Course Syllabi
Department of Computer Science and Engineering

CSL101 COMPUTER PROGRAMMING (3-0-2-4)

Pre-requisite: NIL

Contents:

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, tree structure of storage, 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. Basic programming algorithms: Programs to illustrate basic language constructs in C like - Factorial, Sine/cosine and other mathematical series, Fibonacci series, calculating square-root of a number, calculating GCD of 2 integers (Euclid's method and otherwise), Calculating LCM of 2 integers and similar such programs.

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. Introduction to "Divide and Conquer" via Mergesort and Quicksort.

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.

Practical: Practicals as per course contents.

Text Books:

1. Kerninghan, B.W. and Ritchie, D.M., The C Programming Language, 2nd ed., PHI, Delhi, 2012.
2. 2. Balguruswamy, E., Programming in ANSI C, 6th ed., Tata McGraw Hill, New Delhi, 2013.

Additional Books:

1. Deshpande, P.S. and Kakde, O.G., C and Data Structures, Dreamtech Press, New Delhi, 2009.
2. Dromey, R.G., How to Solve it by Computer, Pearson Education, Delhi, 2008.
3. Gottfried, B.S., Schaum's Outline of Theory and Problems of Programing with C, 2nd ed., McGraw Hill, New York, 2007.

CSL201 DATA STRUCTURES AND PROGRAM DESIGN (3-0-2-4)

Pre-requisite: NIL

Contents:

Types and operations, Iterative constructs and loop invariants, Structured programming and modular design, Illustrative examples, recursion, program stack and function invocations including recursion. Overview of arrays and array based algorithms - searching and sorting, Overview of Selection sort, bubble sort and insertion-sort, Divide and Conquer – Merge sort, Quicksort, Binary search, Introduction to Program complexity (Big Oh notation), Recurrence relations. Sparse matrices. Introduction to pointers, scope rules, parameter passing mechanisms – pass by value and pass-by-reference. Structures (Records) and array of structures (records). Database implementation using array of records.Dynamic memory allocation and de allocation.Dynamically allocated single and multi-dimensional arrays. Files, operations on them, examples of using file. Stack, Queues and its operations. Concept of an Abstract Data Type (ADT), Implementation of stacks and queues using both array-based and pointer-based structures.Uses of stacks in simulating recursive procedures/ functions.Applications of stacks and queues. 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, list-reversal etc. Merge sort for linked lists. 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 , binary trees, binary trees- basic algorithms and various traversals. Binary Search Trees (BSTs) and insertion, deletion in BSTs.Height-balanced (AVL) trees, insertion/deletion and rotations. Heaps and heap sort. Multi-way trees and external sorting – Introduction to B-trees and B+trees. Tries. Applications of the above mentioned trees. Generalisation of trees to graphs – Introduction to DFS, BFS and Topological sort.

Practical: Practicals as per course contents.

Text Books:

1. Kruse, R.L., Tondo, C. L. and Leung, B.P., Data Structures and Program Design in C, 2nd ed., Pearson Education, Delhi, India, 2013.
2. Horowitz, E., Sahni, S. and Anderson-Freed, S., Fundamentals of Data Structures in C, 2nd ed., University Press, Hyderabad, 2012.

Additional Books:

1. Kerninghan, B.W. and Ritchie, D.M., The C Programming Language, 2nd ed., PHI, Delhi, 2012.
2. Dromey, R.G., How to Solve it by Computer, Pearson Education, Delhi, 2008.

CSL202 COMPUTER ORGANIZATION (3-2-0-4)

Pre-requisite: NIL

Contents:

Addressing methods, their application in implementation of HLL constructs and data structures, instruction formats, expanding op-code method, subroutine linkage. Instruction sets of ARM, Intel and Motorola Processors. Processing unit, bus architecture, execution of a complete instruction, sequencing of control signals, micro programmed control, microinstruction format, microinstruction sequencing, bit slice concept. Arithmetic, number representations and their operations, design of fast address, signed multiplication, Booth's Algorithm, bit-pair recording, division , floating point numbers and operations, guard bits and rounding.

Main memory organization, various technologies used in memory design, higher order memory design, multi module memories and interleaving, cache memory, concept of cache memory, mapping functions, replacement algorithms.

Input-output organization, I/O mapped I/O and memory mapped I/O, Direct Memory Access, interrupt and interrupts handling mechanisms, device identification, vectored interrupts, interrupt nesting, I/O interfaces, synchronous vs. asynchronous data transfer, I/O channels. Computer peripherals, I/O devices such as video terminals, video displays, graphic input devices, printers, magnetic disk, magnetic tape , CDROM systems.

Introduction to RISC philosophy, Pipelining, Basic concepts in pipelining.

Text Book:

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

Additional Books:

1. Patterson, D.A.and Hennessy, J.L., Computer Organization and Design: The Hardware/Software Interface, 5th ed., Morgan Kaufmann, Amsterdam, 2014.
2. Stallings, W., Computer Organization and Architecture: Designing for Per formance, 9th ed., Pearson Education, Boston, 2013.
3. Tanenbaum, A.S. and Austin, T., Structured Computer Organization, 6th ed., Pearson Education, 2013.

CSL203 CONCEPTS IN PROGRAMMING LANGUAGES (3-0-2-4)

Pre-requisite: NIL

Contents:

Definition of Programming language.Syntax, semantics.High-level languages.Implementation of high-level languages, Compilers and Software interpreters.Data elements, identifi ers binding, binding time, binding identifiers to names, binding of attributes, importance of binding time. Concept of r-value and l-value .Effect of environment on a language.Language paradigms.

Data type, elementary data type, structured data type, elements of specification and implementation of data type. Implementation of elementary data types : integer, real, character, Boolean and pointer. Implementation of structured data types.Vectors & arrays, records and files. Type checking, type conversion and initialization.

Evolution of data type concept. Abstract data type, encapsulation. Design and implementation of new data types through subprograms.Subprogram definition and activation, their implementation, parameter passing, generic subprograms.

Sequence control structures used in expressions and their implementation. Sequence control structures used between statements or group of statements and their implementation.Sequence control structures used between subprograms, recursive and non-recursive subprogram calls. Data control, referring environment dynamic and static scope, static chain implementation and display implementation.

Type definition as mechanism to create new abstract data types, type equivalence, type definitions with parameters. Defining new abstracts data types Storage management issues, like static and dynamic allocation, stack based allocation and management, Heap based allocation and management. Garbage collection.Introduction to exception handling.

Practical: Practicals as per course contents.

Text Book:

1. Pratt, T.W., Zelkowitz, M.V. and Gopal, T.V., Programming LanguagesDesign and Implementation, 4th ed., Pearson Education, 2006

Additional Book:

1. Sethi R., Programming Languages: Concepts and Constructs, 2nd ed., Pearson Education, Delhi, India, 2005.

CSL204 INTRODUCTION TO OBJECT ORIENTED METHODOLOGY (3-0-2-4)

Pre-requisite: NIL

Contents:

Object Oriented Programming, Features of object oriented programming languages like data encapsulation, inheritance, polymorphism and late binding.

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, run time 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 de-serialization of objects.

Templates, Implementation of data structures like linked lists, stacks, queues, trees, graphs, hash table etc. using object oriented programming languages.

Introduction to concept of refactoring, modeling techniques like UML, Design patterns.

Practical: Practicals as per course contents.

Text Books:

1. Arnold K., Gosling J. and Holmes, D., The Java Programming Language, 3rd ed., Pearson Education, 2013.
2. Weisfeld, M.A.,The Object-Oriented Thought Process, 3rd ed., Pearson, 2013.

Additional Books:

1. Stroustrup, B., The C++ Programming Language,4th ed., Addison-Wesley,2014
2. Schildt, H., C++: The Complete Reference, 5th ed., McGraw-Hill, 2012.
3. Cox, B.J. and Novobilski, A.J., Object-Oriented Programming: AnEvolutionary Approach, 2nd ed., Addison Wesley, 1993.

CSL301 THEORY OF COMPUTATION (3-2-0-4)

Pre-requisite: CSL 201 DATA STRUCTURES AND PROGRAM DESIGN SCL 401DISCRETE MATHEMATICS

Contents:

Preliminaries - Sets, operations, relations, transitive closure, countability and diagonalisation, induction and proof methods- pigeon-hole principle and simple applications- concept of language- grammars and production rules- Chomsky hierarchy. Regular grammars, deterministic finite automata - non determinism, conversion to deterministic automata-e-closures, regular expressions, finite automata, regular sets. Pump lemma for regular sets- closure properties of regular sets, decision properties for regular sets, minimization of automata. Context - free languages, parse trees and ambiguity, reduction of CFGS, Chomsky and Griebach normal forms, push - down Automata (PDA), non-determinism, acceptance by two methods and their equivalence, CFLs and PDAs – Pumping lemma for context free languages, Closure and decision properties of CFLs. Timing machines– variants, recursively enumerable (r. e.) sets, recursive sets, TM as computer of function, decidability and solvability, Halting Problem, reductions, Post correspondence Problem (PCP) and insolvability of ambiguity problem of CFGs.

Introduction to recursive function theory - primitive recursive and partial recursive functions Church-Turing thesis- convergence of viewpoints of what "computability" is: Semi formal treatment.

Text Book:

1. Martin, J.C., Introduction to Languages and the Theory of Computation, 3rded., Tata McGraw Hill, 2014.

Additional Book:

1. Hopcroft, J.E., Motwani, R. and Ullman, J.D., Introduction to AutomataTheory, Languages and Computation, 3rd ed., Pearson Education, 2014.

CSL302 OPERATING SYSTEMS (3-0-2-4)

Pre-requisites: CSL 201 DATA STRUCTURES AND PROGRAM DESIGN CSL 202 COMPUTER ORGANIZATION

Contents:

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.

Practical: Practicals as per course contents.

Text Books:

1. Silberschatz, A., Galvin, P.B. and Gagne, G., Operating System Concepts, 8th ed., Wiley, 2014.
2. Stallings, W., Operating Systems: Internals and Design Principles, 7th ed., Pearson, 2014.

Additional Books:

1. Crowley, C., Operating Systems: A Design-Oriented Approach, Tata McGraw Hill, 2001.
2. Tanenbaum, A.S., Modern Operating Systems, 3rd ed., Prentice Hall of India, 2014.

CSL303 COMPUTER NETWORKS (3-0-2-4)

Pre-requisite: CSL308 ANALYSIS OF ALGORITHMS

Contents:

Introduction to Network Architecture, Layering and Protocols, Internet Architecture Implementing Network Software, Application Programming Interface (Sockets), Protocol Implementation Issues, Performance, Bandwidth and Latency, Delay × Bandwidth Product, High-Speed Networks, Application Performance Needs Perspectives on Connecting Classes of Links, Encoding (NRZ, NRZI, Manchester, 4B/5B), Framing, Byte-Oriented Protocols (PPP), Bit-Oriented Protocols (HDLC), Clock-Based Framing (SONET), Error Detection, Two-Dimensional Parity, Internet Checksum Algorithm, Cyclic Redundancy Check, Reliable Transmission, Stop-and-Wait, Sliding Window, Concurrent Logical Channels, Ethernet and Multiple Access Networks (802.3), Physical Properties, Access Protocol. Introduction to Wireless technologies, 802.11/Wi-Fi, Bluetooth/802.15.1, Cell Phone Technologies, Security of Wireless Links, Internetworking, Switching and Bridging, Datagrams, Virtual Circuit Switching, Source Routing, Bridges and LAN Switches, Basic Internetworking (IP), Service Model, Global Addresses, Datagram Forwarding in IP, Subnetting and Classless Addressing, Address Translation (ARP), Host Configuration (DHCP), Error Reporting (ICMP), Virtual Networks and Tunnels, Routing, Network as a Graph, Distance Vector (RIP), Link State (OSPF), Metrics, Implementation and Performance, Ports, Fabrics, Router Implementation Advanced Internetworking - The Global Internet, Routing Areas, Inter domain Routing (BGP), IP version 6 (IPv6), Multicast, Multicast Addresses, Multicast Routing (DVMRP, PIM, MSDP), Multiprotocol Label Switching (MPLS), Destination-Based Forwarding, Explicit Routing, Virtual Private Networks and Tunnels, Routing among mobile devices, Challenges for Mobile Networking, Routing to Mobile Hosts (Mobile IP) End-to-End Protocols- Simple Demultiplexer (UDP), Reliable Byte Stream (TCP), End-to-End Issues, Segment Format, Connection Establishment and Termination, Sliding Window Revisited, Triggering Transmission, Adaptive Retransmission, Record Boundaries, TCP Extensions, Alternative Design Choices, Remote Procedure Call, RPC Fundamentals, RPC Implementations (SunRPC, DCE), Transport for Real-Time Applications (RTP) - Requirements, RTP Design, Control Protocol Congestion Control and Resource Allocation, Issues in Resource Allocation, Network Model, Taxonomy, Evaluation Criteria, Queuing Disciplines, FIFO, Fair Queuing, TCP Congestion Control,End-to-End Data- Presentation Formatting, Taxonomy, Examples (XDR, ASN.1, NDR), Markup Languages (XML), Multimedia Data, Lossless Compression Techniques, Image Representation and Compression (GIF, JPEG), Video Compression (MPEG), Transmitting MPEG over a Network, Audio Compression (MP3) Applications- Traditional Applications - Electronic Mail (SMTP, MIME, IMAP), World Wide Web (HTTP), Web Services Multimedia Applications - Session Control and

Call Control (SDP, SIP, H.323), Resource Allocation for Multimedia Applications, Common Services, Name Service (DNS), Network Management (SNMP), Overlay Networks - Routing Overlays, Peer-to-Peer Networks, Content Distribution Networks.

CN Lab:

Programs based on

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 Address Resolution Protocol
7. Implementation of Open Shortest Path First Protocol
8. Using n/w simulators like: NS2, DLC/DLL simulator
9. Implementation of multi thread client server application.
10. Implementation of TCP/IP Echo.
11. Using simple UDP.

Text Books:

1. Peterson, L.L. and Davie, B.S., Computers Networks: A Systems Approach,5th ed., Elsevier, 2013.
2. Forouzan, B.A., Data Communications and Networking, 5thed.,Tata McGraw- Hill, 2013.

Additional Books:

1. Tanenbaum, A. S. and Wetherall, D., Computer Networks, 5th ed., Pearson, 2014.
2. Haykin, S.S. and Moher, M., Communication Systems, 5th ed., John Wiley and Sons, 2012.
3. Comer, D., Computer Networks and Internets, 6th ed., Pearson, 2014.
4. Kurose, J.F. and Ross, K.W., Computer Networking: A Top-Down Approach, 6th ed., Pearson Education, 2013.
5. Stallings, W., Data and Computer Communications, 10th ed., Pearson Education, 2014.

CSL304 SYSTEM PROGRAMMING (3-0-2-4)

Pre-requisites: CSL 201 DATA STRUCTURES AND PROGRAM DESIGN, CSL 202 COMPUTER ORGANIZATION

Contents:

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, string various, data types line insert, character, arrays structures.

System utilities - Source code control system, make, link editor, symbolic debugger, pattern matching language like awk.

Device Drivers - Device programming, system drivers, non-system drivers, virtual drivers, Incorporation of driver routines, Basic device driver operation, character and block drivers.

Practical: Practicals as per course contents.

Text Books:

1. Beck, L.L. and Manjula, D., System Software: An Introduction to Systems Programming, 3rd ed., Pearson Education, 2013.
2. Gorsline, G.W, Assembly and Assemblers: The Motorola MC68000 Family, Prentice Hall, 1988.

Additional Books:

1. Dhamdhere, D.M., Systems Programming, Tata McGraw Hill Education, 2011.
2. Kernighan, B.W. and Pike, R.,The Unix programming Environment, Prentice Hall of India, 1993.
3. Egan, J.I. and Teixeira, T.J., Writing a UNIXDevice Driver, 2nd ed., John Wiley and Sons, 1992.
4. Norton, D.A., Writing Windows Device Drivers, Addison Wesley, 1996.
5. Pajari, G., Writing UNIX Device Drivers, Pearson Education, 1995.
6. UNIX System Utilities Manual.

CSL305 DATABASE MANAGEMENT SYSTEMS (3-0-2-4)

Pre-requisite: CSL302 OPERATING SYSTEMS

Contents:

Database system concepts and Architecture - concept of relational database, Relational data model, Relational algebra, SQL-the relational database standard, ER and EER model.

Database design theory - Functional dependencies and normalization, relational database design algorithms, practical database design and demoralization, Relational constants, programmatic ways for implementing constraints, triggers, Chase algorithm.

Physical database design - Concept of physical and logical hierarchy, storage structures like cluster, index organized table, partitions, various table storage Parameters and block storage parameters, concept of index, B-trees, hash index, Function index, bitmap index.

Process and memory management in database- Various types of tasks in database, database buffer management, log buffer management code reuse, concept of two tier and N-tier architecture, data dictionary and catalog information database recovery technique. Arier Algorithm for recovery.

Query optimization and performance tuning- Various techniques for query optimization, strong and weak equivalence, cost base optimization, Use of different storage structures in query optimization.

Transaction Processing - Transaction and system concepts, Desirable properties of transaction, Schedules and recoverability, serializability of schedules, concurrency control, lock base protocols and time stamp based protocols, read consistency.

Practical: Practicals as per course contents.

Text Book:

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

Additional Books:

1. Elmasri, R.A. and Navathe, S.B., Fundamentals of Database Systems, 6th ed., Pearson Education, 2014.
2. Ullman, J.D., Principles of Database Systems, 2nd ed., Computer Science Press, 1990.

CSL306 LANGUAGE PROCESSORS (3-0-2-4)

Pre-requisite: CSL301 THEORY OF COMPUTATION

Contents:

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 frame work to specify the translations. Using syntax directed translation schemes for translation of expressions, controls structures, declarations, procedure calls.

Storage allocation and run time storage administration, 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.

Practical: Practicals as per course contents.

Text Book:

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

Additional Books:

1. Holub, A.I., Compiler Design in C, Prentice-Hall of India, 2006.
2. Fischer, C.N., Cytron, R.K. and LeBlanc, R.J., Crafting a Compiler, Addison Wesley, 2010.

CSL307 SOFTWARE ENGINEERING (3-0-2-4)

Pre-requisite: CSL204 INTRODUCTION TO OO METHODOLOGIES

Contents:

Software Engineering Process & Management: Generic view, Capability Maturity Model, Process models- waterfall, evolutionary, incremental etc., unified process, agile view, project management, metrices estimation, project scheduling, risk management.

Software engineering Principles and Practice: Communication, planning and modeling practices, system engineering and modeling, business process engineering requirement analysis, system analysis- flow oriented and class oriented modeling using data modeling concepts.

Software Design Engineering: Design Concepts: Abstraction Architecture, pattern modularity, information hiding, design classes, refactoring etc., Design of web application, architectural design, component level design, user interface design.

Software Testing and Quality Management: Testing strategies, testing for object oriented software testing for web applications, validation testing etc. Black box testing, white box testing, Basis path testing. Testing for specialized environments, architectures and application. Quality concepts, quality assurance, software reviews, statistical quality assurance.

Software configuration management and advance topics : Elements of configuration management system, process configuration for web engineering, component-based development, clean room software engineering, formal methods, software reengineering, Software Maintenance.

Practical: Practicals as per course contents.

Text Books:

1. Pressman, R.S. and Maxim, B.R., Software Engineering: A Practitioner's Approach, 8th ed., McGraw Hill, 2014.
2. Sommerville, I., Software Engineering, 9thed.,Pearson Education 2013.

Additional Books:

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

CSL308 ANALYSIS OF ALGORITHMS (3-2-0-4)

Pre-requisite: CSL 201 DATA STRUCTURES AND PROGRAM DESIGN
Contents:

Mathematical foundations, summation of arithmetic and geometric series, □n, □n2, Bounding summations using integration, recurrence relations, solutions of recurrence relations using technique of characteristic equation and generating functions.

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, Fast Fourier Transform 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-Queen's 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.

Text Books:

1. Cormen, T.H., Leiserson, C.E. and Rivest, R.L., Shamir, Introduction to Algorithms, 3rd ed., PHI Learning Private Ltd., 2013.
2. Horowitz, E., Sahni, S. and Rajasekaran, S., Fundamentals of ComputerAlgorithms, 2nd ed., University Press, 2012.

Additional Books:

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

CSL309 NEURO-FUZZY TECHNIQUES (3-0-2-4)

Pre-requisite: NIL

Contents:

Neural Networks: History, overview of biological Neuro-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.

Practical: Practicals as per course contents.

Text Books:

1. Haykin, S.S.,Neural Networks and Learning Machines, 3rd ed., PHI Learning, 2013.
2. Ross, T.J., Fuzzy Logic with Engineering Applications, 3rd ed.,JohnWiley & Sons, 2013.

Additional Books:

1. Aliev, R.A. and Aliev, R.R.,Soft Computing and its Applications,World Scientific, 2001.
2. Kosko, B., Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence, Prentice-Hall of India, 1994.
3. Yegnanarayana, B., Artificial Neural Networks, Prentice Hall of India, 2006.
4. Jang, J-S.R., Sun, C-T. and Mizutani, E., Neuro-Fuzzy and Soft Computing: A Computational Approach to Learningand Machine Intelligence,PHI Learning, 2010.
5. Hertz, J.A., Krogh, A. andPalmer, R.G., Introduction to the Theory of Neural Computation, Addison Wesley, 1999.
6. Mehrotra, K., Mohan, C. K. and Ranka, S., Elements of Artificial Neural Networks, Penram International Publishing,1997.

CSL310 COMPUTER GRAPHICS (3-0-2-4)

Pre-requisite: CSL 201 DATA STRUCTURES AND PROGRAM DESIGN

Contents:

Basic fundamentals of random scan, raster-scan devices, LCD displays - point and line drawing techniques and algorithms - input/output devices and interactive techniques.

Polygon filling methods: Seed fill, edge flag algorithm etc. - scan conversion techniques - anti aliasing techniques - clipping algorithms, Polygon clipping, Viewing transformation, Windowing transformation.

Linear transformation: rotation, scaling, translation in 3D -homogeneous coordinates - normalized device coordinates - windowing and view porting, Cartesian Coordinates, Word view etc.

Curve generation - cubic splines, Beziers, blending of curves- other interpolation techniques, Displaying Curves and Surfaces, Shape description requirement, parametric function. Review of 3D vector algebra - parallel and perspective projections and transformation - hidden line/ surface elimination - shading and rendering - ray tracing techniques.

Graphics software packages - segmentation and display files - graphics standards - graphics and computer networks - basic principles of X windows, X terminals, Functions for segmenting display files.

Practical: Practicals as per course contents.

Text Book:

1. Rogers, D.F., Procedural Elements for Computer Graphics, 2nd ed., Tata McGraw Hill, 2012.

Additional Books:

1. Hearn, D. and Baker, M.P., Computer Graphics, Prentice Hall of India, 2003.
2. Foley, J.D., Introduction to Computer Graphics, Addison-Wesley, 2010.

CSL311 INTERNET TECHNOLOGIES (3-0-2-4)

Pre-requisite: NIL

Contents:

Evolution of Internet, TCP/IP: addressing and routing. Internet applications: FTP, Telnet, Email, Chat. World Wide Web: HTTP protocol. Designing web pages: HTML, forms, CGI scripts and clickable maps, JAVA applets, JavaScript, JAVA servlets, Perl. DHTML, XML.

E-Commerce and security issues including symmetric and asymmetric key, encryption and digital signature, authentication. Emerging trends, Internet telephony, virtual reality over the web, etc. Intranet and Extranet, firewall design issues.

Practical: Practicals as per course contents.

Text Book:

1. Comer, D. Internetworking with TCP/IP: Principles, Protocols and Architecture, Vol.I, 6th ed., Pearson Education, 2014.

Additional Books:

1. Fall, K.R. and Stevens, W. R., TCP/IP Illustrated: The Protocols, Vol. I, 2nd ed., Addison Wesley, 2012.
2. Stevens, W. R. and Wright, G.R., TCP/IP Illustrated: The Implementation, Vol. II, Addison Wesley, 2010.
3. Stevens, W. R., TCP/IP Illustrated: TCP for Transactions, HTTP, NNTP, and the UNIX Domain Protocols, Vol. III, Addison Wesley, 2011.
4. Comer, D. and Stevens, D.L., Internetworking with TCP/IP: Client Server Programming and Applications, Vol. III,Prentice Hall of India, 2007.

CSL312 TOPICS IN GRAPH THEORY (3-2-0-4)

Pre-requisites: SCL401 DISCRETE MATHEMATICS, CSL308 ANALYSIS OF ALGORITHMS

Contents:

Introduction to Graphs, Bipartite graphs, Regular graphs, Complete graphs, Independent set, Cut-Vertices/Cut-Edges, Trees, Operation on graphs.

Matchings and covers, Matchings in Bipartite Graphs, Maximum Matchings, Hall's Matching Condition, Independent Sets, Applications and Algorithms, Dominating Sets, Bipartite Matchings, Matchings in General Graphs, Tutte's 1-factor Theorem, *f*-factors of Graphs, Cuts and connectivity, Edge-connectivity, K-connected and K-edge connected graphs, 2-connected Graphs, Applications of Menger's Theorem, Network flow problems, Maximum Network Flow, Integral Flows. Colorings of graphs, Vertex Colorings and Upper Bounds, Upper Bounds, Brooks' Theorem, Structuring of K-chromatic graphs, Critical Graphs,Enumerative Aspects, chordal graphs, Line Graphs and Edge-coloring, Hamiltonian Cycles, The Chinese Postman Problem, Heuristics and Bounds. Planer graphs, Embedding, Euler's formula, Dual Graphs, Characterization of Planar Graphs, Preparation for Kuratowski's Theorem, Parameters of planarity, Coloring of Planar Graphs, Edge-colorings and Hamiltonian Cycles.

Advanced topics: Perfect Graphs, the Perfect Graph Theorem, Imperfect Graphs, the Strong Perfect Graph Conjecture. Matroids, Hereditary Systems and Examples,The Span Function and Duality, Ramsey Theory,Ramsey's Theorem, Graph Ramsey Theory, More Extremal Problems, Branching and Gossip, Partitions Using Paths and Cycles, Random Graphs, Connectivity,Cliques, and Coloring, Eigenvalues of Graphs, GraphPebbling.

Electrical Network Analysis and Operations Research, Applications in Switching and Coding Theory.

Text Book:

1. Deo, N., Graph Theory: With Applications to Engineering and ComputerScience, Prentice Hall of India, 2013.

Additional Books:

1. Harary, F., Graph Theory, Perseus Books, 2001.
2. West, D.B., Introduction to Graph Theory, 2nd ed.,PHI Learning Pvt. Ltd., 2011.

CSL401 REAL-TIME SYSTEMS (3-0-2-4)

Pre-requisite: CSL302 OPERATING SYSTEMS

Contents:

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, Scheduling of Sporadic Jobs.

Resources and resource access control:non preemptive critical sections,basicpriority-inheritance, ceiling protocol, multiprocessor scheduling, predictability and validation of dynamic multiprocessor systems flexible applications, tasks with temporal distance constraints.

Real time Operating systems:Overview, Time Services and Scheduling Mechanisms, Basic Operating System Functions, Processor Reserves and Resource Kernel, Open System Architecture, Capabilities of Commercial RTOS.

Practical: Practicals as per course contents.

Text Book:

1. Liu, J.W.S., Real-Time Systems, Pearson Education, 2013.

Additional Book:

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

CSL402 ARTIFICIAL INTELLIGENCE (3-0-2-4)

Pre-requisite: CSL308 ANALYSIS OF ALGORITHMS

Contents:

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, Handing 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.

Practical: Practicals as per course contents.

Text Book:

1. Russell, S.J. and Norvig, P., Artificial Intelligence:A Modern Approach, 3rded.,Pearson Education, 2014.

Additional Books:

1. Nilsson, N.J. Artificial Intelligence and New Systems, 1st ed.,Elsevier, 2011.
2. Patterson, D.W.,Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India, 2012.

CSL403 FUNDAMENTAL ALGORITHMS IN COMPUTATIONAL BIOLOGY (3-0-2-4)

Pre-requisites: SCL 404 PROBABILITY AND NUMERICAL METHODS, CSL 308ANALYSIS OF ALGORITHMS

Contents:

DNA and Sequence Alignment – KMP-algorithm, BLAST and FASTA, Sorting by Reversals,Biological Databases – formats, downloading and using data,Phylogeny – Distance based algorithms (Hamming /Euclidian 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

Practical: Practicals as per course contents.

Text Books:

1. Ellner, S. P. and Guckenheimer, J., Dynamic Models in Biology, New AgeInternational, 2010.
2. Murray, J. D., Mathematical Biology: An Introduction, 3rd ed., Springer, 2002.

Additional Books:

1. Mandoiu, I.and Zelikovsky, A.,Bioinformatics Algorithms: Techniques and Applications. Wiley Series on Bioinformatics: Computational Techniques and Engineering, John Wiley & Sons, 2008.
2. Course Website of Ron Shamir, Tel Aviv University (http://www.cs.tau.ac.il~rshamir/algmb/algmb-archive.htm).

CSL404 NETWORK SECURITY (3-0-2-4)

Pre-requisites: CSL 303 COMPUTER NETWORKS, CSL 302 OPERATING SYSTEMS, SCL401 DISCRETE MATHEMATICS

Contents:

Classical Ciphers: Affine, Playfair, Hill Cipher, Modern Block and Stream Ciphers: DES, AES, RC4, A5/1, Block Modes of Operation: ECB, CBC, CFB, OFB, CTR Asymmetric Key Cryptosystems: RSA, Digital Signatures: DSS, Hash and MAC: SHA-512 Key Management: Digital Certificates, PKI, Authentication: One-Way Authentication, Mutual Authentication, Dictionary Attacks, Centralized Authentication, The Needham-Schroeder Protocol, Kerberos, Network Layer Security: IPSec, Transport Layer Security: SSL/TLS Non-cryptographic Protocol Vulnerabilities: DoS and DDoS, Session Highjacking and Spoofing, ARP Spoofing and Attacks on DNS, Software Vulnerabilities: Phishing, Buffer overflow, cross site scripting and SQL injection Viruses, Worms, and other Malware: Virus and Worm Features, Internet Scanning Worms, Mobile Malware and Botnets, Access Control in Operating Systems: Discretionary Access Control, Mandatory Access Control, Role Based Access Control, SELinux and Recent Trends ,RFIDs and E-Passports Electronic payment.

Practical: Practicals as per course contents.

Text Books:

1. Forouzan, B.A. and Mukhopadhyay, Debdeep, Cryptography and Network Security, 2nd ed., Tata McGraw Hill, 2013.
2. Stallings, W., Cryptography and Network Security: Principles and Practice, 6th ed., Pearson, 2014.

Additional Books:

1. Schneier, B., Applied Cryptography: Protocols, Algorithms and Source Code in C, 2nd ed., Wiley-India, 2007.
2. Stinson, D.R., Cryptography: Theory and Practice, 3rd ed.,Chapman and Hal CRC Press, 2006.
3. Menezes, A.J., Oorschot, P.C.V. and Vanstone, S.A., Handbook of Applied Cryptography, 5th ed., CRC Press, 2001.
4. Kaufman, C., Perlman, R. and Speciner, M., Network Security: PrivateCommunication in a Public World, 2nd ed., Prentice Hall, 2010.
5. Pfleeger, C.P. and Pfleeger, S.L., Security in Computing, 4th ed., Prentice Hall, 2012.
6. Menezes, B., Network Security and Cryptography, Cengage Learning, 2012.

CSL405 DATA MINING AND DATA WAREHOUSING (3-0-2-4)

Pre-requisite: CSL305 DATABASE MANAGEMENT SYSTEMS

Contents:

Introduction to Datawarehousing- Application of Datawarehousing and mining, Datawarehouse development life cycle, Data warehouse analysis, CUBE, ROLL UP and STAR queries.

Data ware house Architecture, OLAP, ROLAP and MOLAP, Concepts of Fact and Dimension table.

Space Management in Datawarehouse- Schemas for storing data in warehouse using different storage structures, B-tree index, hash index, clusters, Bitmap index functional index, domain index, Data partitions.

Performance and Tuning- Query optimization, memory management, process management.I/o management for Data warehouse.

Data Mining Tools –Association rules, a priori algorithm, Fp-trees algorithm, constraints and solution.

Cluster analysis- paradigms, DBSCAN, cluster algorithms.

Mining tools- decision trees and applications.

Practical: Practicals as per course contents.

Text Books:

1. Han, J., Kamber, M. and Pei, J., Data Mining: Concepts and Techniques, 3rded., Elsevier, 2013.
2. Corey, M.J. andet. al., Oracle 8i Data Warehousing, McGraw Hill, 2001.

Additional Books:

1. Elmasri, R.A.and Navathe, S.B., Fundamentals of Database Systems, 6thed., Pearson, 2014.
2. Pujari, A.K., Data Mining Techniques, 3rd ed., Hyderabad Universities Press Pvt. Ltd., 2013.

CSL406 ADVANCED COMPUTER ARCHITECTURE (3-0-2-4)

Pre-requisites: CSL202 COMPUTER ORGANIZATION

Contents:

Classes of computers, Trends in technology, power and costs, dependability, quantitative principles of computer design, Amdahl's Law, Introduction to computing models. Pipeline and superscalar techniques, linear pipeline processors, reservation and latency analysis, collision free scheduling, pipeline schedule optimization, instruction pipeline design, arithmetic pipeline design, super scalar and super pipeline design. Principles of scalable performance, performance metrics and measures, speedup performance laws, advanced processor technology, superscalar and VLIW processors. Elementary theory about dependence analysis, techniques for extraction of parallelism, branch prediction, dynamic scheduling, multiple issue and speculation, limits on instruction level parallelism. Memory hierarchy, cache performance, protection and examples of virtual memory.Cache Optimizations. Multiprocessors and multi-computers, Brief overview of SIMD, MIMD, vector architectures and multi-core architectures. Verified memory, cache memory organizations, shared memory organizations. Cache coherence. Thread level parallelism.

Practical: Practicals as per course contents.

Text Book:

1. Hennessy, J.L.,Patterson, D.A. and Asanović, K., Computer Architecture: A Quantitative Approach, 5th ed., Elsevier, 2013.

Additional Books:

1. Hwang, K.,Ramachandran, A. and Purushothaman, R., Advanced Computer Architecture: Parallelism, Scalability, Programmability,Tata McGraw Hill,2004.
2. Sima, D., Fountain, T.J. and Kacsuk, P. Advanced Computer Architectures: ADesign Space Approach, Pearson Education, 2005.

CSL407 DISTRIBUTED SYSTEMS (3-0-2-4)

Pre-requisites: CSL 302 OPERATING SYSTEMS, CSL 303 COMPUTER NETWORKS

Contents:

Motivation and goals, broad overview and advantages of distributed systems, main characteristics absence of global clock and state and possibility of large network delays

Issues in distributed systems such as transparency, scalability, security etc.Middlewares such as sockets, RPC, RMI etc. Distributed file systems- design issues- case studies with emphasis on NFS- distributed shared memory-coherence and coherence protocols- design issues and case studies, clock synchronization.Theoretical foundations- Lamport's clocks-Chandy-Lamport Global State recording algorithm- termination detection, leader election. Distributed mutual exclusion- Lamport, Ricart - Agrawal non-token based algorithm - token based algorithms- comparative performance analysis.Distributed deadlock detection issues- central and distributed detection algorithm- agreement protocols- model of processor failures- Byzantine agreement and other problems- solutions and applications. Distributed scheduling- issues, load distributing algorithms- load sharing policies and case studies- task migration and issues Recovery: introduction and basic concepts - backward and forward error recovery, Checkpointing: synchronous and asynchronous- atomic actions and commit protocols- voting protocols- reliable communication.

Practical: Practicals as per course contents.

Text Books:

1. Singhal, M. and Shivaratri, N.G., Advanced Concepts in Operating Systems, Tata McGraw Hill, 2013.
2. Coulouris, G.F., Dollimore, J. and Kindberg, T., Distributed Systems: Concepts and Design, 4th ed., Pearson Education, 2012.

Additional Book:

1. Tanenbaum, A.S., Modern Operating Systems, 3rd ed., Prentice Hall, 2014.

CSL408 INFORMATION RETRIEVAL (3-0-2-4)

Pre-requisite: NIL

Contents:

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.

Practical: Practicals as per course contents.

Text Books:

1. Manning, C.D., Raghavan, P. and Schu¨tze, H.,Introduction to Information Retrieval, Cambridge University Press, England, 2012.
2. Bu¨ttcher,S., Clarke, C.L.A. and Gordon V Cormack, Information Retrieval: Implementing and Evaluating Search Engines,MIT Press, 2010.

Additional Books:

1. Grossman, D.A. and Ophir, F.,Information Retrieval: Algorithms and Heuristics, Springer, 2013.
2. Frakes, W.B., Pearson, Information Retrieval: Data Structures and Algorithms,Prentice Hall, 2002.

CSL409 PATTERN RECOGNITION (3-0-2-4)

Pre-requisites: NIL

Contents:

Introduction to Pattern Recognition. Learning – supervised, unsupervised and reinforcement learning. Bayesian decision theory- classifiers and discriminant functions. Normal density- univariate and multivariate, discriminant functions for normal density, error bounds for normal density- Chernoff bound and Bhattacharyya bound.

Parametric techniques- Maximum-Likelihood estimation- general principle and Gaussian case. Bayesian parameter estimation- general theory and Gaussian case. Nonparametric techniques- kernel density estimators, parzen windows and kn-nearest neighbor estimation.

Unsupervised Methods Exploring the Data for Latent Structure- Curse of dimensionality and small sample size problem. Feature extraction and selection: Principal component analysis (PCA), Fisher linear discriminant and other linear approaches. Single valued decomposition (SVD). Clustering algorithms- k-means and fuzzy c-means. Expectation Maximization (EM) algorithm and Gaussian mixture model.Self organizing maps.

Classifier Ensembles- Bagging and Boosting/AdaBoost. Hidden Markov Models (HMM)- evaluation, decoding and learning. Linear discriminant functions. Multilayer neural networks. Support vector machine (SVM). Nonmetric methods-Decision trees, CART, ID3 and ILA. Algorithm independent machine learning-No Free Lunch Theorem, Ugly Duckling Theorem, Bias and variance for regression and classification. Cross validation.

Practical: Practicals as per course contents.

Text Book:

1. Duda, R.O., P.E. Hart and D.G. Stork. Pattern Classification. 2nd Edition. Wiley-Interscience,2001.

Additional Books:

1. Theodoridis, S. and Konstantinos Koutroumbas. Pattern Recognition. 4th ed. Academic Press, 2008.
2. Bishop, Christopher M. Pattern Recognition and Machine Learning. Springer, 2007.
3. Koller, D. and Nir Friedman. Probabilistic Graphical Models. MIT Press, 2009.

CSL410 INTRODUCTION TO VIRTUALIZATION AND CLOUD COMPUTING (3-0-2-4)

Pre-requisite: NIL

Contents:

Overview of virtualization/cloud computing - Virtualization: Virtualization technologies and architectures, Internals of virtual machine monitors/hypervisors, Migration mechanisms. Cloud Services: "infrastructure-as-a service", "platform-as-a-service" and "software-as-a-service", HPC in cloud computing, Types of Cloud – public, private and hybrid clouds, cloud-in-a-box. Cloud enabling technologies: Introduction to Hadoop, Map-reduce, NoSQL, MongoDB, Encryption techniques, SSL

"Big data" concepts, storage and management: clustering, dynamic provisioning and resource management, security, scalability, privacy and other risks.

Case Study: Implementation examples of Cloud services.

Practical: Practicals as per course contents.

Text Books:

1. Resse, George. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud. O'Reilly, 2009.
2. Smith, James E., and Ravi Nair. Virtual Machines: Versatile Platforms for Systems and Processes. Morgan Kaufmann, 2005.

Additional Book:

1. Buyya, Rajkumar, James Broberg, and Andrzej Goscinski. Cloud Computing – Principles and Paradigms, Wiley, 2011.

CSL411 WIRELESS COMMUNICATION & NETWORKS (3-0-2-4)

Pre-requisite: CSL303 COMPUTER NETWORKS

Contents:

Introduction to wireless networks. Wireless transmission, signal propagation, modulation techniques. Medium access control. Global System for Mobile Communication (GSM). IEEE 802.11 (Wireless LAN), Bluetooth, IEEE 802.15. Mobile Network layer, Mobile IP, Mobile adhoc networks. Mobile transport layer. Recent trends in wireless network and telecommunication systems like 3G, LTE, LTE-advanced, 4G and 5G.

Practical: Practicals as per course contents.

Text Book:

1. Schiller, Jochen. Mobile Communication. 2nd ed. Pearson, 2003.

Additional Books:

1. Rappaport, Theodore S. Wireless Communications: Principles and Practice. 2nd ed. Pearson, 2010.
2. Stallings, William. Wireless Communications & Networks. 2nd ed. Pearson, 2009.

CSL413 ADVANCED COMPUTER NETWORKS (3-0-0-3)

Pre-requisite: CSL 303 COMPUTER NETWORKS

Contents:

An introduction to the internet, the world wide web (WWW), and the Hypertext Transfer Protocol (HTTP), internet servers, high speed networks, optical networks, cellular networks, fixed infrastructure networks, multicast algorithms, intranet and internet routing protocols, comparison between distance vector and link state routing mechanisms, encryption, and resource reservation. Quality of service. General Congestion Control and Queuing. Asynchronous Transfer Mode (ATM), Border Gateway Protocol (BGP), Hypertext Transfer Protocol (HTTP), IP version 6 (IPv6), 802.11 Wireless Networks (a/b/g/n),UMTS, GSM. TCP Variants, Active Queue Management, Overlay Networks' like RON, P2P, CDN etc., Emerging applications.

Text Books:

1. Tanenbaum, Andrew S., and David Wetherall. Computer Networks. 5th ed. Prentice-Hall, 2011.

Additional Books:

1. Kurose, James F. and Keith W. Ross. Computer Networking: A Top-Down Approach. Pearson Education, 2013.
2. Leon-Garcia, Alberto, and Indra Widjaja. Communication Networks – Fundamental Concepts & key architectures. 2nd ed. McGraw-Hill, 2006.

CSL 412 EMBEDDED SYSTEMS (3-0-2-4)

Pre-requisite: CSL202 COMPUTER ORGANIZATION

Contents:

Introduction to embedded systems: Classification, Characteristics and requirements, Applications.

Numbering and coding systems, Digital primer, inside the computer, The 8051 microcontrollers, introduction to 8051 assembly programming, Assembly and running an 8051 programs, the program counter and ROM space in the 8051, 8051 data types and directives, 8051 flag bits and the PSW register, 8051 register banks and stack, Loop and jump instructions, Call instructions, Time delay for various 8051 chips, 8051 I/O programming , I/O manipulation programming, Addressing modes (immediate and register addressing modes, accessing memory using various addressing modes, bit addresses for I/O and RAM, Extra 128-byte on-chip RAM in 8052, Pin description of the 8051, Programming of 8051 timers , Counter programming, Basics of serial communication, 8051 connection to RS232, 9051 serial port programming in assembly, 8051 interrupts, Programming timer interrupts, Programming external hardware interrupts, Programming the serial communication interrupt, interrupt priority in the 8051/52, LCD interfacing, Keyboard interfacing.

Practical: Practicals as per course contents.

Text Book:

1. Mazidi, Muhammand Ali, Janice Gillispie Mazidi, and Rolin D. McKinlay. The 8051 microcontroller and embedded system using assembly and C. 2nd ed. Pearson Education, 2013.

Additional Books:

1. Predko, Myke. Programming and customizing the 8051 microcontroller. McGraw Hill, 2008.
2. Marwedel, Peter. Embedded System Design. 2nd ed. Springer, 2011.
3. Kopetz, Hermann. Real-Time Systems. Springer, 2011.
4. Gupta, Rajesh Kumar. Co-Synthesis of Hardware and Software for Digital Embedded Systems. Springer Science+Buisness Media, 1995.
5. K.V., Shibu. Introduction to Embedded Systems. TMH, 2009.

CSL414 ADVANCED AUTOMATA THEORY (3-0-0-3)

Pre-requisite: CSL301 THEORY OF COMPUTATION

Contents:

Introduction: Notation, Nondeterministic Finite Automata, Deterministic Finite Automata.

Automata and Logical Specifications: Monadic Second-Order (MSO) Logic over words, The Equivalence Theorem, Consequences and Applications in Model Checking, First-Order Definability, MSO definability.

Congruences and Minimization: Homomorphisms, Quotients, and Abstraction; Minimization and Equivalence of DFAs, Equivalence and Reduction of NFAs.

Tree Automata: Trees and Tree Languages, Deterministic Tree Automata, Nondeterministic Tree Automata, Emptiness, Congruences and Minimization, Logic Oriented Formalisms over Trees, applications. Pushdown and counter systems, Communicating systems, Petri nets.

Text Book:

1. Thomas, Wolfgang, and RWTH Aachen. Applied Automata Theory. Springer, 2005.

Additional Book:

1. Pin, Jean-Eric. Mathematical foundations of automata theory. Springer, 2012.

CSL415 STATISTICAL MODELS FOR COMPUTER SCIENCE (3-0-0-3)

Pre-requisites: SCL203 PROBABILITY AND NUMERICAL METHODS

Contents:

Introduction: Probability Models, Sample Space, Events, their algebra, graphical methods of representing events, Probability Axioms and their applications, Conditional probability, Independence of Events, Bayes' Rule and Bernoulli Trials. Random Variables: Random variables, and their event spaces, Probability mass function, Distribution functions, Some discrete distributions (Bernoulli, Binomial, Geometric, Negative Binomial, Poisson, Hypergeometric and Uniform), Probability Generating Function, Discrete random vectors, Continuous random variables: some continuous distributions (Exponential, Hyperexponential, Erlang, Gamma, Normal), 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 behaviour. 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.

Text Book:

1. Trivedi, Kishor S. Probability, Statistics with Reliability, Queuing and Computer Science Applications. Wiley-India, 2008.

Additional Books:

1. Hayes, J.F. Modeling of Computer Communication Networks. Khanna Publishing, Delhi.
2. Ross, Sheldon M. Introduction to Probability Models. 11th ed. Academic Press Inc, 2014.
3. Feller, W. An Introduction to Probability Theory and its applications, 2 vols., Wiley Eastern, 1975.
4. Kleinrock, L. Queuing Systems, 2 vols, John Wiley, 1976.

CSL416 ADVANCED ALGORITHMS (3-0-2-4)

Pre-requisites: CSL201 DATA STRUCTURES, CSL308 ANALYSIS OF ALGORITHMS

Contents:

Overview of Divide and Conquer, Greedy and Dynamic Programming strategies. Basic Search and Traversal Techniques for Graphs, Backtracking, Branch and Bound. Point location Convex hulls and Voronoi diagrams.

Advanced Algorithms for Graph and Combinatorial Optimization Problems, Shortest Path Problems: Single Source Shortest Path (SP) Problems, SP Tree, Ford's Labelling Method, Labelling and Scanning Method, Efficient Scanning Orders – Topological Order for Acyclic Networks, Shortest First Search for Non-negative Networks (Dijkstra), BFS Search for General Networks, Correctness and Analysis of the Algorithms.

Flows in Networks: Basic Concepts, Maxflow-Mincut Theorem, Ford and Fulkerson Augmenting Path Method, Integral Flow Theorem, Maximum Capacity Augmentation, Edmond-Karp Method, Dinic's Method and its Analysis, String Processing: String Searching and Pattern Matching.

Approximation Algorithms for Vertex Cover, Set Cover, TSP, Knapsack, Bin Packing Subset-Sum Problem etc. Simple Lower Bound Results. NP-completeness: Informal Concepts of Deterministic and Nondeterministic algorithms, P and NP, NP-Completeness, Statement of Cook's Theorem, Some Standard NP-Complete Problems, Approximation Algorithms. Randomized Algorithms, Multithreaded and Distributed Algorithms.

Practical: Practicals as per course contents.

Text Book:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein. Introduction to Algorithms. 3rd ed.,MIT Press, 2009

Additional Books:

1. Robert Sedgewick and Kevin Wayne. Algorithms, 4th ed., Addison Wesley, 2011.

2. Rajiv Motvani and Raghvan P., Randomized Algorithms, 1st ed., Cambridge University Press, 1995.

CSL418 PATTERN RECOGNITION AND MACHINE LEARNING (3-0-0-3)

Pre-requisites: NIL

Contents:

Pattern Recognition - Bayesian decision theory, classifiers and discriminant functions. Normal density- univariate and multivariate, discriminant functions for normal density, error bounds for normal density- Chernoff bound and Bhattacharyya bound. Parametric and Nonparametric techniques. Hidden Markov Models (HMM)- evaluation, decoding and learning. Curse of dimensionality and small sample size problem. Feature extraction and selection. Single valued decomposition (SVD).

Machine Learning - Basic concepts. supervised, unsupervised and reinforcement learning. Supervised learning - Neural Network, Rocchio's classification, k-nearest neighbor, Support vector machines. Unsupervised learning – Clustering algorithms- k-means and fuzzy c-means. Expectation Maximization (EM) algorithm and Gaussian mixture model. Self organizing maps. Reinforcement learning and control - Q-learning. Bucket brigade algorithm.

Text Book:

1. Duda, R.O., P.E. Hart and D.G. Stork. Pattern Classification. 2nd Edition. Wiley-Interscience, 2001.
2. Mitchell M. Tom. Machine Learning. Ed. 1. McGraw, 1997.

Additional Books:

1. Theodoridis, S. and Konstantinos Koutroumbas. Pattern Recognition. 4th ed. Academic Press, 2008.
2. Bishop, Christopher M. Pattern Recognition and Machine Learning. Springer, 2007.
3. Koller, D. and Nir Friedman. Probabilistic Graphical Models. MIT Press, 2009.
4. Bishop, C. M. Pattern Recognition and Machine Learning. Ed. 1. Springer. 2007.
5. Koller, D. and N. Friedman. Probabilistic Graphical Models. MIT Press. 2009.

CSL419 COMPUTER VISION AND IMAGE PROCESSING (3-0-0-3)

Pre-requisite: NIL

Contents:

Image Processing – Basics, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships between Pixels, Intensity Transformations and Spatial Filtering, Convolution, Filtering in the Frequency Domain – Fourier Transform and Wavelets, Image Restoration and Reconstruction, Morphological Image Processing, Image Segmentation and Grouping, Corner and Blob Detection, Descriptor.

Computer Vision - Motion Estimation - Regularization theory, Optical computation, Stereo Vision, Structure from motion, Shape Representation and Segmentation - Deformable curves and surfaces, Snakes and active contours. Gaussian Pyramids. Object recognition - Hough transforms and other simple object recognition methods, Scale Invariant Feature Transform (SIFT), Shape correspondence and shape matching, Principal component analysis. Segmentation using clustering methods, Mixture model. Applications – Salient Object Detection, Face Recognition, Optical Character Recognition.

Text Books:

1. Rafael C. Gonzalez and Richard E. Woods. Digital Image Processing, 2nd ed., Prentice Hall, 2002
2. Forsyth A. David and Ponce Jean, Computer Vision, A Modern Approach. 2nd ed., 2011

Additional Book:

1. Richard Szeliski. Computer Vision: Algorithms and Applications. Springer London 2011

CSL420 OPTIMIZATION TECHNIQUES (3-0-0-3)

Pre-requisite: NIL

Contents:

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, Khun-Tucker conditions. 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.

Text Books:

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

Additional Books:

1. Mustafi, C. K. Operations Research, 4th ed., New Age International, 2009
2. Hadley G. Linear Programming, Narosa Publishers, 1997
3. Hillier F. and G. J. Liebermann. Operations Research, Holder Day Inc, 1974
4. Mohapatra, P.K.J. Introduction to System Dynamics Modelling, 1st ed., Universities Press, 1994
5. Schaum Outline Series. Operations Research, 2nd ed., Tata McGraw Hill, 2003
6. Smith, David K. Network Optimization in Practice. Ellis Horwood Publications, 1982.
7. Kanth, K. Introduction to Computer System Performance Evaluation, McGraw Hill, 1992.

CSL421 RESEARCH METHODOLOGY (3-0-0-3)

Pre-requisite: NIL

Contents:

Introduction to Quantitative Research Methods, Concepts, Purpose – Research Process. Problem Identification & Hypotheses formulation. Scientific explanation. Research design and Tools and Techniques of data collection: Types of Research, General Design of Research, Randomized and Correlated Group Design. Methods of Data Collection. Sampling Design. Measurement and Scaling. Reliability and Validity. Analyses of Data: Measures of Frequency Distribution. Central Tendency. Measure of Dispersion. Skewness, Kurtosis and Moments. Correlation and Regression. Data Presentation and Report Presentation, Presentation of Data. Probability Distributions: Binomial, Poisson, Normal. Sampling and Estimation. Hypotheses testing: - t-test, z-test, Chi-square test, Analysis of variance.

Text Books:

1. Kothari, C. R. Research Methodology: Methods and Techniques, 2nd ed., New Age International Publishers, 2004

Additional Books:

1. Cooper, Donald and Pamela Schindler. Business Research Methods, 12th ed., TMGH, 2013
2. Bryman, A. and Emma Bell. Business Research Methods, 3rd ed., Oxford University Press, 2011

CSL422 WIRELESS AND MOBILE COMMUNICATION (3-0-0-3)

Pre-requisites: CSL303 COMPUTER NETWORKS

Contents:

Introduction to wireless networks. IEEE 802.11 (Wireless LAN), Bluetooth, IEEE 802.15. Mobile Network layer. Mobile transport layer. Recent trends in wireless network and telecommunication systems like 3G, LTE, LTE-advanced, 4G and 5G.

Cellular concepts: Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; MAC--SDMA, FDMA, TDMA, CDMA, Cellular Wireless Networks. Modulation schemes: BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM. GSM and GPRS. Mobile IP – Dynamic Host Configuration Protocol, Mobile adhoc networks - Routing Protocols– Multicast routing-TCP over Wireless Networks – Indirect TCP – Snooping TCP – Mobile TCP – Fast Retransmit / Fast Recovery – Transmission.

Text Book:

1. Schiller, Jochen. Mobile Communications, 2nd ed., Pearson Education, 2003.

Additional Books:

1. Rappaport, Theodore S. Wireless Communications: Principles and Practice. 2nd ed. Pearson, 2010.
2. Stallings, William. Wireless Communications & Networks. 2nd ed. Pearson, 2009.

CSL423 CLOUD ENABLED TECHNOLOGIES (3-0-0-3)

Pre-requisite: NIL

Contents:

Introduction to Cloud Computing: virtualization basics, Hypervisor, Types and services of Cloud. Storage and management: clustering, Harnessing RAM, Scalable transactional systems. Datacenter: Virtualized datacenters, Datacenter Networking. Securing Cloud Storage: cloud security; CryptDB, privacy. Cloud Enabled Technologies: Big data concepts, Hadoop; Scalable data storage – NOSQL antecedents, MongoDB, Encryption techniques, SSL, Docker Containers. Programming frameworks: MapReduce recap & MRvDB , Dryad/DryadLINQ, Django. Case Study: Implementation examples of Cloud services

Text Book:

1. Smith, James and Ravi Nair. Virtual Machines: Versatile Platforms for

Systems and Processes, 1st ed., Elsevier, 2005.
2. Chandrasekaran, K. Essentials of Cloud Computing, 1st ed., Chapman and Hall/CRC, 2014

Additional Books:

1. White, Tom. Hadoop: The Definitive Guide, 4th ed., O`Really, 2015
2. Bernard Golden, Amazon Web Services for Dummies, 2015.
3. Kavis, Michael J., Architecting the Cloud: Design Decisions for Cloud Computing Service Models, Wiley, 2014

Web Links:

1. http://web.mit.edu/6.897/www/readings.html

CSL425 INTRODUCTION TO VIRTUALIZATION AND CLOUD COMPUTING (3-0-0-3)

Pre-requisite: NIL

Contents:

Overview of virtualization/cloud computing - Virtualization: Virtualization technologies and architectures, Internals of virtual machine monitors/hypervisors, Migration mechanisms. Cloud Services: "infrastructure-as-a service", "platform-as-a-service" and "software-as-a-service", HPC in cloud computing, Types of Cloud – public, private and hybrid clouds, cloud-in-a-box. Cloud enabling technologies: Introduction to Hadoop, Map-reduce, NoSQL, MongoDB, Encryption techniques, SSL

"Big data" concepts, storage and management: clustering, dynamic provisioning and resource management, security, scalability, privacy and other risks.

Case Study: Implementation examples of Cloud services

Text Book:

1. Resse, George. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud. O' Reilly, 2009.
2. Smith, James E., and Ravi Nair. Virtual Machines: Versatile Platforms for Systems and Processes. Morgan Kaufmann, 2005.

Additional Book:

1. Buyya, Rajkumar, James Broberg, and Andrzej Goscinski. Cloud Computing – Principles and Paradigms, Wiley, 2011.

CSL427 EMBEDDED SYSTEMS (3-0-0-3)

Pre-requisite: CSL202 COMPUTER ORGANIZATION

Contents:

Introduction to embedded systems: Classification, Characteristics and requirements, Applications.

Numbering and coding systems, Digital primer, inside the computer, The 8051 microcontrollers, introduction to 8051 assembly programming, Assembly and running an 8051 programs, the program counter and ROM space in the 8051, 8051 data types and directives, 8051 flag bits and the PSW register, 8051 register banks and stack, Loop and jump instructions, Call instructions, Time delay for various 8051 chips, 8051 I/O programming , I/O manipulation programming, Addressing modes (immediate and register addressing modes, accessing memory using various addressing modes, bit addresses for I/O and RAM, Extra 128-byte on-chip RAM in 8052, Pin description of the 8051, Programming of 8051 timers , Counter programming, Basics of serial communication, 8051 connection to RS232, 9051 serial port programming in assembly, 8051 interrupts, Programming timer interrupts, Programming external hardware interrupts, Programming the serial communication interrupt, interrupt priority in the 8051/52, LCD interfacing, Keyboard interfacing.

Case Studies: Addressing Modes, Pin of 8051 and 8052.

Text Book:

1. Mazidi, Muhammand Ali, Janice Gillispie Mazidi, and Rolin D. McKinlay. The 8051 microcontroller and embedded system using assembly and C. 2nd ed. Pearson Education, 2013.

Additional Books:

1. Predko, Myke. Programming and customizing the 8051 microcontroller. McGraw Hill, 2008.
2. Marwedel, Peter. Embedded System Design. 2nd ed. Springer, 2011.
3. Kopetz, Hermann. Real-Time Systems. Springer, 2011.
4. Gupta, Rajesh Kumar. Co-Synthesis of Hardware and Software for Digital Embedded Systems. Springer Science+Buisness Media, 1995.
5. K.V., Shibu. Introduction to Embedded Systems. TMH, 2009.

CSP401 SOFTWARE LAB (0-0-2-2)

Contents:

Main theme- Use of open source tools.

Advanced use of Apache Web server: Installing and using Apache Web server in load sharing manner (Configuration of 2 or more server hosting a common website, Advanced use of MySQL server: Installing and using mysql servers in load sharing manner (Configuration of 2 MySQL instances in master-slave mode).

Database operations via programs written in C/C++ or Java. Java Native Interface (JNI): Calling C/C++ code from Java and vice versa.

Automatic testing tools – Junit, NUnit, Advanced use of open source cloud platforms: Integration of gmail with google calendar – from gmail you should be able to schedule an appointment with all the recipients of the mail.

Creating a website on Salesforce cloud for tracking inventory from east, west, north, south regions in India separately.Accessing google-map via google-map APIs, Downloading and Installing Hadoop on 3 to 4 machines and writing a distributed sorting program on the same.Creating web-services using Axis-2 (Java) or gSoap library (C/C++) Introduction to SSL. Use digital certificates to encrypt/ decrypt data in transfers Notes- Keytool in Java allows to create/store/manipulate certificates Also, refer www.thawte.com for free download/creation of a certificate Introduction to Android Platform and APIs/libraries provided. A sample game/application on Android.Learning software engineering tools, Design tools - Rational Rose/visio,Memory leaks - Purify /Code Coverage tools, Testing tools– Loadrunner, Winrunner.

Practical: Practicals as per course contents.