frank M. White, Fluid Mechanics, 9th ed., Tata McGraw Hill Education, 2021.

T2. Som S.K., Biswas G. and Chakraborty S., Introduction to Fluid Mechanics and Fluid Machines, 3rd ed., Tata McGraw Hill Education, 2011.

Reference Books

R1. Streeter V.L., Wylie E.B. and Bedford, K.W., Fluid Mechanics, 9th ed., Tata McGraw Hill Education, 2011.
R2. Cengel Y.A. and Cimbala J.M., Fluid Mechanics: Fundamentals and Applications, 3rd ed., Tata McGraw Hill Education, 2015.
R3. Kundu P.K., Cohen I.M. and Dowling, D.R., Fluid Mechanics, 5th ed., Elsevier, 2012.
R4. Khan M.K., Fluid Mechanics and Machinery, 1st ed., Oxford University Press India, 2015.
R5. Fox R.W., Pritchard P.J. and Mcdonald A.T., Introduction to Fluid Mechanics, 7th ed., Wiley India, 2012.

Fluid Mechanics Lab | MEP253 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Demonstrate the principles of the fluid in either static or dynamic conditions.
- Understand the various fluid flows and pressure measuring devices.
- Calculate the coefficient of discharge for different flow measuring devices.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Measure the basic properties of the fluid and determine the stability conditions of solid object in the bulk fluid.
CO 2. Demonstrate important flow and pressure measuring devices pertaining to fluid flow.
CO 3. Perform the hands on and measure the discharge of flowing fluid using distinct flow meters.
CO 4. Visualize the fluid flow phenomenon and determination energy losses during internal flow of the fluid.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. To verify Bernoulli's equation.
2. To reproduce the dye line experiment as performed by Reynolds and to obtain the criteria for Laminar and Turbulent flow.
3. Determination of coefficient of discharge, coefficient of contraction, coefficient of velocity of orifice & mouthpiece.
4. To calculate coefficient of discharge, C_d of Venturimeter.
5. To calculate coefficient of discharge, C_d of Orifice meter.
6. To compare theoretical and actual value of flow over notch.
7. To study free and forced vortices.
8. To find the Coriolis component of acceleration and verify the result.
9. To determine the friction factor of a given pipe of circular cross section.
10. To determine the metacentric height of a floating body (i.e., a model of ship) and to locate the center of Buoyancy, metacentre, and center of gravity.
11. To determine the percentage error in Rotameter with the actual flow rate.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.

T2. Frank M. White, Fluid Mechanics, 9th ed., Tata McGraw Hill Education, 2021.
T3. Som S.K., Biswas G. and Chakraborty S., Introduction to Fluid Mechanics and Fluid Machines, 3rd ed., Tata McGraw Hill Education, 2011.

Reference Books

R1. Streeter V.L., Wylie E.B. and Bedford, K.W., Fluid Mechanics, 9th ed., Tata McGraw Hill Education, 2011.
R2. Cengel Y.A. and Cimbala J.M., Fluid Mechanics: Fundamentals and Applications, 3rd ed., Tata McGraw Hill Education, 2015.
R3. Kundu P.K., Cohen I.M. and Dowling, D.R., Fluid Mechanics, 5th ed., Elsevier, 2012.
R4. Khan M.K., Fluid Mechanics and Machinery, 1st ed., Oxford University Press India, 2015.
R5. Fox R.W., Pritchard P.J. and Mcdonald A.T., Introduction to Fluid Mechanics, 7th ed., Wiley India, 2012.

Solid Mechanics | MEL254 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the Elementary Mechanical Engineering (MEL 152).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop a deep understanding of stress and strain, including their definition, types, and classification.
- Build analytical skills to identify and solve direct, indirect, shear, and bending stresses, and determine principal stress and strain using Mohr's circle.
- Explore the mechanical properties of materials, including elastic constants and their significance in stress analysis.
- Build problem-solving skills by solving determinate and indeterminate problems, including torsion of shafts and beams, and calculating turning moment diagrams.
- Apply concepts of thin pressure vessels, columns, springs, and combined loading to real-world situations, and develop proficiency in using software for problem-solving and visualization.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Demonstrate a deep understanding of stress and strain concepts, including their types and classification, and develop the ability to identify and solve direct, indirect, shear, and bending stresses.
CO 2. Analyze the mechanical properties of materials, including elastic constants, and apply Mohr's circle to determine principal stress and strain in complex problems.
CO 3. Build the ability to analyze direct and indirect stress and strain and apply concepts to solve problems in torsion, beams, and combined loading.
CO 4. Develop proficiency in calculating deflection, slope, and energy in beams, and utilize software programs for problem-solving in bending, torsion, and tension problems.
CO 5. Build the ability to apply concepts of thin pressure vessels, columns, springs, and combined loading to real-world situations and develop critical thinking skills through solving determinate and indeterminate problems.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Stress and Strain, definition, types, and classification; Direct and indirect stresses; Shear and bending stresses; Principal stress and strain, Mohr's Circle; Thermal stress and stain; elastic constants and mechanical properties; determinate and indeterminate problems; torsion of shafts; turning moment diagram with uniform and variable torsion; Beams, types of beams, branding moment and shear force diagrams, stresses in beams, deflection in beam, slop, and energy, energy methods for bending, torsion and tension problems, combined loading; Application of concepts on thin pressure vessels; column and springs; Software Applications : programs and functions for problem

solutions and visualization; programs for deflection, torsion, Mohr's Circle. ASME standards.
Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Nash W.A., Schaum's Outline Strength of Materials, 7th ed., Tata McGraw Hill Education, 2019.
T2. Balan T. A., Engineering Mechanics of Solids by, 2nd ed., Pearson Education, New Delhi, 1998.

Reference Books

R1. Shames, I.H., and Pitarresi, J.M., Introduction to Solid Mechanics, 3rd ed., Prentice Hall India, 2013.
R2. Popov, E.P., Engineering Mechanics of Solids, 2nd ed., Prentice Hall India, 2012.
R3. Beer, F.P. et. al., Mechanics of Materials, 6th ed., Tata McGraw Hill Education, 2013.
R4. Crandall S. H., An Introduction to Mechanics of Solids, McGraw-Hill International, 1978.
R5. Srinath L.S., Advanced Mechanics of Solids, 3rded.Tata McGraw-Hill, 2008.

Solid Mechanics Lab| MEP254 | 1 Credit | 0 0 2 1

Course Prerequisite

The student should have studied the Elementary Mechanical Engineering (MEL 152).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Gain hands-on experience in performing various mechanical testing techniques.
- Understand the principles and procedures involved in mechanical testing of materials.
- Learn the significance of material properties and their impact on engineering applications.
- Develop skills in data analysis and interpretation of experimental results.
- Understand the limitations and precautions involved in mechanical testing.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Perform and analyze compression, tension, double shear, and torsion tests on different materials.
CO 2. Know the impact properties of materials through Izod and Charpy impact tests.
CO 3. Determine the hardness of materials using Brinell hardness tests.
CO 4. Understand of the behavior of beams under deflection in cantilever and simply supported configurations.
CO 5. Calculate the compressive strength of brittle materials.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Compression test on helical spring.
2. Tension test on mild steel rod.
3. Double shear test on ductile materials.
4. Torsion test on mild steel rod.
5. Impact test on metal specimen: (a) Izod Impact Test (b) Charpy Impact Test.
6. Hardness test on metals-Brinell Hardness Test.
7. Deflection test on beams. (a) Cantilever Beam(b) Simply Supported beam.
8. Compression test on brittle materials.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Nash W.A., Schaum's Outline Strength of Materials, 7th ed., Tata McGraw Hill Education, 2019.
T3. Balan T. A., Engineering Mechanics of Solids by, 2nd ed., Pearson Education, New Delhi, 1998.

Reference Books

R1. Shames, I.H., and Pitarresi, J.M., Introduction to Solid Mechanics, 3rd ed., Prentice Hall India, 2013.
R2. Popov, E.P., Engineering Mechanics of Solids, 2nd ed., Prentice Hall India, 2012.
R3. Beer, F.P. et. al., Mechanics of Materials, 6th ed., Tata McGraw Hill Education, 2013.
R4. Crandall S. H., An Introduction to Mechanics of Solids, McGraw-Hill International, 1978.
R5. Srinath L.S., Advanced Mechanics of Solids, 3rded.Tata McGraw-Hill, 2008.

Kinematics of Machines | MEL255 | 4 Credits | 3 2 0 4

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Impart knowledge to identify, formulate and solve the basic mechanism to study the Kinematics of Machines.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Describe/illustrate basic of Kinematic chain, Mechanism and Machine.
CO 2. List and generally explain the main mechanism in in a particular machine.
CO 3. Ability to understand and analysis the position, velocity and acceleration of mechanism
CO 4. Understand the causes and effects of various type mechanisms.
CO 5. Describe the challenges and problems associated to design and synthesis of mechanism.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Basic concept of mechanisms, links, kinematic pairs, kinematic chain, mechanisms, machine, Types of mechanisms, Degree of freedom of link and planer mechanism, Classification of four-bar chain (Class I and Class II) Inversion of four bar chain, Slider crank chain and double slider crank chain.
Velocity, acceleration analysis of planer mechanism by graphical method using relative velocity/acceleration, Instantaneous centre of velocity method, Concept of velocity and acceleration image., Synthesis of four-bar/ slider crank mechanism for gross motion, Input/Output coordination and quick return ratio, Transmission angle.
Types of cams, follower and applications, Synthesis of cam for different types of follower motion like constant velocity, parabolic SHM, cycloidal etc., Construction of eccentric cam, tangent cam and circular arc cam, Analysis of follower motion for cams with specified contours like eccentric cam, tangent cam, and circular arc cam.
Introduction to Belt drive, clutches and brakes, ratio of belt tension, initial tension for flat and V belts, types of clutches and relations for torque transmitted, types of brakes and braking torque relations.
Types of gears, gear tooth terminologies, concept of conjugate action, law of conjugate action, kinematics of involute gear tooth pairs during the contact, number of pairs of teeth in contact, path of approach and path of recess Interference, undercutting for involute profile teeth, introduction to cycloidal profile, types of gear trains.
Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Norton, R.L., Kinematics and Dynamics of Machinery, 1st ed., Tata McGraw hill Education, 2013
T2. Rattan S. S., Theory of Machines, 3rd ed., Tata McGraw Hill Education 2012.

Reference Books

R1. Uicker J.J., Pennock G.R. and Shigley J.E., theory of Machines and Mechanisms, 3rd ed., Oxford University Press, 2013.
R2. Bevan T., The Theory of Mechines, 3rd ed., Pearson Education, 2012.
R3. Rao J.S. and Dukkipati R.V., Mechanism and machine Theory, 2nd ed., New Age International, New Delhi, 2012.
R4. Ghosh A. and Mallik A.K., Theory of Mechanisms and Machines, 3rd ed., New Delhi Affiliated East-West Press, 2011.
R5. Ambedkar A.G., Mechanism and Machine Theory, 3rd ed., Prentice Hall of India, 2011.

Machine Drawing| MEL256 | 1 Credit| 1 0 0 1

Course Prerequisite

The student should have studied the Engineering Drawing (MEL151)

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the concepts drawing conventions, method of dimensioning, and orthographic projections.
- Draw assemblies of machine elements and their sectional views.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Interpret the conventional representation of materials and machine elements.
CO 2. Identify the machine element drawings using orthographic projection and sectional view.
CO 3. Use software to analyse different part drawing and manufacturing techniques.
CO 4. Make assembly drawing using part drawings.
CO 5. Make drawings of assembled views for the part drawings.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to the generation of drawings as a design process for machine assembly. Sectioning, dimensioning, and version control in drawings.
Standardized representation of threads, fasteners, welds, bearings, springs, and related components.
Introduction to limits fits, and tolerances, dimensional and geometric tolerances, surface finish symbols.
Generation of assembly drawings including sectioning and bill of materials.
Evolving details of components from assembly considerations. Solid modelling of components involving shafts, bearing, pulleys, gears, belts, brackets, gearbox, plumber block and tailstock for assembly. Introduction to drafting software (AUTOCAD, CATIA, etc.)

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Naryana, K.L., Kannaiah, P., and Reddy, K.V., Machine Drawing, 4th ed., New Age International, 2013.
T2. Bhatt, N.D., and Panchal, V.M., Machine Drawing, 47th ed., Charotar Publishing House, 2012.

Reference Books

R1. Bureau of Indian Standards, Engineering Drawing Practice for Schools & Colleges, 1st ed., 1998.
R2. Parkinson A.C., Foundation of Technical Drawing, Pitman Publishing, 1968.
R3. Junnarkar, N.D., Machine Drawing, Pearson Education, 2011.

R4. Gill P. S., A textbook of Machine Drawing, S.K. Kataria & Sons, 2013.
R5. Dhawan R. K., A text book of Machine Drawing, S. Chand, 2016.

Machine Drawing Lab| MEP256 | 2 Credits | 0 0 4 2

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the concepts of drawing conventions, method of dimensioning, and orthographic projections.
- Draw assemblies of machine elements and their sectional views.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand and apply the conventional methods used to represent materials and machine elements in engineering drawing.
CO 2. Identify the machine element drawing using orthographic projections and sectional views.
CO 3. Use software to analyse different part drawing and manufacturing techniques.
CO 4. Make assembly drawing using part drawings.
CO 5. Make drawings of assembled views for the part drawings.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Draw the ISO metric screw thread profile with proportions, of external and internal threads, with pitch as 30 mm.
2. Assuming pitch as 20 mm, sketch neatly the following thread profiles, giving proportionate dimensions (a) sharp V, (b) square, (c) B.S.W, (d) Buttress, (e) ACME, (f) worm, (g) Seller's and (h) Knuckle.
3. Sketch a hexagonal bolt and a square bolt giving the proportions in terms of the nominal diameter of the bolt.
4. Sketch the half sectional view of a coupler nut, connecting two rods, each of diameter 25 mm.
5. Draw (a) sectional view from the front and (b) view from above, of the following riveted joints, to join plates of thickness 10 mm: (i) Single riveted lap joint, (ii) double riveted chain lap joint, (iii) double riveted zig-zag lap joint, (iv) Single riveted, single strap butt joint, (v) single riveted, double strap butt joint (vi) double riveted, double strap, chain butt joint.
6. Draw (a) half sectional view from the front, top half in section and (b) half sectional view from the side, left half in section, of a split-muff coupling, indicating proportions to connect two shafts, each of diameter 50 mm.
7. Sketch the required views, indicating proportions of (a) compression-muff coupling, (b) cone coupling and (c) claw coupling, to connect two shafts, each of diameter 30 mm.
8. Draw the half sectional front view and top view of the assembled screw jack.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Naryana, K.L., Kannaiah, P., and Reddy, K.V., Machine Drawing, 4th ed., New Age International, 2013.
T2. Bhatt, N.D., and Panchal, V.M., Machine Drawing, 47th ed., Charotar Publishing House, 2012.

Reference Books

R1. Bureau of Indian Standards, Engineering Drawing Practice for Schools & Colleges, 1st ed., 1998.
R2. Parkinson A.C., Foundation of Technical Drawing, Pitman Publishing, 1968.
R3. Junnarkar, N.D., Machine Drawing, Pearson Education, 2011.

R4. Gill P. S., A textbook of Machine Drawing, S.K. Kataria & Sons, 2013.
R5. Dhawan R. K., A text book of Machine Drawing, S. Chand, 2016.

Casting Welding and Forming| MEL257 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Learn the fundamentals of casting, joining, deformation processes.
- Develop first order mathematical descriptions for selected processes.
- Understand the advantages and limitations of various processes in terms of quality productivity.
- Apply this knowledge to manufacturing process selection, design and part quality.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Identify and analyse the different types of materials and techniques used in casting, joining, and metal forming and identify their advantages, disadvantages, and applications.
CO 2. Design, analyse, and evaluate different types of moulds, patterns, cores, feeders, and gating systems used in casting processes, and develop solutions for casting defects and inspection.
CO 3. Analyse and design different types of welding joints, evaluate the effect of cooling rate on joint properties, and identify and solve welding defects through inspection.
CO 4. Analyse and design various metal forming techniques such as forging, rolling, extrusion, wire drawing, and sheet metal working, and identify forming limits and defects through inspection.
CO 5. Analyse and access the importance of casting, joining, and metal forming processes in manufacturing and apply knowledge to select appropriate manufacturing process based on the type of industrial application.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Casting: Casting Process and its classifications, Heating and Pouring, Fluidity, Porosity, Solidification and Cooling, Shrinkage, Riser and Gating Design, Sand Casting, Shell Moulding, Vacuum Casting, Investment Casting, Permanent Mould Casting - Die Casting, Squeeze Casting, Centrifugal Casting, Foundry Practices, Casting Quality, Product Design Considerations, Casting of Ferrous and Non-ferrous alloys, Economics of Casting, Shaping processes for plastics.
Welding: Classifications, Gas Welding and Cutting, Electric Arc Welding – Principle, Equipment and Electrodes, MMAW, Carbon Arc Welding, TIG, MIG, SAW, PAW, Resistance Welding – Spot, Seam, Upset, Flash, Welding Design, Welding Defects, Thermit Welding, Electroslag Welding, Electron Beam Welding, Laser Beam Welding, Forge Welding, Friction Welding, Diffusion Welding, Explosion Welding, Underwater Welding, Brazing and Soldering.
Metal Forming: Hot/Cold Working, Material Behaviour in MF, Strain Rate Sensitivity, Friction and lubrication in MF, Rolling, Forging, Extrusion, Wire Drawing, Rod and Tube Drawing, Swaging, Sheet Metal Operations – Shearing, Drawing, Spinning, Bending, Embossing, Coining, Sheet Metal Die Design.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Kalpakjian S., and Schmid S.R., Manufacturing Engineering and Technology, 8th ed., Pearson Education, 2020.
T2. Rao P.N., Manufacturing Technology Vol - 1, 5th ed., Mc Graw Hill India, 2018.

Reference Books

R1. Groover M.P., Fundamentals of Modern Manufacturing: Material Processes and Systems, 3rd ed., Wiley India, 2011.

R2. Ghosh A., and Malik A.K., Manufacturing Science, 2nd ed., Affiliated East-West Press Private Limited, 2010.
R3. Schey J.A., Introduction to Manufacturing Processes, 3rd ed., McGraw-Hill Education, 1999.
R4. Little R., Welding and Welding Technology, McGraw Hill Education, 2017.
R5. Shan H.S., Manufacturing Processes: Casting, Forming and Welding, 2nd ed., Cambridge University Press, 2017.

Casting Welding and Forming Lab| MEP257 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Have a fundamental understanding of various manufacturing processes such as casting, welding, and forming, and their applications in the industry.
- Have ability to use modern manufacturing tools and techniques in solving real-world problems.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Learn about the various manufacturing processes.
CO 2. Gain hands-on experience in preparing patterns and using sand-casting processes.
CO 3. Gain hands-on experience in using welding process as per industrial application.
CO 4. Learn metal forming processes and prepare sheet metal products.

Desirable/Advanced (If any):

CO 5. Prepare polymer products using compression molding/hand layup technique.

Experiments for Essential Course Outcomes

1. To study and observe various stages of Sand-Casting Process.
2. To prepare a pattern for given object for casting.
3. To study and observe through demonstration the metal forming processes (Rolling).
4. To prepare a sheet metal product (square container).
5. To study and observe the Gas welding and brazing techniques through demonstration and practice.
6. To prepare a butt joint with mild steel strip using Arc Welding technique.
7. To prepare a butt joint with mild steel strips using brazing Technique.

Experiments for Desired Course Outcomes (If any)

8. To prepare a polymer product using compression molding/Hand layup.

Books/Material

T1. Lab Manuals.
T2. Kalpakjian S., and Schmid S.R., Manufacturing Engineering and Technology, 8th ed., Pearson Education, 2020.
T3. Rao P.N., Manufacturing Technology Vol - 1, 5th ed., Mc Graw Hill India, 2018.

Reference Books

R1. Groover M.P., Fundamentals of Modern Manufacturing: Material Processes and Systems, 3rd ed., Wiley India, 2011.
R2. Ghosh A., and Malik A.K., Manufacturing Science, 2nd ed., Affiliated East-West Press Private Limited, 2010.

R3. Schey J.A., Introduction to Manufacturing Processes, 3rd ed., McGraw-Hill Education, 1999.
R4. Little R., Welding and Welding Technology, McGraw Hill Education, 2017.
R5. Shan H.S., Manufacturing Processes: Casting, Forming and Welding, 2nd ed., Cambridge University Press, 2017.

Machining and Machine Tools | MEL258 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Get equipped with fundamental knowledge and principles in material removal processes.
- Demonstrate the fundamentals of machining processes and machine tools.
- Develop fundamental knowledge on tool materials, cutting fluids and tool wear mechanisms.
- Apply knowledge of basic mathematics to calculate the machining parameters for different machining processes.
- Understand the non-traditional machining methods and process selection.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the mechanics of metal cutting.
CO 2. Explain the ASA, ORS and NRS systems of tool geometry and derive their interrelationships.
CO 3. Develop the relations for chip reduction coefficient, shear angle, shear strain, forces, power, specific energy, and temperatures associated with orthogonal cutting.
CO 4. Select cutting fluids, cutting tool materials and tool geometry for improving machinability and tool life.
CO 5. Understand the principles, processes, and applications of different types of machining processes.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Metal machining: - Chip Formation, Shear Zone, Orthogonal Cutting, Shear Angle and its Relevance, Cutting-Tool Geometry, Dynamometers, Cutting-Tool Materials, Thermal Aspects, Tool Wear and Tool Life, Surface Finish, Cutting Fluids, Empirical and Analytical Determination of Cutting Forces, Economics.
Cutting: - Tool Materials and Cutting Fluids.
Machining Processes: - Turning, Hole making, Milling, Broaching, Sawing, Filing, Gear Manufacturing, Abrasive machining and finishing operations.
Non-Traditional Machining: - Electric-Discharge Machining, Electrochemical Machining, Ultrasonic Machining, Chemical Machining, Laser-Beam Machining, Abrasive Water-Jet Machining (AWJM), Electron-Beam Machining (EBM), Ion-Beam Machining (IBM), Plasma-Arc Machining (PAM).
Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Kalpakjian S., and Schmid S.R., Manufacturing Engineering and Technology, 8th ed., Pearson Education, 2020.
T2. Rao PN, Manufacturing Technology—Metal Cutting and Machine Tools, 3rd ed., Tata McGraw Hill, 2017.

Reference Books

R1. Groover M.P., Fundamentals of Modern Manufacturing: Material Processes and Systems, 3rd ed., Wiley India, 2011.
R2. Ghosh A., and Malik A.K., Manufacturing Science, 2nd ed., Affiliated East-West Press Private Limited,

2010.
R3. Rao P.N., Manufacturing Technology Vol - 2, 5th ed., Mc Graw Hill India, 2018.
R4. Boothroyd, G. and Knight W.A., Fundamentals of Machining and Machine Tools, 3rd ed., CRC Taylor and Francis, 2013.
R5. Shaw M.C., Metal Cutting Principles, 1st ed., CBS Publishers, 2012.

Machining and Machine Tools Lab | MEP258 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Give an overview of various machining processes.
- Give complete knowledge of characteristic features of lathe machine, shaper, etc.
- Perform machining on V-block, drill and tap holes.
- Perform grinding operation on surface grinder machine.
- Better understand the working of USM.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Exhibit the ability in developing sequence of machining operations required for manufacturing of components according to given drawings in industry.
CO 2. Perform the plain turning, step turning taper turning, Facing and Grooving on a circular rod.
CO 3. Perform thread cutting and knurling on a circular C.S rod using the lathe machine.
CO 4. Understand Drilling a hole and perform tapping on a given work piece.
CO 5. Perform Surface finishing on a given work piece.
CO 6. Shape a V- groove in square block.
CO 7. Understand working and constructional features of USM, etc.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Study about the machining processes.
2. To study the characteristic features of lathe Machine.
3. To perform the Turning, Facing, Grooving and Threading operations on given mild steel rod.
4. To study the characteristic features of Milling Machine.
5. To machine the hexagonal head and the slot shown in the sketch on the specimen.
6. To study the characteristic features of Shaper Machine.
7. To machine a V-block as shown in the sketch out of the workpiece provided.
8. To drill and tap holes on the mild steel rod as shown in the sketch.
9. To perform the grinding operation on surface grinder Machine.
10. Introduction about non-conventional machining processes (Working of USM).

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.

T2. Kalpakjian S., and Schmid S.R., Manufacturing Engineering and Technology, 8th ed., Pearson Education, 2020.
T3. Rao PN, Manufacturing Technology—Metal Cutting and Machine Tools, 3rd ed., Tata McGraw Hill, 2017.

Reference Books

R1. Groover M.P., Fundamentals of Modern Manufacturing: Material Processes and Systems, 3rd ed., Wiley India, 2011.
R2. Ghosh A., and Malik A.K., Manufacturing Science, 2nd ed., Affiliated East-West Press Private Limited, 2010.
R3. Rao P.N., Manufacturing Technology Vol - 2, 5th ed., Mc Graw Hill India, 2018.
R4. Boothroyd, G. and Knight W.A., Fundamentals of Machining and Machine Tools, 3rd ed., CRC Taylor and Francis, 2013.
R5. Shaw M.C., Metal Cutting Principles, 1st ed., CBS Publishers, 2012.

Energy Conversion| MEL351| 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the Engineering Thermodynamics (MEL252).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Become familiar with the modern energy conversion systems (power generation systems).
- Understand the fundamental principles of thermodynamics energy transfer in a variety of engineering systems.
- Understand application of the laws of thermo-fluid mechanics to energy conversion systems.
- Get insight into up-to-date technical systems for energy conversion, their components, and processes, as well as economic and environmental importance of energy conversion.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Know the principles of the modern energy conversion systems.
CO 2. Recognize the energy conversion concepts in complex engineering systems.
CO 3. Do assessments of fundamental properties/quantities of a power plant and/or some of their components.
CO 4. Recognize and identify technical, economical, and environmental problems appearing in modern energy conversion systems and their components.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Fundamentals and elementary treatment is expected to be covered in this course. Introduction to I.C. Engines: Two/Four stroke engine. SI and CI engines carburation and fuel injection. Indicated/brake power. Air standard, mechanical, thermal efficiencies. Compressors: Classifications, working principle. Reciprocating compressor: Ideal Cycles, multi stage compression, intercooling, condition for minimum work. Volumetric efficiency and power required. Introduction to Gas Turbines and Jet propulsion: Ideal cycles (open and close cycles), and working of turbojet, turboprop, ramjet & pulsejet, performance. Components of Steam power plant, their functions and processes involved there in. Such as boilers: Classification based on type of fuel, fire tube/water tube, and very high pressure boilers. Steam Turbines: Classifications, Velocity diagrams, Blade/Diagram efficiency. Condensers: Classifications, cooling tower. Law of Partial pressure, air leakage in condenser. Calculations of Condenser efficiency and vacuum efficiency.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Eastop T.D., and McConkey A., Applied Thermodynamics: For Engineering Technologists, 5th ed., Pearson

Education, 2013.
T2. Nag P.K., Power Plant Engineering, 4th ed., Tata McGraw Hill, 2014.

Reference Books

R1. Rogers, G.F.C., and Mayhew Y.R., Thermodynamics and Transport Properties of Fluids, 5th ed., Blackwell Publishers, 2013.
R2. GanesaN V., Internal Combustion Engines, 4th ed., Tata McGraw Hill Education, 2013.
R3. Dixon S.L. and Hall C.A., Fluid Mechanics and Thermodynamics of Turbomachinery, 6th ed., Elsevier, 2010.
R4. Yadav R., Steam and Gas Turbines and Power Plant Engineering, 7th ed., Central Publishing House, 2012.
R5. Ballaney P.L., Thermal Engineering, 5th ed., Khanna Publishers, 2012.

Energy Conversion Lab| MEP351 | 1 Credit | 0 0 2 1

Course Prerequisite

The student should have studied the Engineering Thermodynamics (MEL252).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Get the concepts related to the operation of internal combustion engines based upon the fundamental engineering sciences of thermodynamics.
- Learn the techniques for improving the efficiencies and performance of compressors and refrigeration systems retained to practical applications such as irrigation, air conditioning and refining oil and gas.
- Find the performance of Heat Engines in real-time applications by applying the various testing parameters of an engine.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the practical operation of 2 stroke and 4 stroke I.C engines using valve timing diagram.
CO 2. Analyze the performance of engines with the variation of various performances like load and speed.
CO 3. Compare basic systems of energy conversion techniques.
CO 4. Investigate the effectiveness of energy conversion process in mechanical power generation.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. To draw the valve timing diagram of the given petrol/diesel engine.
2. To draw the port timing diagram of the given petrol/diesel engine.
3. To study the construction and working of 2-stroke petrol engines.
4. To prepare the heat balance sheet of single cylinder VCR diesel engine.
5. To prepare the heat balance sheet of single cylinder VCR petrol engine.
6. Performance test on 4 – Stroke Diesel Engine with Mechanical Loading test rig.
7. Performance test on 4 – Stroke Petrol Engine with Electrical loading test rig.
8. Performance test on 4 – Stroke Diesel Engine with Electrical loading test rig.
9. Determination of calorific value of a gaseous fuel using Bomb Calorimeter.
10. Determination of viscosity of oil by using Redwood viscometer.
11. Determination of flash and fire point of fuel.

12. To study the working of the various types of Compressors.
13. To determine the volumetric efficiency of a reciprocating air compressor.
14. To study the working and types of boilers.
15. To study the working of various types of turbines and find the efficiency.
16. To study the construction and working of condenser.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Eastop T.D., and McConkey A., Applied Thermodynamics: For Engineering Technologists, 5th ed., Pearson Education, 2013.
T3. Nag P.K., Power Plant Engineering, 4th ed., Tata McGraw Hill, 2014.

Reference Books

R1. Rogers, G.F.C., and Mayhew Y.R., Thermodynamics and Transport Properties of Fluids, 5th ed., Blackwell Publishers, 2013.
R2. GanesaN V., Internal Combustion Engines, 4th ed., Tata McGraw Hill Education, 2013.
R3. Dixon S.L. and Hall C.A., Fluid Mechanics and Thermodynamics of Turbomachinery, 6th ed., Elsevier, 2010.
R4. Yadav R., Steam and Gas Turbines and Power Plant Engineering, 7th ed., Central Publishing House, 2012.
R5. Ballaney P.L., Thermal Engineering, 5th ed., Khanna Publishers, 2012.

Fluid Machines| MEL352 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand and apply the fundamental principles governing the energy transfer in a hydraulic machine.
- Describe the operations and performance of pumps, turbines, and similar hydraulic machines.
- Choose the appropriate pumps, turbines and different hydraulic machines for various purposes based on the applications.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the fundamentals of fluid flow behavior and energy conversion process in hydraulic machines i.e. turbines and pumps.
CO 2. Explain basic concepts and design features of turbomachines.
CO 3. Apply the fundamental equations of fluid flow for hydraulic machines.
CO 4. Describe the working principles of Pelton wheel, Kaplan and Francis turbines along with their performance analysis.
CO 5. Describe the working principles of centrifugal, reciprocating, rotary and axial pumps along with their performance analysis.
CO 6. Discuss some specific types of hydraulic machines and understand the cavitation phenomenon in turbines and pumps.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to Hydraulic Machines, Impulse momentum principle, dynamic action of jet on fixed and moving flat plates and curved vanes, series of plates and vanes, water wheels, velocity triangles and their analysis, jet propulsion of ships. Principles and classification of hydraulic machines, element of hydroelectric power plant. Hydraulic Turbine: impulse turbines i.e., Pelton wheel. Reaction turbines i.e., Francis turbines, Propeller turbine, Kaplan turbine and bulb turbine. Principle of operation, construction, design, installation, characteristics, governing, accessories, selection, model testing, degree of reaction, velocity diagram and analysis, unit and specific quantities. Pump: centrifugal pump, reciprocating pump and rotary pumps. Principle of operation, classification, components installation, priming, velocity triangles and their analysis, slip factor, performance characteristics, multistaging of pumps, design, indicator diagram, cavitation, air vessels, model testing, NPSH, unit and specific quantities. Introduction to axial pump, mixed flow pump, self-priming pump, gear pump, sliding vane pump, screw pump & hand pump. Miscellaneous fluid machines: airlift pumps, hydraulic rams, hydraulic cranes, fluid couplings and torque converter.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Ojha C.S.P., Berndtsson R., Chandramouli P.N., Fluid Mechanics and Machinery, 1st ed., Oxford University Press 2010.

T2. Cengel Y.A. and Cimbala J.M., Fluid Mechanics: Fundamentals and Applications, 4th ed., Tata McGraw Hill Education, 2019.

Reference Books

R1. Yahya S.M., Turbines, Fans and Compressors, 4th ed., Tata McGraw Hill, 2012.

R2. Lal J., Fluid Mechanics and Hydraulics, 9th ed., Metropolitan Book Corporation. Private Limited, 2012.

R3. Khan M.K., Fluid Mechanics and Machinery, 1st ed., Oxford University Press India, 2015.

R4. Nag P.K., Power Plant Engineering, 3rd ed., Tata Mc-Graw Hill Education, 2013

R5. Bansal R.K., A Textbook of Fluid Mechanics and Hydraulic Machines, 9th ed., Laxmi Publication, 2014.

Fluid Machines Lab| MEP352 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Have practical knowledge of the different hydraulic machines, pumps, and turbines.
- Understand the working principles and energy conversion processes in hydraulic machines, pumps, and turbines.
- Learn the usage of various fluid flow and pressure measuring devices.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Demonstrate the design features and working principles of hydraulic turbines and pumps.

CO 2. Perform the experiments to determine the power developed and to analyse the performance parameters of turbines.

CO 3. Perform the experiments to determine the power developed and to analyse the performance parameters of different types of pumps.

CO 4. Visualization of the fluid flow phenomenon and energy conversion process in hydraulic machines.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Study of different types of hydraulic turbines.

2. To verify the momentum equation using the impact of jet experiment.
3. To study the performance characteristics of a centrifugal pump and to determine the characteristics with maximum efficiency.
4. To study the performance characteristics of a reciprocating pump and to determine the characteristics with maximum efficiency.
5. To draw the characteristics curves of gear oil pump and determine the efficiency of given gear oil pump.
6. To conduct load test on Pelton wheel turbine and to study the characteristics of Pelton wheel turbine.
7. To conduct load test on Francis turbine and to study the characteristics of Francis turbine.
8. To study the two pump performances, both in series and parallel operation and to draw the characteristics curves in both series and parallel arrangement.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Ojha C.S.P., Berndtsson R., Chandramouli, P.N., Fluid Mechanics and Machinery, 1st ed., Oxford University Press 2010.
T3. Cengel Y.A. and Cimbala J.M., Fluid Mechanics: Fundamentals and Applications, 3rd ed., Tata McGraw Hill Education, 2015.

Reference Books

R1. Yahya S.M., Turbines, Fans and Compressors, 4th ed., Tata McGraw Hill, 2012.
R2. Lal J., Fluid Mechanics and Hydraulics, 9th ed., Metropolitan Book Corporation. Private Limited, 2012.
R3. Khan M.K., Fluid Mechanics and Machinery, 1st ed., Oxford University Press India, 2015.
R4. Nag P.K., Power Plant Engineering, 3rd ed., Tata Mc-Graw Hill Education, 2013
R5. Bansal R.K., A Textbook of Fluid Mechanics and Hydraulic Machines, 9th ed., Laxmi Publication, 2014.

Heat and Mass Transfer | MEL353 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the fundamental principles and mechanisms of heat and mass transfer.
- Develop the ability to analyze and solve problems related to heat and mass transfer in various engineering applications.
- Develop the ability to apply mathematical and computational tools to solve complex heat and mass transfer problems.
- Understand the importance of heat and mass transfer in real-world applications and their impact on society and the environment.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the basic modes of heat transfer.
CO 2. Understand and derive heat diffusion equation and analyze steady and transient case of heat conduction.
CO 3. Understand and analyze both free and forced convection.
CO 4. Understand laws of radiation, black and gray bodies, radiation exchange between surfaces and radiation shields.

CO 5. Understand Heat exchangers, different methods used to design a heat exchanger- LMTD and NTU, mass transfer and boiling phenomenon.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Conduction: Heat diffusion equation, 1-D steady state conduction in extended surfaces, infinite and semi-infinite walls, heat generation, lumped capacitance and simple transient models. Convection: Forced and free convection - mass, momentum and energy conservation equations, non-dimensional numbers, hydrodynamic and thermal boundary layers, basics of heat transfer in external and internal laminar and turbulent flows, and use of co-relations. Boiling and condensation: Physical phenomena and co-relations. Mass transfer: Fick's law, similarity with convection and correlations. Radiation: Properties, laws, 3- surface network for diffuse-gray surfaces, Heat exchanger fundamentals and design. Conduction: Heat diffusion equation, 1-D steady state conduction in extended surfaces, infinite and semi-infinite walls, heat generation, lumped capacitance and simple transient models. Convection: Forced and free convection - mass, momentum and energy conservation equations, non-dimensional numbers, hydrodynamic and thermal boundary layers, basics of heat transfer in external and internal laminar and turbulent flows, and use of co-relations. Boiling and condensation: Physical phenomena and co-relations. Mass transfer: Fick 's law, similarity with convection and correlations. Radiation: Properties, laws, 3- surface network for diffuse-gray surfaces, Heat exchanger fundamentals and design.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Cengel Y.A. and GhajaR A.J., Heat and Mass Transfer, 6th ed., Tata McGraw Hill Education, 2020.
T2. Som S.K., Introduction to Heat Transfer, 1st ed., Prentice Hall India Learning Private Limited, 2008.

Reference Books

R1. Holman J.P. and Bhattacharyya S., Heat Transfer, 10th ed., Tata McGraw Hill Education, 2017.
R2. Sukhatme S.P., A Textbook on Heat Transfer, 4th ed., Universities Press, 2013.
R3. Ghoshdastidar P.S., Heat Transfer, 2nd ed., Oxford University Press, 2012.
R4. Nag P.K., Heat and Mass Transfer, 3rd ed. Tata McGraw Hill Education, 2011.
R5. Incropera F.P, DeWitt D.P., Bergmaman T.L, Lavine A.S., Principles of Heat and Mass Transfer, 8th ed., Wiley India, 2017.

Heat and Mass Transfer Lab | MEP353 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the fundamental principles of heat and mass transfer and apply them to solve practical problems and analyse the behavior of different systems.
- Gain hands-on experience with different types of equipment and instruments used in heat and mass transfer experiments.
- Conduct experiments to study heat and mass transfer phenomena such as conduction, convection, radiation, diffusion.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Perform conduction experiment to determine thermal conductivity of material and performance of fin.
CO 2. Perform the experiment to study convection phenomenon.
CO 3. Assess the performance of heat exchanger and study boiling phenomenon.
CO 4. Perform experiment to study radiation phenomenon

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. To determine thermal conductivity of metal rod.
2. To determine efficiency and effectiveness of the fin by forced convection using Pin fin apparatus.
3. To determine efficiency and effectiveness of the fin by natural using Pin fin apparatus.
4. Determination of thermal conductivity of pipe insulation by lagged pipe apparatus.
5. To determine Stefan Boltzmann constant for radiant heat transfer.
6. To determine forced convection heat transfer coefficient for flow through the given Horizontal tube.
7. To study the pool boiling phenomenon up to critical heat flux apparatus.
8. To determine heat transfer coefficient in parallel and counter flow in a tubular heat exchanger.
9. Analysis of heat exchangers using thermal designing software.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Cengel Y.A. and GhajaR A.J., Heat and Mass Transfer, 6th ed., Tata McGraw Hill Education, 2020.
T3. Incropera F.P, DeWitt D.P., Bergmaman T.L, Lavine A.S., Principles of Heat and Mass Transfer, 8th ed., Wiley India, 2017.

Reference Books

R1. Holman J.P. and Bhattacharyya S., Heat Transfer, 10th ed., Tata McGraw Hill Education, 2017.
R2. Sukhatme S.P., A Textbook on Heat Transfer, 4th ed., Universities Press, 2013.
R3. Ghoshdastidar P.S., Heat Transfer, 2nd ed., Oxford University Press, 2012.
R4. Nag P.K., Heat and Mass Transfer, 3rd ed. Tata McGraw Hill Education, 2011.
R5. Som S.K., Introduction to Heat Transfer, 1st ed., Prentice Hall India Learning Private Limited, 2008.

Dynamics of Machines | MEL354 | 4 Credits | 3 2 0 3

Course Prerequisite

The student should have learned Kinematics of Machines (MEL255).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the concept of free body equilibrium, work-energy equation, and general plane motion with translation and rotation.
- Explore impulse-linear momentum, angular impulse-angular momentum, impact, and generalized angular impulse-angular momentum.
- Analyze static and dynamic force analysis, friction effects, equivalent dynamical systems, and gyroscopic motion.
- Apply concepts to analyze gyroscopic effect, flywheel and turning moment diagram, slider-crank mechanism, governors, brakes, and dynamometer.
- Develop proficiency in analyzing the balancing of engines, friction devices, and the application of cam and follower in vibration.
- Understand the concept of free body equilibrium, work-energy equation, and general plane motion with translation and rotation.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Develop the ability to understand and apply the concept of free body equilibrium and work-energy equation in general plane motion.

CO 2. Analyze impulse-linear momentum, angular impulse-angular momentum, impact, and generalized angular impulse-angular momentum in complex problems.

CO 3. Build proficiency in analyzing static and dynamic force analysis, friction effects, equivalent dynamical systems, and gyroscopic motion in complex systems.

CO 4. Apply concepts to analyze gyroscopic effect, flywheel and turning moment diagram, slider-crank mechanism, governors, brakes, and dynamometer in real-world situations.

CO 5. Build the ability to analyze the balancing of engines, friction devices, and the application of cam and follower in vibration and develop critical thinking skills to apply concepts to solve problems in forced vibration, base excitation, vibration isolation, and vibration transmission.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Dynamics: Concept of free body and its equilibrium, work-done-energy equation, general plane motion with translation and rotation, impulse-linear momentum, angular impulse angular momentum, impact, generalized angular impulse-angular momentum, static force analysis, friction effects, D 'Alembert 's principle, dynamic force analysis, equivalent dynamical systems, simple gyroscopic motion. Application: Gyroscopic effect and application, Flywheel and turning moment diagram, Dynamics of slider-crank mechanism, concept of offsets, governors and its types, brakes and dynamometer, Balancing of engines, analysis of friction devices (belt drives, pivots and collars, plate and cone clutches, band and block brakes), applications of Cam and follower.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Uicker J.J., Pennock G.R. and Shigley J.E., Theory of Machines and Mechanisms, 3rd ed., Oxford University Press, 2013.

T2. Rao J.S. and Dukkipati R.V., Mechanism and Machine Theory, 2nd ed., New Age International, New Delhi, 2012.

Reference Books

R1. Bevan T., Theory of Machines, 3rd ed., Pearson Education, 2012.

R2. Ghosh A. and Malik A.K., Theory of Mechanisms and Machines, 3rd ed., Affiliated East-West Press, 2011.

R3. Rattan S. S., Theory of Machines, 3rd ed., Tata McGraw Hill Education, 2012.

R4. Norton R.L., Kinematics and Dynamics of Machinery, 1st ed., Tata McGraw Hill Education, 2013.

R5. Rao J.S. and Gupta K., Theory and Practice of Mechanical Vibration, 2nd ed., New Age International, 2012.

Metrology and SQC | MEL355 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Learn the principles of measurements and their importance in manufacturing processes.
- Use the various tools and techniques used for linear, angular, and surface measurements.
- Provide students with an understanding of the co-ordinate measuring machine (CMM) and automatic gauging and sorting machines.
- Learn statistical quality control techniques, process control charts, and acceptance sampling techniques, TQM concepts, quality assurance, and quality circles.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Design a procedure to measure product dimensional features & use various tools and techniques for linear, angular, and surface measurements.
CO 2. Use comparators and gauges for measurement and inspection.
CO 3. Measure dimensions of screw threads, gears, and surface texture using appropriate tools and techniques.
CO 4. Use CMM and automatic gauging and sorting machines for measurement and inspection.
CO 5. Apply statistical quality control techniques and use process control charts such as X-bar, R, p and np charts and process capability to improve manufacturing processes.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Metrology: Definition, need, line and end standards, principles of measurements, calibration, accuracy and precision, tolerances, interchangeability, selective assembly, limits & fits, types of fits, shaft basis system, hole basis system, allowances, IS specifications, Taylor principle, design of limit gauges & its types, process planning sheet and tolerance chart preparation.
Linear and angular measurements; Comparators: Mechanical, Fluid displacement & Pneumatic, Electrical; Interferometry: principle and types, optical flat; Screw thread measurement; Gear measurement; Measurement of surface texture, straightness, flatness parallelism, circularity; Co-ordinate Measuring Machine (CMM); Automatic Gauging and Sorting machine.
Quality: Definition, function, objectives, concepts, characteristics, quality of design & conformance; Statistical Quality Control, Process control charts & process capability, acceptance sampling techniques, sampling plans, inspection types and objectives Basics of ISO 9000 and ISO 14000, TQM concepts, quality assurance, quality circles.
Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Jain R.K., Engineering Metrology, 20th ed., Khanna Pub., New Delhi, 2017.
T2. Mitra A., Fundamentals of quality control and improvement, 3rd ed., John Wiley & Sons, 2013.

Reference Books

R1. Hume K.J., Engineering metrology, 1st ed., Macdonald Co. (publisher) London, 1963.
R2. Smith G.T., Industrial metrology: surfaces and roundness, 1st ed., Springer Science & Business Media, 2002.
R3. Feigenbaum A.V., Total Quality Control, 4th ed., I.K. International Publishing House, New Delhi, 2008.
R4. Leavenworth R.S., Grant E.L., Statistical Quality Control, 7th ed., Tata McGraw-Hill Education, 2000.
R5. Bestefield D.H., Quality Control, Revised 3rd ed., Prentice Hall (Pearson), 2003.

Metrology and SQC Lab| MEP355 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Learn the principles of measurements and their importance in manufacturing processes.
- Use the various tools and techniques used for linear, angular, and surface measurements.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Define metrology and understand its importance in manufacturing processes.
CO 2. Apply the Taylor principle and design limit gauges and their types, prepare process planning sheets, and tolerance charts.
CO 3. Perform linear and angular measurements using mechanical, fluid displacement and pneumatic, and electrical comparators.
CO 4. Measure dimensions of screw threads & gears, and surface texture using appropriate tools and techniques.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. To understand the construction of Vernier Caliper and calculate its least count.
2. To understand the construction of outside micrometer and calculate its least count.
3. To Study & Observe Vernier Height gauge, Digital Height gauge and Vernier Depth gauge.
4. To study and use Depth micrometer.
5. To study and use direct and indirect measuring instruments like Screw pitch gauge, radius gauge, small hole gauge, Telescopic gauge and Feeler gauge.
6. To study and use Vernier Bevel Protractor.
7. To find unknown angle of a given component using Sine Bar.
8. Micrometer calibration by Slip Gauges.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Jain R.K., Engineering Metrology, 20th ed., Khanna Pub., New Delhi, 2017.
T3. Mitra A., Fundamentals of quality control and improvement, 3rd ed., John Wiley & Sons, 2013.

Reference Books

R1. Hume K.J., Engineering metrology, 1st ed., Macdonald Co. (publisher) London, 1963.
R2. Smith G.T., Industrial metrology: surfaces and roundness, 1st ed., Springer Science & Business Media, 2002.
R3. Feigenbaum A.V., Total Quality Control, 4th ed., I.K. International Publishing House, New Delhi, 2008.
R4. Leavenworth R.S., Grant E.L., Statistical Quality Control, 7th ed., Tata McGraw-Hill Education, 2000.
R5. Bestefield D.H., Quality Control, Revised 3rd ed., Prentice Hall (Pearson), 2003.

Operations Management | MEL356 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an ability to learn to analyze and improve business processes in services or in manufacturing.
- Apply techniques on how to increase productivity and deliver higher quality standards.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Identify the key role that the operations function plays in creating the competitive strength of the firm.
CO 2. Develop comprehensive, clear written and mathematical analyses that make sense and that foster the decision-making process.
CO 3. Effectively assess a well-managed and well executed operations strategy.
CO 4. Identify effective soft management skills applicable to operations management.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Production systems and performance measures, Life Cycle of a production system, Major managerial decisions in the life of a production system, Just in Time (JIT), Theory of Constraints (TOC), Product design and process selection, Location and Layout of production systems, Product, Process and Cellular layouts, Demand Forecasting, Aggregate production planning, Inventory and MRP, Scheduling decisions and emerging trends.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Russell R. S. and Taylor B. W., Operations Management, 7th ed., Wiley India, 2013.
T2. Krajewski L. J., Malhotra M., Operations Management: Processes and Supply Chains, 13th ed., Pearson Education, 2021.

Reference Books

R1. Martinich J. S., Production and Operations Management – An Applied Modern Approach, 1st ed., Wiley India, 2008.
R2. Gaither N. and Frazier G., Operations Management, 9th ed., Cengage Learning, 2002.
R3. Chary S. N., Production and Operations Management, 6th ed., Tata McGraw-Hill, 2019.
R4. Boeuf M. L., Essence of Time Management: Principles and Practice, 1st ed., Jaico Publishing House, 2001.
R5. Gupta A. K. and Sharma J. K., Management of Systems, 1st ed., Macmillan India Limited, 2000.

Design of Machine Elements | MEL357 | 4 Credits | 3 2 0 4

Course Prerequisite

The student should have studied the Solid Mechanics (MEL254) and Kinematics of Machines (MEL255).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand procedure of machine design and develop an ability to apply it for simple component design by using design data handbook.
- Understand the different theories of failure and develop an ability to apply its knowledge for design of mechanical component and determine the resisting areas against failure.
- Determine forces on the machine components subjected to various loading conditions.
- Determine the endurance strength and design of components subjected to fluctuating loads.
- Apply computer-based techniques in the analysis, design and/or selection of machine components.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Calculate the stress and strain on mechanical components and identify failure modes for mechanical parts.
CO 2. Analyse the concepts of principal stresses, theories of failure, stress concentration and fatigue loading.
CO 3. Understand the machine component behaviour subjected to different loads.
CO 4. Solve the design problem successfully.
CO 5. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to Design of Machine Elements, Basic Procedure of Machine Design, Manufacturing Considerations in Design, Review of Failure theories, Design Against Static Load, Design Against Fluctuating Load, Stress Concentration, Design procedure for fatigue failure, Endurance limit, Low-cycle and High-cycle Fatigue, Design of machine elements subjected to simple and fatigue loading, Power Screws, Torque Requirement for lifting and lowering load, Design of Shafts, Shaft Design on Strength and Rigidity Basis, Design of Hollow Shaft, Design of Square and Flat Keys, Couplings, Design Procedure for Muff Coupling, Springs, Design of Helical Spring, Belts, Analysis of Belt, Chain, Bearing, Design for Cyclic Loads and Speeds, Gears, Dynamic Load Carrying Capacity.
Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Bhandari V. B., Design of Machine Elements, 4th ed., McGraw Hill, 2016.
T2. Spotts M.F., Shoup T.E., Hornberge L.E., Design of Machine Elements, 8th ed., Pearson Education, 2019.

Reference Books

R1. Norton R.L., Machine Design: An Integrated Approach, 2nd ed., Pearson Education, 2013.
R2. Spotts M. F., Design of Machine Elements, 8th ed., Pearson Education India, 2006.
R3. Black P.H. and Adams, O.E., Machine Design, 3rd ed., McGraw Hill, 1981.
R4. Budynas R.G. and Nisbett J.K., Shigley's Mechanical Engineering Design, 9th ed., Tata McGraw Hill Education, 2013.
R5. Juvinall R. C. and Marshek K. M., Machine Component Design, 5th ed., Wiley India, 2012.

Refrigeration and Air Conditioning | MEL451 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the Courses Heat and Mass Transfer (MEL353), Fluid Mechanics (MEL253).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the fundamentals of refrigeration and air conditioning.
- Know the principles used for low temperature applications.
- Analyse the cycle performance of vapour absorption system with respect to varying enthalpy and concentration.
- Understand the different refrigerants with respect to properties, applications.
- Calculate the cooling/heating load for different applications as per the recommended standards.
- Recognize and identified various operating and safety controls employed in refrigeration air conditioning systems.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Illustrate the basic concepts of refrigeration system and analyse the vapour compression cycle.
CO 2. Understand VARS, aircraft refrigeration system and select proper refrigerant.
CO 3. Use psychrometric principles for air-conditioning systems.
CO 4. Develop understanding of the principles and practice and requirements of ventilation and generalized psychrometries of moist air and apply to HVAC processes.
CO 5. Gain some knowledge on Design of air-conditioning systems for a particular application.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Fundamentals of refrigeration and air conditioning. Vapor compression system: Ideal and real cycle analyses, Refrigerants: designation, properties, and environmental considerations. Actual vapor compression cycles, Multi-stage compression. Air refrigeration cycle Components: condensers, evaporators, compressors, and expansion devices – construction, operation and performance. Vapor absorption cycles: operation, system design, components. Psychrometry: definitions, heating, cooling, humidification and dehumidification processes, evaporative cooling systems. Environmental comfort specifications and standards.
Cooling load estimation and use of standards. Air-conditioning systems and apparatus, air flow ducts, air quality. Control and optimization of HVAC systems. Applications and environmental issues.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Arora C.P., Refrigeration and Air Conditioning, 3rd ed., Tata McGraw Hill Publication, 2013.
T2. Prasad M., Refrigeration and Air Conditioning, 2nd ed., New Age International Publishers, 2006.

Reference Books

R1. Dossat R.J., Principles of Refrigeration, 4th ed., Pearson Education, 2010.
R2. Ballaney P.L., Refrigeration and Air Conditioning, 7th ed., Khanna Publishers, 1992.
R3. Khurmi R.S. and Gupta J.K., Textbook of Refrigeration and Air Conditioning, 5th ed., S. Chand Publication, 2011.
R4. Pita E.G., Air Conditioning Principles and Systems: An Energy Approach, 4th ed., PHI Learning Private Limited, 2008.
R5. American Society of Heating, Refrigerating and Air-Conditioning Engineers, 2013 ASHRAE Handbook: Fundamentals, Inch-Pound ed., ASHRAE, 2013.

Refrigeration and Air Conditioning Lab | MEP451 | 1 Credit | 0 0 2 1

Course Prerequisite

The student should have studied the courses Heat and Mass Transfer Lab (MEP353), Fluid Mechanics Lab (MEP253).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the fundamental principles governing various types of refrigeration systems.
- Apply basic thermodynamic principles to evaluate performance parameters related to refrigeration systems.
- Understand the difference between various types of refrigeration systems along with their applications.
- Acquire knowledge about the fundamental principles of psychrometry, air conditioning process and various types of air conditioning systems.
- Comparative study of different refrigerants with respect to their properties, applications and environmental impact.
- Know the construction and working of equipment employed in refrigeration and air conditioning systems along with their operating and safety controls.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the basic components of refrigeration systems and evaluate the performance of vapour compression refrigeration system.
CO 2. Operate, analyze and maintain various refrigeration and air conditioning systems in different modes of operation.
CO 3. Learn troubleshooting of devices, testing of leakage in refrigeration systems.
CO 4. Investigate the effect of psychrometric processes on the performance of air conditioning systems.
CO 5. Select suitable refrigerant and right equipment for a particular application.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. To study refrigeration test rig and to study the vapour compression refrigeration cycle.
2. To simulate an industrial cooling tower and study its performance based on the cooling load.
3. To find out the HP Blower of the axial fan fitted in a duct.
4. Trial on Air Conditioning test rig.
5. Study of Household/Domestic Refrigerator.
6. Study of Leak Detection, Evaluation and Charging Procedure for Refrigerant.
7. Study of Refrigerating Controls.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Arora C.P., Refrigeration and Air Conditioning, 3rd ed., Tata McGraw Hill Publication, 2013.
T3. Prasad M., Refrigeration and Air Conditioning, 2nd ed., New Age International Publishers, 2006.

Reference Books

R1. Dossat R.J., Principles of Refrigeration, 4th ed., Pearson Education, 2010.
R2. Ballaney P.L., Refrigeration and Air Conditioning, 7th ed., Khanna Publishers, 1992.
R3. Khurmi R.S. and Gupta J.K., Textbook of Refrigeration and Air Conditioning, 5th ed., S. Chand Publication, 2011.
R4. Pita E.G., Air Conditioning Principles and Systems: An Energy Approach, 4th ed., PHI Learning Private Limited, 2008.
R5. American Society of Heating, Refrigerating and Air-Conditioning Engineers, 2013 ASHRAE Handbook: Fundamentals, Inch-Pound ed., ASHRAE, 2013.

Mechanical Vibrations | MEL452 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the course Dynamics of Machines (MEL354).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an ability to understand the basic concepts and to realize the importance of mechanical vibration.
- Develop basic skills in reading and interpretation of vibration study.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Draw the free body diagram and solve the differential equations of motion for free vibration a single degree of freedom (DOF) systems and analyze the resulting harmonic motion.
CO 2. Apply energy methods for analyzing and solving single and multi DOF systems.
CO 3. Understand different types of damping and solve the systems undergoing free and forced vibrations with viscous damping.
CO 4. Understand the concepts of self-excited vibration, motion and force transmission in a single and multi-DOF system and apply them for the design of mechanical systems such as automotive suspensions.
CO 5. Model, analyze and solve multi-DOF systems using modal analysis.
CO 6. Understand the concepts of vibration of continuous system and solve analytically.

CO 7. Understand the distinguishing characteristics of non-linear vibration and the concepts of phase plane and stability of equilibrium.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Fundamentals of Vibration: Basic concepts of vibration, classification, importance, vibration analysis procedure.
Single degree of freedom system: Free vibration analysis of undamped translational and torsional system, Rayleigh's energy method, Free vibration with various types of damping (viscous, coulomb, hysteresis), Free vibration response under harmonic and other general forcing conditions, transient response through Duhamel's integral.
Two degree of freedom systems: Free vibration analysis of damped and undamped translational and torsional system, Coordinate coupling and principal coordinates, Semi-defined system.
Multi degree of freedom systems: Modeling of continuous systems as multi degree of freedom system using Newton's second law, Influence coefficients, eigenvalue problem, and forced vibration of undamped and damped systems using modal analysis.
Determination of natural frequencies and mode shapes: Dunkerley's formula, Rayleigh's method, Jacobi's method.
Vibration of continuous systems: Longitudinal vibration of bar/rod, lateral vibration of beams and torsional vibration of shafts.
Vibration control: Control of vibration, control of natural frequencies, vibration isolation and absorbers.
Vibration measurement and applications: Role of vibration measurement and analysis in machine design and machine condition monitoring.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Rao S.S., Mechanical Vibrations, 6th ed., Pearson Education, 2018.
T2. Grover G.K, Mechanical Vibrations, 8th ed., Nem. Chand & Bros, 2009.

Reference Books

R1. Rao J. S. and Gupta K., Introductory Course on Theory and Practice of Mechanical Vibrations, 2nd ed., New Age International Publishers, 2012.
R2. Meirovitch L., Fundamentals of Vibrations, 2nd ed., Waveland Press, 2010.
R3. Timoshenko S., Vibration Problems in Engineering, 2nd ed., Oxford City Press, 2011
R4. Thomson W.T. and Dahleh M.D., Theory of Vibration with Applications, 5th ed., Pearson, 2008.
R5. Kelly S.G., Mechanical Vibrations: Theory and Applications, CL Engineering, 2011.

Mechanical Vibrations Lab | MEP452 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Work effectively in a team in conducting experiments, collecting data, discussing results, and writing reports.
- Understand the motion and the natural frequency.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand and construct the equations of motion for single degree of freedom Systems.
CO 2. Understand the concept of natural frequency and how to find it for a vibrating system.
CO 3. Learn the process of vibration measurements.
CO 4. Understand the vibration of continuous systems.

Desirable/Advanced (If any): Nil.

Experiments for Essential Course Outcomes

1. To verify the relation of time period of simple pendulum.
2. To determine the radius of gyration of given bar using bifilar suspension.
3. To determine the radius of gyration 'K' of a given compound pendulum.
4. To study the torsional vibrations of a single rotor system.
5. To study the free vibration of two rotor system & to determine the natural frequency of vibration theoretically and experimentally.
6. To study the damped torsional oscillation to determine the damping co-efficient.
7. To verify the Dunker Ley rule.
8. To study the forced vibration of cantilever beam.
9. To study longitudinal vibration of helical spring and to determine the frequency, time period of oscillation, theoretically and experimentally.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Rao, S.S., Mechanical Vibrations, 6th ed., Pearson Education, 2018.
T3. Grover, G.K, Mechanical Vibrations, 8th ed., Nem Chand & Bros, 2009.

Reference Books

R1. Rao J. S. and Gupta K., Introductory Course on Theory and Practice of Mechanical Vibrations, 2nd ed., New Age International Publishers, 2012.
R2. Meirovitch L., Fundamentals of Vibrations, 2nd ed., Waveland Press, 2010.
R3. Timoshenko S., Vibration Problems in Engineering, 2nd ed., Oxford City Press, 2011
R4. Thomson W.T. and Dahleh M.D., Theory of Vibration with Applications, 5th ed., Pearson, 2008.
R5. Kelly S.G., Mechanical Vibrations: Theory and Applications, CL Engineering, 2011.

Measurement and Control | MEL358 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the importance of measurement in mechanical engineering and the basic principles of measurement.
- Understand the various types of measuring instruments and their application in mechanical engineering.
- Understand the fundamental concepts of error analysis and uncertainty in measurements.
- Be able to identify and select appropriate measuring instruments and techniques for specific measurement tasks.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Analyze and calculate errors and uncertainty in measurements using statistical analysis.
CO 2. Understand working principles in the measurement of different field quantities.
CO 3. Analyze and identify sensors for measurement of vibration, thermo-physical properties and radiation properties of surfaces.
CO 4. Comprehend the conceptual development of zero, first and second order systems.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Mechanical Measurements: Purpose, structure and elements of measuring system, Static performance characteristics, Generalized model of system element and calibration, linearity, static sensitivity, accuracy, precision, repeatability, hysteresis, threshold, resolution, and readability. Measurement error: Sources of errors, error analysis, propagation of uncertainties, theory of experimentation. Dynamic Performance characteristics, Input types, instrument types, zero, first, and second order instruments. Measurements and methods applications: Classification, Principle, Construction, Range and working of instruments for following measurements, Displacement, Speed, Force, Torque, Temperature, Flow, Level, Pressure, Sound, Light intensity. Classical Control: Laplace Transformation, Block diagram and its reduction, Time response, Root Locus Analysis, Routh Stability, Frequency response, Bode, Polar, Nyquist, Nichols charts, Nyquist stability, Compensation: Lead, Lag, Lead-Lag, PID controller. Modern Control: State space method, Signal Flow Graph (SFG), State Transition Matrix, Stability, Steady state error. Advanced Control: Digital control, z-transformation, Digital transformation, Stability, Performance plot, Root Locus, Compensation, PID controller, Robust control, Concept of system sensitivity, Sensitivity function, Perturbation: additive, multiplicative, Robust stability, Uncertain system and its stability, Robust PID controller

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Doeblin E.O. and Manik D. N., Doblin's Measurement Systems, 6th ed., McGraw Hill, 2012.

T2. Nakra B.C and Chaudhry K.K., Instrumentation Measurement and Analysis, 3rd ed., Tata McGraw Hill, 2013.

Reference Books

R1. Bentley J.P., Principles of Measurement Systems, 4th ed., Pearson Education, 2011.

R2. Beckwith T.G, Lienhard V J.H., Morangoni R.D., Mechanical Measurements, 6th ed., Pearson Education, 2012.

R3. Rangan C.S., Sharma G.R. and Mani, V.S.V., Instrumentation Devices and Systems, 2nd ed., McGraw Hill, 2011.

R4. Ogata K., Modern Control Engineering, 5th ed., Pearson Education,2015.

R5. Bewoor A. K. and Kulkarni V.A., Metrology and Measurement, McGraw Hill, 2012.

Measurement and Control Lab | MEP358 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the principles of measurement and the various methods used to measure mechanical quantities.
- Identify and select appropriate measuring instruments and techniques for specific measurement tasks.
- Understand the importance of error analysis and uncertainty in measurements.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Select suitable mechanical measuring instruments for basic and special requirement in the industries.

CO 2. Calibrate and analyze the characteristics of measuring instruments.

CO 3. Conduct experiments to measure mechanical quantities like temperature, flow rate, humidity, length etc.

CO 4. Determine error and analyze uncertainty in the measurements.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. To measure temperature using temperature measuring devices.
2. To study characteristic graph of LVDT sensor.
3. To measure the tensile, bending, and torsional strain using strain gauge.
4. To measure volumetric flow rate using venturimeter.
5. To measure roughness of the surface using roughness testing machine.
6. To measure humidity of ambient air using hygrometer.
7. To measure length using micrometer.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Doeblin E.O. and Manik D. N., Doeblin_s Measurement Systems, 6th ed., McGraw Hill, 2012.
T3. Nakra B.C and Chaudhry K.K., Instrumentation Measurement and Analysis, 3rd ed., Tata McGraw Hill, 2013.

Reference Books

R1. Bentley J.P., Principles of Measurement Systems, 4th ed., Pearson Education, 2011.
R2. Beckwith T.G, Lienhard V J.H., Morangoni R.D., Mechanical Measurements, 6th ed., Pearson Education, 2012.
R3. Rangan C.S., Sharma G.R. and Mani, V.S.V., Instrumentation Devices and Systems, 2nd ed., McGraw Hill, 2011
R4. Ogata K., Modern Control Engineering, 5th ed., Pearson Education,2015.
R5. Dorf R. C., Bishop R. H., Modem control systems., 6th ed., Addison-Wesely Publishing, Reading, MA, 1995.

Fundamentals of Electric Vehicles | MEL359 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the architecture design, components assembly, motor drives & drive control and regenerative system of an electric vehicle (EV).

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Explain the basics of electric vehicles, their architecture, technologies, and fundamentals.
CO 2. Calculate various forces acting on the moving vehicle, power and torque required to drive the vehicle.
CO 3. Understand the battery parameters such as SoC, SoH, factors affecting battery cell lifecycle and parameters to select EV battery.
CO 4. Explain various battery thermal management methods.
CO 5. Explain torque production, d-equivalent, chargers and charging standards.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to Electric Vehicles, overview of EV in India, Basics of Batteries, Charging and swapping infrastructure, source of Lithium for batteries, EV subsystem. Vehicle Dynamics- Forces acting when a vehicle moves, Aerodynamics drag, rolling resistance and uphill resistance, power, and torque to accelerate. Vehicle subsystems: EV power-train, concept of the drive cycle, drive cycle and energy used per km, EV subsystem: Design of EV drive train, Introduction to battery parameters, why Lithium-ion battery? Batteries in the future, Li-Ion battery cell, state of charge and state of health estimation and self-discharge, battery pack development, computation of effective cost of the battery, charging batteries, Fundamentals of battery pack design, mechanical design, thermal design, electricals design, and BMS design of EV. Battery thermal Management- Active and passive cooling. Vehicle Accessories- EV motors and controllers, power and efficiency, torque production, speed and back EMF, the q-equivalent circuit, field-oriented control, three-phase AC, thermal design, engineering considerations, future frontiers. Battery charging and Swapping- EV chargers, slow and fast, battery swapping, standardization and onboard chargers, public chargers, bulk-chargers/swap stations, analytics.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Denton T., Electric and Hybrid vehicles, 2nd ed., Routledge, 2020.
T2. Husain I., Electric and Hybrid vehicles: Design Fundamentals, CRC Press, 2010.

Reference Books

R1. Ehsami M., Gao Y., Longo S., Ebrahimi K. M., Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press, 2018.
R2. Hayes J., Goodarzi A.A., Electric Powertrain, Wiley, 2017.
R3. Erjavec J., Hybrid Electric, and Fuel –Cell Vehicles, Cengage Learning, 2012.
R4. Pistoia G., Electric and Hybrid Vehicles, 1st ed., Focal Press, 2010.
R5. Larminie J., Lowry J., Electric Vehicle Technology Explained, 1st ed., Wiley, 2003.

Introduction to Data Science for Mechanical Engineers | MEL360| 3 2 0 4

Course Prerequisite

The student should have studied the Applied Mathematics- I&II (SCL152 & 153).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the fundamentals of data acquisition and basics of statistical analysis of experimental data acquired.
- Understand the principles of mathematics applicable to large data sets.
- Understand the transformation algorithms and the respective application field.
- Apply the various learning models of classification and pattern recognitions.
- Predict the course of events in an experiment using processed data.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Acquire data based on characteristics of the system.
CO 2. Calculate and generate the significant parameters of the state of component.
CO 3. Identify the difference between the conditions of the system.
CO 4. Solve and analyse the performance of the system using fundamental AI tools.
CO 5. Transform the observation into desirable domains.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to data science; Data arrays, Data loading and selection, Data visualization, Functions, data manipulation and models, Conditionals and loops, Probability as a measure of uncertainty, The basic rules of probability, Discrete random variables, Continuous random variables, Expectation and variance, Normal distribution, quantiles, credible intervals, Fitting models with the principle of maximum likelihood, Covariance, correlation, and linear regression. Multimodal data generation and collection. Statistical analysis: analysis of experimental data. Confidence intervals and level of significance. Chauvinist's criteria and chi-square test of fits.
Transformations: Fourier transformation, Fast Fourier transformation, Short Time Fourier transform Wavelet transformation. Time and frequency domain analysis. Data conversion technique. Introduction to signal processing.
Fundamentals of learning models and Applications of pattern recognition; K-Means, gaussian mixture model, other clustering operations. Feature extraction, Data and dimensionality reduction. Signal decompositions.
Regression models; linear and non-linear regression models, Neural Networks etc. Optimization problems.
Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Maheshwari U., Sujatha R., Introduction to Data Science, a practical approach, Willy Publication, 2021.
T2. Randall R. B., Vibration-based condition monitoring: industrial, automotive and aerospace applications, John Wiley & Sons., 2021.

Reference Books

R1. Mohanty A R, Machinery Condition Monitoring: Principles and Practices, CRC Pub., 2021.
R2. Brunton S. L., & Kutz J. N., Data-driven science and engineering: Machine learning, dynamical systems, and control, Cambridge University Press, 2022.
R3. Rao R. N., Machine Learning in Data Science Using Python, 1st ed., Dreamtech Press, India, 2022
R4. Fishman H., Smarter Data Science, 1st ed., Willey, 2020.
R5. Thomas N., Essential Math for Data Science: Take Control of Your Data with Fundamental Calculus, Linear Algebra, Probability, and Statistics, 1st ed., O'Reilly Media, 2020.

Operation Research | MEL453 | 4 Credits | 3 2 0 4

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Learn the concept of Operations Research (OR) and its various models used in decision-making.
- Understand the characteristics, and limitations of OR, as well as the application of OR models in linear programming, assignment problems, transportation problems, and dynamic programming.
- Have a thorough understanding of OR and its various models, as well as the ability to apply them in real-world decision-making scenarios.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Define and formulate linear programming problems and appreciate their limitations.
CO 2. Solve linear programming problems using appropriate techniques, interpret the results obtained and translate solutions into directives for action and explain the primal-dual relationship.
CO 3. Solve multi-level decision problems using dynamic programming method and formulate and solve a transportation problem involving many shipping routes.
CO 4. Develop mathematical skills to analyse and solve network models arising from a variety of applications, as well as to solve an assignment problem using the Hungarian method.
CO 5. Understand different inventory, queuing and replacement situations and find the optimal solutions using models for different situations.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to Operation Research (OR) & basic OR models, definition, characteristics and limitations of OR. Linear programming: solutions of LPP by graphical method and simplex method, formulation of dual of LPP. Assignment model, travelling salesman problem, transportation Problems, transshipment model. Dynamic programming, structure and characteristics of dynamic programming, application of dynamic programming to resource allocation, inventory control & linear programming. Project management: drawing of network, CPM & PERT, Probability of completion of project, cost analysis of project, allocation and updating of networks. Replacement models: concept of equivalent, interest rate, present worth, economic evaluation of alternatives, group replacement models. Inventory control models, analysis of single product deterministic models. Waiting line situations, queuing theory and models (no derivations expected). Simulation concept and its application in waiting line situations, inventory and networks.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Taha H.A., Operations Research: An Introduction, 9th ed., Pearson Education, 2013.

T2. Sharma J.K., Operations Research, 4th ed., Macmillan India Ltd., 2009.

Reference Books

R1. Gupta P.K. and Hira D.S., Operations Research, S. Chand and Co. Ltd., 2012.

R2. Vohra N.D, Quantitative Techniques in Management, 4th ed., Tata McGraw Hill, New Delhi, 2011.

R3. Hillier F.S. and Lieberman G.J., Introduction to Operations Research, 10th ed., McGraw Hill, 2014.

R4. Ravindran A., Phillips D.T., and Solberg J.J., Operations Research: Principles and Practice, 2nd ed., John Willey and Sons, 2009.

R5. Mittal K.V. and Mohan C., Optimization Methods in Operations Research and Systems Analysis, New Age, 2003.

Industrial Engineering | MEL454 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an ability to learn industrial engineering principles that influence the productivity improvement in organizations.
- Apply work study and time study principles in organizations.
- Understand the concept of Quality control and its applications.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Apply the methods engineering and operational analysis in re-designing of work systems.

CO 2. Apply engineering work measurement principles in analysing and measurement of work.

CO 3. Analyze the work processes using advanced work study tools and techniques.

CO 4. Develop an understanding of emerging concepts and applications in designing work systems.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Organization: Factory system, principles of organization, types of organization and their selection; Work study: Introduction, Scientific management – Productivity - Advantages of work study to Management; Method Study: Introduction – Process charts, Critical Examination, Identification of key activities on process charts, Diagrams and Templates, Therbligs, Micro motion analysis, Memo motion study; Ergonomics: Basics of Ergonomics and its industrial applications, Anthropometry; Principles of Motion Economy: Related to human body, work place,

equipment; Work Measurement: Work measurement techniques – Rating - Measuring the job – Allowances - Standard time - Synthetic data - Analytical estimating – PMTS, Work factor, MTM, Activity sampling, Its applications; Job analysis, Job Evaluation, Techniques of job evaluation - Merit rating – Incentive plans, Value engineering and analysis; Quality and Quality Control: Types of inspections, statistical quality control; Control charts for variables and attributes: X bar, R, p and c charts; Sampling, concepts and scope of TQM and QFD.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Buffa E. S. and Sarin R. K., Modern Production / Operations Management, 8th ed., John Wiley & Sons, 2007.

T2. Barnes R.M., Motion and Time Study, Design and Measurement of Work, 7th ed., John Wiley, 2009.

Reference Books

R1. Kanawaty G., Introduction to work study, 4th ed., International Labour Organization, 1992.

R2. Russell R. S. and Taylor B. W., Operations Management, 7th ed., Wiley India, 2013.

R3. Bridger R., Introduction to ergonomics. 3rd ed., CRC Press, 2008.

R4. Chary S. N., Production and Operations Management, 6th ed., Tata McGraw-Hill, 2019.

R5. Zandin K. B. and Maynard H. B., Industrial Engineering Handbook, 5th ed., McGraw-Hill, 2001.

Compressible and Incompressible Fluid Flow| MEL455 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the Fluid Mechanics (MEL253).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the fundamental knowledge of fluid under various conditions of internal and external flows.
- Develop understanding of governing equations like mass, momentum, energy equation in fluid flow.
- Learn the application of the above concepts to internal and external flows, introduce the boundary layer concept, lift and drag, flow separation, and drag reduction fundamentals.
- Understand the dynamics of fluid flows and the governing non-dimensional parameters and basic ideas of compressible flow.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand and derive the physical laws governing the fluid motion and types of fluid flows.

CO 2. Solve for internal flow in pipes through simplified solutions of the Navier-Stokes equations.

CO 3. Analyze various problems involving fluid properties and shear forces resulting from Newtonian fluids.

CO 4. Analyze the compressible flow with normal shock and oblique shock.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Concept of compressible flow, one dimensional isentropic flow, normal shock, Oblique shock, flow with frictional heat transfer. Basic Concepts in Incompressible Flows, Incompressible Navier-Stokes Equations, Continuity equation, Momentum equation, Forces acting on a fluid element and the stress tensor, Straining of a fluid element and the strain rate tensor, Solutions to the Incompressible Navier-Stokes Equations, Potential Flows, Euler equation for inviscid flows, Bernoulli's equation, Relation between Bernoulli's equation and the first law of thermodynamics, Analytical Solutions to the Incompressible Navier-Stokes Equations, Parallel flow solutions, Couette-Poiseuille flow, Hagen-Poiseuille flow in a pipe, Creeping flow solutions, Derivation of the boundary layer equations, Boundary layer flow over a flat plate with zero pressure gradient, Differential analysis – Principle of similarity, Integral analysis,

Displacement and momentum thickness, Boundary layer flows with non-zero pressure gradient, Similarity solutions, Von Karman – Pohlhausen integral solution, Separation and drag, Other flows governed by the boundary layer equations, Turbulent Flows, Reynolds averaging, Reynolds Averaged Navier Stokes (RANS) equations, Boussinesq hypothesis, Turbulence modeling, Universal structure of the mean velocity profile in the turbulent boundary layer.
Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. White F.M., Fluid Mechanics, 7th ed., Tata McGraw Hill Education, 2013.
T2. Som S. K., Biswas G. and Chakraborty S., Introduction to Fluid Mechanics and Fluid Machines, 3rd ed., Tata McGraw Hill Education, 2012.

Reference Books

R1. Yahya S.M., Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, 4th ed., New Age International, 2012.
R2. Kundu P. K., Cohen I. M. and Dowling D.R., Fluid Mechanics, 5th ed, Elsevier, 2013
R3. Streeter V.L., Wylie E.B. and Bedford K.W., Fluid Mechanics, 9th ed., Tata McGraw Hill Education, 2011.
R4. Schlichting and Gersten. Boundary-Layer Theory, 8th ed., Springer-Verlag, 2000.
R5. Muralidhar K. and Biswas G., Advanced Engineering Fluid Mechanics, 2nd ed., Narosa, 2005.

Computer Aided Design | MEL456 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Learn the mathematical elements of CAD to the students. The procedural element of computer graphics is beyond the scope of the course.
- be aware of the 2D and 3D transformations of objects for display and data exchange formats for CAD and CAM.
- Learn fundamentals of design of curves, surfaces, and solid models to the students.
- Design geometric features of an object on a computer, display it on the screen and interact with it with a pointing device.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand basic features of CAD and related terms, and design geometric features of an object on a computer, display it on the screen and interact with it with a pointing device.
CO 2. Perform two and three-dimensional transformations for display of geometric entities on the computer screen.
CO 3. Design plane and space curves and generate points on it for displaying the curve on the screen for visualization and apply it in design and analysis of engineering components.
CO 4. Design surface patches and generate points on the surface for displaying the surface on the screen and apply it in design and analysis of engineering components.
CO 5. Make solid models and apply in design and analysis of engineering components.

Desirable/Advanced (If any):

CO 6. Understand and choose data exchange file formats for CAD/CAM.

Syllabus for Essential Course Outcomes

Introduction to computer aided design, brief history.
Two and three-dimensional transformations: Introduction, representation of points, transformation of points and straight lines, rotation, reflection, scaling, combined transformations, translations and homogeneous coordinates and

associated transformations; affine and perspective geometry, transformations for parallel and perspective projections.

Design of curves: Introduction, curve representation, curve fitting and curve fairing.
Plane curves: non-parametric and parametric curves; Space curves: representation of space curves, cubic splines, normalized cubic splines, Bezier curves, B-spline curves, rational B-spline curves.
Design of surfaces: Introduction, surface models and surface representation, surface of revolution, sweep surfaces, quadric surface, bilinear surface, ruled and developable surface, brief introduction of the following surface patches: linear-Coons surface, Coons bicubic surface, Bezier surface, B-spline surface, Rational B-spline surface, NURBS.
Solid modeling: Introduction, solid models and solid representation, Boundary Representation (B-rep), Constructive Solid Geometry (CSG), half spaces and other representations.

Contents for Desired Course Outcomes (If any)

CAD/CAM data exchange formats: ISO standard, STEP, DXF, IGES, STL and PDES formats – a brief introduction.

Text Books

T1. Rogers D. F. and Adams J. A., Mathematical Elements for Computer Graphics, McGraw-Hill Education, 2nd ed., 2017.
T2. Zeid Ibrahim and Sivasubramanian R., CAD/CAM: Theory and Practice: Special Indian Edition, 2nd ed., McGraw Education, 2009.

Reference Books

R1. Faux I.D. and Pratt M.J., Computational Geometry for Design and Manufacture, Ellis Horwood Limited (a division of John Wiley & Sons), 1987.
R2. Rooney J. and Steadman P., Principles of Computer-aided Design, CRC Press, 1997.
R3. Mortenson M. E., Geometric Modeling, 3rd ed., John Wiley & Sons, 2006.
R4. Rao P. N., CAD/CAM: Principles and Applications, 3rd ed., McGraw Hill Education (India) Pvt Ltd, 2010.
R5. Hearn D. and Baker M. Pauline, Computer Graphics, 2nd ed., Pearson Education India, 2002.

Computer Aided Design Lab| MEP456 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Become proficient in a feature-based, CAD software package such as AutoCAD, SolidWorks or CATIA and learn surface and solid modeling.
- Learn two and three-dimensional curve design.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Design geometric features of an object on a computer, display it on the screen and interact with it with a pointing device.
CO 2. Design two and three-dimensional curves using CATIA, a CAD software tool and display it on a computer monitor.
CO 3. Design surfaces and solid models using CATIA, a CAD software tool and display it on a computer monitor.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Solid modelling of a part and extracting its orthographic views (One lab turn).
2. Assembly of a machine element such as a knuckle joint (Two lab turns).

3. Assembly of another machine element (Two lab turns).
4. Detailed part drawing and assembly of a machine element such as a universal coupling (Two lab turns).
5. Design of planar and space curves (Total four lab turns).
6. Detailed part drawing and assembly of another machine element such as a belt roller support (Two lab turns).

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Zeid I. and Sivasubramanian R., CAD/CAM: Theory and Practice: Special Indian Edition, 2nd ed., McGraw Education, 2009.
T3. Rogers D. F. and Adams J. A., Mathematical Elements for Computer Graphics, McGraw-Hill Education, 2nd ed., 2017.

Reference Books

R1. Faux I.D. and Pratt M.J., Computational Geometry for Design and Manufacture, Ellis Horwood Limited (a division of John Wiley & Sons), 1987.
R2. Rooney J. and Steadman P., Principles of Computer-aided Design, CRC Press, 1997.
R3. Mortenson M. E., Geometric Modeling, 3rd ed., John Wiley & Sons, 2006.
R4. Rao P. N., CAD/CAM: Principles and Applications, 3rd ed., McGraw Hill Education (India) Pvt Ltd, 2010.
R5. Hearn D. and Baker M. Pauline, Computer Graphics, 2nd ed., Pearson Education India, 2002.

Computer Integrated Manufacturing | MEL457 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the product design with the implementation of computer integrated manufacturing system through the application of the fundamental knowledge.
- Enhancing their knowledge related to flexible manufacturing system and group technology.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Design and evaluation of automated manufacturing system.
CO 2. Analyze problems of manufacturing system to formulate the design requirements for CIM systems.
CO 3. Apply principle of project management for effective execution of manufacturing projects.
CO 4. Design subsystem of computer integrated manufacturing by integrated automation with mechanical systems.
CO 5. Practice part programming on CNC machine.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerized elements of CIM system –Types of production – Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation.
Programmable control – Introduction, NC controller technology, computer numerical control combined with DNC/CNC

systems, adaptive control machining systems.
Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP).
Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method – Arranging Machines in a GT cell – Hollier Method.
Types of Flexibility – FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety.
Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Groover M.P., Automation, Production Systems and Computer Integrated Manufacturing, 3rd ed., Pearson Education, 2014.
T2. Goetsch D.L., Fundamentals of CIM Technology: Automation in Design, Drafting and Manufacturing, Delmar Publication, 1988

Reference Books

R1. Singh N., Systems Approach to Computer Aided Design and Manufacturing, John Wiley and Sons, 1996.
R2. Harrington J., Computer Integrated Manufacturing, Krieger Publication, 1985.
R3. Shover R.N., An Analysis of CAD/CAM Application with Introduction to CIM, Prentice Hall.
R4. Bedworth D.D. et.al., Computer Integrated Design and Manufacturing, McGraw Hill, 1991.
R5. Scholz-Reiter B., CIM Interfaces, Chapman and Hall, 1992.

Mechatronics | MEL458 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Define key elements of Mechatronics system and their representation into block diagram.
- Understand principles of sensors and its characteristics.
- Apprehend the system modelling and analysis in time domain and frequency domain.
- Understand the concept of PLC system and significance of PLC systems in industrial application.
- Select the appropriate microcontroller for an industrial application.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Demonstrate the ability to use the different elements of mechatronics.
CO 2. Formulate the architecture of mechatronic systems for industrial application.
CO 3. Explain the concept of signal processing and use of interface such as an A/D converter, D/A converter.
CO 4. Design basic control systems using different actuators.
CO 5. Demonstrate an understanding of PLC programming.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

System Integration, Scope of Mechatronics, Measurement system, open and closed loop system, architecture of mechatronic system, approach towards mechatronic design. Basic electrical terminologies, basic electrical elements, semiconductor electronics, junction diode, Bipolar junction transistor, Field effect transistor. Function of Sensors, Performance terminology. Displacement / Position Sensors, Proximity sensors, Velocity / Motion sensors, Force Sensors, Temperature sensors, Fluid pressure sensor, Light sensors. Signal conditioning processes, protection circuits. A/D converters, D/A converter, Multiplexer, Data Acquisition. Analog and Digital Indicators, Digital display, Alarm Indicators, Recorders, magnetic recording. Hydraulic/Pneumatic Actuation, Rotary actuators, Mechanical Actuation, Electrical Actuation. Continuous and discrete processes, control modes, PID controllers, adaptive control. Digital controllers. Logic gates, Boolean algebra, application of logic gates. Microprocessors and microcontrollers, Basic structure of PLC, Input/Output processing, PLC programming.

Contents for Desired Course Outcomes (If any): Nil.

Text Books

T1. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 6th ed., Pearson Education, 2003.
T2. Ramachandran K. P., and Vijayaraghavan G. K., Balasundaram M.S., Mechatronics: Integrated Mechanical Electronic Systems, John Wiley & Sons, 2008.

Reference Books

R1. Alciatore D.G. and Histand M.B., Introduction to Mechatronics and Measurement Systems, 4th ed., McGraw Hill, 2012.
R2. Iserman R., Mechatronic Systems: Fundamentals, Springer, 1st ed., 2005.
R3. Jouaneh M., Fundamentals of Mechatronics, 1st ed., Cengage Learning, 2012.
R4. Carryer, Introduction to Mechatronic Design, 1st ed., Pearson Education India, 2012.
R5. Bolton W., Mechatronics: A Multidisciplinary Approach, 4th ed., Pearson Education, 2011.

Mechatronics Lab | MEP 458 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Describe the basic of all the elements of Mechatronics system.
- Demonstrate the PLC system and significance of PLC systems in industrial application
- Explain the working of various pneumatic and hydraulic systems.
- Select the appropriate microcontroller for an industrial application.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Explain the architecture of mechatronic systems.
CO 2. Perform experiments on pneumatic and hydraulic systems.
CO 3. Demonstrate the ability to design basic control systems using different actuators.
CO 4. Formulate the ladder programming for PLC system.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Perform operation of single acting and double acting Cylinder with controlled speed.

2. Perform operation of single acting and double acting Cylinder using OR and AND gate.
3. Perform operation of single acting and double acting Cylinder using 3/2-way solenoid valve.
4. Design and Testing of Pneumatic Circuits Operation of double acting cylinder with AND & OR logic circuit.
5. Robot programming for pick and placing operation both in manual and automatic mode.
6. Perform continuous forward & return cycle of double acting cylinder using proximity switches.
7. Holding operation of single acting and double acting cylinder using 5/2-way solenoid dcv with latch switch.
8. Perform experiments controlling number of rotations of pneumatic motor with Programmable Logic Controller.
9. Operation of single acting cylinder with AND and OR logic using PLC.
10. PLC controlled clamp & declamp system.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.

T2. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 6th ed., Pearson Education, 2003.

T3. Ramachandran K. P., and Vijayaraghavan G. K., Balasundaram M.S., Mechatronics: Integrated Mechanical Electronic Systems, John Wiley & Sons, 2008.

Reference Books

R1. Alciatore D.G. and Histand M.B., Introduction to Mechatronics and Measurement Systems, 4th ed., McGraw Hill, 2012.

R2. Iserman R., Mechatronic Systems: Fundamentals, Springer, 1st ed., 2005.

R3. Jouaneh M., Fundamentals of Mechatronics, 1st ed., Cengage Learning, 2012.

R4. Carryer, Introduction to Mechatronic Design, 1st ed., Pearson Education India, 2012.

R5. Bolton W., Mechatronics: A Multidisciplinary Approach, 4th ed., Pearson Education, 2011.

Gas Turbine and Compressor| MEL459 | 3 Credits | 3 0 0 3

Course Prerequisite

The students should have studied the course Energy Conversion (MEL351).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Get familiar with gas turbines and different types of compressors.
- Understand the principles of gas turbine and compressor operation.
- Learn about the different components of gas turbines and compressors.
- Explore the different applications of gas turbines and compressors, such as in power generation and aerospace.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand and analyze the ideal and practical gas turbine cycles.

CO 2. Evaluate the performance of centrifugal and axial flow compressors.

CO 3. Design axial and radial in-flow gas turbines.

CO 4. Analyze the off-design performance and matching of the components of a gas turbine.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to gas turbines and compressor, its classification and application, Gas Turbine Cycles: Ideal and actual cycles, multi-stage compression, reheating, regeneration, combined and cogeneration. Energy transfer between fluid and rotor, axisymmetric flow in compressors and gas turbines. Centrifugal Compressors: Principles of operation, compressor losses, adiabatic efficiency, slip factor, pressure coefficient, power unit and design consideration for impeller and diffuser systems, performance characteristics. Axial Flow Compressors: Elementary theory, vortex theory, degree of reaction, simple design, elementary air-foil theory, isolated air foil and cascade theory, three-dimensional flow, stages, stage efficiency and overall efficiency, performance characteristics. Turbines: Axial flow and radial flow turbines, impulse and reaction turbines, fundamental relations and velocity triangles, elementary vortex theory, limiting factors in turbine design, application of air foil theory to the study of flow through turbine blades, aerodynamic and thermodynamic design considerations, blade materials, blade attachment and blade cooling. Gas Turbine Power Plants: Fuel and fuel feed systems, combustion systems-design considerations and flame stabilization, regenerator types and design, gas turbine power plant performance and matching, application.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Saravanamuttoo H.I.H., Rogers G.F.C., Cohen H. and Straznicky, P.V., Gas Turbine Theory, 7th ed., Pearson Prentice Hall, 2017.

T2. Ganesan V., Gas Turbines, 3rd ed., Tata McGraw-Hill Education, 2010.

Reference Books

R1. Bathie W. W., Fundamentals of Gas Turbines, 2nd ed., John Wiley & Sons, 1995.

R2. Lefebvre H. and Ballal D. R., Gas Turbine Combustion, 3rd ed., CRC Press, 2010.

R3. Yahya S. M., Turbines Compressors and Fans, Mc Graw Hill, 4th ed., 2017.

R4. Otis C., Aircraft Gas Turbine Powerplants, Aviation Maintenance Pub., 2001.

R5. Bloch H.P., Godse A., Compressor and Modern Process Applications, John Wiley & Sons, 2006.

Quality Assurance| MEL460 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Define the various elements in Quality Assurance program.
- Learn the Statistical concepts in quality, probability distributions.
- Develop measuring and improvement processes for quality assurance and control.
- Learn how process capabilities studies and control charts are utilized.
- Identify useful quality improvement techniques for continual improvement.
- Identify the importance of quality standards, models and awards (ISO 9000 quality system, TQM, Malcolm Baldrige, EFQM etc.).

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Compare various elements in Quality Assurance program.

CO 2. Develop measuring and improvement processes for quality assurance and control.

CO 3. Describe how process capabilities studies and control charts are utilized.

CO 4. Compare and categorize various quality rating.

CO 5. Describe economics of product inspection.

CO 6. Explain the importance of quality standards, models and awards (ISO 9000 quality system, TQM, Malcolm Baldrige, EFQM etc.).

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to quality assurance and quality control, Various elements in Quality Assurance program, On-line and Off-line quality control, Statistical concepts in quality, probability distributions, Central limit theorem, Chance and assignable causes of quality variation, Process control charts for variables, Control chart parameters, Target process setting/Centering, Control limits and specification limits. Process capability studies, Capability indices, Quality remedial/Corrective actions, Special purpose control charts, Reject limits, Variable's inspection and attributes Inspection, Quality rating, Defects classification, Average run length. Economics of product inspection, Quality costs, ISO 9000 quality system, Product quality and reliability, Failure data analysis and life testing Problems and illustrations in Quality Assurance, Automatic gauging, automatic measuring machines for inspecting multiple workpiece dimensions, measurement with coordinate measuring machines.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Mitra A., Fundamentals of quality control and improvement, 4th ed., John Wiley & Sons, 2016.

T2. Berk J. and Berk S., Total Quality Management: Implementing Continuous Improvement, 1st ed., Sterling Publishing, NY, 1993.

Reference Books

R1. Leavenworth R.S., Grant E.L., Statistical Quality Control, 7th ed., Tata McGraw-Hill Education, 2000.

R2. Bestefield D.H., Quality Control, Revised 3rd ed., Prentice Hall (Pearson), 2003.

R3. Feigenbaum A.V., Total Quality Control, 3rd ed., Tata McGraw-Hill Education, 1983.

R4. Bossert J. L., Quality Function Deployment: A Practitioner's Approach, Marcel Dekker, 1994.

R5. Taguchi G., Elsayed A and Hsiang T., Quality Engineering in Production Systems, McGraw Hill, 1989.

Robotics | MEL461 | 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the Kinematics of Machines (MEL255).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the basic concepts associated with the design, functioning and applications of Robots.
- Develop skills in performing spatial transformations associated with robot motion.
- Select the appropriate actuating mechanism and sensors for a Robot.
- Provide the knowledge and analysis skills associated with trajectory planning.
- Analyze the kinematics of the Robot.
- Determine forces on the machine components subjected to various loading conditions.
- Perform programming for a Robot.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Explain the fundamentals of coordinate system, robotics and its components.

CO 2. Demonstrate the ability to simulate the kinematics and control of robotic systems.

CO 3. Explain the need and implementation of actuators & control in robotics.

CO 4. Demonstrate the ability to integrate sensory and mechanical components within a robotic system.

CO 5. Analysis Robot Programming, Motions pf Programming, Robot Languages and VAL systems.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Common Robot configurations, coordinate system, work envelop, Elements of robotic system, actuators, controller, teach pendant, sensors, Specification of robots, Applications. Robot Kinematics: Forward and reverse Kinematics of 3 DOF Robot arms, Homogeneous transformations, Kinematics equation using homogeneous transformations. Actuators: Hydraulic actuators, Pneumatic actuator, Electrical actuators, Directional control, Servo Control Flow control valves. End Effectors: Classification of end effectors, Drive systems, Magnetic, Mechanical, Vacuum and Adhesive Grippers, force analysis in Grippers. Sensors: Need for sensing systems, Sensory devices, Types of sensors, Robot vision system. Robot Programming: Types of Programming, Motions Programming, Robot Languages - VAL systems.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Groover M. P., Industrial Robotics: Technology, Programming and Applications, 2nd ed., Tata McGraw Hill, 2013.

T2. Craig J., Introduction to Robotics, 4th ed., Pearson, 2022.

Reference Books

R1. Deb S. R., Robotics Technology and Flexible Automation, 2nd ed., Tata McGraw Hill, 2010.

R2. Niku S., Introduction to Robotics: Analysis, Control, Applications, 2nd ed., Wiley, 2011.

R3. Saha S.K. Introduction to Robotics, 2nd ed., Tata McGraw Hill, 2008.

R4. Koren Y., Robotics for Engineers, 2nd ed., McGraw Hill, 1987.

R5. Mittal R. K., and Nagrath I. J., Robotics and control, 5th ed., Tata McGraw-Hill, 2017.

Robotics Lab | MEP 461 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Demonstrate the basic architecture of Robot.
- Develop and Model a basic Robot.
- Explain the forward Kinematics of 2 and 3 DOF Robot manipulator.
- Explain the Inverse Kinematics of 2 and 3 DOF Robot manipulator.
- Program the Robot for industrial application.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Perform basic programming using robot programming language.

CO 2. Perform basic program the kinematics of 2-Degree of freedom robot manipulator.

CO 3. Program the kinematics of 3-Degree of freedom robot manipulator.

CO 4. Understand the functioning and application of robots.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Study the various components of robots and its DH parameters.
2. Study the forward and Inverse Kinematics of 2 – DOF robot manipulator.

3. Study the forward and Inverse Kinematics of 3 – DOF robot manipulator.
4. Design a control system using sensors for obstacle detection system
5. Robot programming for pick and placing operation both in manual and automatic mode.
6. Analysis of forward Kinematics of PUMA 560.
7. Analysis of Inverse Kinematics of PUMA 560.
8. Analysis of forward kinematics of Movemaster RM-501.
9. Computer vision programming tool open CV.
10. Robot Teaching Using VAL Programming.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Groover M. P., Industrial Robotics: Technology, Programming and Applications, 2nd ed., Tata McGraw Hill, 2013.
T3. Craig J., Introduction to Robotics, 4th ed., Pearson, 2022.

Reference Books

R1. Deb S. R., Robotics Technology and Flexible Automation, 2nd ed., Tata McGraw Hill, 2010.
R2. Niku S., Introduction to Robotics: Analysis, Control, Applications, 2nd ed., Wiley, 2011.
R3. Saha S.K. Introduction to Robotics, 2nd ed., Tata McGraw Hill, 2008.
R4. Koren Y., Robotics for Engineers, 2nd ed., McGraw Hill, 1987.
R5. Mittal R. K., and Nagrath I. J., Robotics and control, 5th ed., Tata McGraw-Hill, 2017.

Automation in Production | MEL462 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the concepts of automated flow lines and their analysis.
- Classify automated material handling, automated storage and retrieval systems.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Illustrate the basic concepts of automation in machine tools.
CO 2. Analyze various automated flow lines, explain assembly systems and line balancing method.
CO 3. Describe the importance of automated material handling and storage systems.
CO 4. Interpret the importance of adaptive control systems, automated inspection systems.
CO 5. Describe the basics of robotic systems.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Modern developments in automation in manufacturing and its effect on global competitiveness, Need and implications of automation in Manufacturing, Different types of production systems and automation, hard/fixed automation including process automation, Rapid prototyping and tooling. Hydraulic and pneumatic actuators, their

design and control devices, sequence operation of hydraulic/pneumatic actuators, designing of complete systems with hydraulic, electro-hydraulic and digital control devices, applications in manufacturing, material handling systems, feeders, orienting and escapement devices, their analysis and design, Automatic assembly machines, designing for automatic assembly.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Groover M.P., Automation, Production Systems and Computer Integrated Manufacturing, 3rd ed., Pearson Education, 2014.

T2. Lamb F., Industrial Automation, McGraw-Hill, 2013.

Reference Books

R1. Grover M.P. and Zimmers E.W., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2008.

R2. Kundra T.K., Rao P.N. and Tewari N.K., Computer Aided Manufacturing, Tata McGraw Hill, 2010.

R3. Koren Y., Computer Control of Manufacturing Systems, 3rd ed., Tata McGraw Hill, 2005.

R4. Chang T., Wysk R. A., and Wang H., Computer Aided Manufacturing, Pearson, 2009.

R5. Dawkins N., Automation and Controls: A guide to automation, controls, PIC's and PLC programming, 2014.

Power Plant Engineering | MEL463| 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the basic knowledge of different types of power Plants, site selection criteria of each one of them.
- Understand of thermal power plant operation, turbine governing, different types of boilers and combustion systems.
- Get basic knowledge of different types of nuclear power plants and hydroelectric plants.
- Learn environmental and safety aspects of power plant operation.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Apply the principles of thermodynamics to analyse the performance of steam, gas, combined, hydroelectric plants and nuclear power plants.

CO 2. Acquire knowledge of power plant components for optimum performance.

CO 3. Select appropriate site and technology for power plants.

CO 4. Evaluate economic and environmental implications on power plants.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to power systems and technologies, Demand variation and forecasting, Diesel generators: Systems, equipment and layout. Fossil-fuelled steam power plants: Boiler and accessories, turbine and accessories, feed cycle equipment, generator. Combined cycle power plants: Gas turbine, heat recovery boiler. Nuclear power: nuclear reactions, fuel, moderator and coolant, neutron life cycle. Reactors: Light water, heavy water, gas-cooled and fast reactors. Hydroelectric plants: Features and siting, Pelton, Francis, Kaplan and propeller turbines construction, mini- and micro-turbines. Introduction to renewable energy sources, Co-generation systems, Environmental issues, sustainability and future scenarios. Plant investment costs, fixed charges, Operation costs, energy costs, depreciation and operating costs on the selection of equipment, incremental cost, and comparison of fixed and operating costs.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Nag P.K., Power Plant Engineering, 4th ed., Tata McGraw Hill, 2014.
T2. El-Wakil M.M., Power Plant Technology, 4th ed., Tata McGraw Hill, 2011.

Reference Books

R1. British Electricity International, Modern Power Station Practice, 3rd ed., Pergamon Press, 1992.
R2. Babcock and Wilcox Company, Steam: Its Generation and Use, 36th ed., Kessinger Pub. Co., 2008.
R3. O'Hayre R.P. et. al., Fuel Cell Fundamentals, 2nd ed., John Wiley and Sons, 2009.
R4. Skrotzki B.G.A. and Vopat W.A., Power Station Engineering and Economy, Tata McGraw Hill, 2009.
R5. Arora S.C. and Domkundwar S., A Course in Power Plant Engineering, 3rd ed., Dhanpat Rai and Sons, 1988.

Renewable Energy Technology | MEL464 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Develop an ability to find the alternate and renewable energy sources and their efficient utilization with the development of renewable energy systems.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. List and generally explain the main sources of energy and their primary applications in INDIA, and the world.
CO 2. Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.
CO 3. Discuss remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources.
CO 4. List and describe the primary renewable energy resources and technologies.
CO 5. Describe/illustrate basic electrical concepts and system components.
CO 6. Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Need for alternative sources of energy, various options available, Solar Energy: Introduction, Spectral distribution of solar radiation, beam and diffused radiations, measurement of solar radiation, pyranometer, pyrheliometer, sunshine recorder. Solar radiation geometry, radiation on tilted surface, tilt factors. Different types of collectors & their analysis, Solar energy storage & Application. Introduction to biogas generation, fixed dome & floating drum biogas plants, their constructional details, factors affecting generation of biogas, utilization of biogas. Introduction of biomass energy, methods of obtaining energy from biomass, incineration, thermal gasification. Up draft and down draft gasifiers, their constructional details, Applications of producer gas. Wind Energy: Introduction, Power in wind, basic principles of wind energy conversion, basic components of WEC Systems, Savonius and Darrieus rotors, application of wind energy. Ocean Thermal Electric Conversion (OTEC): Introduction, open and closed cycle of OTEC, hybrid cycle, energy from tides, generation components of tidal power plants, single and double basin design arrangement, estimation of tidal power and energy. Geothermal Energy: Introduction, Principles, Resources, Electricity Production, Conversion Technology, Challenges, Economics.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Sukhatme S.P. and Nayak J. K., Solar Energy: Principles of Thermal Collection and Storage, 3rd ed., Tata Mc Graw Hill, 2013.

T2. Twidell J., Renewable Energy Resources, 4th ed., Routledge, NY, 2022.

Reference Books

R1. Beckman W.A. and Duffie J.A., Solar Engineering of Thermal Processes, 4th ed., John Wiley & Sons, 2013.

R2. Rai G.D., Non-Conventional Sources of Energy, 4th ed., Khanna Publishers, 2009.

R3. Garg H.P. and Prakash J., Solar Energy: Fundamentals and Applications, 8th ed., Tata McGraw Hill, 2007.

R4. Enrlich R., Geller H. A., Renewable Energy: A First Course, 2nd ed., CRC Press, 2017.

R5. Boyle G., Renewable Energy: Power for a Sustainable Future, 3rd ed., Oxford University Press, 2012.

Automobile Engineering | MEL465 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Learn the anatomy of the automobile in general with the location.
- Get the importance of each part and functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels.
- Understand the working principal of Suspension, frame, springs and other connections including Emissions, ignition, controls, electrical systems and ventilation.
- Gain some knowledge about hybrid and electric vehicles.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Identify the different parts of the automobile.

CO 2. Explain the working of various parts like engine, transmission, clutch, brakes.

CO 3. Describe how the steering and the suspension systems operate.

CO 4. Understand the environmental implications of automobile emissions.

CO 5. Develop a strong base for understanding future developments in the automobile industry.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Brief history of automobile development, present scenario of automobiles in India and abroad. Chassis, articulated and rigid vehicles, vehicles layout. Engine construction: structural components and materials, Steering system: principle of steering, centre point steering, steering linkages, geometry and wheel alignment, power steering, special steering systems. Tyres specifications, factors affecting tyre performance, special tyres, wheel balancing, Suspension system: function of spring and shock absorber, conventional and independent suspension system, telescopic shock absorber, Clutch: requirements of a clutch system, types of clutches. Transmission: necessity of transmission, principle, types of transmission, sliding mesh, constant mesh, synchromesh, transfer gear box, gear selector mechanism, propeller shaft, universal joint, constant velocity joint. Differential: need and types of rear axle and front axles. Brakes: mechanical brakes, hydraulic, pneumatic brakes, electrical brakes, engine exhaust brakes, drum and disc brakes, comparison. Introduction to hybrid and electric vehicles: Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency. Basic concept of electric traction, introduction to various electric drive-train. Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Singh K., Automobile Engineering (Vol. I & II), 13th ed., Standard Publishers and Distributors, 2012.
T2. Hussein I., Electric and Hybrid Vehicles: Design Fundamentals, 3rd ed., CRC Press, 2021.

Reference Books

R1. Ramalingum K.K., Automobile Engineering, 2nd ed., Scitech Publications, Chennai, 2011.
R2. Srinivasan S., Automotive Engines, 2nd ed., Tata McGraw Hill, New Delhi, 2004.
R3. Crouse W.H. and Anglin D.L., Automotive Mechanics, 10th ed., Tata McGraw Hill, 2007.
R4. Ball J. K., Stone R., Automotive Engineering Fundamentals, SAE International, 2004.
R5. Babu A. K., Sharma S. C., Banga T. R., Automobile Mechanics, Khanna Book Publishing Co. Pvt. Ltd., 2019.

Automobile Engineering Lab | MEP465 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Learn the anatomy of the automobile in general with the location.
- Get the importance of each part and functioning of the engine and its accessories, gear box, clutch, brakes, steering, axles and wheels.
- Understand the working principal of Suspension, frame, springs and other connections including Emissions, ignition, controls, electrical systems and ventilation.
- Gain some knowledge about hybrid and electric vehicles.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the basic concepts, requirements and working of various components of automobile.
CO 2. Design basic systems like brakes, steering, and suspensions.
CO 3. Understand construction and working of different systems like transmission, steering and suspensions.
CO 4. Aware about recent technologies in automobile engineering and its working.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Study of Clutches.
2. Study of UV Joint.
3. Study different types of steering gears & suspension systems.
4. Study the Suspension system.
5. Study the Brake system.
6. Study the Gear Box.
7. Study about the Dodge car.
8. Replacement of tyre of the automobile.

9. Study the basic circuit of car.
10. Replace the clutch/brake wire in scooter/motor vehicle.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Singh K., Automobile Engineering (Vol. I & II), 13th ed., Standard Publishers and Distributors, 2012.
T3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 3rd ed., CRC Press, 2021.

Reference Books

R1. Ramalingum, K.K., Automobile Engineering, 2nd ed., Scitech Publications, Chennai, 2011.
R2. Srinivasan, S., Automotive Engines, 2nd ed., Tata McGraw Hill, New Delhi, 2004.
R3. Crouse, W.H. and Anglin D.L., Automotive Mechanics, 10th ed., Tata McGraw Hill, 2007.
R4. Ball J. K., Stone R., Automotive Engineering Fundamentals, SAE International, 2004.
R5. Babu A. K., Sharma S. C., Banga T. R., Automobile Mechanics, Khanna Book Publishing Co. Pvt. Ltd., 2019.

I. C. Engines and Hybrid Vehicles | MEL466| 3 Credits | 3 0 0 3

Course Prerequisite

The student should have studied the Engineering Thermodynamics (MEL252) and Energy Conversion (MEL351).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand ideal and actual thermodynamic cycles of operation.
- Understand combustion phenomena in SI and CI engines and factors influencing combustion chamber design.
- Understand the working principal of fuel supply systems, lubricating systems and cooling systems of I.C. engines and get familiarized with the terms supercharging and scavenging.
- Apply analytical techniques to find out the performance parameters of internal combustion engines.
- Gain some knowledge about electric vehicles/hybrid vehicles.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Compare the general specifications of various commercially available vehicles.
CO 2. Apply material and design considerations for various engine components.
CO 3. Evaluate effects of various parameters including use of alternate fuels on normal and abnormal combustion, emission and performance in CI and SI Engines.
CO 4. Compare basic layout and structure of EV and I C Engines.
CO 5. Work out the battery and motor sizing for various applications in two, three and four-wheeler segment.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to I C Engines: Historical Perspective, General Specifications of Engines used in various Two, Three, and Four Wheelers. Air Standard Thermodynamic Cycles for I C Engines and its comparison with Fuel Air and Actual Cycle, Thermodynamic properties of the working fluid, Material and Design Consideration for Engine Components: Piston, Cylinder, Piston Rings, Connecting Rod, Cam Shafts, Crank Shafts, etc. Combustion in SI and CI Engines: Combustion Phenomenon in SI and CI Engines, Normal and Abnormal combustion in SI and CI Engines, modeling combustion process in SI engines. Alternate Fuelled Engines: Producer Gas, Biogas, and Biodiesel Fuelled Engines.

Engine Emission: Introduction to air pollution from SI and CI Engines, Photochemical smog, primary and secondary pollutants, Formation of NO and NO_2 in SI and CI Engines, Mechanism of Particulate Matter formation, Composition of Particulates, soot structure, soot formation, Measurement of emission, instrumentation for HC, CO, NOx, and PM, EGR and Diesel Particulate Filter. Introduction to Hybrid Vehicles: Limitations of Internal Combustion Engines as Prime Mover, History of HV Systems, Structure of Hybrid Vehicle covering essential Components, General Layout, Govt. policies on HV and its impact on the automotive sector.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Ganesan, V., Internal Combustion Engines, 4th ed., Tata McGraw Hill, 2013.

T2. Ehsani M., Gao Y., Longo, S., Ebrahimi K., Modern Electric, Hybrid Electric and Fuel Cell Vehicles, 3rd ed., CRC Press, 2018.

Reference Books

R1. Heywood J.B., Internal Combustion Engine Fundamentals, 1st ed., Tata McGraw Hill Education, 2012.

R2. Dankundwar A.V., Course in Internal Combustion Engines, 5th ed., Dhanpat Rai and Co (P) Ltd., New Delhi, 2002.

R3. Mathur M.L. and Sharma R.P., Course in Internal Combustion Engines, 8th ed., Dhanpat Rai and Co (P) Ltd., New Delhi, 2003.

R4. Pulkrabek W.W, Engineering Fundamentals of the Internal Combustion Engine, 2nd ed., Pearson Education, 2014.

R5. Kent J., Handbook of Electric Vehicles, Illustrated ed., Clanrye International, 2015.

I. C. Engines and Hybrid Vehicles Lab | MEP466 | 1 Credit | 0 0 2 1

Course Prerequisite

The student should have studied the Engineering Thermodynamics (MEL252) and Energy Conversion Lab (MEP351).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand ideal and actual thermodynamic cycles of operation.
- Understand combustion phenomena in SI and CI engines and factors influencing combustion chamber design.
- Understand the working principal of fuel supply systems, lubricating systems and cooling systems of I.C. engines and get familiarized with the terms supercharging and scavenging.
- Apply analytical techniques to find out the performance parameters of internal combustion engines.
- Gain some knowledge about electric vehicles/hybrid vehicles.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the practical operation of 2 stroke and 4 stroke I.C engines using valve timing diagram.

CO 2. Analyze the performance of multi cylinder engines with the variation of various performances like load and speed.

CO 3. Compare basic layout and structure of EV and I C Engines.

CO 4. Work out the battery and motor sizing for various applications in two, three and four-wheeler segment.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. To draw the valve timing diagram of the given 4-stroke diesel engine.
2. To measure and plot the torque crank angle curve as a function of crank position for 4-stroke single cylinder SI engine.

3. To determine the viscosity of lubricating oil by Redwood Viscometer.
4. To study the construction and working of 2-stroke petrol engines.
5. To study of fuel supply system for petrol engine.
6. To study of fuel supply system for diesel engine.
7. To study the performance of 2-stroke single cylinder petrol engine connected to a rope brake dynamometer.
8. To prepare the heat balance sheet of single cylinder VCR diesel engine working with alternate fuels.
9. To prepare the heat balance sheet of single cylinder VCR petrol engine.
10. Demonstrate any charging technique of lead acid battery/ Lithium-Ion battery.
11. Battery pack design for given HV application (Testing Various series parallel combinations for given application).

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. Ganesan V., Internal Combustion Engines, 4th ed., Tata McGraw Hill, 2013.
T3. Ehsani M., Gao Y., Longo, S., Ebrahimi, K., Modern Electric, Hybrid Electric and Fuel Cell Vehicles, 3rd ed., CRC Press, 2018.

Reference Books

R1. Heywood J.B., Internal Combustion Engine Fundamentals, 1st ed., Tata McGraw Hill Education, 2012.
R2. Dankundwar A.V., Course in Internal Combustion Engines, 5th ed., Dhanpat Rai and Co (P) Ltd., New Delhi, 2002.
R3. Mathur M.L. and Sharma R.P., Course in Internal Combustion Engines, 8th ed., Dhanpat Rai and Co (P) Ltd., New Delhi, 2003.
R4. Pulkrabek W.W, Engineering Fundamentals of the Internal Combustion Engine, 2nd ed., Pearson Education, 2014.
R5. Kent J., Handbook of Electric Vehicles, Illustrated ed., Clanrye International, 2015.

Processing of Non-Metals | MEL467 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Attain the knowledge about structure and properties of various non-metals.
- Understand the manufacturing science and engineering of non-metals.
- Correlate the concepts of processing and properties of plastics.
- Recognize the microstructure and properties of PMCs and CMCs.
- Explain different processing techniques of ceramics, polymers and composite materials.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Recognize different structure of non-metals and their constitution.
CO 2. Acquire the knowledge of engineering non-metals – Glass, ceramic, etc.
CO 3. Process and characterize different non-metals such as ceramics, polymers and composites for engineering applications.
CO 4. Analyze and recognize the process capability and applications of various techniques of

processing of non-metals.

CO 5. Identify the need of secondary operations during processing of non-metals.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction to structure and properties of non-metals. Processing of Glass and ceramics: Glass structure and properties, glass melting and forming, glass annealing, Ceramic powder preparation, synthesis of ceramic powders, fabrication of ceramic products from powders: pressing, casting, vapor phase techniques, sintering, finishing, machining. Ceramic coatings Processing of Plastics: thermoplastics and thermosets, Processing of Plastics: Extrusion. Injection molding. Thermoforming. Compression molding. Transfer molding. General behavior of polymer melts, Machining of plastics. Processing of polymer matrix composites: Classification of composite materials, properties of composites hand lay-up, autoclaving, filament winding, pultrusion, compression molding, pre-pegging, sheet molding compounds etc., process capability and application areas of various techniques. Ceramic matrix composites: mechanical properties of ceramic matrix composites, different processing techniques for ceramic matrix composites, process capability and applications of various techniques. Secondary processing of composite materials: Need of secondary operations, different type of secondary operations, machining and drilling of non-metals, machining induced damage, different methods of reducing the damage on account of secondary processing. Introduction to sustainable non-metallic materials, Hands on practice in developing sustainable non-metallic materials and evaluation of their physical and mechanical properties.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Kalpakjian S., Manufacturing Processes for Engineering Materials, 3rd ed., Addison – Wesley, 1997.

T2. Rao PN, Manufacturing Technology—Foundry, Forming and Welding, 4th ed., Tata McGraw Hill, 2013.

Reference Books

R1. Strong A.B., Plastic Hall, Materials and Processing, Pearson Prentice, 2006.

R2. Mathews F.L. and Rawlings R.D., Composite Materials: Engineering and Science, Woodhead Publishing, 1999.

R3. Peters S.T., Handbook of Composites, 2nd ed., Chapman Hall, 1998.

R4. Callister WD, Rethwisch DG., Materials science and engineering: An introduction. 7th ed., John Wiley & sons, NY, 2007.

R5. Schwartz M.M., Composite Materials: Processing, fabrication, and applications, 1st ed., Prentice Hall, 1997.

Additive Manufacturing Technology | MEL468 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Gain knowledge of the additive manufacturing (AM) technology used for conceptual modeling, prototyping, and rapid manufacturing.
- Understand representative systems under different category.
- Become aware of the wide applications of AM in industry and society.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the importance of time to market a product and the use of Additive Manufacturing (AM) for conceptual modeling and rapid prototyping.

CO 2. Select AM system for a particular application

CO 3. Classify the AM processes and understand representative AM processes in different classes. Understand the material that can be used in the processes.

CO 4. Apply AM and Rapid Manufacturing (RM) processes in one or more of the several categories.
CO 5. Apply AM for medical applications
CO 6. Select AM system for a particular application

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction, prototyping, rapid prototyping, definition of Additive Manufacturing (AM), process chain of additive manufacturing; Classification of AM Processes: Liquid-based, solid-based, and powder-based AM processes; Stereolithography and other liquid based systems, Fused Deposition processes, Laminated Object Manufacturing, Shape Deposition Manufacturing, Laser sintering based technologies, 3D printing, Direct Metal Deposition (DMD) and LENS; applications of AM – Introduction, applications of AM in different categories such as conceptual design, rapid manufacturing, rapid tooling, terrain modeling, medical AM, advanced materials; design for Additive Manufacturing (DFAM) – core DFAM concepts, unique capabilities of 3DP and design freedom. STL file format – description, errors, and file repair.

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Paul C. P. and Jinoop A.N., Additive Manufacturing: Principles, technologies and applications, 1st ed., McGraw Hill, 2021.
T2. Gibson I., Rosen D.W. and Stucker B., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd ed., Springer, New York, 2015.

Reference Books

R1. Prasad H. and Badrinarayan K.S., Rapid Prototyping and Tooling, ISBN: 978-81-923-2065-6, 1st edition, SIP-Page Turners Publications, Surya Infotainment Products Pvt. Ltd., Bangalore, 2013.
R2. Gibson I., Advanced Manufacturing Technologies for Medical Application – Reverse Engineering, Software Conversion and Rapid Prototyping, John Wiley and Sons Ltd, West Sussex, England, 2005.
R3. Chua C K, Leong K. F., Rapid Prototyping: 3D Printing and Additive Manufacturing – Principles and Applications, 5th ed. (paperback), World Scientific Publishing Co Pte Ltd., 2019.
R4. Kumar S., Additive Manufacturing Processes, 1st ed., Springer, 2020.
R5. Cooper K. G., Rapid Prototyping Technology: Selection and Application, CRC Press.

Additive Manufacturing Technology Lab | MEP468 | 1 Credit | 0 0 2 1

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Gain knowledge of the additive manufacturing (AM) technology used for conceptual modeling, prototyping, and rapid manufacturing.
- Operate Fused Deposition Modeling (FDM), plastic laser sintering and metal-based AM machines.
- Select an AM system and material for a particular application.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Operate a Fused Deposition Modeling (FDM) based AM machine.
CO 2. Do modeling and pre-processing in software packages and repair STL files and add process parameters.
CO 3. Operate a plastic laser sintering based AM machine.
CO 4. Operate a metal-based AM machine.

CO 5. Select an AM system for a particular application and recommend an AM system in his/her company where he/she will be working, depending upon the needs and will be able to apply the technology for his company.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Pre-processing for the Fused Deposition Modeling (FDM) based AM machine: CAD file preparation, exporting in STL, PLY or VRML file format, familiarity with the pre-processing software packages of the machine and adding operating parameters using these software packages. (Expt. no. 1-2)
   An announcement is to be made at this point of time to take up a project if the course coordinator plans to give a course project here.
2. Part fabrication in the FDM based machine and post processing. (Expt. no. 3)

   The projects should be started around this time and students should start working on them.

3. Pre-processing for the plastic laser sintering based machine: CAD file preparation, exporting in STL or another suitable AM file format, STL file repair using Magics RP software, operating parameters addition in the pre-processing software of the machine. (Expt. no. 4-5)
4. Part fabrication in plastic laser sintering based machine: familiarity with process planning software, machine preparation and operation. (Expt. no. 6)
5. Post processing after part building in plastic laser sintering based machine. (Expt. no. 7)
6. Pre-processing for the metal-based machine: CAD file preparation, exporting in STL or another suitable AM file format, STL file repair using a software package, operating parameters addition in the pre-processing software of the machine. (Expt. no. 8)
7. Part fabrication in metal-based machine: familiarity with process planning software, machine preparation and operation. (Expt. no.9)
8. Post processing after part building in metal-based machine. (Expt. no. 10)
   The students should complete the projects by now and the part fabrication should be completed.
9. Segmentation, reconstruction and implant design in Medical AM software such as MIMICS. (11-12)
10. Project presentations in case the course coordinator has announced projects. (Expt no. 13-14)

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Lab Manuals.

T2. Paul C. P. and Jinoop A.N., Additive Manufacturing: Principles, technologies and applications, 1st ed., McGraw Hill, 2021.

T3. Gibson, I., Rosen, D.W. and Stucker, B., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd ed., Springer, New York, 2015.

Reference Books

R1. Prasad H. and Badrinarayan K.S., Rapid Prototyping and Tooling, ISBN: 978-81-923-2065-6, 1st edition, SIP-Page Turners Publications, Surya Infotainment Products Pvt. Ltd., Bangalore, 2013.

R2. Gibson I., Advanced Manufacturing Technologies for Medical Application – Reverse Engineering, Software Conversion and Rapid Prototyping, John Wiley and Sons Ltd, West Sussex, England, 2005.

R3. Chua C K Leong K. F., Rapid Prototyping: 3D Printing and Additive Manufacturing – Principles and Applications, 5th ed. (paperback), World Scientific Publishing Co Pte Ltd., 2019.

R4. Kumar S., Additive Manufacturing Processes, 1st ed., Springer, 2020.

R5. Cooper K. G., Rapid Prototyping Technology: Selection and Application, CRC Press.

Material Resource Planning | MEL469 | 3 Credits | 3 0 0 3

Course Prerequisite

Nil

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Illustrate the role and cope of materials management techniques in material productivity improvement.
- Acquaint students with the strategic aspects, structure, and organization of purchase management.
- Elaborate the key characteristics of Vendor rating system.
- Learn about various Material requirement planning systems.
- Identify Design of inventory distribution systems.
- Describe Inventory management in Kanban and Just-in-time.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Set strategic objectives, design structure, and organize the materials purchasing activities in the organization.
CO 2. Make decisions to the basic materials management elements such as the decision to make or buy, purchase commodities versus capital goods, and purchase for resale.
CO 3. Determine the appropriate inventory control models to use, warehousing location, warehouse layout, and organizational policies and procedures.
CO 4. Compare and categorize various vendor rating systems and material requirement planning systems.
CO 5. Integrate important materials functions to both products and services & use MRP, ERP, & JIT in managing materials

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Role of materials management techniques in material productivity improvement, cost reduction and value improvement. Purchase management, incoming material control. Acceptance sampling and inspection. Vendor rating system. Inventory management, various inventory control models. Material requirement planning systems. Discrete lot sizing techniques. Wagner and Whitin algorithm. Silver-Meal algorithm. Algorithms for multi-product lot sizing with constraints inventory management of perishable commodities. Design of inventory distribution systems. Inventory management in Kanban and Just-in-time

Contents for Desired Course Outcomes (If any) Nil

Text Books

T1. Gopalakrishnan P., Purchasing and Materials Management, TMH, New Delhi, 2010.
T2. Leenders M.R., Fearon H.E., Purchasing and Materials Management, 11th ed., Irwin Burr Ridge, Illinois, 1997.

Reference Books

R1. Russell R. S. and Taylor B. W., Operations Management, 7th ed., Wiley India, 2013.
R2. Tersine R.J., Material Management and Inventory Systems, North Holland, New York, 1979.
R3. Arnold J.R., Chapman S.N., Clive L.M, Introduction to Materials Management, 4th ed., Pearson Prentice Hall, 2008.
R4. Nauhria R. N. and Prakash R., Management of Systems, 1st ed., Wheeler Publishing, 1995.
R5. Groover M. P., Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 4th ed., Wiley, 2010.

Machine System Design Lab | MEP 471 | 2 Credits | 0 0 4 2

Course Prerequisite

The student should have studied Design of Machine Elements (MEL357).

Course Objectives

The course objectives define the student learning outcome for the course. After completing the above course, student is expected to:

- Understand the concepts of machine components design, and their assembly process.
- Calculate forces and power involved in the machining components.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Learn about the conventional representation of machine elements.
CO 2. Identify the detailed specifications for the machine element including components dimension and interfaces.
CO 3. Use software to analyze forces involved in different machine components.
CO 4. Make foolproof assembly of machine elements.
CO 5. Understand the production drawing of machine components.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Learn about the conventional representation of machine elements.
2. Identify the detailed specifications for the machine element including components dimension and interfaces.
3. Use of software to analyze forces involved in different machine components.
4. Make foolproof assembly of machine elements.
5. Understand the production drawing of machine components.
6. Learn about the conventional representation of machine elements.
7. Identify the detailed specifications for the machine element including components dimension and interfaces.
8. Use of software to analyze forces involved in different machine components.

Experiments for Desired Course Outcomes (If any) Nil

Books/Material

T1. Lab Manuals.
T2. PSG college of Technology, Design data, 1st ed., DPV Printers, Coimbatore, 2002.
T3. Simant, Mishra R C, Mechanical System Design, PHI Learning Pvt. Ltd. 2009.

Reference Books

R1. Budynas R.G. and Nisbett J.K., Shigley's Mechanical Engineering Design, 10th ed., McGraw-Hill Education, 2015.
R2. Bhandari V. B., Design of Machine Elements, 4th ed., McGraw Hill, 2016.
R3. Shigley J. E. and Mischke C. R., Standard Handbook of Machine Design, McGraw- Hill, 1996.
R4. Khurmi R. S. and Gupta J. K., Machine Design, Eurasia Publishing House (PVT) Ltd., 2005.
R5. Norton R.L., Machine Design: An Integrated Approach, 2nd ed., Pearson Education, 2013.

B.Tech (Electronics and Communication Engineering)
OVERALL CREDIT STRUCTURE

Undergraduate Core(UC)		Undergraduate Elective (UE)	
Category	*Credit*	*Category*	*Credit*
DC	67	**DE**	23 (minimum)
BS	19	**HM**	06 (minimum)
ES	22	**OC**	18 (Balance)
HM	05	**UN**	0 (03 Courses)
Total	**113**	**Total**	47
Grand Total (UC + UE)			**160**

Basic Science (BS)			
Course Code	**Course**	**L-T-P**	**Credit**
MAL102	Applied Mathematics-I	3-2-0	04
MAL103	Applied Mathematics-II	3-2-0	04
MAL201	Applied Mathematics-III*	3-0-0	03
PHL151	Applied Physics	3-0-0	03
PHP151	Applied Physics Lab	0-0-2	01
CYL101	Applied Chemistry	3-0-0	03
CYP101	Applied Chemistry Lab	0-0-2	01
Grand Total			**19**

Humanities and Management (Core) (HM)			
Course Code	**Course**	**L-T-P**	**Credit**
HSP152	Technical Communication	1-2-2	03
HSL151	Social Science	2-0-0	02
Grand Total			**05**

Engineering Arts and Science (ES)			
Course Code	**Course**	**L-T-P**	**Credit**
MEL152	Elementary Mechanical Engineering	3-0-0	03
EEL151	Elementary Electrical Engineering	3-0-0	03
EEP151	Elementary Electrical Engineering Lab	0-0-2	01
ECL151	Basic Electronics Engineering	3-0-0	03
ECP151	Basic Electronics Engineering Lab	0-0-2	01
MEL151	Engineering Drawing	3-0-0	03
MEP151	Engineering Drawing Lab	0-0-2	01
CSL151	Computer Programming and Problem Solving	3-0-0	03
CSP151	Computer Programming and Problem Solving Lab	0-0-2	01
MEP152	Mechanical Workshop	0-0-2	01
CEL151	Environmental Science	2-0-0	02
Grand Total			**22**

Non-Credit Requirement (UN)			
Course Code	**Course**	**L-T-P**	**Credit**
NCN101	NCC#	-	0
NSS152	NSS-I#	-	0
NSS153	NSS-II#	-	0
NCN103	NSO#	-	0
SPB151	Sports-I#	0-0-4	0
SPB152	Sports-II#	0-0-4	0
HSD251	Community Project	-	0
ECT251	Practical Training	-	0
#A student has to opt at least one from NCC, NSS, NSO and Sports (I & II both).			

Department Core (DC)		**L-T-P**	**Credit**
ECL251	Signals and Systems	3-2-0	04
ECL252	Analog Circuits	3-0-0	03
ECP252	Analog Circuits Lab	0-0-2	01
ECL253	Analog Communication Systems	3-0-0	03
ECP253	Analog Communication Systems Lab	0-0-2	01
ECL254	Engineering Electromagnetics	3-0-0	03
ECL255	Solid State Devices	3-0-0	03
ECL256	Digital Circuits	3-0-0	03
ECP256	Digital Circuits Lab	0-0-2	01
ECL351	Linear Integrated Circuit	3-0-0	03
ECP351	Linear Integrated Circuit Lab	0-0-2	01
ECL352	Digital Signal Processing	3-0-0	03
ECP352	Digital Signal Processing Lab	0-0-2	01
ECL354	Antenna Theory	3-0-0	03
ECL355	Digital Communication Systems	3-0-0	03
ECP355	Digital Communication Systems Lab	0-0-2	01
ECL356	Microwave Theory and Techniques	3-0-0	03
ECP356	Microwave Theory and Techniques Lab	0-0-2	01
ECL359	Microprocessor and Interfacing	3-0-0	03
ECP359	Microprocessor and Interfacing Lab	0-0-2	01
ECL360	Optical Communication Systems	3-0-0	03
ECP360	Optical Communication Lab	0-0-2	01
EEL251	Basic Electrical Circuits	3-0-0	03
EEP251	Basic Electrical Circuits Lab	0-0-2	01
EEL254	Control System	3-0-0	03
EEP254	Control System Lab	0-0-2	01
CSL251	Data Structures	3-0-0	03
CSP251	Data Structures Lab	0-0-2	01
CSL258	Computer Organization and Architecture	3-0-0	03
ECD351	Minor Project	-	01
ECD451	Major Project	-	02

Department Elective (DE)		L-T-P	Credit
ECP361	Electronics Workshop and Tinkering Lab	0-0-4	02
ECL462	Electronic System Design	3-0-0	03
ECP462	Electronic System Design Lab	0-0-2	01
ECL466	Finite Automata	3-0-0	03
ECL467	Radio Frequency and Microwave Engineering	3-0-0	03
ECL468	Embedded System Design	3-0-0	03
ECP468	Embedded System Design Lab	0-0-2	01
ECL470	Wireless and Mobile Communications	3-0-0	03
ECP470	Wireless and Mobile Communication Lab	0-0-2	01
ECL471	Radar and Satellite Communication Systems	3-0-0	03
ECL473	FPGA based IC/System Design	3-0-0	03
ECP473	FPGA based IC/System Design Lab	0-0-2	01
ECL474	Data Communication and Networks	3-0-0	03
ECL475	Information Theory & Coding Techniques	3-0-0	03
ECL476	Advanced Analog Circuits	3-0-0	03
ECL477	Intelligent Instrumentation	3-0-0	03
ECL519	VLSI/ULSI Technology	3-0-0	03
ECL531	Advanced Microwave Engineering	3-0-0	03
ECL533	Advanced Digital Communication Systems	3-0-0	03
ECL542	Image Processing	3-0-0	03
ECP542	Image Processing Lab	0-0-2	01
ECL552	Advanced Machine Learning	3-0-0	03
ECP552	Advanced Machine Learning Lab	0-0-2	01
ECL563	Matrix Theory for System Analysis	3-0-0	03
ECL564	Robotics Control and Computer Vision	3-0-0	03
ECL565	Advanced Topics in Semiconductor Devices	3-0-0	03
CSL252	Operating System	3-0-0	03
CSP252	Operating System Lab	0-0-2	01
CSL353	Data Science	3-0-0	03
CSP353	Data Science Lab	0-0-2	01
EEL255	Power Electronics	3-0-0	03
EEP255	Power Electronics Lab	0-0-2	01

Course Syllabi
(Under Graduate)
Department of Electronics Engineering

Course Code: ECL151
Course Title: Basic Electronics Engineering
Structure (L-T-P): 3-0-0
Prerequisite: NIL

Course Objectives:
After completing the course, student is expected to:

- Understand the physics behind the conduction in a semiconductor and the working of a diode
- Analyze diode based circuits such as rectifier clipper, clamper, shunt regulator, multiplier circuits etc.
- Compute different parameters for BJT and MOSFET transistor circuits.
- Apply the knowledge of operational amplifiers in common applications.
- Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.

Course Outcomes
At the end of the course, students will be able to-
Essential:

CO 1. Understand the physics behind the conduction in a semiconductor and the working of a diode.
CO 2. Analyze diode based circuits such as rectifier clipper, clamper, shunt regulator, multiplier circuits etc.
CO 3. Apply the knowledge of operational amplifiers in common applications.
CO 4. Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.
CO 5. Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes
Basic Semiconductor Physics: temperature effect, intrinsic and extrinsic semiconductor, band diagram, mobility, conductivity hall effect, Diode, Depletion layer, V-I characteristics, ideal and practical, diode resistance, capacitance, Diode Equivalent Circuits, Transition and Diffusion Capacitance, Zener Diodes breakdown mechanism (Zener and avalanche).

Diode Applications: Parallel and Series Diode Configuration, Half and Full Wave rectification, Clippers, Clampers, Zener diode as shunt regulator, Voltage-Multiplier Circuits. Light-Emitting Diodes, Varactor (Varicap) Diodes, Tunnel Diodes, Liquid-Crystal diodes and displays. Introduction to LASERs

Transistor Theory: Bipolar Junction Transistor, Transistor Construction, Operation, Amplification action, Common Base, Common Emitter, Common Collector Configuration. Amplifiers. Field Effect Transistor:

Construction and I-V Characteristics of JFETs. Construction and I-V Characteristics of MOSFET, CS, CD, CG amplifier and analysis of CS amplifier MOSFET (Depletion and Enhancement) Type.

Digital Electronics: Introduction to digital electronics, Number Systems, Conversion between various number systems, Basic Logic gates.

Operational Amplifiers: Introduction, Differential Amplifier Circuits, Op-Amp Basic, Practical Op-Amp Circuits (Inverting Amplifier, Noninverting Amplifier, Unit Follower, Summing Amplifier, Integrator, Differentiator). Differential and Common-Mode Operation, CMRR, PSRR.

Fundamentals of Communication Engineering: Elements of a Communication System, Need of modulation, electromagnetic spectrum and typical applications, terminologies in communication systems, Basics of signal representation and analysis, Fundamentals of amplitude and angle modulation, modulation and demodulation techniques

Contents for Desired Course Outcomes (If any): Nil

Text Books

T1. Robert L. Boylestad & Louis Nashelsky. Electronic Devices and Circuit Theory, Tenth Edition, Pearson
T2. David A. Bell, Electronics Devices and Circuits, 5th Edition, OXFORD University Press 2008.
T3. George Kennedy, Electronic Communication System, Fifth Edition, TMH Publication, 2012.

Reference Books

R1. Jacob Millman, Christos C. Halkias, Satyabrata Jit, Electronics Devices and Circuits, 3rd Edition, TMH 2008.
R2. H S Kalsi, Electronics Instrumentation, Third Edition, TMH Publication 2012

Course Code: ECP151
Course Title: Basic Electronics Engineering Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL151

Course Objectives

After completing the course, student is expected to:

- Understand the physics behind the conduction in a semiconductor and the working of a diode
- Analyze diode based circuits such as rectifier clipper, clamper, shunt regulator, multiplier circuits etc.
- Compute different parameters for BJT and MOSFET transistor circuits.
- Apply the knowledge of operational amplifiers in common applications.
- Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Analyze diode based circuits such as rectifier clipper, clamper, shunt regulator, multiplier circuits etc.

CO 2. Apply the knowledge of operational amplifiers in common applications.

CO 3. Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.

CO 4. Employ the concept of basic communication systems and digital electronics to explain transmission of signals through a communication channel.

Desirable/Advanced (If any):

List of Experiments

1. Study of CRO-Applications
2. V-I Characteristics of Silicon & Germanium PN Junction diodes
3. V-I Characteristics of Zener Diode
4. Characteristics of BJT in Common Emitter Configuration
5. Characteristics of JFET in Common Source Configuration
6. Half Wave and Full Wave Rectifier Without Filter
7. Half Wave and Full Wave Rectifier with Filter
8. Common Emitter BJT Amplifier
9. Applications of Operational Amplifier
10. Implementation of Logic Gates
11. Study of communication modulation techniques

Contents for Desired Course Outcomes (If any): Nil

Text Books

T1. Robert L. Boylestad & Louis Nashelsky. Electronic Devices and Circuit Theory, Tenth Edition, Pearson

T2. David A. Bell, Electronics Devices and Circuits, 5th Edition, OXFORD University Press 2008.

T3. George Kennedy, Electronic Communication System, Fifth Edition, TMH Publication, 2012.

Reference Books

R1. Jacob Millman, Christos C. Halkias, Satyabrata Jit, Electronics Devices and Circuits, 3rd Edition, TMH 2008.

R2. H S Kalsi, Electronics Instrumentation, Third Edition, TMH Publication 2012

Course Code: ECL251
Course Title: Signals and Systems
Structure (L-T-P): 3 2 0
Prerequisite: NIL

Course Objectives

After completing the course, student is expected to:

- Represent and Classify signals and systems,
- Employ convolution to obtain the response of a linear time invariant system
- Obtain Fourier Series expansion of a periodic signal
- Obtain Fourier Transform of aperiodic signals
- Use z-Transform method to analyze discrete systems

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Analyze the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.

CO 2. Characterize different types of signals and systems.

CO 3. Analyze system behavior using time and frequency domain techniques.

CO 4. Identify the sources of signals in real life.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

An introduction to signals and systems- Signals and systems as seen in everyday life, and in various branches of engineering and science electrical, mechanical, hydraulic, thermal, biomedical signals and systems as examples. Extracting the common essence and requirements of signal and system

Formalizing signals- energy and power signals, signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. Formalizing systems- system properties: linearity: additivity and homogeneity, shift invariance, causality, stability, realizability.

Continuous time and discrete time linear shift-invariant (LSI) systems in detail-the impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of linear shift invariant systems. System representation through differential equations and difference equations.

Periodic and semi-periodic inputs to an LSI system, the notion of a frequency response and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. The idea of signal space and Orthogonal bases of signals.

The Laplace Transform for continuous time signals and systems- the notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior. Generalization of Parseval's Theorem. The z-Transform for discrete time signals and systems- eigen functions, region of convergence, system functions, poles and zeros of systems and sequences, z-domain analysis. Generalization of Parseval's Theorem. Applications of Laplace Transform and z-Transform.

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. B. P. lathi, Oxford, Principles of Linear Systems and Signals, Second edition, 2009.
T2. Oppenheim, A.V., Willsky, A.S., and Nawab, S.H. Signals and Systems. 2nd ed., PHI Learning Private Limited., 2012.
T3. Haykin, S.S. and Veen, B.V. Signals and Systems .2nd ed. Wiley, 2013

Reference Books

R1. Phillips, C.L., Parr, J.M., and Riskin, E.A. Signals, Systems and Transforms.5th ed. Pearson Education, 2014.
R2. Carlson, G.E. Signal and Linear System Analysis. 2nd ed. Allied Publishers Limited, 1993.

Course Code: ECL252
Course Title: Analog Circuits
Structure (L-T-P): 3 0 0
Prerequisite: ECL151
Course Objectives

After completing the course, student is expected to:

- Understand fundamentals of MOSFET and their small and large signal equivalent model.
- Understand the analog integrated circuit and its building blocks.
- Analyze different analog circuits in terms of gain, input resistance and output resistance.
- Solve practical and state of the art analog IC design problems to serve VLSI industries.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Understand the basic of semiconductor device physics & MOS/BJT characteristics.
CO 2. To be well versed with the MOS fundamentals, small signal models and analysis of MOSFET based circuits.
CO 3. Analysis of Single Stage Amplifier such as CE/CS, CB/CG, CC/CD.
CO 4. Able to analyze and design analog circuits such as Differential Amplifier, OP- AMP, Current mirrors, Biasing circuits.
CO 5. Solve practical and state of the art analog IC design problems to serve VLSI industries.

Desirable/Advanced (If any):

CO 6. Analysis of various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues. Feedback topologies.

Syllabus for Essential Course Outcomes

Introduction: Scope and applications of analog electronic circuits. Amplifier models: Voltage amplifier, current amplifier, transconductance amplifier and trans-resistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, various configurations(such as CE/CS, CB/CG, CC/CD) and their features, small signal analysis, low frequency transistor models, estimation of volt-age gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers. High frequency transistor models, frequency response of single stage and multistage amplifiers, cascade amplifier. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin. Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Collpits, Clapp etc.), non-sinusoidal oscillators, Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues.

Contents for Desired Course Outcomes (If any)

Research papers related to the field.

Text Books

T1. Sedra, A.S. and Smith, K.C., Microelectronic Circuits: Theory and Applications, 6th ed., Oxford University Press, 2013.
T2. Boylestad, R.L. and Nashelsky, L., Electronic Devices and Circuit Theory, 10th ed., Pearson Education, 2013

Reference Books/Additional Books:

R1. Bell, D.A., Electronic Devices and Circuits, 4th ed. Prentice Hall of India, 2001.
R2. Meade, R.L., Foundations of Electronics Circuits and Devices, 5 th ed. Delmar Learning, 2007.
R3. Horowitz, P. and Hill, W., The Art of Electronics, 3rd ed., Cambridge University Press, 2011.
R4. Wait, J.V., Huelsman, L. P. and Korn, G.A., Introduction to Operational Amplifier Theory and Applications, 2nd ed., Tata McGraw Hill, 1992.
R5. M]illman, J., Microelectronics, 2nd ed., Tata McGraw Hill, New Delhi, 2003.Gray, P.R.et. al., Analysis and Design of Analog Integrated Circuits, 5th ed., John Wiley, 2010.

Course Code: ECP252
Course Title: Analog Circuits Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL151, ECP151, ECL252

Course Objectives

- The objective of this course is to provide students with hands-on experience in designing, building, testing, and analyzing analog circuits in a laboratory setting.
- Students will learn fundamental principles of analog circuit design, circuit analysis techniques, and practical skills in using laboratory equipment and tools for designing and testing analog circuits.
- Through a series of laboratory experiments, students will gain practical experience in designing and implementing analog circuits, analyzing their performance, and troubleshooting circuit issues.

Course Outcomes

At the end of the course, students will be able to

Essential:

CO 1. Understand the fundamental principles of analog circuit design.
CO 2. Use laboratory equipment and tools for circuit testing and measurement.
CO 3. Design and implement analog circuits such as CE/CS, CB/CG, CC/CD.
CO 4. Design and implement analog circuits such as Differential Amplifier, OP-AMP, Current mirrors, Biasing circuits.

Desirable/Advanced (If any):

CO 5. Apply analog circuit design principles to real-world applications: Students will be able to apply their knowledge of analog circuit design principles to real-world applications. They will understand the practical applications of analog circuits in areas such as communication systems, sensor circuits, audio amplifiers, and other analog signal processing circuits, and develop the skills to design and implement analog circuits for these applications.

Experiments for Essential Course Outcomes:

1. BJT Common Emitter Amplifier: Design and build a BJT common emitter amplifier circuit, measure and analyze its DC operating point, input/output characteristics, voltage gain, and frequency response. Explore the effect of different biasing arrangements and component values on the amplifier performance.
2. BJT Common Source Amplifier: Design and build a BJT common source amplifier circuit using a MOSFET, measure and analyze its DC operating point, input/output characteristics, voltage gain, and frequency response. Explore the effect of different biasing arrangements and component values on the amplifier performance.
3. BJT Differential Amplifier: Design and build a BJT differential amplifier circuit, measure and analyze its DC operating point, input/output characteristics, common mode rejection ratio (CMRR), and differential mode gain. Explore the effect of different biasing arrangements and component values on the differential amplifier performance.
4. MOSFET Common Gate Amplifier: Design and build a MOSFET common gate amplifier circuit, measure and analyze its DC operating point, input/output characteristics, voltage gain, and frequency response. Explore the effect of different biasing arrangements and component values on the amplifier performance.
5.

Course Code: ECL253
Course Title: Analog Communication Systems
Structure (L-T-P): 3 0 0
Prerequisite: ECL251

Course Objectives

After completing the course, student is expected to:

- Learn the importance of analog communication systems.
- Analyze different analog modulation and demodulation techniques
- Design AM/FM transmitters and receivers
- Apply the role of different analog modulation techniques on noise performance.
- Compare different pulse analog modulation techniques.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Apply the theoretical concepts of signal and systems, frequency domain analysis, different communication channels in the field of communication system.
CO 2. To analyze the analog communication systems and compare the performance of different amplitude modulation and demodulation schemes
CO 3. Compare and analyze -NBFM and WBFM schemes, TRF and superheterodyne receivers
CO 4. Solve & analyze the noise performance of analog communication systems
CO 5. Analyze the sampling process and pulse modulation techniques.

Desirable/Advanced (If any):

CO 6. Design an analog communication system using different modulation processes to meet desired needs within realistic constraints.

Syllabus for Essential Course Outcomes

Introduction to Communication systems, Review of Signal Representations, Frequency domain analysis of signals using Fourier Transforms. Concept of bandwidth, Mathematical models for communication channels Linear filter channel, Linear time-invariant channel

Analog Signal Transmission and reception: Modulation, Amplitude Modulation: Equation or AM wave, Modulation Index and Power relationships. AM transmitter: Generation of AM. AM demodulator: Theory and Mathematical analysis of Square Law detector, Envelope detector and synchronous detector. DSB AM: Principle of nonlinear resistance, Balance modulator and Switching Modulator, DSB Demodulation through product modulator, Costas receiver, SSB AM: Time domain representation of SSB signal, Generation methods: Filter, Phase shift method using Hilbert Transformer, SSB demodulator. VSB-AM generation, Demodulation using sideband filters, Quadrature Carrier multiplexing, FDM.

Frequency and phase modulation, NBFM, WBFM, Generation of Frequency Modulation, Reactance modulator and Indirect method, FM receiver: block diagram, FM discriminator: slope detector, balance slope detector and phase discriminator, Phase locked loop, Multiplexed Stereo FM system Radio receivers: Tuned radio frequency receiver, Superheterodyne receiver Sensitivity and selectivity, selection of IF. Block diagram and features of Communication Receiver.

Noise in Communication Systems: Thermal noise, Shot noise, S/N ratio, noise Equivalent bandwidth, Concept of Random Variables, PDF, CDF, Different types of Pdfs, Gaussian Rayleigh PDF, Noise performance of AM, DSB,SSB, Noise in FM systems under AWGN, Noise in FM, Pre-emphasis & De- emphasis , Capture effect & Threshold effect in FM

Sampling Theorem, Analog Pulse modulation schemes PAM, PPM, PWM. Quantization Process, Quantization Error

Contents for Desired Course Outcomes (If any): NIL

Text Books

T1. Haykin, S.S. and Moher, M., Introduction to Analog and Digital Communications, 2nd ed., Wiley, 2012.

T2. Lathi, B.P. and Ding, Z., Modern Digital and Analog Communication Systems, 4th ed., Oxford University Press, 2012

Reference Books

R1. Taub, H., Schilling, D.L. and Saha, G., Principles of Communication Systems; 2ndedition, Tata McGraw-Hill, 2008.

R2. Kennedy, G. and Davis, B., Electronic Communication Systems, 4th ed., Tata McGraw Hill, 1999.

R3. Choenbeck, R.J., Electronic Communications: Modulation and Transmission, 2nd ed., Prentice Hall, 1992.

Course Code: ECP253
Course Title: Analog Communication Systems Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL251, ECL253

Course Objectives

After completing the course, student is expected to:

- Apply the knowledge of analog communication systems.
- Analyze the performance of different analog modulation and demodulation techniques
- Design AM/FM transmitters and receivers
- Perform noise performance analysis of different analog modulation techniques.
- Compare the performance of different pulse analog modulation techniques.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Measure various performance parameters of a communication system using CRO and Function generator.

CO 2. Analyze various modulation techniques like AM, FM, PM using experimental analysis.

CO 3. Compare the waveform of PAM, PWM, and PPM using experimental analysis.

CO 4. Observe the waveform of modulated signal on CRO/DSO.

Desirable/Advanced (If any):

CO 5. Apply some theoretical concept to design a FM receiver.

Experiments for Essential Course Outcomes

1. To implement simple Amplitude Modulation (AM), demodulation and calculate the modulation index.
2. To implement DSB-SC Modulation (AM) and demodulation using kits.
3. To implement SSB Modulation (AM) and demodulation using kits.
4. To implement Frequency Modulation (FM) and demodulation using kits.
5. To implement Pulse Amplitude Modulation (PAM) and Demodulation.
6. To implement Pulse Position Modulation (PPM).
7. To implement Pulse Width Modulation (PWM).
8. To study and implement Pre-emphasis and De-emphasis circuits.
9. To perform sampling and reconstruction of the analog signal.
10. To determine the performance of PCM.

11. To determine the performance TDM (PAM) and TDM (PCM).
12. To determine the spectrum of AM/FM using a spectrum analyzer.

Experiments for Desired Course Outcomes (If any)

1. To implement Phase Locked Loop (PLL) and find out the lock range and capture range.
2. To design and test the circuit of Voltage to Frequency Converter (VCO) using IC 555.

Books/Material

T1. Lab Manuals
T2. Haykin, S.S. and Moher, M., Introduction to Analog and Digital Communications, 2nd ed., Wiley, 2012.
T3. Lathi, B.P. and Ding, Z., Modern Digital and Analog Communication Systems, 4th ed., Oxford University Press, 2012.

Reference Books

R1. Kennedy, G. and Davis, B., Electronic Communication Systems, 4th ed., Tata McGraw Hill, 1999.
R2. Schoenbeck, R.J., Electronic Communications: Modulation and Transmission, 2nd ed., Prentice Hall, 1992.
R3. Taub, H., Schilling, D.L. and Saha, G., Principles of Communication Systems; 2ndedition, Tata McGraw-Hill, 2008.

Course Code: ECL254
Course Title: Engineering Electromagnetics
Structure (L-T-P): 3 0 0
Prerequisite: NIL

Course Objectives

After completing the course, student is expected to:

- To introduce the basic mathematical concepts related to electromagnetic vector fields.
- To familiarize the students with the different concepts of electrostatic, magneto static and time varying electromagnetic systems.
- To expose the students to the ideas of electromagnetic waves and structure of transmission line.
- To provide the basic skills required to understand, develop, and design various engineering applications involving electromagnetics.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Illustrate the physical concepts of static, time varying electric and magnetic fields.
CO 2. Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering.
CO 3. Analyze the fundamental characteristics of transmission lines, its matching using various methods.

Desirable/Advanced (If any): NIL

Syllabus for Essential Course Outcomes

Review of Vector calculus. Review of basic laws of electrostatics: Coulomb's law, Electric field intensity, Field of 'n' point charges, Field of line and sheet of charge. Electric flux density, Gauss's law and it's applications. Divergence and Divergence theorem. Definition of potential difference and potential, Potential of point charge and system of charges. Potential gradient, Energy density in electrostatic field.

Poisson's and Laplace's equations. Current and current density, Continuity of current. Capacitance. Review of basic laws of magneto statics: Biot-Savart and Amperes circuital laws and their applications, Curl, Stoke's theorem. Magnetic flux density, Scalar and Vector magnetic potential. Maxwell's equations in steady electric and magnetic fields. Time varying fields and Maxwell's equations.

Uniform plane waves, wave motion in free space, perfect dielectric, lossy dielectric and good conductor, skin effect. Poynting vector and power considerations. Reflection of uniform plane waves, Standing ratio, boundary conditions.

Transmission lines: S-parameters, telegraphers model of transmission line. Various terminations. Transmission line equations and their solutions. Transmission line parameters, Characteristic impedances, Propagation constant, Attenuation constant, Phase constant, Waveform distortion, Distortion less transmission lines, Loading of transmission lines, Reflection coefficient and VSWR. Equivalent circuits of transmission lines, Transmission lines at radio frequency. Open circuited and short circuited lines, Smith Chart, Stub matching.

Contents for Desired Course Outcomes (If any)

NIL

Text Book/ Material:

T1. Hayt, W.H. and Buck, J.A., *Engineering Electromagnetics*, 7th ed., Tata McGraw Hill, 2013.
T2. Sadiku, M.N.O., *Principles of Electromagnetics*, 4th ed., Oxford University Press, 2013.
T3. Shevgaonkar, R. K. *Electromagnetic waves*. Tata McGraw-Hill Education, 2005.

Reference Books:

R1. Rao, N.N., *Elements of Engineering Electromagnetics*, 6th ed., Prentice Hall of India, 2004.
R2. Elgerd, O. I., *Electric Energy Systems Theory: An Introduction*, 2nd ed., Tata McGraw-Hill, New Delhi, 2007.

R3. Jordan, E.C. and Balmain, K.G., Electromagnetic Waves and Radiating Systems, 2nd ed., Prentice Hall of India, 2013.

Course Code: ECL255
Course Title: Solid State Devices
Structure (L-T-P): 3 0 0
Prerequisite: ECL151, ECP151

Course Objectives
After completing the course, student is expected to:

- To develop an ability to learn fundamentals of semiconductor and its physics.
- To develop the physics and working of different types of transistor action.
- Students would be able to apply the basic fundamentals of semiconductors in analysing the semiconductor based devices and fabrication process flow.

Course Outcomes:
Essential:

CO 1. Able to understand the basics of Quantum Machines Energy band diagram for semiconductors.
CO 2. Able to understand the charge carrier transport phenomenon and recombination-generation process for semiconductors in P-N junction Diode and Solar Cell.
CO 3. Able to understand the Characteristics & Current flow of semiconductor devices like BJT, JFET, MOSFET & Metal-Semiconductor Junction & Hetero Junction Devices and basic fabrication process flow.
CO 4. Able to analyse the design parameters of MOSFET i.e.,- Channel length & width, depletion width, surface field and potential, ON resistance, transconductance, equivalent circuits, amplification factors, capacitances, noise margins, scaling & short channel effects MOSFET.

Syllabus for Essential Course Outcomes
Introduction to E-K diagram, Introduction: Evolution and uniqueness of Semiconductor Technology, Equilibrium carrier concentration, Thermal Equilibrium and wave-particle duality, intrinsic semiconductor – Bond and band models, Extrinsic semiconductor – Bond and band models
Carrier transport: Random motion Drift and diffusion Excess carriers: Injection level, Lifetime, Direct and indirect semiconductors Procedure for analysing semiconductor devices.
Basic equations and approximations P-N Junction: Device structure and fabrication. Equilibrium picture, DC forward and reverse characteristics, Small-signal equivalent circuit, Switching characteristics, Solar cell, Introduction to Tunnel, IMPATT, TRAPATT diodes.
Bipolar Junction Transistor: Device structures and fabrication, Transistor action and amplification, Common emitter DC characteristics
MOS Junction: C-V characteristics, threshold voltage, body effect Metal Oxide Field Effect Transistor: Device structures and fabrication, Common source DC Characteristics, Small-signal equivalent circuit, Differences between a MOSFET and a BJT Junction FET and MESFET, Recent Developments, Heterojunction FET, Heterojunction bipolar transistor.

Contents for Desired Course Outcomes (If any): NIL

Text Books:
T1. Streetman, B.G., and Banerjee, S.K. Solid-state Electronics devices. 7th ed. Pearson Education, 2014.

Reference Books:
R1. Bell, David A. Electronics Devices and Circuits. 4th Ed, Prentice Hall India, 2009.
R2. Sedra, A. S., and Smith, K.C. Microelectronics Circuits. 7th ed. Oxford University Press, 2015.
R3. Millman, J., and Halkias, Christos C. Integrated Electronics. Tata McGraw-Hill Education, 1991.

Course Code: ECL256
Course Title: Digital Circuits
Structure (L-T-P): 3 0 0
Prerequisite: NIL

Course Objectives
After completing the course, student is expected to:

- Design & analyze combinational circuits and implementation of minimization techniques.
- Understand and design different arithmetic circuits.
- Design of synchronous and asynchronous sequential circuits using State Diagrams & Tables.
- Design and implement sequential logic function using FSM & ASM.
- Implement & Verify of digital logic circuits & systems using Verilog HDL for enhancing the employability skills in VLSI Domain.

Course Outcomes
At the end of the course, students will be able to-
Essential:

CO 1. Design & analyze combinational circuits and implementation of minimization techniques.
CO 2. Understand and design different arithmetic circuits.
CO 3. Design of synchronous and asynchronous sequential circuits using State Diagrams & Tables.
CO 4. Design and implement sequential logic function using FSM & ASM.

Desirable/Advanced (If any):

CO 5. Implement & Verify of digital logic circuits & systems using Verilog/VHDL for enhancing the employability skills in VLSI Domain.

Syllabus for Essential Course Outcomes

Number systems and Boolean algebra: Introduction to number systems and Boolean algebra; Boolean identities, basic logic functions, standard forms of logic expressions, simplification of logic expressions.

Combinational logic: Arithmetic circuits, decoders, encoders, multiplexers, de-multiplexers, and their use in logic synthesis; Hazards in combinational circuits.

Sequential logic circuits: Latches and Flip Flops (SR, D, JK, T); Timing in sequential circuits; Shift register; Counters – synchronous, asynchronous; Finite state machines: Basic concepts and design; Moore and Mealy machines examples; State minimization/reduction, state assignment; Finite state machine design case studies

ROM and RAM, PLA, PAL and FPGA

Logic families: Brief overview of Transistor as a switch; Logic gate characteristics – propagation delay, speed, noise margin, fan-out and power dissipation; Standard TTL and static CMOS gates.

Contents for Advanced Course Outcomes (If any)

Introduction to Verilog/VHDL: Behavioral – data flow, and algorithmic and structural description, lexical elements, data objects types, attributes, operators; Verilog/VHDL coding examples, combinational circuit design examples in VHDL and simulation, RTL based design projects and their implementation in FPGA using VHDL, Sequential circuit design examples in Verilog/VHDL and simulation, FSM circuit design examples in VHDL and simulation.

Text Books:

T1. Mano, M.M. and Ciletti, M.D. *Digital Design: With an Introduction to the Verilog HDL*. 5th ed. Pearson Education, 2013.

T2. Kohavi, Z. and Jha, N.K. *Switching and Finite Automata Theory*.3rd ed. Cambridge University Press, 2013.

T3. Thomas L. Floyd ,Pearson Education, Digital Fundamentals,11th ed. , 2014

Reference Books:

R1. Palnitkar, S. *Verilog HDL: A guide to Digital Design a Synthesis.* 2nd ed., Pearson, 2013.

R2. Brown, S.D. and Vranesic, Z.G. *Fundamentals of Digital Logic with Verilog Design*. 3rd ed. McGraw-Hill, 2013.

R3. Bhaskar, J. *VHDL Primer*. 3rd ed. Prentice Hall of India, 2011.

R4. Kumar, A. Anand. *Fundamentals of Digital Circuits*. PHI Learning Pvt. Ltd., 2003

Course Code: ECP256
Course Title: Digital Circuits Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL256

Course Objectives

After completing the course, student is expected to:

- Design & analyze combinational circuits and implementation of minimization techniques.
- Understand and design different arithmetic circuits.
- Design of synchronous and asynchronous sequential circuits using State Diagrams & Tables.
- Design and implement sequential logic function using FSM & ASM.
- Implement & Verify of digital logic circuits & systems using Verilog HDL for enhancing the employability skills in VLSI Domain.

Course Outcomes

Essential:

CO 1. Design & analyze combinational circuits and implementation of minimization techniques.
CO 2. Understand and design different arithmetic circuits.
CO 3. Design of synchronous and asynchronous sequential circuits using State Diagrams & Tables.
CO 4. Design and implement sequential logic function using FSM & ASM.
CO 5. Implement & Verify of digital logic circuits & systems using Verilog HDL for enhancing the employability skills in VLSI Domain.

Desirable/Advanced (If any):

CO 6. Apply some additional processes to advance the performance of I C engines.

Experiments for Essential Course Outcomes

1. Familiarization of Digital trainer kit and study of logic gates
2. Realization of Boolean expressions using logic gates
3. Realization of Boolean expressions using universal gates
4. Realization of code converters
5. Design of Adders/ Subtractors
6. Design of Multiplexers/ De-Multiplexers
7. Design of Encoders/ Decoders
8. Study of flip-flops
9. Design of Synchronous counters
10. Design of Asynchronous counters
11. Design basic blocks in Verilog/VHDL

Experiments for Desired Course Outcomes (If any): NIL

Text Books:

T1. Lab Manuals

Reference Books:

R1. Palnitkar, S. *Verilog HDL: A guide to Digital Design and Synthesis.* 2nd ed., Pearson, 2013.
R2. Brown, S.D. and Vranesic, Z.G. *Fundamentals of Digital Logic with Verilog Design*. 3rd ed. McGraw-Hill, 2013
R3. Bhaskar, J. *VHDL Primer*. 3rd ed. Prentice Hall of India, 2011.
R4. Kumar, A. Anand. *Fundamentals of Digital Circuits*. PHI Learning Pvt. Ltd., 2003

Course Code: ECL351
Course Title: Linear Integrated Circuit
Structure (L-T-P): 3 0 0
Prerequisite: ECL252, ECP252

Course Objectives
After completing the course, student is expected to:
- Understand ideal and actual operational amplifier.
- Understand the linear and non-linear applications of the op-amp.
- Gain some knowledge about internal architecture of op-amp.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO.1. To study the basic principles, configurations for ideal and practical Op-amp and finding limitations of Op-amp.
CO.2. To understand the various linear and non-linear applications of Op-amp for negative feedback, open loop and positive feedback conditions.
CO.3. To analyze, design and explain the characteristics and applications of active filters.
CO.4. In-depth knowledge of applying the concepts in real time applications.
CO.5. To understand the operation of the most commonly used D/A & A/D converters and its applications.
CO.6. To design the building blocks of Op-amp i.e. Differential Amplifier, Current Mirror and Two stage CMOS Op-amp.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes
Differential amplifier and Op-amp design, configurations (FET, BJT).DC & AC analysis, constant current bias, current mirror, cascaded differential amplifier stages, level translator. Review of feedback topologies

OPAMP, inverting, noninverting, differential amplifier configurations, negative feedback, voltage gain, input & output impedance, Bandwidth. Input offset voltage, input bias and offset current, Thermal drift, CMRR, PSRR, Frequency response.

Linear applications, DC, ac amplifiers, summing differential amplifier, instrumentation amplifier, V to I and I to V converters, Integrator, Differentiator. First/second order low/high/ band pass, band reject active filters,

All pass filter Phase shift oscillator, Wein bridge oscillator, Square wave and triangular waveform generators. Nonlinear applications, Comparators, Schmitt Trigger, Clipping and Clamping circuits,

Absolute value circuits, Peak detectors, Sample and hold circuits, Log and antilog amplifiers. Data Converters (ADC and DAC's), 555 Timer, Voltage Regulator, Phase Locked Loops (PLL).

Contents for Desired Course Outcomes (If any): Nil

Text Books
T1. Graeme, J.G., Tobey, G.E., and Huelsman, L.P. Operational Amplifiers: Design and Applications. New Delhi: McGraw Hill, 1986.
T2. R.A. Gayakwad. Op-amps and Linear Integrated Circuits. 4th ed., Prentice Hall of India, 2012.
Reference Books
R1. Franco, S. Design with Operational Amplifiers and Analog Integrated Circuits. 4th ed., McGraw Hill Education, 2014.
R2. Fiore, J.M. Op amps and Linear Integrated Circuits: Theory and Application. Delmar Thomson Learning, 2001.
R3. Choudhury. Roy D. Linear integrated Circuits. 2nd ed. New Age International Publications, 2003.

Course Code: ECP351
Course Title: Linear Integrated Circuit Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL252, ECP252, ECL351

Course Objectives
After completing the course, student is expected to:
- Understand the pin diagram of 741 and 555.
- Able to perform various linear and non-linear applications of analog signal processing using op-amp ICs.

Course Outcomes
Essential:
CO.1. To design and study of various amplifier configurations of Op-amp such Inverting, Non-inverting, differential, adder etc.
CO.2. To design and study of various order filter configuration such as low pass, high pass, band pass etc.
CO.3. To design and study of various waveform generators such as sine wave, square wave, saw-tooth etc.
CO.4. To design and study of various modes of 555 timer IC.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. To design and study of the non-inverting amplifier using operational amplifier.
2. To design and study of the inverting amplifier using operational amplifier.
3. To design and study of the Integrator and Differentiator.
4. To design and study of the second order active low pass filter.
5. To design and study of the second order active high pass filter.
6. To design and study of the second order sine wave oscillator (wein-bridge).
7. To design and study of the second order sine wave oscillator (R-C phase shift).
8. To design and study of the Schmitt Trigger.
9. To design and study of the 555 IC as an astable multivibrator.
10. To design and study of the 555 IC as an mono-stable multivibrator.

Books/Material
T1. Lab Manuals

Course Code: ECL352
Course Title: Digital Signal Processing
Structure (L-T-P): 3 0 0
Prerequisite: ECL251

Course Objectives
After completing the course, student is expected to:
- Demonstrate an understanding of the fundamentals of discrete-time signals and systems
- Be familiar with the techniques of analysis of discrete-time signals and systems using Z-transform
- Derive knowledge of spectral properties of discrete-time systems through the use of Discrete Fourier Transform of sequences
- Design digital filters

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO.1. Interpret and analyze discrete-time signals
CO.2. Identify various types of discrete systems.
CO.3. Compute DFT and apply Fast Fourier Transform algorithms to analyze discrete signals and systems.
CO.4. Design FIR and IIR filters.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes
Discrete time signals Sequences; representation of signals on orthogonal basis; Sampling and reconstruction of signals;

Discrete systems, Classification of LTI, Discrete time systems, Linear convolution, Inverse systems

Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), theorems, DFT symmetry relations, Circular convolution, Linear convolution using DFT, overlap add method, overlap save method.

Fast Fourier Transform (FFT) algorithms, decimation in time and frequency domain and algorithms, Goertzel algorithms

Realization of discrete systems: Signal flow graph representation, Direct Form, parallel cascade and state space representation.

Design of FIR digital filter using window method, Park-McClellans method.

Design of IIR digital filter, Butterworth, Chebyshev and Elliptic Approximations with Bilinear Transformation and Impulse In-variant method. Lowpass, Bandpass, Bandstop and High pass filters

Contents for Desired Course Outcomes (If any): Nil

Text Books
T1. Oppenheim, A.V. and Schafer, R.W., Discrete-Time Signal Processing, 3rd ed., Pearson, 2013.
T2. Proakis, J.G. and Manolakis, D.G., Digital Signal Processing: Principles, Algorithms and Applications, 4th ed., Pearson, 2011.

Reference Books
R1. Phillips, C.L., Parr, J.M., and Riskin, E.A. Signals, Systems and Transforms.5th ed. Pearson Education, 2014.
R2. Carlson, G.E. Signal and Linear System Analysis. 2nd ed. Allied Publishers Limited, 1993.
R3. Mitra S. K., Digital Signal Processing: a Computer based Approach, 3rd ed., Tata McGraw-Hill, 2012.

Course Code: ECP352
Course Title: Digital Signal Processing Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL251, ECL352

Course Objectives
After completing the course, student is expected to:
- Use MATLAB and/or other software to analyze and produce discrete signals
- Obtain outputs of discrete systems by giving suitable inputs to the system
- Design digital filters

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO.1. Use MATLAB and/or other computing software for signal processing
CO.2. Perform analysis of discrete signals and systems
CO.3. Design Digital filters
CO.4. Use DSP kits to verify the simulation results

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Generate discrete cosine waveforms of varying periods
2. Generate Ramp sequence, unit sample sequence and unit step sequence
3. Obtain the 4-point DFT of a given sequence
4. Using FFT obtain 8-point DFT of a sequence
5. Obtain IDFT of a given sequence
6. Find the Circular convolution of a given sequence
7. Design a Butterworth Filter using Bilinear Transformation
8. Design a Butterworth Filter using Impulse Invariant Technique
9. Design a Chebyschev Filter using Bilinear Transformation
10. Obtain the impulse response of a given system
11. Application of DSP to speech signal processing

Experiments for Desired Course Outcomes (If any): Nil

Books/Material

T1. Vinay K. Ingle, John G. Proakis, Digital Signal Processing using MATLAB, Cengage Learning 2012

Reference Books

R1. L. Milic, Multirate Filtering for Digital Signal Processing: MATLAB Applications, Information Science Reference 2009

Course Code: ECL354
Course Title: Antenna Theory
Structure (L-T-P): 3 0 0
Prerequisite: ECL254

Course Objectives

After completing the course, student is expected to:

- Be proficient in the radiation phenomena associated with various types of antennas and understand basic terminology and concepts of antennas along with emphasis on their applications.
- Analyze radiation characteristics and designing techniques of different antenna structures and hence develop entrepreneurship skills.
- Analyze the real time applications of various modern antenna structures.
- Justify the propagation of the waves at different frequencies through different layers in the existing layered free space environment structure.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO.1. Analyses the radiation phenomena and need of antenna theory for wireless applications to promote sustainable employment in the RF field.

CO.2. Understand the basic concepts and characteristics of antennas and arrays in the transmit and receive mode.

CO.3. Analyze radiation characteristics and designing techniques of various planar and non-planar antenna structures for various applications.

Desirable/Advanced (If any): Nil

CO.1. Analyze the structure of the atmosphere for the wave propagation.

Syllabus for Essential Course Outcomes

Fundamental Concepts: Physical concept of radiation, retarded potentials, Hertzian dipole; Antenna parameters: Radiation pattern, gain, directivity, effective aperture, and reciprocity; Radiation from dipoles of arbitrary length. Introduction of various antenna structures: linear wire and loop antennas, aperture antennas, horn antennas, travelling wave and broadband antennas, broadband dipole antennas.

Planar antennas: Radiation from rectangular and circular patches, feeding techniques.

Antenna arrays: Arrays of point sources, End-fire and broadside Arrays, pattern multiplication, introduction of modern arrays including microstrip patch array.

Modern antenna structures:- reconfigurable antennas, ultra wideband antennas, meta material based antennas, dielectric resonator antennas, substrate integrated waveguide antennas, wearable textile antennas, smart antennas.

Application based antennas:- frequency allocations for various applications, antennas for mobile communication, satellite communication, navigation purposes, radar and remote sensing, Bluetooth antennas, Wi-Fi applications, automobile, defense, biomedical, Tera Hertz applications etc.

Contents for Desired Course Outcomes (If any):

Introduction to microwave communication and wave propagation.

Text Books:

T1. Balanis, C.A., Antenna *Theory and their applications*, 4th Ed., Indian Adaptation, John Wiley & Sons. 2021.

T2. Kraus, J.D. And Fleisch, D.A., *Electromagnetics with Applications*, McGraw-Hill. 1999.

T3. Jordan, E.C. and Balmain, K.G., *Electromagnetic Waves and Radiating Systems*, 2nd Ed., Prentice-Hall of India. 1993.

Reference Books:

R1. Stutzman, W.L. and Thiele, H.A., *Antenna Theory and Design*, 2nd Ed., John Wiley & Sons. 1998

R2. Elliot, R.S., *Antenna Theory and Design*, Revised edition, Wiley IEEE Press. 2003

R3. Garg, R., Bhartia, P., Bahl, I. and Ittipiboon, A., *Microstrip Antenna Design Handbook*, Artech House. 2001

Course Code: ECL355
Course Title: Digital Communication Systems
Structure (L-T-P): 3 0 0
Prerequisite: ECL253

Course Objectives

- This course presents the principles and techniques fundamental to the analysis and design of digital communication systems.
- It focuses on the basic building blocks of a digital communication system (channel encoder/decoder, digital modulator/demodulator and channel characteristics).
- The emphasis is on mathematical underpinnings of communications theory along with practical applications.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO.1. To apply knowledge of digital modulation techniques to the analysis and design of digital communication systems.
CO.2. Identify and formulate and solve engineering problems in the area of digital communication.
CO.3. Apply the theoretical concepts like random process, error probability, bit error rate, spread spectrum techniques and various digital modulation techniques to efficiently utilize the modern engineering tools such as MATLAB, necessary for engineering practice in the field of communication systems.
CO.4. Apply knowledge of spread spectrum and multiple access techniques to the analysis and design of digital communication systems.
CO.5. Analyze and design a digital communication system using source codin techniques or modulation processes to meet desired needs within realistic constraints.

Desirable/Advanced (If any):

CO.6. Analyze and design a digital communication system using different modulation processes to meet desired needs within realistic constraints.

Syllabus for Essential Course Outcomes

Introduction to digital communication systems: Principles of digital data transmission, Advantages and disadvantages of digital communication, Pulse Code Modulation, Line codes Source Coding of Analog Sources: PCM, DPCM, Delta modulation, Adaptive DM, ADPCM, Introduction to concept of probability, random variable and its characterization, probability density functions, transformations of random variables, statistical averages

Baseband data transmission systems, Error probability, ISI, pulse shaping, Nyquist criterion for Zero ISI, Scrambling. Signal Space Representation: Orthogonal expansion of signals, Gram-Schmidt Procedure, Representation of digitally modulated signals; Digital Transmission over the AWGN Channel.

Passband Transmission: Digital modulation schemes, ASK, FSK, PSK, QPSK, DPSK, GMSK,and QAM systems, Probability of error of each scheme, Matched filter receiver and its characteristics and Implementation, Signal space representation of digital modulation systems, Probability of error in digital modulation schemes under AWGN environment, Performance comparison of various digital modulation schemes. Continuous phase modulation,

Spread spectrum systems: direct sequence modulation and frequency hopping Case study — code division multiple access (CDMA); Multichannel and multicarrier systems: OFDM, Introduction to Information Theory, Channels, Channel Capacity, Shannon channel capacity theorem, Source coding techniques,

Contents for Desired Course Outcomes (If any): Nil

Text Books

T1. Haykin, S.S. and Moher, M., Introduction to Analog and Digital Communications, 2nd ed., Wiley, 2012.
T2. Lathi, B.P. and Ding, Z., Modern Digital and Analog Communication Systems, 4th ed., Oxford University Press, 2012

Reference Books

R1. Proakis, J.G. and Salehi, M., Digital Communications, 5th ed., McGraw Hill, 2010.
R2. Taub, H., Schilling, D.L. and Saha, G., Principles of Communication Systems, 2nd edition, Tata McGraw-Hill, 2008.
R3. M.S. Roden, Digital Communication System Design
R4. M. Rice, Digital Communications - A Discrete-Time Approach, Prentice-Hall, 2009.
R5. B. Sklar, Digital Communications: Fundamentals & Applications, 2nd ed., Prentice Hall, 2001.

Course Code: ECP355
Course Title: Digital Communication Systems Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL253, ECP253, ECL355

Course Objectives

This course presents the principles and techniques fundamental to the analysis and design of digital communication systems. It focuses on the basic building blocks of a digital communication system (channel encoder/decoder, digital modulator/demodulator and channel characteristics). The emphasis is to apply communications theory for practical applications.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO.1. Analyze PCM and Delta modulation using experiments.

CO.2. Analyze and compare digital modulation techniques practically.

CO.3. Implement NRZ and Manchester coding practically.

CO.4. Analyze and compare source coding techniques.

Desirable/Advanced (If any):

CO.5. Perform some additional experiments on some simulation software.

Experiments for Essential Course Outcomes

1. To verify the sampling theorem
2. To perform PCM signal generation and demodulation.
3. To perform DPCM signal generation and demodulation.
4. To perform DM signal generation and demodulation.
5. To perform ADM signal generation and demodulation.
6. To perform Amplitude Shift Keying (ASK) modulation and demodulation
7. To perform Binary-Frequency Shift Keying (B-FSK) modulation and demodulation.
8. To perform Binary-Phase Shift Keying (B-PSK) modulation.
9. To perform experiment on Manchester/RZ/NRZ coding and decoding
10. To perform TDM and de-multiplexing.
11. Implementation and analysis of QPSK modulation and demodulation.
12. To perform different source coding techniques using different programming methods.

Experiments for Desired Course Outcomes (If any)

1. To implement source encoding algorithms using simulations.

Books/Material

T1. Lab Manuals

T2. Haykin, S.S. and Moher, M., Introduction to Analog and Digital Communications 2nd ed., Wiley, 2012.

T3. Lathi, B.P. and Ding, Z., Modern Digital and Analog Communication Systems, 4th ed., Oxford University Press, 2012

Reference Books

R1. Proakis, J.G. and Salehi, M., Digital Communications, 5th ed., McGraw Hill, 2010.

R2. Taub, H., Schilling, D.L. and Saha, G., Principles of Communication Systems, 2nd edition, Tata McGraw-Hill, 2008.

R3. M.S. Roden, Digital Communication System Design

R4. M. Rice, Digital Communications - A Discrete-Time Approach, Prentice-Hall, 2009.

R5. B. Sklar, Digital Communications: Fundamentals & Applications, 2nd ed., Prentice Hall, 2001.

Course Code: ECL356

Course Title: Microwave Theory and Techniques

Structure (L-T-P): 3 0 0

Prerequisite: ECL254

Course Objectives

After completing the course, student is expected to:

- Foster knowledge about electromagnetic waves, transmission lines, their propagation and field patterns to promote sustainable development in high frequency and improvised skill set.
- Skillfully design different waveguide components, their characteristic measurement, hence develop employability skills in high frequency industries.
- Design and implement various microwave components to support entrepreneurship.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO.1. Describe microwave transmission modes and transmission lines.

CO.2. Analyze microwave networks and measure their measurement parameters.

CO.3. Analyze the working of various microwave devices.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Transmission line theory: Lumped element circuit model, field analysis, terminated lossless transmission line, smith chart, quarter wave transformer, generator and load mismatches, lossy transmission lines, transient analysis.

General solutions for TEM, TE and TM waves, parallel plate waveguide, rectangular waveguide, circular wave guide, coaxial line, surface waves on a ground dielectric sheet, stripline, microstripline, transverse resonant techniques, wave velocities and dispersion.

Microwave Network analysis: Equivalent voltages and currents, Impedance and Admittance matrices, scattering matrix, ABCD matrix, signal flow graphs, Excitation of waveguides. Matching with lumped elements, single stub matching, quarter wave transformer, theory of small reflections.

Microwave resonators: series parallel resonator circuits, transmission line resonators, rectangular and circular cavity resonators, excitation of resonators, cavity perturbations. Properties of power dividers and couplers, The T junction power divider, the Wilkinson power divider, wave guide directional couplers, the

quadrature hybrid, coupled line directional couplers, lange coupler, 180 degree hybrid.

Contents for Desired Course Outcomes (If any)
NIL

Text Books
T1. Pozar, D.M. *Microwave Engineering Theory and Techniques, Indian adaptation,* Wiley, 2020.
T2. Shevgaonkar, R.K., *Electromagnetic Waves,* 6th ed., Tata McGraw-Hill, 2011.

Reference Books
R1. Jordan, E.C. and Balmain, K.G., *Electromagnetic Waves and Radiating Systems*, 2nd ed., Prentice Hall of India, 2013.
R2. Collin, R.E. *Foundation of Microwave Engineering*. 2nd ed. Wiley India, 2012.

Course Code: ECP356
Course Title: Microwave Theory and Techniques Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL254, ECL356
Course Objectives
On completion of this lab course the students will be able to:
- Able to handle microwave equipment
- Able to understand the characteristics of microwave generators.
- Able to analyze the transmission line characteristics and parameters.
- Able to understand the characteristics of microwave devices and components through various parametric and power measurements.
- Able to understand Waveguide and antenna measurements.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO 1. Design test bench for measurement of various microwave parameters and microwave generators.
CO 2. Analyze various characteristics of microwave junctions and design of microwave communication links.
CO 3. Use a microwave test bench in analyzing various types of microwave equipment.
Desirable/Advanced (If any):
CO 4. To analyze the radiation pattern and gain of the various antennas.

Experiments for Essential Course Outcomes
1. Study of Microwave Components and Instruments
2. To verify the relationship between free space wavelength, Guide Wavelength and Cut- off wavelength.
3. To study the V-I characteristics of Gunn Diode.
4. To study the following characteristics of Gunn Diode.
5. Output power and frequency as a function of voltage.
6. To Study of the characteristics of klystron tube and to determine its electronic tuning range.
7. To determine the frequency & wavelength in a rectangular waveguide working on TE10 mode.
8. To determine the standing wave ratio and reflection coefficient.
9. To study the square law behavior of a microwave crystal detector.
10. To study the resonant cavity.
11. To study the variable attenuator.
12. To measure an unknown impedance with Smith Chart.
13. Study of attenuators (fixed and variable type).
14. Study of various Tee like E Plane Tee - H Plane Tee - Magic Tee.
15. Study the function of multi-hole directional coupler by measuring the following parameters.
16. Main line & Auxiliary line VSWR.
17. Coupling factor and directivity and Isolation.
18. Study of Scattering parameters of circulators/Isolator.
19. To study the phase shift measurements by using phase shifter
20. Study of Square wave modulation through Pin Diode.
21. To Measure the Dielectric constant.(Solid and liquid).

Experiments for Desired Course Outcomes (If any)
1. Study of wave guide horn and its radiation pattern and determination of the Beam width.
2. To measure the gain of a waveguide horn antenna.
3. Radiation pattern Measurement of Parabolic Dish Antenna.

Books/Material
T1. Lab Manuals
T2. Pozar, D.M. *Microwave Engineering Theory and Techniques, Indian adaptation,* Wiley, 2020

Reference Books
R1. Jordan, E.C. and Balmain, K.G., *Electromagnetic Waves and Radiating Systems*, 2nd ed., Prentice Hall of India, 2013.
R2. Collin, R.E. *Foundation of Microwave Engineering*. 2nd ed. Wiley India, 2012.
R3. Shushrut Das, Microwave Engineering, Oxford Higher Education, 2014

Course Code: ECL359
Course Title: Microprocessor and Interfacing
Structure (L-T-P): 3 0 0
Prerequisite: ECL256, ECP256

Course Objectives
- After completing the course, student is expected to:

- To introduce students with the architecture and operation of typical and advanced microprocessors.
- To familiarize the students with the programming and interfacing of microprocessors.
- To provide strong foundation for designing real world applications using microprocessors.

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO.1. Assess and solve basic binary math operations using the microprocessor and explain the microprocessor's internal architecture and its operation within the area of manufacturing and performance.

CO.2. Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor.

CO.3. Compare and Analyze assembly language programs; select appropriate assemble into machine a cross assembler utility of a microprocessor.

CO.4. Design electrical circuitry to the Microprocessor I/O ports in order to interface the processor to external devices that will provide solutions real-world control problems.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Microprocessor based personal computer system, Von Neumann and Harvard architecture. Brief History of Microprocessors. RISC and CISC Architectures.

Intel 8085 Microprocessor: Architecture, Addressing Modes Instruction set, instruction types and formats; Instruction execution, instruction cycles, different types of machine cycles and timing diagram.

Intel 8086 Microprocessor: Programmer's model for 8086. Segmented memory operation. Instruction set of 8086.

Intel 8086/8088 Microprocessor — Architectures, Pin Diagrams and Timing Diagrams, addressing modes supported by 8086 instruction set. 8086/8088 Instruction Set, Assembly language programming.

Memory Basic Peripherals and their Interfacing, Special Purpose Programmable Peripheral Devices and Their Interfacing, Priority Interrupt controller 8259, Interfacing with 8255, RAM, ROM, keyboard etc.

Multimicroprocessor Systems, Introduction to 80286, 80386, and 80486—The 32-Bit Processors, Recent Advances in Microprocessor Architectures—A Journey from Pentium Onwards.

Contents for Desired Course Outcomes (If any): Nil

Text Books

T1. Gaonkar, R. Microprocessor Architecture, Programming and Applications with the 8085. 5th ed., Penram International Publishing, 2011.

T2. K M. Bhurchandi and A. K. Ray, Advanced Microprocessor and Peripherals, 3rd Edition, 2012.

Reference Books

R1. Predko, M. Programming and Customizing the 8051 Microcontroller. McGraw Hill, 1999.

R2. Hall, D.V. Microprocessors & Interfacing. 3rd ed. Tata McGraw-Hill, 2012

Course Code: ECP359
Course Title: Microprocessor and Interfacing Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL256, ECP256, ECL359

Course Objectives

- To provide skills for designing flowcharts and writing algorithms
- To provide skills for writing Embedded programs
- To enable the students to debug programs

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO.1. Write algorithms and programming task involved for a given problem

CO.2. Design and develop modular programming skills

CO.3. Trace and debug a program.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

1. Write a program using 8085 Microprocessor for Decimal, Hexadecimal addition and subtraction of two Numbers.
2. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers.
3. To perform multiplication and division of two 8 bit numbers using 8085.
4. To find the largest and smallest number in an array of data using 8085 instruction set.
5. To write a program to arrange an array of data in ascending and descending order.
6. To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8085 instruction set.
7. To write a program to initiate 8255 and to check the data transfer using it.
8. To interface 8253 programmable interval timer to 8085 and verify the operation of 8253 in six different modes.

Contents for Desired Course Outcomes (If any): Nil

Text Books

T1. Gaonkar, R. Microprocessor Architecture, Programming and Applications with the 8085.

T2. 5th ed., Penram International Publishing, 2011.

Reference Books

R1. Hall, D.V. Microprocessors & Interfacing. 3rd ed. Tata McGraw-Hill, 2012

Course Code: ECL360
Course Title: Optical Communication Systems
Structure (L-T-P): 3 0 0
Prerequisite: ECL253, ECP253, ECL355

Course Objectives

After completing the course, student is expected to:

- Understand the need of optical communication systems.
- Compare the different types of optical fibers, and losses within fiber
- Learn optical power launching and coupling schemes.
- Analyze different optical sources and detectors.
- Apply the analog & digital modulation schemes to design Optical communication system

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Design test bench for measurement of various optical parameters of optical communication link
CO 2. Classify the structures of Optical fiber and its types.
CO 3. Analyze various coupling losses of optical communication systems.
CO 4. Compare different Optical sources and detectors.
CO 5. Design an efficient fiber optic system.

~~Desirable~~/Advanced (If any):

CO 6. To analyze the characteristics of optical fiber, sources and detectors, design as well as conduct experiments in software and hardware, analyze the results to provide valid conclusions.

Syllabus for Essential Course Outcomes

Overview of optical fiber communication- The general system, advantages of optical fiber communications. Optical fiber waveguides- Introduction, Ray theory transmission, Optical fiber Modes and configuration, Mode theory for circular Waveguides, Step Index fibers, Graded Index fibers. Single mode fibers- Cut off wavelength, Mode Field Diameter, Effective Refractive Index. Fiber Material and its Fabrication Techniques
Signal distortion in optical fibers- Attenuation, Absorption, Scattering and Bending losses, Core and Cladding losses. Information capacity determination, Group delay, Attenuation Measurements Techniques, Types of Dispersion - Material dispersion, Wave-guide dispersion, Polarization mode dispersion, Intermodal dispersion. Pulse broadening. Overall fiber dispersion in Multi mode and Single mode fibers, Special Fibers, Fiber dispersion measurement techniques, Optical fiber Connectors: Joints, Couplers and Isolators.
Optical sources- LEDs, Structures, Materials, Quantum efficiency, Power, Modulation, Power bandwidth product. Laser Diodes- Basic concepts, Classifications, Semiconductor injection Laser: Modes, Threshold conditions, External quantum efficiency, Laser diode rate equations, resonant frequencies, reliability of LED & ILD
Optical detectors- Physical principles of PIN and APD, Detector response time, Temperature effect on Avalanche gain, Comparison of Photo detectors.
Design considerations of fiber optic systems: Analog and digital modulation, Optical receiver operation, Power Budget and Rise time Budget analysis, Introduction to Integrated Photonics

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1. Senior, John M. Optical Fiber Communication. 3rd ed. Pearson Education 2009.
T2. Keiser, G. Optical Fiber Communications .4th ed. TMH, 2013.

Reference Books:

R1. Agrawal, G. P. Fiber Optic Communication Systems.4th ed. Wiley, 2010.
R2. Ramaswami R., Sivarajan K. N. Optical Networks. 3rd ed. Elsevier, 2010.
R3. Fiber Optic Communications, Harold B Killen, Prentice hall, 1991.

Course Code: ECP360
Course Title: Optical Communication Lab
Structure (L-T-P): 0-0-2
Prerequisite: NIL

Course Objectives

After completing the course, student is expected to:

- Learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
- Understand the different kinds of losses, signal distortion, SM fibers.
- Analyze the various optical sources, materials and fiber splicing
- Analyze fiber optical receivers and noise performance in photo detectors.
- Design link budget, WDM

Course Outcomes

At the end of the course, students will be able to-

Essential:

CO 1. Apply the Knowledge of optical devices to design a simple optical communication link.
CO 2. Identify, describe and analyze the most important devices like light sources, fibers and detectors from both physical and system point of view.

CO 3. Perform measurements of numerical aperture and fiber losses.
CO 4. Apply knowledge about the measurements done at THz frequencies to conduct experiments.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. Setting up a fiber optic digital link.
2. To study the coupling of laser to fiber and measuring the coupling efficiency.
3. To measure fiber losses.
4. Calculation and Measurement of numerical aperture of the fiber.
5. Voltage vs. current (V-I) characteristics of laser diode
6. Voltage vs. current (V-I) characteristics of LED.
7. Characteristics of photodiodes and measure the responsivity.
8. Characteristics of avalanche photodiodes [APD] and measure the responsivity.
9. To perform wavelength division multiplexing /demultiplexing
10. Study of VI and PI Characteristics of LASERS. (1310nm and 1550nm)
11. To design a basic optical fiber communication system using Opti-System software

Experiments for Desired Course Outcomes (If any)
1. Performing experiments using Opti-System simulation software.

Books/Material
T1. Lab Manuals
T2. Senior, John M. Optical Fiber Communication. 3rd ed. Pearson Education 2009.

Reference Books:
R1. Keiser, G. Optical Fiber Communications .4th ed. TMH, 2013.
R2. Agrawal, G. P. Fiber Optic Communication Systems.4th ed. Wiley, 2010.
R3. Ramaswami R., Sivarajan K. N. Optical Networks. 3rd ed. Elsevier, 2010.
R4. Fiber Optic Communications, Harold B Killen, Prentice hall, 1991.
R5. Fiber Optics Communications, Harold B Kolimbiris, United states Edition, Pearson Educational International.

Course Code: ECP361
Course Title: Electronics Workshop and Tinkering Lab
Structure (L-T-P): 0-0-4
Prerequisite: NIL

Course Objectives
After completing the course, student is expected to:

- To make the students familiar to various electronic measuring instruments, devices and using them for developing applications.

Course Outcomes
At the end of the course, students will be able to-
Essential:
CO.1. Use CRO, DSO, Function Generator, Spectrum Analyzer and other measuring instruments.
CO.2. Design PCB on a PCB prototype Machine.
CO.3. Perform soldering operation
CO.4. Design useful projects.

Desirable/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1. Familiarization to CRO and DSO
2. Familiarization to Spectrum Analyzer, Digital Multimeter and LCR meter.
3. Familiarization to Power supply and Function generator.
4. Identification of basic electronic components, resistor color codes, and ICs
5. Understand the working of a PCB prototype machine
6. Design PCB layouts and generate supporting files for working on a PCB prototype machine.
7. Using multimeter to test the diode and transistor
8. Programming a microcontroller
9. Design a Working project 1
10. Design a Working Project 2

Experiments for Desired Course Outcomes (If any): Nil

Books/Material
T1. K. A. Navas, "Electronics Lab Manual", Volume I, PHI, 5th Edition, 2015

Reference Books
R1. T.K Hemingway, "Electronic Designer's Handbook", Business Books Limited.

Course Code: ECL462
Course Title: Electronics System Design
Structure (L-T-P): 3 0 0
Prerequisite: ECL151, ECP151

Course Objectives

- The objective of the course is to provide students with a comprehensive understanding of the design principles and techniques involved in developing power supply systems, amplifiers, oscillators, and filters. Through theoretical concepts and practical applications, the course aims to equip students with the necessary knowledge and skills to design and analyze various components of power supply systems and amplifiers and filters, ensuring their proper functioning and performance.

- **Course Outcomes**

At the end of the course, students will be able to-

Essential:

CO.1. Analyze and design unregulated DC power supply systems with rectifiers and filters, ensuring stable and smooth output voltages.

CO.2. Develop and design switch-mode power supplies (SMPS) with step-up and step-down capabilities, considering efficiency and voltage regulation.

CO.3. Design class A and class AB audio power amplifiers with appropriate driver circuits, considering power requirements and fidelity.

CO.4. Evaluate the figure of merit for various oscillator circuits, considering factors like frequency stability, distortion, and signal purity.

CO.5. Design Butterworth and Chebyshev filters using voltage-controlled voltage sources (VCVS) and inverting-gain multiple feedback (IGMF) configurations for achieving desired frequency response characteristics.

~~Desirable~~/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Design of Power supply system: Unregulated D.C.. power supply system with rectifiers and filters. Design of emitter follower regulator, series regulators, overload protection circuits for regulators. Design of SMPS: Step up and step down.

Design of class A small signal amplifiers: Emitter follower, Darlington pair amplifiers with and without Bootstrapping, Two stage direct coupled amplifier. Design of class A, Class AB audio power amplifier with drivers.

Design of sinusoidal oscillators: OPAMP based Wein bridge and Phase Shift oscillators with AGC circuits, Transistor based Hartley, Colpits and Crystal oscillators, Evaluation of figure of merit for all above oscillator circuits.

Design of constant current sources, Design of function generators, Design of tuned amplifiers. Design of Butterworth, Chebyshev filters upto sixth order with VCVS and IGMF configuration.

Contents for Desired Course Outcomes (If any): NIL

Text Books:

T1. Regulated Power supply Handbook. Texas Instruments.

T2. Electronics : BJT's, FETS and Microcircuits – Anielo.

T3. Monograph on Electronic circuit Design : Goyal & Khetan.

Reference Books:

R1. Kim R. Fowler, Electronic Instrument Design, Oxford University Press.

R2. Henry W. Ott, Noise Reduction Techniques in Electronic Systems, Wiley Publications.

R3. John F. Wakerly, Digital Design Principles and Practices, Prentice-Hall International.

R4. Robert F. Coughlin, Operational Amplifiers and Linear Integrated Circuits, Prentice-Hall.

R5. Walter C. Bosshart, Printed Circuit Boards-Design and Technology, TMH.

Course Code: ECP462
Course Title: Electronics System Design Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL151, ECP151, ECL462

Course Objectives

- The objective of the course is to provide students with a comprehensive understanding of the design principles and techniques involved in developing power supply systems, amplifiers, oscillators, and filters.
- Through theoretical concepts and practical applications, the course aims to equip students with the necessary knowledge and skills to design and analyze various components of power supply systems and amplifiers and filters, ensuring their proper functioning and performance.

Course Outcomes

Essential:

CO.1. To understand the principles and techniques involved in designing unregulated DC power supply systems using rectifiers and filters.

CO.2. Able to develop an understanding of the design and simulation of switch-mode power supplies (SMPS), including step-up and step-down configurations, while evaluating efficiency, voltage regulation, and transient response.

CO.3. Able to design two-stage direct-coupled amplifiers, and sinusoidal oscillators.

CO.4. Develop the skills to design and build function generators capable of generating square, triangle, and sine waveforms, and evaluate their frequency range, amplitude control, and waveform quality.

CO.5. Able to design and simulate Butterworth and Chebyshev filters up to the sixth order using VCVS and IGMF configurations, and measure and compare their frequency response, gain, and filter characteristics.

~~Desirable~~/Advanced (If any): Nil

Experiments for Essential Course Outcomes

1) Unregulated DC Power Supply System

a. Design and construct an unregulated DC power supply system using rectifiers and filters.

b. Measure and analyze the output voltage waveform under different load conditions.

c. Evaluate the ripple voltage and its effect on the system performance.

2) Emitter Follower Regulator

a. Design and build an emitter follower regulator circuit.
b. Measure and analyze the output voltage regulation characteristics.
c. Investigate the effect of varying input voltage and load conditions on the regulator performance.

3) Series Regulator and Overload Protection Circuit
a. Design and implement a series regulator circuit with overload protection.
b. Analyze the voltage regulation and the response of the overload protection circuit.
c. Test the circuit's performance under different load conditions and evaluate its effectiveness.

4) Design of Switch-Mode Power Supplies (SMPS)
a. Design and simulate a step-up and a step-down switch-mode power supply (SMPS).
b. Analyze the efficiency, voltage regulation, and transient response of the SMPS circuits.
c. Compare the performance of the step-up and step-down configurations.

5) Design of Class A Small Signal Amplifiers
a. Construct and analyze an emitter follower amplifier circuit.
b. Build a Darlington pair amplifier circuit with and without bootstrapping.
c. Measure and compare the gain, frequency response, and distortion characteristics of the amplifiers.

6) Two-Stage Direct-Coupled Amplifier
a. Design and assemble a two-stage direct-coupled amplifier.
b. Measure and analyze the voltage gain, frequency response, and distortion characteristics.
c. Evaluate the overall performance of the amplifier circuit.

7) Design of Class A and Class AB Audio Power Amplifiers
a. Design and construct a class A audio power amplifier with appropriate driver circuits.
b. Design and build a class AB audio power amplifier with drivers.
c. Measure and compare the power output, efficiency, and distortion characteristics of both amplifiers.

8) Design of Sinusoidal Oscillators
a. Design and implement an OPAMP-based Wein bridge oscillator with AGC circuits.
b. Build transistor-based Hartley, Colpitts, and Crystal oscillators.
c. Evaluate the frequency stability, distortion, and figure of merit for each oscillator circuit.

9) Design of Constant Current Sources
a. Design and construct a constant current source for biasing amplifier circuits.
b. Analyze the stability and accuracy of the current source under different load conditions.

10) Design of Function Generators
a. Design and build a function generator capable of generating square, triangle, and sine waveforms.
b. Measure and analyze the frequency range, amplitude control, and waveform quality of the function generator.

11) Design of Tuned Amplifiers
a. Design tuned amplifiers for selective frequency amplification.
b. Measure and analyze the frequency response, gain, and bandwidth of the tuned amplifiers.

12) Design of Butterworth and Chebyshev Filters
a. Design and simulate Butterworth and Chebyshev filters up to the sixth order.
b. Implement the filters using VCVS and IGMF configurations.
c. Measure and compare the frequency response, gain, and filter characteristics of the designed filters.

Contents for Desired Course Outcomes (If any): NIL

Text Books:
T1. Regulated Power supply Handbook. Texas Instruments.
T2. Electronics : BJT's, FETS and Microcircuits – Anielo.
T3. Monograph on Electronic circuit Design : Goyal & Khetan.

Course Code: ECL466
Course Title: Finite Automata
Structure (L-T-P): 3 0 0
Prerequisite: ECL256, ECP256

Course Objectives
Course should provide a formal connection between algorithmic problem solving and the theory of languages and automata and develop them into a mathematical (and less magical) view towards algorithmic design and in general computation itself. The course should in addition clarify the practical view towards the applications of these ideas in the engineering part of CS.

Course Outcomes
Essential:
CO 1. Model, compare and analyse different computational models using combinatorial methods.
CO 2. Apply rigorously formal mathematical methods to prove properties of languages, grammars and automata.
CO 3. Construct algorithms for different problems and argue formally about correctness on different restricted machine models of computation.
CO 4. Identify limitations of some computational models and possible methods of proving them.
CO 5. Have an overview of how the theoretical study in this course is applicable to and engineering application like designing the compilers.

Syllabus for Essential Course Outcomes

Brief review of combinational and sequential circuit design and optimization, functional decomposition and symmetric functions, identification of symmetric functions.
Threshold logic, synthesis of threshold networks. Fault detection in combinational circuits, Boolean differences and Path sensitization.
Synchronous sequential circuits and iterative networks, memory elements and their excitation functions, synthesis of synchronous sequential circuits, Moore and Mealy machines,
Applications to controller design, finite state machine flow charts, tables, ASM charts. Machine minimization, Asynchronous Sequential circuits, synthesis, state assignment, minimization.

Contents for Desired Course Outcomes (If any): NIL.

Text Books

T1. Kohavi, Z. and Jha, N. K. *Switching and Finite Automata Theory*, 3rd ed. Cambridge University Press, 2013
T2. Shevgaonkar, R.K., Electromagnetic Waves, 6th ed., Tata McGraw-Hill, 2011.
T3. S.Y. Liao, Microwave Devices and Circuits, 4th edition, Pearson education.

Reference Books

R1. Kohavi, Z. Switching and Finite Automata Theory, 2nd ed. Tata McGraw Hill, 1978.
R2. Taub, H. *Digital Circuits and Microprocessors*. McGraw Hill, 1986.
R3. Mano, M.M. *Digital Logic and Computer Design*. Pearson, 2011.
R4. Lee, S.C. *Modern Switching Theory and Digital Design*. Prentice-Hall, 1978.

Course Code: ECL467
Course Title: Radio Frequency & Microwave Engineering
Structure (L-T-P): 3 0 0
Prerequisite: ECL254, ECL354

Course Objectives

After completing the course, student is expected to:

- Understand the need of radio frequency and microwave engineering through basic and advanced electromagnetic theory.
- Analyze the importance of microwave signal, learn important microwave devices and classify problems related to the communication systems and the prospects of entrepreneurship;
- Analyze the operation of different microwave generators at high microwave frequency.
- Outline the recent trends in advanced microwave communication for future industry applications.

Course Outcomes

At the end of the course, students will be able to-
Essential:

CO 1. Know about the microwave frequencies and the transmission lines that are used in communication.
CO 2. Assess qualitatively and quantitatively the role of microwave in the application areas of wireless communication.
CO 3. Understand the operation and working of the various tubes or sources for the transmission of the microwave frequencies.

Desirable/Advanced (If any):

CO.4 Analyze the recent trends and techniques pertaining to microwave engineering.

Syllabus for Essential Course Outcomes

Introduction: Microwave frequency bands, microwave engineering applications.
Overview of fundamentals of electromagnetic theory: Maxwell Equations, Poynting's theorem, uniform plane waves, electromagnetic waves and propagation medium, concept of good conductors and dielectrics, concept of wave transmission through wired transmission lines, overview of microwave radiation and microwave antenna theory.
Microwave communication: Friis formula, link budget and margin, radio receiver architecture, microwave propagation, introduction to radar systems, satellite systems, mobile communication system.
Microwave solid state generators: operation, characteristics and application of BJTs and FETs - Principles of tunnel diodes-Varactor, Step recovery diodes, Gunn diode-Avalanche Transit time devices-IMPATT and TRAPATT devices. Parametric devices-Principles of operation- applications of parametric amplifier.
Microwave Tubes:- Classifications:- O type and M type, klystrons, Reflex Klystrons, Travelling wave tube, magnetron.
Contents for Desired Course Outcomes (If any)
Recent Trends:- Microwave monolithic integrated circuit (MMIC) - Materials and fabrication techniques and others.

Text Books

T1. Pozar, D.M. Microwave Engineering Theory and Techniques, Indian adaptation, Wiley, 2020.
T2. Shevgaonkar, R.K., Electromagnetic Waves, 6th ed., Tata McGraw-Hill, 2011.
T3. S.Y. Liao, Microwave Devices and Circuits, 4th edition, Pearson education.

Reference Books

R1. Jordan, E.C. and Balmain, K.G., Electromagnetic Waves and Radiating Systems, 2nd ed., Prentice Hall of India, 2013.
R2. Collin, R.E. Foundation of Microwave Engineering. 2nd ed. Wiley India, 2012.
R3. K. T Mathew, Microwave Engineering, Wiley India, 2012

R4. Sushrut Das, Microwave Engineering, Oxford Higher Education, 2014.

Course Code: ECL468
Course Title: Embedded Systems Design
Structure (L-T-P): 3 0 0
Prerequisite: ECL359, ECP359

Course Objectives

- The objective of this course is to provide a comprehensive introduction to the field of embedded systems, focusing on the fundamental concepts, design principles, and practical applications. Students will learn about the integration of hardware and software in embedded systems, including microcontrollers, and real-time operating systems.
- The course will cover topics such as embedded system architecture, programming, interfacing, and system integration. Students will gain hands-on experience through lab exercises and projects involving embedded system development and programming.

Course Outcomes
Essential:

CO 1. Introduce students to the fundamental concepts and components of embedded systems.
CO 2. Familiarize students with microcontrollers used in embedded systems.
CO 3. Enhance students' ability to interface and integrate hardware and software in embedded systems.
CO 4. Design an embedded system considering the trade-off between designing functionality in hardware versus software.
CO 5. Perform design analysis and modular implementation for a complete system.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Microcontroller family: Architecture, basic assembly language programming concepts, The program Counter and ROM Spaces in the 8051, Data types, 8051 Flag Bits ad PSW Register, 8051
Register Banks and Stack Instruction set, Loop and jump instructions, Call Instructions, Time delay generations and calculations, I/O port programming Addressing Modes, accessing memory using various addressing modes, Arithmetic instructions and programs, Logical instructions, BCD and ASCII application programs, Single-bit instruction programming, Reading input pins vs. port Latch,
Programming of 8051 Timers, Counter Programming. Communication with 8051: Basics of communication, Overview of RS-232, I2C Bus, UART, USB, 8051 connections to RS-232, 8051 serial communication programming, 8051 interrupts, Programming of timer interrupts, Programming of External hardware interrupts, Programming of the serial communication interrupts, interrupt priority in the 8051
Interfacing with 8051: Interfacing an LCD to the 8051, 8051interfacing to ADC, Sensors, Interfacing a Stepper Motor, 8051 interfacing to the keyboard, Interfacing a DAC to the 8051, 8255 Interfacing with 8031/51, 8051/31 interfacing to external memory
Contents for Desired Course Outcomes (If any): Nil

Text Books:

T1. Raj Kamal, —Embedded Systems‖, TMH, 2004.
T2. M.A. Mazidi and J.G. Mazidi, —The 8051 Microcontroller and Embedded Systems‖, PHI, 2004.

Reference Books:

R1. David E.Simon, —An Embedded Software Primer‖, Pearson Education, 1999.
R2. K.J. Ayala, —The 8051 Microcontroller‖, Penram International, 1991.
R3. Dr. Rajiv Kapadia, —8051 Microcontroller & Embedded Systems‖, Jaico Press

Course Code: ECP468
Course Title: Embedded Systems Design Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL359, ECP359, ECL468

Course Objectives

The objective of this course is to provide a comprehensive introduction to the field of embedded systems, focusing on the fundamental concepts, design principles, and practical applications. This practical course covers the fundamentals necessary to take up embedded software development and also students can dive in to the details of embedded software programming by running the applications.

Course Outcomes
Essential:

CO 1. Introduce students to the fundamental concepts and components of embedded systems.
CO 2. Familiarize students with microcontrollers used in embedded systems.
CO 3. Enhance students' ability to interface and integrate hardware and software in embedded systems.
CO 4. Design an embedded system considering the trade-off between designing functionality in hardware versus software.
CO 5. Perform design analysis and modular implementation for a complete system.

Syllabus for Essential Course Outcomes

1. Interfacing of D to A converter using 8051 microcontroller
2. Interfacing of A to D converter using 8051 microcontroller
3. Interfacing of DC motor using 8051 microcontroller

4. Arithmetic and Logical operations using 8051 Trainer Kit Average of N Numbers, Ascending order and Descending order, Palindrome checking
5. Interrupts programming using 8051 Trainer Kit
6. Interfacing Programming using 8051 Trainer Kit: DAC & ADC Interface ,Traffic Lights Interface, Hex Keypad Display, Controlling 8 LEDs using DIP switch, Elevator Interface, 7 Segment Display
7. Arithmetic and logical operations using ARM Trainer Kit: Fibonacci Series, G.C.D Numbers, 2 X 2 Matrix Addition
8. Interrupts Programming using ARM Trainer Kit
9. Interfacing Programs using ARM Trainer Kit: LCD Display, Buzzer, Temperature Sensor, UART, DC Motor

Contents for Desired Course Outcomes (If any)
NIL

Text Books:
T1. Lab Manual
T2. Raj Kamal, —Embedded Systems‖, TMH, 2004.
T3. M.A. Mazidi and J.G. Mazidi, —The 8051 Microcontroller and Embedded Systems‖, PHI, 2004.

Reference Books:

R1. David E.Simon, —An Embedded Software Primer‖, Pearson Education, 1999.
R2. K.J. Ayala, —The 8051 Microcontroller‖, Penram International, 1991.
R3. Dr. Rajiv Kapadia, —8051 Microcontroller & Embedded Systems‖, Jaico Press

Course Code: ECL470
Course Title: Wireless & Mobile Communications
Structure (L-T-P): 3 0 0
Prerequisite: ECL253, ECP253, ECL355, ECP355

Course Objectives
After completing the course, student is expected to:
- Explain the architecture, functioning, capabilities, evolution and applications of various wireless communication networks.
- Understand the concept of multiple access techniques and the cellular systems which are using these techniques.
- Evaluate design challenges, constraints and security issues associated with radio wave and cellular communication networks and standards..
- Foster knowledge about the recent trends in advanced wireless communication for future industry applications.

Course Outcomes
Essential:
CO 1. Discuss the cellular system design and technical challenges.
CO 2. Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling
CO 3. Demonstrate their understanding on functioning of wireless communication system and evolution of different wireless communication systems.
CO 4. Foster knowledge about radio wave communication and cellular communication systems.
CO 5. Analysis of Logical and Conditional methods for wireless communication systems and standards to provide solutions in terms of employability
Desirable/Advanced (If any):
CO 6. Introduction to future trends for wireless communication

Syllabus for Essential Course Outcomes
Introduction to Wireless Systems- Evolution of Wireless Communication Technologies, Modeling Wireless Channel, Wireless Fading Channel Model, Fading Channel Distribution, Rayleigh Fading Channel, Bit Error Rate (BER) Performance, Bit Error Rate (BER) of AWGN Channels, Performance in Fading wireless channels- Bit Error Rate of Rayleigh Fading Wireless Channel, Exact BER Expression for Rayleigh Fading Wireless Channel, Deep Fade Analysis of Wireless Communication, Principle of Diversity, Multiple Antenna Diversity, Maximal-Ratio Combining
Multiple Antenna Wireless Systems and Diversity- BER of Multiple Antenna Wireless Systems, Approximate BER for Multiple Antenna Wireless System, Examples for BER of Wireless Communication, Deep Fade in Multi Antenna Systems, Intuition for Deep Fade in Multi-Antenna System, Definition of Diversity Order
Wireless Channel Characterization Delay Spread and Doppler- Max Delay Spread, RMS Delay Spread, Delay Spread and Inter Symbol Interference, Coherence Bandwidth of Wireless Channel, Mobility and Doppler Effect in Wireless Channels, Impact of Doppler Effect on Wireless Channel
Principles of CDMA Wireless Communication- Introduction to Code Division Multiple Access (CDMA), Chip Time and Bandwidth Expansion in CDMA, Code Generation for CDMA, CDMA Codes: Properties of PN Sequences, BER of CDMA Systems
Principles of OFDM Wireless Communication-Capacity of MIMO Wireless Systems, SVD based MIMO Transmission, Orthogonal Frequency Division Multiplexing (OFDM), Transmission in Multicarrier Systems, FFT/IFFT Processing in OFDM, Cyclic Prefix in OFDM Systems, Schematic Representation of OFDM Transmitter and Receiver, BER Performance of OFDM Systems

Text Books
T1. T. S. Rappaport, “Wireless Communications: Principles and Practice”, second Edition, Pearson Education, 2009.
T2. A. Dornan, “The essential guide to wireless communications applications: from cellular systems to WiFi”, second Edition, Prentice Hall, 2002.

Reference Books

R1. W. Stallings, "Wireless communications and networking", Prentice Hall, 2002.
R2. Balanies, C.A., Antenna *Theory and their applications*, 4th Ed., Indian Adaptation, John Wiley & Sons. 2021.
R3. Aditya K Jagannathan, Principles of Modern Wireless Communication Systems Theory & Practice, Mcgraw Hill Education, 2015
R4. Misra, "Wireless Communications and Networks: 3G & Beyond", Tata McGraw-Hill, 2009.

Course Code: ECP470
Course Title: Wireless and Mobile Communication Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL253, ECP253, ECL355, ECP355, ECL470

Course Objectives

The objective of this course is to enable the student to understand the emerging technologies of wireless and mobile communications and simulate them. To develop an ability to compare recent technologies used for wireless communication

Course Outcomes

Essential:

CO 1. Apply the knowledge of cellular system design.
CO 2. Identify, describe and analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling.
CO 3. Perform experiments on the multiple access techniques.
CO 4. Perform experiments on Multiuser Systems, CDMA, and OFDM Concepts.

Desirable/Advanced (If any): NIL

Experiments for Essential Course Outcomes

1. To perform the generation of Pseudo Random Binary sequence and determine the chip rate using PN sequence.
2. To test the various AT commands on GSM Evaluation Kit for IMSI Information along with performing basic implementation of GSM based Mobile Phone Kit.
3. To study and perform basic implementation of CDMA (DSSS) on CDMA Evaluation Kit.
4. To study and implement TDM based experiments related to various modulation schemes on Evaluation Kit.
5. To study Spread Spectrum – DSSS Modulation & Demodulation on trainer kit.
6. Analyse the BER for the M-ary PSK Using MATLAB/Simulink for Rayleigh fading with AWGN.
7. To study Gaussian Minimum Shift Keying (GMSK) modulation technique.
8. To write and execute a MATLAB program to calculate the median path loss for the Okumura model for outdoor propagation.
9. To write a MATLAB program to calculate the median path loss for Hata model for outdoor propagation.
10. To determine bit error rate of modulated signal transmitted over Rayleigh fading channel.
11. To determine bit error rate of modulated signal transmitted over Rician fading channel.
12. Analysis of multipath signal reception with equalizer and without equalizer for different path delays.

Experiments for Desired Course Outcomes (If any)

1. Performance analysis of SISO and SIMO using equal gain combining method.
2. To Simulate OFDM and observe bit error rate for given signal to noise ratio.

Text Books:

T1. Lab Manuals
T2. Rappaport, T.S., Wireless Communication: Principles and Practices, 2nd ed., Pearson Education, 2013.

Reference Books:

R1. Mischa Schwartz, Mobile Communication, Cambridge, University Press, 2005.
R2. William Stallings, Wireless Communications and Networks. PHI, 2002.
R3. Feher, K., Wireless Digital Communication, Prentice Hall of India, 2011.
R4. Proakis, J.G. and Salehi, M., Digital Communications, 5th ed., McGraw Hill, 2010.
R5. Haykin, S., Digital Communication, Wiley India, 2012.
R6. Schiller, J., Mobile Communication, 2nd ed., Pearson Education, 2012.

Course Code: ECL471
Course Title: Radar and Satellite Communication Systems
Structure (L-T-P): 3 0 0
Prerequisite: ECL254, ECL354

Course Objectives

After completing the course, student is expected to:

- Understand the need of radio frequency and microwave engineering through basic and advanced electromagnetic theory.
- Understand the basic principle, characteristics and some of the important applications of radio frequency and microwave.
- Analyze the operation of different microwave generators at high microwave frequency.
- Foster knowledge about the recent trends in advanced microwave communication for future industry applications.

Course Outcomes

Essential:

CO 1. Analyze the importance of microwave signal, learn important microwave devices and classify problems related to the communication systems and the prospects of entrepreneurship;
CO 2. Estimate problems and the working principle of different RADAR systems and their applications;
CO 3. Demonstrate knowledge about the Satellite fundamentals and the types of satellite systems to provide solutions in terms of employability;
CO 4. Foster knowledge about working of a Satellite communication system and its other subsystems, highlighting the applications of satellites in different areas for development of skills.

Desirable/Advanced (If any):

CO 5. Designing the uplink and downlink link budget considering the specified CNR and various attenuations.

Syllabus for Essential Course Outcomes

Introduction to Radar, radar parameters: Introduction, block diagram, applications of radar systems, radar frequencies, basic pulsed radar system, system losses, range resolution, cross range resolution, Doppler resolution, pulse repetition frequency, radar accuracy.
Basic Radars:- Principal of operation of basic radar, radar range equation for monostatic and bistatic radar, pulsed radar, continuous wave radar, frequency modulated continuous wave radar, pulsed Doppler radar, surface search and navigation radar, moving target indicator, MST radar, synthetic aperture radar, phased array radar, laser radar.
Radar displays, fundamentals of radar navigation, introduction of radar antennas.
Satellite Communications: The Origin of satellite communications, brief history of satellite communications, advantages and disadvantages of current status of satellite communication, Satellite applications, Kepler's law, satellite orbits, satellite orbit patterns, classifications, spacing and frequency allocation of satellite, satellite antenna radiation, frequency reuse, satellite system parameters, link equations. Satellite Subsystems, Earth Station Technology. Inter-satellite communication.

Contents for Desired Course Outcomes (If any)

Satellite link design: design of Uplink and downlink link budgets.

Text Books

T1. M. I. Skolnik, "*Introduction to Radar Systems*", 3rd Ed., McGraw Hill, 2003. T2.
T2. T. Pratt "Satellite communications", 3rd edition, Indian adaptation, John Wiley and Sons (2021).

Reference Books

R1. G.S.N Raju., "*Radar Engineering and fundamentals of navigation aids",* John Wiley, 2020.
R2. E. Byron, "*Radar: Principles, Technology, Applications",* Prentice- Hall education, 2004.
R3. D. Barton, "Radar system analyses and Modeling", Artech house, 2005.
R4. M. Antonio, "Bistatic radar emerging technology", John Wiley, 2008.
R5. Dennis Roddy, "Satellite communications", McGraw-Hill international edition.

Course Code: ECL473
Course Title: FPGA based IC/System Design
Structure (L-T-P): 3 0 0
Prerequisite: ECL256, ECP256

Course Objectives

- The objective of this course is to provide students with a comprehensive understanding of Field-Programmable Gate Array (FPGA) technology and its application in Very Large Scale Integration (VLSI) design.
- Students will learn the fundamental concepts, design methodologies, and tools used in FPGA-based VLSI design, with a focus on designing digital circuits and systems using FPGA platforms.

Course Outcomes

Essential:

CO 1. Understand the fundamentals of FPGA-based VLSI design: Students will have a strong understanding of the basic concepts, principles, and techniques of FPGA-based VLSI design, including digital logic design, VHDL or Verilog programming, FPGA architecture, and synthesis.
CO 2. Design and implement complex digital systems on FPGAs: Students will be able to design, implement, and verify complex digital systems using FPGA tools and methodologies. This includes creating RTL (Register Transfer Level) designs using VHDL or Verilog, synthesizing the RTL code to generate a bitstream file, and programming the FPGA to implement the designed system.
CO 3. Optimize and debug FPGA-based designs: Students will learn techniques to optimize the performance and area utilization of FPGA-based designs. They will also acquire skills to debug and troubleshoot issues related to timing, routing, and functional correctness in FPGA designs.
CO 4. Design and implement FPGA-based projects: Students will be able to apply their knowledge and skills to design and implement FPGA-based projects, such as digital signal processing (DSP) systems, embedded systems, and system-on-chip (SoC) designs. They will be able to prototype and test their designs on FPGA development boards, and demonstrate their projects with real-world applications.

Desirable/Advanced (If any):

CO 5. Stay updated with the latest trends and advancements in FPGA-based VLSI design.

Syllabus for essential outcome

Different types of VLSI Design style, Modeling digital systems, Finite state machines: Basic concepts and design; Moore and Mealy machines examples; State minimization/reduction, state assignment; Finite state machine design case studies.

Hardware design environment, Design Flow, Hardware description languages, Various design styles. Introduction to Verilog, elements of Verilog, basic concepts in Verilog, simulation, synthesis. Dataflow modeling, Concurrent signal assignment, delays, Behavioral modeling, processes.

Design organization, Structural specification of hardware, parameterization, hierarchy, abstraction, configurations, utilities. Subprogram, packages, libraries, Basic I/O, Programming mechanics Synthesis, RTL description, constraints attributes, FPGA, CPLD structure, technology libraries.

Introduction to VHDL Programming. RTL based design projects and their implementation in FPGA using VHDL, Sequential circuit design examples in Verilog/VHDL and simulation, FSM circuit design examples in VHDL and simulation.

Contents for Desired Course Outcomes (If any)

Latest conferences and Journals related to the field.

Text Books

T1. Palnitkar, S. Verilog HDL: A guide to Digital Design and Synthesis. 2nd ed. Pearson, 2013.

Reference Books/Additional Books:

R1. Bhasker, J. A System Verilog Primer. 1st Indian ed. B.S. Publication, 2013.

R2. Navabi, Z. VHDL: Analysis and Modeling of Digital Systems. 2nd ed. McGraw Hill, 2000.

R3. Weste, N.H.E., Harris, D., and Banerjee, A CMOS VLSI Design: A Circuits and Systems Perspective. 3rd ed. Pearson Education, 2012.

R4. Pucknell, D.A. and Eshraghian, K. Basic VLSI Design. 3rd ed. PHI Learning Private Limited, 2011.

R5. Brown, S.D. and Vranesic, Z.G. Fundamentals of Digital Logic with VHDL/Verilog Design. 3rd ed. McGraw-Hill, 2009.

Course Code: ECP473
Course Title: FPGA based IC/System Design Lab
Structure (L-T-P): 0-0-2
Prerequisite: ECL256 , ECP256, ECL473

Course Objectives

- The objective of the Hardware Description Language Lab is to provide hands-on experience to students in designing, implementing, and testing digital circuits using Field-Programmable Gate Arrays (FPGAs) as a key technology in Very Large Scale Integration (VLSI) design.
- The lab aims to develop practical skills in FPGA-based design methodologies, tools, and techniques, and enable students to design and implement complex digital systems using FPGA platforms.

Course Outcomes

Essential:

CO 1. Understand the fundamentals of digital system design and the role of FPGAs in VLSI design.

CO 2. Select and utilize appropriate FPGA development tools, software, and hardware platforms for designing digital circuits.

CO 3. Implement digital circuits using Hardware Description Languages (HDL) such as VHDL or Verilog.

CO 4. Design, simulate, synthesize, and implement digital circuits on FPGA platforms using industry-standard design tools.

CO 5. Develop skills in designing and implementing advanced digital circuits such as arithmetic circuits, memory circuits, and complex control circuits using FPGAs.

Desirable/Advanced (If any):

CO 6. Apply the concepts and techniques learned in the lab to real-world applications and projects involving FPGA-based VLSI design.

Experiments for Essential Course Outcomes:

1. Introduction to FPGA Development Tools and Hardware Platforms: Familiarization with FPGA development tools such as Xilinx Vivado or Intel Quartus, and hardware platforms such as Xilinx FPGA boards or Intel FPGA boards. Understanding the basics of FPGA architectures, FPGA programming flows, and hardware description languages (HDL) like VHDL or Verilog.
2. Basic Digital Logic Design on FPGA: Implementing and testing basic digital logic circuits such as AND, OR, NOT gates, and their combinations on an FPGA platform. Understanding the concept of combinatorial and sequential logic.
3. Design of Arithmetic Circuits on FPGA: Designing, simulating, synthesizing, and implementing arithmetic circuits such as adders, multipliers, and dividers using FPGA platforms. Analyzing the performance parameters such as speed, area, and power consumption of the circuits.
4. Design of Memory Circuits on FPGA: Designing, simulating, synthesizing, and implementing memory circuits such as SRAM, DRAM, and ROM using FPGA platforms. Understanding the working principles, performance parameters, and trade-offs of different memory types.
5. Design of Complex Control Circuits on FPGA: Designing, simulating, synthesizing, and

implementing complex control circuits such as state machines, timers, and counters on an FPGA platform. Understanding the concept of synchronous and asynchronous design, and analyzing the performance parameters of these circuits.

6. Design of Finite State Machines (FSMs) on FPGA: Designing, simulating, synthesizing, and implementing finite state machines using FPGA platforms. Understanding the concept of FSMs, state encoding, state minimization, and state transition diagrams.
7. Design of Digital Signal Processing (DSP) Circuits on FPGA: Designing, simulating, synthesizing, and implementing digital signal processing circuits such as filters, FFT, and PID controllers on an FPGA platform. Analyzing the performance parameters such as signal quality, latency, and throughput of the DSP circuits.
8. Design of Custom IP Cores on FPGA: Designing, integrating, and testing custom Intellectual Property (IP) cores on FPGA platforms. Understanding the concept of IP cores, IP integration, and IP reuse in FPGA-based designs.
9. Design of System-Level Designs on FPGA: Designing, simulating, synthesizing, and implementing system-level designs involving multiple IP cores, interconnects, and peripherals on an FPGA platform. Analyzing the performance, power consumption, and resource utilization of the system-level designs.
10. Real-time Testing and Validation of FPGA Designs: Implementing real-time testing and validation of FPGA designs using input/output interfaces, sensors, actuators, and communication protocols on FPGA platforms. Analyzing the real-time performance, responsiveness, and reliability of the FPGA-based designs.

Experiments for Desired Course Outcomes (If any)

1. Project: Design and build a FPGA Based projects few examples are as follows-
2. Design of a custom processor or microcontroller on FPGA
3. Implementation of a digital communication system on FPGA
4. Design of a digital image processing system on FPGA
5. Development of a video processing or gaming application on FPGA
6. Design of a digital audio processing system on FPGA
7. Implementation of a cryptographic system or security application on FPGA
8. Design of a sensor interface or control system on FPGA
9. Implementation of a digital control or automation system on FPGA
10. Design of a data acquisition or processing system on FPGA
11. Development of a custom IP core or accelerator for a specific application on FPGA.

Text Books

T1. Palnitkar, S. Verilog HDL: A guide to Digital Design and Synthesis. 2nd ed. Pearson, 2013.

Reference Books/Additional Books:

R1. Bhasker, J. A System Verilog Primer. 1st Indian ed. B.S. Publication, 2013.
R2. Navabi, Z. VHDL: Analysis and Modeling of Digital Systems. 2nd ed. McGraw Hill, 2000.
R3. Weste, N.H.E., Harris, D., and Banerjee, A CMOS VLSI Design: A Circuits and Systems Perspective. 3rd ed. Pearson Education, 2012.
R4. Pucknell, D.A. and Eshraghian, K. Basic VLSI Design. 3rd ed. PHI Learning Private Limited, 2011.
R5. Brown, S.D. and Vranesic, Z.G. Fundamentals of Digital Logic with VHDL/Verilog Design. 3rd ed. McGraw-Hill, 2009.

Course Code: ECL474
Course Title: Data Communication and Networks
Structure (L-T-P): 3 0 0
Prerequisite: ECL253, ECP253, ECL355, ECP355

Course Objectives

- To introduce basic concepts of Data communication with different models. Enumerate the physical layer, Data Link Layer, Network Layer, Transport Layer and Application Layer, explanation of the function(s) of each layer. Understanding of switching concept and different types of switching techniques.

Course Outcomes

Essential:

CO 1. Apply knowledge of basic concepts of internet, OSI Model, TCP/IP model to the analysis and design of Data communication and networks.
CO 2. Understand and analyze the various techniques of error correction and detection,switching, switches and functions of the data link layer.
CO 3. Understand Multiple Access techniques like ALOHA, CDMA, CSMA/CD, CSMA/CA,Controlled Access, and Channelization in order to have sustainable development of data communication.
CO 4. Analyse routing algorithm, subnet masks and IP addresses to fulfill networking requirements.
CO 5. Use the concepts and modern engineering tools such as cryptography and network security for secure data communication system

Desirable/Advanced (If any):

CO 6. To analyse and design the recent trends adopted in data communication systems and wireless standards.

Syllabus for essential outcome

Overview of Data Communication and Networking: Data communications, Networks, The Internet, Protocols and standards, Layered tasks, OSI model, TCP/IP protocol Architecture.
Physical layer: Analog and digital, Analog signals, Digital signals, Analog versus digital, Data rate limit, Transmission impairments, Line coding, Block coding, Sampling, Transmission mode, Modulation of digital data, Telephone modems, Modulation of analog signal, FDM, WDM, TDM, Guided media, Unguided media, Circuit switching, Telephone networks, DSL technology, Cable modem, SONET
Data link layer: Types of errors, Detection, Error correction, Flow and error control, Stop and wait ARQ, go back n ARQ, Selective repeat ARQ, HDLC, Point to point protocol, PPP stack, Random access, Controlled access, Channelization, Traditional Ethernet, Fast Ethernet, Gigabit Ethernet, IEEE802.11, Bluetooth, Connecting devices, Backbone network, Virtual LAN, Cellular telephony, Satellite networks, Virtual circuit switching, Frame relay, ATM.
Network layer: Internetworks, Addressing, Routing, ARP, IP, ICMP, IPV6, Unicast routing, Unicast routing protocol, Multicast routing, Multicast routing protocols.
Transport layer: Process to process delivery, User datagram protocol (UDP), Transmission control protocol (TCP), Data traffic, Congestion, Congestion control, Quality of service, Techniques to improve QOS, Integrated services, Differentiated services, QOS in switched networks.
Application layer: Client server model, Socket interface, Name space, Domain name space, Distribution of name space, DNS in the internet, Resolution, DNS messages, DDNS, Encapsulation, Electronic mail, File transfer, HTTP, World wide web (WWW), Digitizing audio and video, Audio and video compression, Streaming stored audio/video, Streaming live audio/video, Real time interactive audio/video, Voice over IP.
Switching: Circuit Switching Networks, Concepts, Control Signaling, Soft switch Architecture, Packet switching, Packet size, X.25, Frame Relay, ATM, Message Switching.

Text Books:

T1. B. A. Forouzan, “Data Communications and Networking”, MGH, 4th ed. 2007
T2. S. Tanenbaum, “Computer Networks”, PHI.

Reference Books:

R1. W. Stallings, “Data and Computer Communication”, PHI.
R2. W. Tomasi, “Introduction to Data Communications and Networking”, Pearson Education.
R3. Williiam J Beyda, “Data Communications: from basics to broadband”, 4 th Ed Pearson Education.

Course Code: ECL475
Course Title: Information Theory Coding
Structure (L-T-P): 3 0 0
Prerequisite: ECL253, ECP253, ECL355, ECP355

Course Objectives

After completing the course, student is expected to:

- Apply information theory concepts for communication systems.
- Apply error control coding techniques to design efficient communication systems.
- Study various data compression methods and describe the most common such methods
- Apply the different source encoding techniques.
- Understand and apply different channel encoding techniques.

Course Outcomes

Essential:

CO 1. Quantify the notion of information, entropy, channel capacity in a mathematically sound way and understand its significance in the communications systems.
CO 2. Differentiate between lossy compression techniques and decide an efficient data compression scheme for a given information source.
CO 3. Differentiate between lossless compression techniques and decide an efficient data compression scheme for a given information source.
CO 4. Apply different channel coding techniques for error detection and correction schemes.
CO 5. Design communication systems with error control capabilities.

Desirable/Advanced (If any):

CO 6. Analyze and design a communication system using different error control capabilities to meet desired needs within realistic constraints.

Syllabus for Essential Course Outcomes

Information Theory and Source Coding: Introduction to Information Theory, Uncertainty and Information, Average Mutual Information and Entropy, Information Measures for Continuous Random Variables, Relative Entropy,
Source Coding Theorem, Huffman Coding, Shannon-Fano-Elias Coding, Arithmetic Coding, The Lempel-Ziv Algorithm, Run Length Encoding, Rate Distortion Function, Optimum Quantizer Design, Entropy Rate of a Stochastic Process
Channel capacity and coding: Channel Models, Channel Capacity, Channel Coding, Information Capacity Theorem, Parallel Gaussian Channels, The Shannon Limit, Channel Capacity for MIMO Systems, Capacity Region for Multiple Access Channel
Error control coding: Linear Block Codes for Error Correction, Cyclic Codes, Perfect Codes, Hamming Codes, Low Density Parity Check (LDPC) Codes, Cyclic codes,
Convolutional codes, Turbo codes, Trellis coded modulation, Coding for secure communication

Contents for Desired Course Outcomes (If any): Nil

Text Books:

T1. Haykin, S.S. and Moher, M., Introduction to Analog and Digital Communications, 2nd
T2. W.E Ryan and S Lin, Channel Codes-Classical and Modern, Cambridge University Press, 2009.
T3. R.W Yeung, Information Theory And Network Coding, Springer, 2008

Reference Books:

R1. F.J. MacWilliams and N.J.A Sloane, The Theory of Error-Correcting Codes, Elsevier Science, 1988.
R2. D Lun and T Ho, Network Coding - An Introduction, Cambridge University Press, 2008
R3. F.J. MacWilliams and N.J.A Sloane, The Theory of Error-Correcting Codes, Elsevier Science, 1988.
R4. D Lun and T Ho, Network Coding - An Introduction, Cambridge University Press, 2008

Course Code: ECL476
Course Title: Advanced Analog Circuits
Structure (L-T-P): 3 0 0
Prerequisite: ECL351, ECP351

Course Objectives

- To understand and analyze second order functions and design op-amp RC and active filters.
- To develop the ability to understand the applications of OTAs and switch capacitors in analog circuits.
- To apply the knowledge of switch capacitors and OTA in designing the filters, PLL and analog building blocks of communication system.
-

Course Outcomes

Essential:

CO.1. Students will be able to identify basic building blocks of OTA as well as its applications in analog multipliers.
CO.2. Students will be able to analyze and design op-amp RC and active filters, admittance converters and inverters, generalized impedance converter, inductance simulation, sinusoidal oscillators, amplitude stabilization and control using Operational Transconductance Amplifier (OTA).
CO.3. Students will gain understanding on voltage controlled filters, phase locked loop operational modes & voltage controlled oscillators.
CO.4. Students will be able to design, analyze and implement Switch Capacitor Filters for various applications.
CO.5. Students will gain an understanding of MOSFET-C filters and techniques used in non-linearity cancellation in MOS circuits.

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Review of Opamp, Basics second order functions, op-amp RC and active filter design, admittance converters and inverters, generalized impedance converter, inductance simulation,
Operational Transconductance Amplifier (OTA), Basic building blocks using OTA, Application examples, Operational Transconductance Amplifier (OTA), Basic building blocks using OTA, Application examples Analog Multiplier and its applications: Gilbert multiplier cell 2-quadrant and 4-quadrant operations.
Modulation, demodulation and frequency changing, voltage-controlled filters, phase locked loop, operational modes, voltage-controlled oscillators, IC PLL: basic PLL principle, three modes of operation, PLL as AM detector, FM detector, frequency synthesis, FM demodulator, PLL motor speed control and voltage to frequency converter, Frequency response of bilinear and second order transfer functions,
Filter approximation Functions: Butterworth, Chebyshev, Pole locations, Filter specifications, Comparison of maximally flat and equal ripple response Frequency Transformation: Low pass to High pass, Low pass to band pass, Low pass to band elimination, GIC and optimal design,
Switch capacitor using a MOSFET, SC integrator, Switch capacitor filter, filter, Generations of current Conveyers, MOSFET-C Filters and techniques of non-linearity cancellation in MOS circuit.

Text Books

T1. Rolf Schaumann and Mac E. Van Valkenberg, Design of Analog Filters, Oxford Indian Edition, 2008, CRC, 2ndEditionPrenticehall International (ISBN: 0849337739) 2008
T2. Analysis and Design of Analog Integrated Circuits by, Paul R.Gray/ Robert G.Meyer, Wiley, Third edition 2009

Reference Books/Additional Books:

R1. G. Daryanani, Principles of active network synthesis and design Wiley 2003.
R2. G. Ferri, N. C. Guerrini, Low-Voltage Low-Power CMOS Current Conveyors. Kluwer Academic Publishers 2003,
R3. Design with Operational Amplifiers and Analog Integrated Circuits by Sergio Franco, TMH.

Course Code: ECL477
Course Title: Intelligent Instrumentation
Structure (L-T-P): 3 0 0
Prerequisite: NIL

Course Objectives

After completing the course, student is expected to:

- Demonstrate an understanding of the novel category of Instrumentation Systems with integrated intelligent features and smart sensing technologies.

Course Outcomes

Essential:

CO 1. Classify sensors for various applications.

CO 2. Understand Linearization, calibration and compensation of sensors

CO 3. Apply Artificial Intelligence to sensor signals

CO 4. Work with interfacing protocols in wireless networking platform

Desirable/Advanced (If any): Nil

Syllabus for Essential Course Outcomes

Introduction: Intelligent instrumentation, definition, types of instruments, static and dynamic characteristics of instruments, Historical Perspective, Current status, software based instruments.

Intelligent Sensors: Classification, Smart sensors , Monolithic Integrated Smart Sensors, Hybrid Integrated Smart Sensors, Cogent Sensors, Soft or Virtual sensors, self-adaptive, self-validating sensors, Soft Sensor Secondary Variable Selection, Rough Set Theory , Model Structures. Self-Adaptive Sensors, Self-Validating Sensors, VLSI Sensors, Temperature Compensating Intelligent Sensors, Pressure Sensor.

Linearization, Calibration, and Compensation: Analog Linearization of Positive and Negative Coefficient Resistive Sensors. Higher-Order Linearization , Quadratic Linearization , Third Order Linearization Circuit, Nonlinear ADC- and Amplifier-Based Linearization, Interpolation, Piecewise Linearization, Microcontroller-Based Linearization, Lookup Table Method, Artificial Neural Network–Based Linearization, Nonlinear Adaptive Filter–Based Linearization, Sensor Calibration, Conventional Calibration Circuits , Offset Compensation, Error and Drift Compensation, Lead Wire Compensation.

Sensors with Artificial Intelligence: Artificial Intelligence, Sensors with Artificial Intelligence, Multidimensional Intelligent Sensors, AI for Prognostic Instrumentation, ANN-Based Intelligent Sensors, Fuzzy Logic–Based Intelligent Sensors.

Intelligent Sensor Standards and Protocols: IEEE 1451 Standard, STIM, TEDS, NCAP, Network Technologies, Lon Talk, CEBUS, J1850 Bus, 1 Signal Logic and Format, MI Bus, Plugn-Play Smart Sensor Protocol

Contents for Desired Course Outcomes (If any): Nil

Text Books

T1. Manabendra Bhuyan, ―Intelligent Instrumentation: Principles and Applications‖ CRC Press, 2011.

Reference Books

R1. R1. G. C. Barney, ―Intelligent Instrumentation‖, Prentice Hall, 1995