Course Syllabi
Department of Civil Engineering

CEL101 ENGINEERING MECHANICS (3-0-2-4)

Pre-requisite: NIL

Contents:

Co-planer Statics: Anxioms of static and basic concepts, law of forces, force system, resultant and resolution of forces (concurrent parallel and non-concurrent), supports-types and reaction, free body diagram, equilibrium of forces, conditions of equilibrium.
Cables: Weightless flexible cables under concentrated loads and uniformly distributed load with level & non-level supports.
Friction: Laws of static friction, application to inclined planes and ladder.
Properties of areas: Centroid of areas, first and second moments of area about an axis in plane, parallel axis theorem, radius of gyration about an axis.
Pin jointed trusses: Solution by method of joints and method of section.
Graphic Statics: Force polygon and funicular polygon for coplanar forces.
Conditions of equilibrium, reactions at supports of simply supported beamsand trusses, centroids of planer bodies, simple trusses – Maxewell diagrams.
Practical: Practicals as per course contents.

Text Books:

1. Beer, F.P. and et. al., Vector Mechanics for Engineers: Statics and
2. Dynamics, 10th ed., Tata McGraw-Hill, 2013.

Additional Books:

1. Hibbeler, R.C., Engineering Mechanics, 12th ed., Prentice Hall, 2011.
2. Shames, I.H., Engineering Mechanics: Statics and Dynamics, 4th ed., Pearson Education, 2011.
3. Meriam, J.L. and Kraige, L.G., Engineering Mechanics, 7th ed., Wiley, 2013.
4. Timoshenko, S. and Young, D.H. and Rao J.V., Engineering Mechanics, Tata McGraw Hill, 2010.
5. Kumar, K.L. and Kumar V., Engineering Mechanics, 4th ed., Tata McGrawHill, 2011.
6. Soutas-Little, R.W. and Inman D.J. and Balint D.S., Engineering Mechanics: Statics and Dynamics, Cengage Learning, 2009.
7. Boresi, A.P. and Schmidt, R.J., Engineering Mechanics: Statics, Cengage Learning, 2010.
8. Harbola, M.K., Engineering Mechanics, Cengage Learning, 2011.
9. Singer, F.L. and Pytel, A., Strength of Materials, 4th ed., Harper and Row Publishers, New York.

CEL102 ENVIRONMENTAL SCIENCE (2-0-2)

Pre-requisite: NIL

Contents:

Eco System: Concept, Structure and functions; Biodiversity and its conservation. Sustainable development: definition, significant issues in the context of India, Environmental carrying capacity Environmental Pollution: Air, Water,
Land, Noise etc., Pollution sources and effects, Pollution Prevention Strategies; Cleaner Technologies of Production, Principles of waste minimization, Global warming, green house effect, acid rains. Solid waste management: Introduction to solid waste management, Sources, quantity and quality, Classification and components, Physical and chemical characteristics, Per capita contribution, Sampling and analysis. Collection and transportation of solid waste, Collection systems,
Equipments used for collection and transportation, Transfer station. Composting of Waste: Principles of composting, factors affecting composting and methods of composting used in India. Social issues and the environment: Urban problems related to energy, Waste lands, Wetland and its reclamation, Nature, energy and water conservation, Rain water harvesting.
Practical: Practicals as per course contents.

Text Book:

1. Dhameja, S.K., Environmental Engineering and Management, 2nd ed., S.K. Kataria and Sons, 2013

Additional Books:

1. Nathanson J.A. and Schneider, R.A., Basic Environmental Technology: Water Supply, Waste Management and Pollution Control, 6th ed., Pearson Education, 2014.
2. Weiner R.F., Matthews, R.A. and Vesilind, P.A., Environmental Engineering 4th ed., Butterworth-Heinemann, 2003.
3. Sandhu R.S., Minhas, S.S. and Sandhu, J., Sustainable Human Settlements: The Asian Experience. Rawat Publication, 2001.
4. Pachauri, R.K., The Message from WSSD, The Energy and Resources Institute, 2003.
5. Rao, C.S., Envirmental Pollution Control Engineering, 2nd ed., New Age International, New Delhi, 2011.
6. Bhide, A.D., Sundaresan, Pollution Control Engineering, New Age International Pvt Ltd Publishers, 2002.

CEL201 STRENGTH OF MATERIALS (3-2/2-2/2-4)

Pre-requisite: NIL

Contents:

Simple stress and strain relationship: Stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle. Bending moment and shear force diagrams for beams. Simple bending theory, flexure and shear stresses, unsymmetrical bending, shear center. Thin walled pressure vessels, uniform torsion, buckling of column, combined and direct bending stresses.
Practical: Practicals as per course contents.

Text Books:

1. Gere, J.M. and Timoshenko, S.P., Mechanics of Materials, 3rd ed., CBS Publishers and Distributors Pvt. Ltd., 2012.
2. Beer, F.P., Johnston, E.R., Dewolf, J.T. and Mazurek, D.F., Mechanics of Materials, 5th ed., Tata McGraw Hill, 2011.

Additional Books:

1. Shames, I.H., Introduction to Solid Mechanics, 3rd Ed., Prentice Hall India, 2006.
2. Popov, E.P., Engineering Mechanics of Solids, 2nd Ed., Prentice Hall India, 2012.

CEL202 FLUID MECHANICS (3-2/2-2/2-4)

Pre-requisite: NIL

Contents:

Properties of fluids, 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, laminar and turbulent flow, flow in pipes, pipe networks. Types of open channels, Uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump. Forces on immersed bodies, Dimensional analysis and hydraulic modeling. Kinematics of flow, velocity triangles, and specific speed of pumps and turbines.
Practical: Practicals as per course contents.

Text Books:

1. Som, S.K. and Biswas, G., Fluid Mechanics and Fluid Mechanics, Tata McGraw Hill, 2013.
2. Subramanya, K., Flow in Open Channels, Tata McGraw Hill, 2008.

Additional Books:

1. Fox, R.W. and McDonald, A.T., Introduction to Fluid Mechanics, John Wiley and Sons, 2013.
2. Garde, R.J. and Mirajgaoker, A.G., Engineering Fluid Mechanics, Nem Chand and Bros, 2002.
3. Srivastava, R., Flow through Open Channels, Oxford University Press, 2010.

CEL203 ENGINEERING GEOLOGY (2-0-2-3)

Pre-requisite: NIL

Contents:

Introduction: Earth and its interior, role of engineering geology in planning, Design construction and post construction aspects of river valley projects and other civil engineering objects. Minerals and Rocks: Essential rock forming minerals, identification of common minerals in hand specimen. Types of rocks, texture and structures, importance in planning for construction in hills.
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. Weathering and soil formation: Types and agents of weathering – Mechanical and chemical weathering, impact of weathering on strength of slope materials, different soil types, soil map in India. Geological hazards: Earthquake and Landslides. River Valley Projects: Engineering geological considerations in river valley projects. Small hydro-electric projects.
Roads and bridges in hills: Engineering geological investigations in selection of hill roads alignments, stability of cuts slopes, types of bridges, slope stability of abutment foundation.
Practical: Practicals as per course contents.

Text Books:

1. Bell, F. G., Fundamentals of Engineering Geology, Elsevier, 2007.
2. Waltham, T., Foundations of Engineering Geology, Spon Press, 2009.

Additional Books:

1. Anbalagam, R., Singh B., Chakarborthy, D. and Kohli, A., A Field Manualfor Landslide Investigation, DST, Government of India, New Delhi.
2. Singh, P., Engineering and General Geology, S.K. Kataria and Sons, 2012.
3. Krynine, D.P. and Judd, W.R., Principles of Engineering Geology and Geotechnics, Tata McGraw Hill, 2001.

CEL204 BUILDING MATERIALS AND CONSTRUCTION TECHONOLOGY (3-0-2-4)

Pre-requisite: NIL

Contents:

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; Concrete - constituents, proportioning, properties in fresh and hardened state, characteristic strength, quality control (sampling, acceptance, etc.), transportation and placing, porosity; Admixtures – chemical, mineral; Basics of concrete mix design. Steel – properties, types of steel, steel in civil engineering; Bricks – manufacture, properties and classification; masonry bonds; Bitumen – source, composition, characterization, various forms, tests on bitumen; Bituminous mix design; Brick masonry; bonds, stone masonry, types of walls, plastering and pointing. Types of roofs, floors and foundations, damp proofing.Doors and windows, stairs, staircases, lifts and escalators. White washing, colour washing, painting, and distempering, Shuttering, Scaffolding and Centering. Expansion and construction joints, sound and fire proof construction, principles of building drawing; preparation of working drawings including reinforcement scheduling in RCC construction.

Practical: Practicals as per course contents.

Text Books:

1. Gambhir, M.L., Concrete Technology, Tata McGraw Hill, 2013.
2. Kumar, S., Building Construction, Standard Publishers, 2010.

Additional Books:

1. Neville, A.M. and Brooks, J.J., Concrete Technology, ELBS Ed., Longman Ltd., 2013.
2. Taylor, G.D., Materials of Construction, Prentice Hall, 2012.
3. Dayaratnam, P., Brick and Reinforced Brick Structures, Oxford and IBH Publication, 2012
4. Khanna, P.N., Indian Practical Civil Engineering Handbook, Engineers Publishers, 1988.

CEL205 ENVIRONMENTAL ENGINEERING-I (3-0-2-4)

Pre-requisite: NIL

Contents:

Water supply: Sources, Water demand and forecasting. Quality of water, water borne diseases, standards, water quality index. Unit Processes: Systems and unit processes of water purification. Water distribution networks. Wastewater Engineering: Sewage treatment and sewerage system, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, sludge treatment and disposal, effluent discharge standards. Domestic wastewater treatment, quantity of characteristics of domestic wastewater, primary and secondary treatment Unit operations and unit processes of domestic wastewater.

Practical: Practicals as per course contents.

Text Books:

1. Hammer M.J. and Hammer. M.J., Water and Wastewater Technology, 4th ed., Prentice Hall of India, 2008.
2. McGhee, T.J., Water Supply and Sewerage, McGraw Hill, 1991.

Additional Books:

1. Davis, M.L. and Cornwell, D.A., Introduction to Environmental Engineering, McGraw Hill, 2012.
2. Peavy, H.S., Rowe, D.R. and Tehobanoglous, G., Environmental Engineering, McGraw Hill. 1985.
3. Kenneth, W., Warner, F.C. and Davis, W.T., Air Pollution its Origin and Control, Prentice Hall, 1997.
4. Mishra, P.C., Fundamental of Air and Water Pollution, South Asia Books. 1990.
5. Masters, G. Introduction to Environmental Engineering and Science.Prentice Hall. 2004.

CEL206 TRANSPORTATION ENGINEERING–I (3-0-2-4)

Pre-requisite: NIL

Contents:

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. Flexible pavements and their design, review of old methods, CBR method, equivalent single wheel load factor, rigid pavements, stress in rigid pavement, IRC design method. Construction of various layers, earthwork, WBM, GSB, WMM, various types of bituminous layers, joints in rigid pavements, Hot Mix Plants, Construction of Rigid Pavements. Traffic characteristics, road user and vehicular characteristics, traffic studies, road traffic safety, traffic operations, traffic control devices, intelligent transport systems, pollution due to traffic.

Practical: Practicals as per course contents.

Text Books:

1. Khanna, S.K. and Justo, C.E.G., Highway Engineering, Nem Chand and Bros, 2011.
2. Kadiyali, L.R., Traffic Engineering and Transportation Planning, Khanna Publishers, 2012

Additional Books:

1. Sharma, S.K., Principles and Design of Highway Engineering, S. Chand and Co., 2012.
2. Papacostas, C.S. and Prevedouros, P.D., Transportation Engineering and Planning, Prentice Hall, 2008.
3. JotinKhisty, C. and Kent Lall, B., Transportation Engineering: An Introduction, Prentice Hall, 2008.
4. Khanna, S.K. and Justo, C.E.G., Highway Material Pavement Testing Manual, Nem Chand and Bros., 2013.
5. Roess, R.P., Prassas, E.S. and McShane, W.R., Traffic Engineering, Pearson, 2013.

CEL207 SURVEYING (3-0-2-4)

Pre-requisite: NIL

Contents:

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.

Practical: Practicals as per course contents.

Text Books:

1. Arora, K.R., Surveying, Vols. I, II and III, Standard Book House, 2013.
2. Chandra, A.M., Surveying, New Age International Publishers, 2010.

Additional Books:

1. Anderson, J.M. and Mikhail, E.M., Surveying: Theory and Practice, McGraw Hill, 1988
2. Schofield, W. and Breach M., Engineering Surveying, 6th ed., Butterworth-Heineman, 2007.

CEL301 STRUCTURAL ANALYSIS – I (3-2/2-2/2-4)

Pre-requisite: CEL201 STRENGTH OF MATERIALS

Contents:

Introduction to structures, loading and modeling. Internal forces in statically determinate structures–trusses, beams, frames, arches. Deflection of statically determinate structures moment area method, conjugate beam method, unit load method. Strain energy method for slopes and deflections. virtual work method. Static and Kinematic indeterminacy of structures.Castigliano's theorems, theory of least work

Practical: Practicals as per course contents.

Text Books:

1. Hibbeler, R.C., Structural Analysis, Pearson Press, 2013.
2. Reddy, C.S., Basic Structural Analysis, Tata McGraw Hill, 2012.

Additional Books:

1. William, F. R. et al., Mechanics of Materials, John Wiley and Sons. 2006.
2. Norris, C. H., Wilbur, J. B. and Utku, S., Elementary Structural Analysis, Tata McGraw Hill. 1991.
3. West, H.H., Analysis of Structures, John Wiley and Sons, 2002.
4. Wang, C.K., Intermediate structural Analysis Structures, Tata McGraw Hill, 2010.

CEL302 GEOTECHNICAL ENGINEERING-I (3-0-2-4)

Pre-requisite: NIL

Contents:

Origin of soils, soil classification, three-phase system, Physical Properties and their interrelationships, Indian system of classification, mechanical sieve analysis, consistency of fine grained soils, Atterberg's limits, relative density, Unified soil classification system, 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, rock forming minerals and rock types, physical and Engineering

property of rocks: UCS, point load strength index, Brazilian and Triaxial compression tests, Deere-Miller classification of rocks stress-strain response and strength criteria.

Practical: Practicals as per course contents.

Text Books:

1. Craig, RF., Craig's Soil Mechanics, Taylor and Francis, 2010.
2. Ranjan, G. and Rao, A.S.R., Basic and Applied Soil Mechanics, New Age International Publishers, 2012.

Additional Books:

1. Holtz, R.D. and Kovacs, W.D., An Introduction to Geotechnical Engineering, Prentice Hall, 2011.
2. Couduto, D.P., Geotechnical Engineering: Principles and Practices, Prentice Hall of India, 2007.
3. Murthy, V.N.S., Text Book of Soil Mechanics and Foundation Engineering, CBS Publishers, 2011.
4. Lambe, T.W. and Whitman, R.V., Soil Mechanics, John Wiley and Sons, 2008.

CEL303 HYDROLOGY AND IRRIGATION ENGINEERING (3-0-2-4)

Pre-requisite: NIL

Contents:

Hydrology: Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, Hydrographs, flood estimation, reservoir capacity, reservoir and channel routing. Well hydraulics.

Irrigation: Duty, delta, Crop water requirements, Evapo-transpiration. Design of: lined and unlined canals, waterways, head works, gravity dams and spillways. Design of weirs on permeable foundation. Types of Irrigation system, Irrigation methods. Water logging and drainage, sodic soils.

Practical: Practicals as per course contents.

Text Books:

1. Ojha, C.S.P., Berndtsson, R. and Bhunya, P., Engineering Hydrology, Oxford University Press, 2012.
2. Asawa, G.L., Irrigation and Water Resources Engineering, New Age International Publishers, 2013.

Additional Books:

1. Subramanya, K., Engineering Hydrology, Tata McGraw Hill, New Delhi, 2013.
2. Chow, V. T., Maidment, D.R. and Mays, L.W., Applied Hydrology, Tata McGraw Hill, 2013.

CEL304 ENVIRONMENTAL ENGINEERING-II (3-0-2-4)

Pre-requisite: NIL

Contents:

Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits. Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/recycle, energy recovery, treatment and disposal). Noise Pollution: Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Practical: Practicals as per course contents.

Text Books:

1. Davis, M.L. and Cornwell, D.A., Introduction to Environmental Engineering, Tata McGraw Hill, 2012.
2. Peavy, H.S., Rowe, D.R. and Tehobanoglous, G., Environmental Engineering, Tata McGraw Hill, 2012.

Additional Books:

1. Kenneth, W., Warner, F.C. and Davis, W.T., Air Pollution its Origin and Control, Prentice Hall, 1997.
2. Mishra, P.C., Fundamental of Air and Water Pollution, South Asia Books, 1990.
3. Masters, G., Introduction to Environmental Engineering and Science, Prentice Hall, 2004.

CEL305 STRUCTURAL ANALYSIS – II (3-2-0-4)

Pre-requisite: CEL201 STRENGTH OF MATERIALS, CEL301 STRUCTURAL ANALYSIS – I

Contents:

Analysis of rolling loads. Influence lines for statically determinate and statically indeterminate structures. Force method of analysis of indeterminate structures. Displacement approach; basic principles. Slope deflection method. Moment distribution method, frame with/without sway, use of symmetry and anti-symmetry. Matrix displacement method, Basic principles, Application to planar structures-trusses, beams and frames.Plastic analysis of beams and frames.

Text Books:

1. Hibbeler, R.C., Structural Analysis, Pearson Press, 2013.
2. Reddy, C.S., Basic Structural Analysis, Tata McGraw Hill, 2012.
3. Wang, C.K., Intermediate Structural Analysis, McGraw Hill, 2012.

Additional Books:

1. William, F. R. et al., Mechanics of Materials, John Wiley and Sons, 2004.
2. Norris, C.H. et. al., Elementary Structural Analysis, Tata McGraw Hill, 1991.
3. West, H.H., Analysis of Structures, John Wiley and Sons, 2011.
4. Weaver, W. Jr. and Gere, J.M., Matrix Analysis of Framed Structures, CBS Publishers, 2004.

CEL306 GEOTECHNICAL ENGINEERING-II (3-0-2-4)

Pre-requisite: CEL302 GEOTECHNICAL ENGINEERING-I

Contents:

Sub-surface investigations- scope, soil boring techniques, sampling, penetration tests, plate load test. Earth pressure theories, effect of water table, layered soils. Methods of Stability of slopes-infinite slopes, finite slopes. Earth Pressure and Retaining structures – stability analysis. Foundation types: Foundation design requirements, Shallow Foundations: bearing capacity, effect of shape, size, water table and other factors, stress distribution, settlement analysis in sands and clays. Deep foundations–pile types, dynamic and static formulae, load capacity of piles in sands and clays, negative skin friction. Concept of rock mass, Rocks Mass classification systems: RMR, Q

systems; Foundations on rocks and rock masses, bearing capacity theories, Foundations of dams, barrages, bridge piers, foundation treatment, Rock Slopes: Failure Modes, Kinematics analysis of rock slopes; Analysis of plane failure; stress distribution around circular tunnels, support systems

Practical: Practicals as per course contents.

Text Books:

1. Ranjan, G. and Rao, A.S.R., Basic and Applied Soil Mechanics, New Age International
2. Publishers, 2014.
3. Craig, R.F., Craig's Soil Mechanics., 2004, Taylor and Francis, New York, USA, 2010
4. Bowles, J.E., Foundation Analysis and Design, 1997, Tata McGraw Hill, 2013.

Additional Books:

1. Das, B.M., Principles of Geotechnical Engineering, Thomson, India, 2007.
2. Som, N.N. and Das, S.C., Theory and Practice of Foundation Design, Prentice-Hall, 2009.
2. Couduto, Donald P., Geotechnical Engineering: Principles and Practices, Prentice-Hall, 2007.
3. Peck, R.B., Hanson, W.E. and Thornburn, T.H., Foundation Engineering, John Wiley, 2012.
4. Murthy, V.N.S., Text Book of Soil Mechanics and Foundation Engineering, CBS Publishers, 2013.

CEL307 DESIGN OF RCC STRUCTURES (3-2/2-2/2-4)

Pre-requisite: CEL201 (STRENGTH OF MATERIALS), CEL301 STRUCTURAL ANALYSIS – I, CEL305 STRUCTURAL ANALYSIS – II

Contents:

Concrete Technology- properties of concrete, basics of mix design. Concrete design- basic working stress and limit state design concepts, working stress design for common flexural members. Design of R.C. beam Sections in flexure, shear, torsion and bond by limit state design; Design for serviceability; Design of one way and two way R.C. Slabs; Design of R.C. short and long columns; Design of R.C. footings. Basic elements of prestressed concrete.

Practical: Practicals as per course contents.

Text Books:

1. Pillai, S.U. and Menon, D., Reinforced Concrete Design, Tata McGraw Hill, 2013.
2. Jain, A.K., "Reinforced Concrete" Nem Chand and Bros,2012.

Additional Books:

1. Sinha, S.N., Reinforced Concrete Design, Tata McGraw Hill, 2013.
2. Gambhir, M.L., Fundamentals of Reinforced Concrete Design, Prentice Hall of India, 2012.
3. Shah, V.L. et. al., Limit State Theory and Design of Reinforced Concrete, Structures Publications, 2007.
4. Varghese, P.C., Limit State Design of Reinforced Concrete, Prentice-Hall, 2011.
5. Park, R. and Pauley, T., Reinforced Concrete Structures, John Wiley and Sons, 2010.

CEL308 DESIGN OF STEEL STRUCTURES (3-2/2-2/2-4)

Pre-requisites: CEL201 (STRENGTH OF MATERIALS, CEL301 STRUCTURAL ANALYSIS – I, CEL305 STRUCTURAL ANALYSIS – II

Contents:

Introduction, properties of structural steel, I.S. rolled sections, I.S. specifications. Design approach, elastic method, limit state design. Connections, simple and

moment resistant riveted, bolted and welded connections. Tension members.Compression members, struts and columns.Roof trusses, roof and side coverings, design loads, purlins, members, end bearings.Built-up columns, beams, stability of flange and web, built-up sections.Plate-girders including stiffeners, splices and curtailment of flange plates. Beam column, stability consideration, interaction formulae, column bases, slab base, gusseted base and grillage footings.

Practical: Practicals as per course contents.

Text Books:

1. Subramanian, N. Design of Steel Structures, Oxford University Press, 2012.
2. Duggal, S.K., Design of Steel Structures, Tata McGraw-Hill, 2012.

Additional Books:

1. Arya, A.S. and Ajmani, J.L., Design of Steel Structures, Nem Chand and Bros, 2007.
2. Bhavikatti, S. S., Design of Steel Structures by Limit State Method as Per IS: 800—2007, IK International, 2012

CEL401 GROUND IMPROVEMENT TECHNIQUES (3-0-0-3)

Pre-requisite: CEL302 GEOTECHNICAL ENGINEERING-I

Contents:

Role of ground improvement in foundation engineering- methods of ground improvement–Geotechnical problems in alluvial, lateritic and black cotton soils -Selection of suitable ground improvement techniques based on soil condition.Drainage techniques - Well points - Vaccum and electro-osmotic methods - Seepage analysis for two dimensional flow-fully and partially penetrating slots in homogenous deposits (Simple cases only). In-situ densification of cohesionless and consolidation of cohesive soils - Dynamic compaction and consolidation - Vibrofloation - Sand pile compaction - Preloading with sand drains and fabric drains – Stone columns – Lime piles- Installation techniques only - relative merits of various methods and their limitations.Concept of reinforcement - Types of reinforcement material - Applications of reinforced earth – use of GeoTextiles for filtration, drainage and separation in road and other works. Types of grouts - Grouting equipment and machinery -Injection methods - Grout monitoring – Stabilisation with cement, lime and chemicals - Stabilisation of expansive soils.

Text Books:

1. Moseley, M.P., Ground Improvement Blockie Academic and Professional, Chapman and Hall, Glassgow, 1993.
2. Jones J.E.P., Earth Reinforcement and Soil Structure, Butterworths, 1995.

Additional Books:

1. Koerner, R.M., Design with Geosynthetics, 3rd ed. Prentice Hall, NewJersey, 2002.
2. Jewell, R.A., Soil Reinforcement with GeoTextiles, CIRIA special publication, London, 1996.
3. Das, B.M., Principles of Foundation Engineering, Thomson Books/Cole, 2003.

CEL402 TRANSPORTATION ENGINEERING-II (3-0-0-3)

Pre-requisite: NIL

Contents:

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.

Text Books:

1. Chandra, S. and Agarwal, M.M., Railway Engineering, Oxford University Press, New Delhi, 2013.
2. Arora, S. P. and Saxena, S.C, A Text book on Railway Engineering, Dhanpat Rai Publications Pvt. Ltd., New Delhi, 2006.
3. Saxena, S. C., Airport Engineering: Planning and Design, CBS Publishers and Distributors Pvt. Ltd., New Delhi, 2008.

Additional Books:

1. Mundrey, J. S., Railway Track Engineering, Tata McGraw Hill Publishing, 2009.
2. Khanna, S. K., Arora, S. P. and Jain, S. S., Airport Planning and Design, Nem Chand and Bros, Roorkee, 1999.

CEL403 DESIGN OF HYDRAULIC STRUCTURES (3-0-0-3)

Pre-requisite: NIL

Contents:

Canal layout, regime Canal design, design concepts for irrigation structures on permeable foundations, Canal control structures; Canal Falls, Canal regulators, Canal outlets, Canal Escapes, energy dissipation devices, design of diversion works, cross drainage works, Canal falls.

Text Books:

1. Asawa, G. L., Irrigation and Water Resources Engineering, New Age International Publishers**,** 2013.
2. Varshney, R. S., Gupta S.C. and Gupta R.L., Theory and Design of Irrigation Structures, Vol. I and II, Nem Chand and Bros. 2007

Additional Books:

1. Modi, P.N., Introduction to Water Resources and Waterpower Engineering, Standard Publication, Delhi, 2013.
2. Garg, S.K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2013.

CEL404 ROCK ENGINEERING (3-0-0-3)

Pre-requisite: CEL203 ENGINEERING GEOLOGY

Contents:

Rock forming minerals and rock types, rock mass, classification systems for rocks and rock masses: RMR, Q, GSI systms, strength and deformation behaviour 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, protection measures. Stress distribution around circular tunnels, various support systems.

Text Books:

1. Ramamurthy, T., Engineering for rocks: Foundations, Slopes and Tunnels, IBH Publication, 2003.
2. Goodman P.E., Introduction to Rock Mechanics, John Wiley and Sons, 1999.

Additional Books:

1. Brow, E.T., Rock Characterisation Testing and Monitoring, Pergaman Press, 1991.
2. Arogyaswamy, R.N.P., Geotechnical Application in Civil Engineering, Oxford and IBH Publication, 1991.
3. Hock, E. and Bray, J., Rock Slope Engineering, Institute of Mining and Metallurgy, 1991.

CEL405 INDUSTRIAL WASTE MANAGMENT (3-0-0-3)

Pre-requisite: CEL205 ENVIRONMENTAL ENGINEERING -I, CEL304 ENVIRONMENTAL ENGINEERING-II

Contents:

Nature and characteristics of industrial wastes; Control and removal of specific pollutants in industrial wastewaters, i.e., oil and grease, cyanide. Fluoride, Toxic Organics, Heavy metals. Recent trends in industrial waste management; Prevention versus control of industrial pollution; Linkage between technology and pollution prevention; Tools for clean production, reuse, recycle, recovery, source reduction, raw material substitution, toxic use reduction and process modifications; Point, and area source: dispersion modeling of industrial air pollutants. Source reduction and control of industrial air pollution; Minimization of industrial solid and hazardous waste; Waste management case studies from various Industries.

Text Books:

1. Rao, M.N. and Dutta, A.K., Wastewater Treatment, Oxford-IBH Publication, 1995.
2. Freeman, H.M., Industrial Pollution Prevention Hand Book, McGraw Hill Inc., New Delhi, 1995.

Additional Books:

1. Eckenfelder, W.W., Industrial Water Pollution Control, McGraw Hill Book Company, New Delhi, 2000.
2. Shen, T.T., Industrial Pollution Prevention, Springer, 1999.
3. Stephenson, R.L. and Blackburn, J.B., Industrial Wastewater Systems HandBook, Lewis Publishers, New York, 1998.
4. Bishop, P.L., Pollution Prevention: Fundamental and Practice, Tata McGrawHill, 2000.

CEL406 FINITE ELEMENTS METHOD (3-2-0-4)

Pre-requisite: CEL201 STRENGTH OF MATERIALS

Contents:

Introduction - Overview of different methods, background of finite element method, general steps, advantages and disadvantages; One-dimensional analysis - Linear spring, truss, beam, plane frame, grid, torsion, steady state heat

conduction, flow through porous media, flow through pipes; Two-dimensional analysis - two dimensional flow through porous media, stress analysis, review of theory of elasticity, plane stress analysis, plane strain analysis, axisymmetric analysis, Isoparametric formulation, numerical integration; Computer implementation of finite element method - solution of large set of equations, use of symmetry and anti-symmetry conditions, sub-structuring, application of boundary conditions.

Text Books:

1. Bathe K.J., Finite Element Procedures, Prentice Hall of India, 2010.
2. Krishnamoorthy, C.S., Finite Element Analysis: Theory and Programming, Tata McGraw Hill, New Delhi, 1987.

Additional Books:

1. Reddy, J. N., An Introduction to Finite Element Method, 3rd ed., McGraw Hill Company, 2012.
2. Trupathi, R C. and Belegundu, A.D., Introduction of Finite Elements in Engineering, 3rd ed., Prentice Hall of India, 2012.
3. Seshu, P., Text book of Finite Element Analysis, Prentice Hall of India, 2012.
4. Zienkiewicz, O.C., Taylor, R.L. and Zhu, J.Z., Finite Element Method: Its Basis and Fundamentals, 6th ed., Elsevier Butterworth Heinemann, Oxford, 2005.
5. Desai, Y. M., Eldho, T. I. and Shah, A. H., Finite Element Method with Applications in Engineering, Pearson, 2011.

CEL407 TRANSPORTATION PLANNING (3-0-0-3)

Pre-requisite: CEL206 TRANSPORTATION ENGINEERING

Contents:

Overview of transportation systems, nature of traffic problems in cities, Transportation modes and comparison, Role of transportation: Economic, Social, Political, Environmental; Goals and objectives of Transportation planning. Survey Methodology Design, Data types and sources, Revealed and Stated Preference Data, Data collection techniques (Household and non-household based) to collect revealed and stated preference data, Sample size, and sampling techniques.Transportation demand and supply, Transportation cost analysis, consumer surplus, Elasticity. Trips, trip classification, Four-stage sequential travel demand modeling: Trip generation (Regression and category analysis), Trip distribution (Growth factor and Gravity Models), Modal split including behavioural analysis based on Random Utility Theory, Analysis of Networks, Shortest travel path algorithms, and Trip assignment (Single and multi-path route assignments). Planning for pedestrians, bicyclists and public transport systems.

Text Book:

1. Kadiyali, L.R., Traffic Engineering and Transport Planning, 6th ed., Khanna Publishers, 2012

Additional Books:

1. Ortuzar, J.D. and Willumsen, L.G., Modelling Transport, 4th ed., John Willey and Sons, 2011.
2. Morlok, E.K., Introduction to Transportation Engineering and Planning, Tata McGraw Hill, 1978.
3. Hutchinson, B. G., Principles of Urban Transport Systems Planning, Scripta Book Co., Washington, 1974.

CEL408 ENVIRONMENTAL IMPACT AND RISK ASSESSMENT (3-0-0-3)

Pre-requisite: CEL205 ENVIRONMENTAL ENGINEERING-I, CEL304 ENVIRONMENTAL ENGINEERING-II

Contents:

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.

Text Book:

1. Jain, P. K., Environment Impact Assesment, John Wiley and Sons, 1978.
2. Paustenbach, D.A., Risk Assesment: A Text Book of Case Studies, John Wiley and Sons, 1992.

Additional Books:

1. Kenneth, W., Warner, F.C. and Davis, W.T., Air Pollution its Origin and Control, Prentice Hall, 1997.
2. Mishra, P.C., Fundamental of Air and Water Pollution, South Asia Books, 1990.
3. Masters, G., Introduction to Environmental Engineering and Science, Prentice Hall, 2004.

CEL409 ADVANCED CONCRETE DESIGN (3-2-0-3)

Pre-requisite: CEL307 DESIGN OF RCC STRUCTURES

Contents:

Design of Reinforced Cement Concrete (RCC) Structures – Building frames static and dynamic analysis and component design, provisions of ductile detailing. Liquid retaining structures, Earth retaining walls, Flat slabs, Design of bridge, standard specifications and general design considerations.

Text Books:

1. Pillai, S.U. and Menon, D., Reinforced Concrete Design, Tata McGraw Hill, 2013.
2. Jain, A. K., Reinforced Concrete, Nem Chand and Bros, 2012.

Additional Books:

1. Sinha, S.N., Reinforced Concrete Design, Tata McGraw Hill, 2013.
2. Shah, V.L. et. al., Limit State Theory and Design of Reinforced Concrete, Structures Publications, 2007.
3. Nilson, A.H., and Winter, G., Design of Concrete Structures, McGraw Hill, New Delhi, 1983.
4. Victor D.J, Essential of Bridge Engineering, Oxford and IBH Publication, 2007.

CEL410 RIVER MECHANICS (3-0-0-3)

Pre-requisite: CEL202 FLUID MECHANICS

Contents:

Introduction, River morpohology, 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. Comparison and evaluation of sediment transport equations. Stable Channel design with critical tractive force theory.

Text Book:

1. Garde, R.J. and Ranga, Raju K., Mechanics of Sediment Transportation and Alluvial Stream Problems, New Age International Publishers, 2000.

Additional Books:

1. Yang, C. T., Sediment Transport: Theory and Practice, Tata McGraw Hill, New Delhi, 1996.
2. Henderson, F. M., Open Channel Flow, MacMillan, New York, 1996.
3. Chang, H. H., Fluvial Processes in River Engineering, John Wiley and Sons, 1988.
4. Simons, D. B. and Senturk, F., Sediment Transport Technology, Water Resources Publications, Fort Collins, Colorado, 1977.

CEL411 TRAFFIC ENGINEERING (3-0-0-3)

Pre-requisite: CEL206 TRANSPORTATION ENGINEERING

Contents:

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, Greenburg, Underwood, Edie, multi-regime relationships. 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, Design service volume of urban and rural roads; 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.

Text Book:

1. Kadiyali, L.R., Traffic Engineering and Transport Planning, 6th ed., Khanna Publishers, 2012

Additional Books:

1. McShane, W.R. and Roess, R.P., Traffic Engineering, Prentice Hall, 2010.
2. Papacostas, C. S. and Prevedouros, P.D., Fundamentals of Transportation Engineering, Prentice Hall, 2001

CEL412 CONSTRUCTION PLANING AND MANAGEMENT (3-0-0-3)

Pre-requisite: NIL

Contents:

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: Organisational 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 Asphatt Concrete Plants.

Text Books:

1. Srinath, L.S., PERT and CPM: Principles and Applications, East West Press, New Delhi, 2013
2. Sengupta, B. and Guha, H., Construction Management and Planning, Tata McGraw Hill, New Delhi, 1998.

Additional Books:

1. Moder, J.J. and Phillips, C.R., Project Management with CPM and PERT, Van Nostrand Reinhold, 1983.
2. Pilcher, R., Appraisal and Control of Project Cost, 1973.
3. Jebsen, J., Cost and Optimisation Engineering, Tata McGraw Hill, New York.

CEL413 ADVANCED FOUNDATION ENGINEERING (3-0-0-3)

Pre-requisites: CEL302 GEOTECHNICAL ENGINEERING-I, CEL306 GEOTECHNICAL ENGINEERING-II

Contents:

Shallow Founations: Design criteria, Bearing Capacity theories, Empirical methods, Layered soils, Foundations under eccentric and inclined loads, Foundations on or near slopes, Limit state design principles;
Deep Foundations: Pile Foundations: Types and their selection, Ultimate load of individual piles under
compressive, uplift, and lateral loading, Pile load tests, Downdrag, Pile groups. Caissons/Well foundations– bearing capacity theories; Construction methods, Machine Foundations: Principles of Vibrations, Types of machine foundations, Design criteria, Design of block foundations; Earth Retaining Structures including RC Cantilever, RC Counterfort Type Structures, Sheet piles etc.

Text Books:

1. Craig, R.F., Craig's Soil Mechanics., 2004, Taylor and Francis, New York, 2010.
2. Ranjan, G. and Rao, A.S.R., Basic and Applied Soil Mechanics, New Age International Publishers, 2014.
3. Bowles, J.E., Foundation Analysis and Design, 1997, Tata McGraw Hill, 2013.

Additional Books:

1. Das BM., Principles of Geotechnical Engineering., Thomson, India, 2007.
2. Som, N.N. and Das, S.C., Theory and Practice of Foundation Design, Prentice Hall, 2006.
3. Couduto, Donald P., Geotechnical Engineering: Principles and Practices, Prentice Hall, 2010.
4. Peck, R.B., Hanson, W.E. and Thornburn, T.H., Foundation Engineering, John Wiley and Sons, 1974.
5. Saran, S., Soil Dynamics and Machine Foundations, Galgotia Publication, 1979.

CEL414 GEOMATICS ENGINEERING (3-0-2-4)

Pre-requisite: CEL207 SURVEYING

Contents:

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, preprocessing, 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.

Practical: Practicals as per course contents.

Text Books:

1. Agarwal, C.S. and Garg, P.K. Remote Sensing in Natural Resources Monitoring and Management, Wheeler Publishing House, New Delhi, 2000.
2. Lillesand, T.L., and Kiefer, R.W., Remote Sensing and Image Interpretation, 4th ed., John Wiley and Sons, 2005.

Additional Books:

1. Ghilani, C.D. and Wolf, P.R. Elementary Surveying: an Introduction to Geomatics, Pearson, 2012.
2. Bossler, J.D. Manual of Geospatial Science and Technology, Taylor and Francis, London, 2002.
3. Burrough, P.A. and McDonnell, R.A. Principles of Geographic Information System, Oxford University Press, 2000.
4. Chandra, A.M. and Ghosh, S.K. Remote Sensing and Geographical Information Systems, Alpha Science, Oxford U.K., 2005.
5. Gopi, S. Global Positioning System: Principles and Applications, TataMcGraw Hill, 2005.
6. Lo, C.P. and Yeung, A.K.W. Concepts and Techniques of Geographical Information System, Prentice Hall, India, 2002.

CEL415 NON-DESTRUCTIVE TESTING OF MATERIALS (3-0-2-4)

Pre-requisite: CEL204 BUILDING MATERIALS AND CONSTRUCTION TECHONOLOGY

Contents:

Types of materials, tests and the variables involved, destructive and non-destructive testing correlation of properties obtained by NDT with the basic structure of matter and other properties; NDT of different materials by various techniques such as radiographic, sonic and ultrasonic, electrical and magnetic, soleoroscopic, microwave, eddy current penetrant, thermal optical, holographic etc., practical applications and advances in NDT.

Practical: Practicals as per course contents.

Text Books:

1. Bungey, S., Lillard, G. and Grantham, M.G. Testing of Concrete in Structures, 4th Ed. Taylor and Francis, London.
2. Malhotra, V.M. and Carino, N.J., Handbook on Non-Destructive Testing of Concrete, 2nd Ed., Taylor and Francis, London.

Additional Books:

1. Krautkramer, H., Ultrasonic Testing of Materials, Springer-Verlag, 1969.
2. Novgoresky, M.A., Testing of Building Materials and Structures, Mir Publishers, 1973.
3. American Society of Metals: Handbook, Vol. II, Destructive Inspection and Quality Control, 1976.

CEL416 DESIGN OF PRESTRESSED CONCREATE AND INDUSTRIAL STRUCTURES (3-0-2-4)

Pre-requisite: CEL307 DESIGN OF RCC STRUCTURES

Contents:

Prestressed Concrete Structures – Fundamentals of prestressing, Prestressing technology, Analysis of prestressed members, Prestress losses, Design for Flexure, Design for shear and torsion, Design of anchorage Zones in post-tensioned members. Industrial Structures. Analysis and design of Cylindrical shell structures, Folded plates, Chimneys, Silos, Bunkers.

Practical: Practicals as per course contents.

Text Books:

1. Jain, A.K., Reinforced Concrete, Limit State Design, 5th ed., Nem Chand and Bros. 2012.
2. Raju, N. Krishna, Advanced Reinforced Concrete Design, CBS Publishers and Distributors, 2013.

Additional Books:

1. Pillai, S.U. and Menon, D., Reinforced Concrete Design, Tata McGrawHill, 2013.
2. Krishna, J. and Jain O.P., Plain and Reinforced Concrete, Vol. 2, NemChand and Bros, 2002.

CEL417 URBAN WATER AND ENVIRONMENTAL MANAGEMENT (3-0-0-3)

Pre-requisite: NIL

Contents:

Review of Urban Hydrologic and Hydraulic Principles: Urban hydrologic cycle, rainfall analysis and design storm, hydraulic and hydrodynamic principles Introduction to Drainage Problems in Different Climate: 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 drainage 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: Administrative, legal and financing aspects, International, national and municipal legal aspects, Administrative structure for drainage planning, Financing for drainage projects.

Text Books:

1. Akan, A.O., Urban Stormwater Hydrology: A Guide to Engineering Calculations, Lancaster Technomic, 1993.
2. Larry, W.M, Stormwater Collection Systems Design Handbook, Tata McGraw Hill, New York, 2001.

Additional Books:

1. Strickland, G., Urban Hydrology for Small Watersheds, NTIS, Springfield, 1975.
2. Deb, R., Municipal Stormwater Management, Lewis Publishers, 1995.
3. Hittman Associates, Approaches to Stormwater Management, NTIS, Springer, 1973.
4. Hall, M.J., Urban Hydrology, Elsevier, London, 1984.

CEL418 ESTIMATION AND COSTING (3-0-0-3)

Pre-requisite: NIL

Contents:

Estimates: Types, complete set of estimate, working drawings, site plan, layout plan, index plan, plinth area administrative approval and Technical Sanction. 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.

Text Books:

1. Chakraborti, M., Estimating and Costing, 2002.
2. Dutta, B. N., Estimating and Costing in Civil Engineering, UBS Publishers and Distributors Ltd., New Delhi, 1999.

Additional Books:

1. Birdie, G.S., Estimating and Costing, Dhanpat Rai and Sons, 1994.
2. Kohli, D. D., Kohli, R.C., Estimating and Costing, S. Chand and Company, New Delhi, 2004.

CEL419 SOFTWARE LAB (0-0-6-3)

Contents:

Introduction to Auto Cad, Staad Pro, Ansys, Abacus, Matlab, PrimaVira, and Microsoft Project

Practical: Practicals as per course contents.

CEL420 STRUCTURAL DYNAMICS (3-0-2-2)

Pre-requisite: CEL301 STRUCTURAL ANALYSIS – I

Contents:

SDOF System : Equation of motion; Free vibration; Harmonic load; Evaluation of damping,; Periodic load; General load (time domain, frequency domain); Response spectrum load. MDOF Systems: Structural matrices; Un-damped free vibration; Generation of damping matrix, Mode superposition analysis; Practical considerations. Continuous Systems: Equation of motion; Un-damped free vibration; Forced response. Random Vibrations: Random variables and random recesses; Models of random dynamic loads; Stochastic response of SDOF and MDOF systems.

Practical: Practicals as per course contents.

Text Books:

1. Chopra, A. K., Dynamics of Structures, Applications to Earthquake Engineering, Prentice Hall, 2000.
2. Clough, R. W. and Penzien, J., Dynamics of Structures, 2nd ed., Tata McGraw Hill, Singapore, 1993.

Additional Books:

1. Meirovitch, L., Elements of Vibration Analysis, 2nd edition, Tata McGraw Hill, Singapore, 1986.
2. Agarwal, P. and Shrikhande, M., Earthquake Resistant Design of atructures, PHI Learning Pvt. Ltd., 2006.
3. James, L.S, Manual of Seismic Design, Pearson Education, 2004.

CEL421 NUMERICAL METHODS IN CIVIL ENGINEERING (3-0-0-3)

Pre-requisite: NIL

Contents:

Numerical Methods in General: Introduction: Floating Point, Round-off, Error Propagation etc.; Solution of Equations by Iteration; Interpolation; Splines; Numerical Integration and Differentiation. Numerical Methods for Differential Equations: Methods for First-Order Differential Equations; Methods for Systems and Higher Order Equations; Methods for Elliptic Partial Differential Equations; Methods for Parabolic Equations; Methods for Hyperbolic Equations. Numerical Methods in Linear Algebra: Linear Systems: Gauss Elimination, LU-Factorization, Matrix Inversion, Solution by Iteration, Ill-Conditioning, Norms; Method of Least Squares; Introduction to Matrix Eigenvalue Problem; Eigenvalues by Iteration (Power Method); Brief Discussion on Tri-diagonalization and QR-Factorization.

Text Book:

1. Chapra, Steven C., and Raymond P. Canale. Numerical methods for engineers. Fifth Edition, New York: McGraw-Hill, 2012.

Additional Books:

1. Wilkinson, J. H. The Algebraic Eigenvalue Problem. Oxford University Press, London, 1965.
2. Atkinson, K.E. An Introduction to Numerical Analysis. John Wiley and Sons, New York, 1989.
3. Golub G. E. and Loan, C.F. Van. Matrix Computations. Johns Hopkins University Press, Baltimore, 1989.

CEL422 OPTIMIZATION TECHNIQUES FOR CIVIL ENGINEERING (3-0-0-3)

Pre-requisite: NIL

Contents:

Linear Programming: Standard form of linear programming (LP) problem; Canonical form of LP problem; Assumptions in LP Models; Elementary operations; Graphical method for two variable optimization problem; Examples; Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems; Revised simplex method; Duality in LP; Primal-dual relations; Dual Simplex method; Sensitivity or post optimality analysis; other algorithms for solving LP problems – Karmarkar's projective scaling method. Use of software for solving linear optimization problems using graphical and simplex methods; Examples for transportation, assignment, water resources, structural and other optimization problems. Dynamic Programming: Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality; Recursive equations – Forward and backward recursions; Computational procedure in dynamic programming (DP); Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP. Problem formulation and applications for Design of continuous beam, Optimal geometric layout of a truss, Water allocation as a sequential process, Capacity expansion, Reservoir operation etc. Integer Programming: Formulating integer programming problems, the branch-and-bound algorithm for pure integer programs, the branch-and-bound algorithm for mixed integer programs, Non-linear Programming: Introduction to non-linear programming (NLP), Convex and concave functions, NLP with one variable, Line search algorithms, Multivariable unconstrained problems, constrained problems, Lagrange Multiplier, The Karush-Kuhn-Tucker (KKT) conditions, The method of steepest ascent, Convex combination method, penalty function methods, Quadratic programming, Dynamic programming, Evolutionary algorithms such Genetic Algorithm, concepts of multi-objective optimization, Markov Process, Queuing Models.

Text Book:

1. Rao, S. Optimisation, Theory and Applications. 2nd Edition, Wiley Eastern Ltd., New Delhi, 1991.

Additional Books:

1. Hillier, H. and Liberman, G. J. Introduction to Operations Research. Tata McGraw-Hill, 2010.
2. Morris, J. (Editor). Foundations of Structural Optimisation - A Unified Approach. John Wiley and Sons, Chichester, 1982.
3. Winston, L. Operations Research: Applications and Algorithm. 4th Edition, Cengage Learning, 1994.
4. Arora, S. Introduction to Optimum Design. McGraw-Hill International Edition, New York, 1989.
5. Reklaitis, V., Ravindran, A. and Ragsdell, K.M. Engineering Optimisation Methods and Applications. John Wiley, New York, 1983.

CEL423 MODELING, ANALYSIS AND SIMULATION (3-0-0-3)

Pre-requisite: NIL

Contents:

Taxonomy of model types, steps in model building, Simulation, Algorithms and Heuristics, Simulation languages. Relationships via physical laws, Relationships via Curve fitting, Parameter estimation problems, State transition models. Collection and presentation of data, Measures of Central tendency, Elementary probability theory, Random events, Bay's theorem, Random variables and distributions, Derived distributions, Moments and Expectations, Common probabilistic models, Statistical inference, Estimation of parameters, Tests of hypotheses and significance, Goodness of fit tests, Regression and Correlation analysis, Multivariate analysis and applications, Time services. Neighborhood and distances, Cluster analysis, Individual and group preference patterns. Graphical models and matrix models, Input-Output type models, Decomposition of large systems, routing problems. Block diagram representation, State space models, Stability, System Control. Discrete and continuous growths, Limits to growth, Competition among species, Growth process and integral equations, Discrete event approach, Population planning.

Text Book:

1. Law, Averill M. Simulation Modeling and Analysis. 4th edition, McGraw Hill Education (India) Private Limited, 2007.

Additional Books:

1. May, A. D. Traffic Flow Fundamentals. Prentice–Hall, 1990.
2. Bolstad, William M. Introduction to Bayesian Statistics. John Wiley & Sons, 2013.

CEL424 ADVANCED CIVIL ENGINEERING MATERIALS (3-0-2-4)

Pre-requisite: NIL

Contents:

Characterization and Classification of Cementitious Materials: Cement components, hydration kinetics and different hydration models, microstructural development, Characterization techniques- Calorimetry, Microscopy, XRD, TGA, X-ray tomography, MIP, Special cements: Calcium Aluminate Cements, Ca (Sulpho) aluminate-based cements, Calcium Sulphate-based cements, - polymers, Pozzolanas based cement, Alkali activated binders, Geo-polymers, Metakaolin and Fly ash based geo-polymers, Supersulphated cements, Admixtures: Mineral Admixtures- Pozzolanas, Fly-ash, Silica Fume, Rice Husk Ash, Ground Granulated Blast Furnace Slag, effect of mineral admixture on the fresh and mature concrete, Chemical Admixtures-Different types of chemical admixtures and fresh and mature concrete. Durability of concrete: Dimensional stability of concrete, Deterioration of Reinforced Concrete- Corrosion, Freeze-Thaw damage, Sulphate Attack, Alkali Silica Reaction, Fire Damage, Cracks causes and their Repair, Probabilistic design approach to durability- Lifetime safety factor method, Intended service period design method, Lifetime design method. Special Concretes: High strength and high performance concrete, Self-Compacting Concrete, Fiber-Reinforced concrete, Mass Concrete, Roller Compacted Concrete, Mix Design of High strength, Self-Compacting concretes, Special Concreting Operations- Shotcreting or Gunneting, Under- Water Concreting, Polymers in construction: Introduction to Polymers and polymer composites, theory of reinforcement. Use in Construction. Polymer concrete composites. Uses of polymer in repair, adhesives, sealants, moisture barrier etc. and other architectural uses.

Practical: Practicals as per course contents.

Text Book:

1. Mehta, P.K. and Monteiro, P.J.M. Concrete Microstructure, Properties and Materials. Third Edition, Tata McGraw Hill, 2006

Additional Books:

1. Holland, T.C. Specifications for Silica Fume for Use in Concrete. CANMET/ACI. 1995
2. Neville, A.M. and Brooks, J.J. Concrete Technology. ELBS.
3. Neville, A.M. Properties of Concrete. PITMAN.
4. Newman, John & Choo, Ban Sang. Advanced Concrete Technology-Constituent Materials. Elsevier, 2003.
5. Newman, John & Choo, Ban Sang. Advanced Concrete Technology-Concrete Properties. Elsevier 2003.
6. Newman, John & Choo, Ban Sang. Advanced Concrete Technology-Processes. Elsevier 2003.
7. Newman, John & Choo, Ban Sang. Advanced Concrete Technology-Testing and Quality. Elsevier 2003.
8. Shah, S.P., and Ahmad, S.H. High Performance Concrete and Applications. Edward Arnold. 1994.

CEL425 THEORY OF ELASTICITY (3-0-0-3)

Pre-requisite: NIL

Contents:

Introduction to the general theory of elasticity with assumptions and applications of linear elasticity. Analysis of stress, stress tensors. Two-dimensional state of stress at a point, principal stresses in two dimensions, Cauchy's stress principle, direction cosines, stress components on an arbitrary plane with stress transformation. Principal stresses in three dimensions, stress invariants, equilibrium equations, octahedral stresses, Mohr's stress circle, construction of Mohr Circle for two and three-dimensional stress systems, equilibrium equations in polar coordinates for two-dimensional state of stresses. General state of stress in Three-Dimensions in cylindrical coordinate System. Introduction to analysis of strain, types of strain, strain tensors, strain transformation. Principal strains, strain invariants, octahedral strains, Mohr's Circle for Strain, equations of Compatibility for Strain, strain rosettes. Stress-strain relations, generalized Hooke's law, transformation of compatibility Condition from Strain components to stress components. Strain energy in an elastic body, St. Venant's principle, uniqueness theorem. Two dimensional problems in Cartesian coordinate system, plane stress and plane strain problems. Stress function, stress function for plane stress and plane strain cases. Solution of two-dimensional problems with different loading conditions by the use of polynomials. Two dimensional problems in polar coordinate system, strain-displacement relations, compatibility equation, stress-strain relations, stress function and bi-harmonic equation. Axisymmetric problems, thick-walled cylinders, rotating disks of uniform thickness, stress concentration, effect of circular holes on stress distribution in plates. Winkler's - Bach theory, stresses in closed rings. Torsion of prismatic bars, general solution of the torsion problem, stress function, torsion of circular and elliptic cross sections. Prandtl's membrane analogy, torsion of thin walled and multiple cell closed sections. Introduction to elastic solutions in geotechnics. Solutions to the problems of Kelvin, Boussinesq, Flamant, Cerrutti, and Mindlin.

Text Book:

1. Timoshenko, S. P., and Goodier, J.N. Theory of Elasticity. McGraw-Hill Book Company.

Additional Books:

1. Wang, C.T. Applied Elasticity. McGraw-Hill Book Company.
2. Sitharam, T.G., and Govinda Raju L. Applied Elasticity. Interline Publishers, Bangalore.
3. Fung, Y. C. Foundations of Solid Mechanics. Prentice - Hall Publishers.

CEL426 ADVANCE STRUCTURAL MECHANICS (3-0-0-3)

Pre-requisite: NIL

Contents:

Review of basic concepts of structural analysis, Basis for principle of virtual work, Principle of virtual forces - standard and matrix formulation; Force method for analyzing skeletal structure; Principles of virtual displacements - standard and matrix formulation; Displacement method for analyzing skeletal structures; Extension of displacement method to the generalized stiffness method; Basic concepts associated with computer implementation of stiffness method. One dimensional beam element: Basis for cross-sectional level formulation of flexibility and stiffness; Gauss quadrature numerical integration scheme; Flexibility approach for determining element stiffness; Stiffness approach for determining element stiffness; Special consideration of shear effects in stiffness approach; Consideration of torsional effects for thin walled member - incl. torsion bending; special considerations for finite joints(both rigid and flexible); Consideration of local load(incl. temp.) effects; Formulation of geometric stiffness due to axial force; Linearized buckling analysis. Simplifications to reduce computational effort in analysis: Substructure analysis (static condensation); Symmetry consideration in structures.

Text Book:

1. Kanchi, M.B. Matrix Methods of Structural Analysis. John Wiley & Sons, 1982

Additional Books:

1. Weaver, Gere. Matrix Structural Analysis.
2. Pandit and Gupta. Structural Analysis by Matrix Approach. Mc Graw Hills, 1994.

CEL427 ADVANCED MATHEMATICS FOR CIVIL ENGINEERS (3-0-0-3)

Pre-requisite: NIL

Contents:

Homogeneous Linear Equations of Second Order; Second-Order Homogeneous Equations with Constant Coefficients; Case of Complex Roots, Complex Exponential Function; Nonhomogeneous Equations; Solution by Undetermined Coefficients; Solution by Variation of Parameters. Fourier Integrals and Transforms: Fourier Integrals; Fourier Cosine and Sine Transforms; Fourier Transform. Partial Differential Equations: Basic Concepts; Modeling: Vibrating String, Wave Equation; Separation of Variables, Use of Fourier Series; Modeling: Membrane, Two-Dimensional Wave Equation and Heat Equation; Rectangular Membrane, Use of Double Fourier Series. Linear Algebra: Rank of a Matrix, Linear Independence, Vector Space; Solutions of Linear Systems: Existence, Uniqueness, General Form; Vector Spaces, Inner Product Spaces, Linear Transformations; Eigenvalues, Eigenvectors; Similarity of Matrices, Basis of Eigenvectors, Diagonalization. Data Analysis, Probability Theory: Random Variables, Probability Distributions; Mean and Variance of a Distribution; Binomial, Poisson and Hypergeometric Distributions; Normal Distribution; Distributions of Several Random Variables. Mathematical Statistics: Introduction, Random Sampling; Estimation of Parameters; Confidence Intervals; Testing of Hypotheses, Decisions; Goodness of Fit, Chi-Square Test; Regression Analysis, Fitting Straight Lines; Correlation Analysis.

Text Book:

1. Kreyszig, E. Advanced Engineering Mathematics. 10th Edition, John Wiley & Sons, 1999.

Additional Books:

1. Greenberg, M. Foundation of Applied Mathematics. Dover Publication, 2014.
2. Benjamin, J.R. and Cornell, C.A. Probability, Statistics, and Decision for Civil Engineers. 1st Edition, McGraw-Hill, 1970.
3. Wylie, C.R. and Barrett, L.C. Advanced Engineering Mathematics. 6th Edition, McGraw-Hill, 1995.
4. Dasgupta, B. Applied Mathematical Methods. 1st Edition, Pearson, 2006.
5. Wilkinson, J. H. The Algebraic Eigenvalue Problem. Oxford University Press, London, 1965.
6. Atkinson, K.E. An Introduction to Numerical Analysis. John Wiley and Sons, New York, 1989.
7. Golub, G. E. and Loan, C.F. Van. Matrix Computations. Johns Hopkins University Press, Baltimore, 1989.

CEL428 CONCEPTS OF GREEN BUILDING DESIGN (3-0-0-3)

Pre-requisite: NIL

Contents: 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.

Text Book:

1. Keeler, Marian and Burke, Bill. Fundamentals of Integrated Design for Sustainable Building. John Wiley & Sons, 2009

Additional Books:

1. Mendler, Sandra F., Odell, William, and Lazarus, Mary Ann. The HOK Guidebook to Sustainable Design. Second Edition. John Wiley & Sons, 2005
2. 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
3. Yudelson, Jerry. Green Building A to Z: Understanding the Language of Green Building. New Society Publishers, 2007
4. Kibert, Charles J. Sustainable Construction: Green Building Design and Delivery. John Wiley & Sons.
5. McHarg, Ian L. Design with Nature. First edition. John Wiley & Sons, 2005.
6. Mazria, Edward. The Passive Solar Energy Book. Rodale Press, 1980.
7. Kwok, Alison and Grondzik, Walter. The Green Studio Handbook: Environmental Strategies for Schematic Design. Second edition, Architectural Press, 2011.
8. Indian Green Building Council: www.igbc.inIGBC Green Homes Abridged Reference Guide.

CEL429 RELIABILITY ANALYSIS AND RELIABILITY BASED DESIGN OF STRUCTURES STRUCTURE (3-0-0-3)

Pre-requisite: NIL

Contents:

Basic Concept of Reliability- General introduction to structural safety and reliability, Concept of uncertainty in reliability-based analysis, Mathematics of Probability and Modelling of Uncertainty- Introduction to Set Theory, Axioms of Probability and probability functions, Theorem of Total Probability, Bayes' Theorem, steps in Quantifying Randomness, Analytical Models to Quantify Randomness- Continuous Random Variables, Discrete Random Variables, Multiple Random, Variables Conditional probability, Common probability distributions, Correlation between random variables, Random vectors and functions of random variables, Randomness in Response Variables- Known Functional Relationship Between the Response and a Single Basic Random Variable. Response as a Known Function of Multiple Random Variables, Partial and Approximate Solutions, Multiple Random Variables with Unknown Relationship, Regression Analysis, Fundamentals in Reliability Analysis- Concept of failure of a structure, Risk and Safety Factors Concept, Risk-Based Design Concept and the Development of the Risk-Based Design Format, First Order Reliability Methods (FORM). Risk-Based Design Format Using FORM, Advanced topics- Second order reliability method (SORM), Reliability Analysis with Correlated Variables, Probabilistic Sensitivity Indices, System Reliability Evaluation, Implicit Performance Functions and response surface modelling, Simulation Techniques- Monte Carlo Simulation Technique, Variance Reduction Techniques, Simulation of Correlated Random Variables, Simulation based methods. Variance reduction techniques.

Text Book:

1. Haldar, A., and Mahadevan, S. Probability, reliability and statistical methods in engineering design. John Wiley and Sons, New York, 2011

Additional Books:

1. Nowak, Andrzej S. & Collins, Kevin R. Reliability of Structures. CRC Press.
2. Ang, A. H. S., and Tang, W. H. Probability concepts in engineering planning and design. Volume II: Decision, Risk & reliability. John Wiley, NY, 1984
3. Haldar, A., and Mahadevan, S. Reliability assessment using stochastic finite element analysis. John Wiley and Sons, New York, 2000
4. Ranganathan, R. Structural reliability analysis and design. Jaico Publishing House, Mumbai, 1999
5. Choi, Seung-Kyum, Grandhi, Ramana V., and Canfield, Robert A. Reliability-based Structural Design. Springer, 2007.
6. Benjamin, J R and Cornell, C.A. Probability, statistics and decisions for civil engineers. John Wiley, New York, 1970,
7. Melchers, Robert E. Structural Reliability Analysis and Prediction. John Wiley & Sons.

CEL430 ADVANCED SOIL MECHANICS (3-0-2-4)

Pre-requisite: NIL

Contents:

Soil composition and soil structure: Soil formation; Types of soils and their characteristics; Particle sizes and shapes; their impact on engineering properties; Soil structure; Clay mineralogy; Soil-air-water interaction; Consistency; Soil compaction; Concept of effective stress. Elastic theories of stress distributions in soils - Boussinesq's equation, Wester-gaard, Burmister Theories, Different conditions of loads, Constitutive relationship for soils. Shear strength parameters of cohesion less and saturated cohesive soils, Principles of Effective stress condition, Effect of rate of stress on shear parameters, Stress- Strain relationship, Skempton's Pore pressure coefficients, Hvorslev's true shear parameters, Effect of over consolidation on shear parameters. Stability analysis of a slope and finding critical slip surface; Sudden Draw down condition, effective stress and total stress analysis; Seismic displacements in marginally stable slopes; Reliability based design of slopes, Methods for enhancing stability of unstable slop; Time-Dependent Behaviour of Clays: Introduction - quasi-reconsolidation, rate effects, clay minerals, Creep and stress relaxation, Rheological models, Singh-Mitchell model.

Practical: Practicals as per course contents.

Text Book:

1. Das, Braja M. Advanced Soil Mechanics. CRC Press, 2013.

Additional Books:

1. Taylor, D.W. Fundamental of soil Mechanics. John Wiley and Sons.
2. Holtz, R.D., Kovacs, W.D., and Sheahan, T.C. An Introduction to Geotechnical Engineering. 2nd edition, Pearson, 2011.
3. Mitchell, James K. and Soga, K. Fundamentals of Soil Behaviour. 3rd edition, John Wiley & Sons, 2005.
4. Kurian, N. P. Modern Foundations – Introduction to Advanced Techniques. Tata McGraw-Hill Publishing Company Limited, New Delhi, 1984.

CEL431 AIRPORT PLANNING AND DESIGN (3-0-0-3)

Pre-requisite: NIL

Contents:

History and organization of air transport, Aircraft characterizes related to airport design, Airport configuration, Airport planning and air travel demand forecasting, Geometric design of the airside, Structural design of airfield pavements, airport drainage, Airport airside capacity and delay, Planning and design of the terminal area, Airport access, Passenger terminal system and its components. Design considerations: terminal demand parameters, facility classification, level of service criteria. Terminal planning process: overall space requirements, concept development, horizontal distribution concepts, vertical distribution concepts. Apron gate system: number of gates, ramp charts, gate size, aircraft parking type, apron layout, apron circulation, passenger conveyance to aircraft, apron utility requirements, Airport lighting and marking, Financial strategies for implementation, Environmental impacts of airports.

Text Book:

1. Kumar, V., and Chandra, S. Air Transportation Planning and Design. Galgotia Publications Pvt. Ltd., New Delhi, India, 1999.

Additional Books:

1. Neufville, R. D., and Odoni, A. Airport Systems: Planning, Design, and Management. McGraw-Hill, New York, USA, 2003.
2. Khanna, S. K., Arora, M. G., and Jain, S. S. Airport planning and Design. Sixth Edition, Nem Chand and Bros, Roorkee, India, 2012.
3. Horonjeff, R. and Mckelvey, F. X. Planning & Design of Airports. 5th Edition, McGraw Hill, New York, 2010.
4. Ashford, N., Mumayiz, S. and Wright, P. H. Airport Engineering. 4th Edition, John Wiley, New York, 2011.

CEL432 GEOMETRIC DESIGN OF TRANSPORTATION FACILITIES (3-0-0-3)

Pre-requisite: NIL

Contents:

Geometric design of highways: Design controls and criteria; Design Elements; Cross section Elements; Geometric standards for Mobility and Accessibility; Landscaping; Optical Design; Express ways Requirements – Weaving areas, Deceleration and Acceleration Lanes, Ramp configurations. Geometric design of

at grade intersections: Types and their Suitability, Factors Affecting Design – Design Principles – Data Requirements, Parameters of Intersection Design, Principles of Channelization, Functional Classification of Channelizing Islands, Island Designs, Delineation and Approach-end Treatment, Design of Orthogonal, Skewed, Rotary Intersections, Mini Roundabouts and New Types of Intersections, Location of Bus Stops and Parking Controls, Use of Templates and Flexi Curves. Geometric design of grade separated intersections: Types of grade separations; warrants; Spacing; Ramps; Control of Access; Design of Merging and Diverging lanes; Design of weaving sections, Over and Under structures; Vertical clearances; Multiple interchanges. Design of bicycle and pedestrian facilities: Bikeways Facilities – Bikeway Design Specifications – Bikeway Level of Service – Junction Treatments – Bicycle Parking Facilities – Cycle Network Planning – Pedestrian Facilities – Pedestrian q-k-v Relationships – Walkway Widths – LOS for Walkways – Subways and Over Bridges – Pedestrian Precincts – Passenger Conveyors. Parking layout and design: Parking Demand Analysis; Design of On – Street and Off – Street Facilities; Parking lots; Garage Design; Operational Design elements; Entry and Exits; Traffic Circulation Layout; Design elements for Large Parking generators.

Text Book:

1. Veeraragavan, Khanna, S.K and Justo, C.E.G. Highway Engineering. Nem Chand & Brothers, 2014.

Additional Books:

1. Wright, P. H. Highway Engineering. John Wiley & Sons, 1996.
2. Rogers, M. Highway Engineering. Blackwell Publishing, 2003.
3. May, A.D. Traffic Flow Fundamentals. Prentice Hall, 1st Edition, 1989.
4. Mannering, Fred L., Washburn, Scott S., and P., Kilareski Walter. Principles of Highway Engineering and Traffic Analysis. Wiley India Pvt Ltd., 4th Edition, 2011.
5. Institute of Transportation Engineers, Traffic Engineering Hand Book. 4th Edition, Prentice Hall., 1991.
6. Fruin, Pedestrian Planning and Design, McGraw Hill Publication, 1987.

CEL433 PLANNING, DESIGN AND CONSTRUCTION OF RURAL ROADS (3-0-0-3)

Pre-requisite: NIL

Contents:

Introduction, Overview of Development of Rural Roads, rural roads plan, road alignment and surveys, governing factors for route selection, Materials and Construction Technology, Network Planning and Design of Rural Roads, Construction of Rural Roads, Preparation of DPR, Alternatives to reduce cost of rural road construction, Use of locally available materials, Maintenance and Management of Rural Roads, Environmental and Social Safeguard Issues, Road Safety Issues in Relation to Rural Roads, Culverts and Small Bridges: Geometric standards for culverts, Design loading, design of culverts, types of culverts, causeways and submersible bridge.

Text Book:

1. Chatburn, G. R. Highway Engineering-Rural Roads and Pavements. John Wiley and Sons, Inc. Publication, 2010.

Additional Books:

1. Rural Road Manual: IRC: SP:20–2002, Indian Roads Congress. Ministry of Rural Development, New Delhi.
2. Quality Assurance Handbook for Rural Roads, Volume-I, 2007, Published by National Rural Roads Development Agency, Ministry of Rural Development Government of India.
3. Cook, J. R., Petts, R C and Rolt, J. Low Volume Rural Road Surfacing and Pavements- A Guide to Good Practice. OTB Engineering UK LLP, 2013

CEL434 PAVEMENT MATERIALS AND EVALUATION (3-0-0-3)

Pre-requisite: NIL

Contents:

Subgrade functions, Importance of subgrade soil properties on pavement performance. Aggregates: Classification, Properties of aggregates, design of aggregate gradation, texture, polishing and skid resistance. Bituminous road binders: Straight- run bitumen, emulsions, Cutback and modified binders. Rheology of bituminous binders, modified binders – adhesion and stripping, penetration index, viscosity, temperature susceptibility of viscosity. Additives and their suitability, Fillers. Design of Bituminous mixes: Marshall method. Design of emulsified mixes, Visco-elastic and fatigue properties of bituminous mixtures, resilient modulus of pavement materials. Requirements of paving concrete, design of mixes: IRC, absolute volume, Vibrated Concrete mix design, design of DLC and SFRC mixes, Soil stabilization techniques. Application of waste and locally materials for construction of pavements, quality control and assurance practices. Introduction to Super pave grading system, Super pave mix designs of different types of mixes.

Text Book:

1. Papagiannakis, A.T. and Masad, E.A. Pavement Design and Materials. John Wiley and Sons, New Jersey, USA, 2008.

Additional Books:

1. IRC: 44-2008, Guidelines for Cement Concrete Mix Design for Pavements. The Indian Roads Congress, New Delhi, India, 2008.
2. Khanna, S. K. and Justo, C. E. G. Highway Material Testing. Nem Chand & Bros., 1999.
3. Sherwood, P.T. Alternative materials in road construction. Thomas Telford, New York, USA, 1997.
4. Papagiannakis, A.T. and Masad, E.A. Pavement Design and Materials. John Wiley and Sons, New Jersey, USA, 2008.
5. Asphalt Institute. Mix Design Methods – For Asphalt Concrete and Other Hot-Mix Types Manual Series No. 2 (MS-2). Asphalt Institute, Kentucky, USA, 1997.

CEL435 PAVEMENT ANALYSIS AND DESIGN STRUCTURE (3-0-0-3)

Pre-requisite: NIL

Contents:

Types and component parts of pavements, materials used in pavements. Layered system concepts, Stress solution for one, two and three layered systems, Fundamental design concepts, Stress analysis in flexible pavements using KENLAYER. Stresses in Rigid Pavements: Westergaard's theory and assumptions, Stresses due to curling, stresses and deflections due to loading, frictional stresses, Stresses in dowel bars and tie bars, Stress analysis in rigid pavements using KENSLABS. Design of Flexible Pavements: IRC method of flexible pavement design, Asphalt Institute's methods with HMA and AASHTO method of flexible pavement design. Design of Rigid Pavements: IRC methods of rigid pavement design, AASHTO method of rigid pavement design, Design of rigid pavement shoulders.

Text Book:

1. Huang, Y.H. Pavement Analysis and Design. Second Edition, Dorling Kindersley (India) Pvt. Ltd., New Delhi, India, 2008.

Additional Books:

1. Yoder, E.J. and Witczak, M.W. Principles of Pavement Design. Second Edition, John Wiley and Sons, New York, USA, 1975.
2. Yang, N.C. Design of Functional Pavements. McGraw-Hill Book Company, New York, USA, 1972.
3. Croney, D. and Croney, P. The design and performance of road pavements. McGraw-Hill Book Company, London, UK, 1991.
4. IRC: 37-2012 Guidelines for the Design of Flexible Pavements. The Indian Roads Congress, New Delhi, India, 2012.
5. Ministry of Road Transport and Highways. Specifications for Road and Bridge Works. Fifth Edition, Indian Roads Congress, New Delhi, India, 2013.
6. IRC: 58-2011 Guidelines for the Design of Plain Jointed Rigid Pavements for Highways. The Indian Roads Congress, New Delhi, India, 2011.

CEL436 TRAFFIC FLOW THEORY (3-0-0-3)

Pre-requisite: NIL

Contents:

Traffic Stream Models: Stream flow fundamentals; individual models; family of models, pedestrian stream models. Highway capacity analysis: Capacity and level of service concepts; Factors affecting capacity and LOS; capacity of rural highways, Urban arterials; Signalised intersections; Un-signalized intersections; HCM and IRC standards. Signal Coordination: Methods of signal coordination, time-space diagram; vehicle detectors and their placement; Hydrodynamic & Kinematic Analysis of Traffic: Continuity equation; Waves in traffic, Traffic fluid state considerations, Quantitative analysis; platoon diffusion, Heat flow analysis. Shockwave Analysis: Shock wave equations; Shock waves at signalised intersections; Shock waves along a highway Queueing Analysis: Deterministic Queuing analysis; Stochastic queuing analysis; Single channel; Multiple channels; Moving queues.

Text Book:

1. Pignataro, L. J. Traffic Engineering: Theory and Practice. Prentice hall, Inc, 1973.

Additional Books:

1. Kadiyali, L.R. Traffic Engineering and Transportation Planning. Khanna Publishers, 2011.
2. Kerner, Boris S. Introduction to Modern Traffic Flow Theory and Control. Springer, 1st Edition. Edition, 2009.
3. Drew, D.R. Traffic flow theory and control. McGraw Hill Book Company, 1976.
4. Highway Capacity Manual, Transportation Research Board, Washington, D.C., 2010.
5. Roess, Roger P., Prassas, E. S. and McShane, W. R. Traffic Engineering. Prentice Hall, 4th edition, 2010.
6. Currin. Introduction to Traffic Engineering: Manual F/data Collect & Analysis, CL Engineering, 2nd Edition, 2012.

CEL437 TRANSPORT ECONOMICS (3-0-0-3)

Pre-requisite: NIL

Contents:

Economic significance of transport, Demand for transport – influencing factors, temporal and spatial variations, elasticity of demand, Supply of transport Costs – Long – term and short – term Costs, fixed and variable costs, and marginal costs, Pricing of services, Road User Costs, Evaluation of transport projects – Cost – benefit ratio, first year rate of return, net present value and internal – rate of return methods, Indirect Costs and benefits of transport projects, Project ownership and financing, Highway finance and Taxation.

Text Book:

1. Winfrey, Robley. Economic Analysis for Highway. International Textbook, Co., Pennsylvania, USA, 1969.

Additional Books:

1. Kadiyali, L.R. Traffic Engineering and Transportation Planning. Khanna Publishers, 2011.
2. Fair and Williams. Economics of Transportation. Harperand Brothers, Publishers, New York, 1959.
3. Button, Kenneth. Transport Economics. Edward Elgar Publishing, 3rd Edition, 2010.
4. McCarthy, Patrick. Transportation Economics. Wiley-Blackwell, 1st Edition, 2001.

CEL438 STABILITY OF STRUCTURES (3-0-0-3)

Pre-requisite: NIL

Contents:

Concept of stability, instability and bifurcation, different forms of structural instability, analytical approaches of stability analysis. Discrete System: Law of minimum potential energy and its implication, stability of single and two-degrees of freedom systems, large deflection analysis, effect of small imperfections. Column: Governing differential equation, cases of standard boundary conditions, effective length concept, elastically restrained column, column with geometric imperfections, eccentrically loaded column, large deflection analysis. Stability of columns and beams; Inelastic buckling. Beam-columns and Frames: Standard cases of beam columns, continuous columns and beam columns, single-storey frames, frames with sway and no-sway, buckling analysis using stiffness method, Haarman's method. Energy methods. Hamilton's principle and Lagrange's equation. Axioms for determining equilibrium and stability for static systems. Rayleigh-Ritz and Galerkin formulations. FE formulation of elastic stability problem. Thin Rectangular Plates: Governing differential equation and boundary conditions, plate with all edges simply supported, plates with other boundary conditions, buckling under in-plane shear, post buckling analysis. Buckling of frames: exact solutions. FE solutions. Demonstrations on ABAQUS/ANSYS software. Static Stability: Lateral buckling of beams; Beams on elastic foundation. Buckling of perfect Arches. Von Mise's truss. Snap through. Inelastic buckling. Double modulus theory. Dynamic Stability: Introduction to parametric instability. Strutt's diagram. Floquet's coefficients. Non-conservative loads. Divergence and flutter. Concept of follower forces and discussion of conflicting views on its existence.

Text Books:

1. Timoshenko, S.P. and Gere, JM. Theory of elastic stability. McGraw Hill, London, 1963
2. Bazant, Z. P. and Cedolin, L. Stability of structures. Oxford University Press, Oxford, 1990,

Additional Books:

1. Chajes, A. Principles of elastic stability. Prentice Hall, NJ, 1974,
2. Simitses, G. J. An introduction to the elastic stability of structures. Prentice Hall, NJ. 1976,
3. Galambos, T. V. Guide to stability design criteria for metal structures. Wiley, NY, 1998.
4. Cook, R. D., Malkus, D. S. and Plesha, M E. Concepts and applications of finite element analysis. Wiley, NY. 1989
5. McGuire, W., Gallagher, R H and Zieman, R. D. Matrix structural analysis. John Wiley, NY, 2000,
6. Bolotin, V. V. Dynamic stability of elastic systems. Holden-Day, San Fransisco, 1964,
7. Ziegler, H. Principles of structural stability. Blaisdel Publishing Company, Waltham 1968.
8. Nayfeh A. H. and Mook, D. T. Nonlinear oscillations. John Wiley, NY, 1979,

CEL501 CONTINUUM MECHANICS (3-0-0-3)

Pre-requisites: CEL425 THEORY OF ELASTICITY, CEL426 ADVANCE STRUCTURAL MECHANICS

Contents:

Continuum mechanics: an introduction, Mathematical Preliminaries, Vector spaces, Index notations, Tensor algebra, Tensor calculus. Kinematics, Motion of a body: referential and spatial descriptions, The deformation gradient, Stretch, strain and rotation, Spin, circulation and vorticity, Deformation of volume and area, Discussion on frames of reference. Basic Thermo-Mechanical Principles, Conservation of mass, Surface tractions, body forces and stress tensor, Conservation of linear and angular momentum, Conservation of energy, Clausius-Duehm inequality. Constitutive Relations, Principle of material objectivity, Thermo-elastic materials: isotropic, transversely isotropic and orthotropic, Inviscid fluids, Viscous fluids. Typical boundary value problems, Bending of beams, Torsion of a circular cylinder, Fluid flow: Poiseuille flow and Couette flow.

Text Book:

1. Fung, Y.C. First course in continuum mechanics. Englewood Cliffs: Prentice-Hall, 1977.

Additional Books:

1. Lai, W. Michael, Rubin, David and Krempl, Erhard. Introduction to continuum mechanics. Pergamon Press, Oxford, 1993.
2. Gurtin, Morton E. Introduction to continuum mechanics. Academic Press, Boston, 1981.
3. Spencer, A.J.M. Continuum mechanics. Courier Dover Publications, 2004.

CEL502 EARTHQUAKE RESISTANCE DESIGN OF STRUCTURES (3-0-0-3)

Pre-requisite: CEL420 STRUCTURAL DYNAMICS

Contents: Seismic performance of structures and structural components during earthquakes; Ground motion parameters; Response spectrum, design Spectrum. Concept of strength, over-strength and ductility, Concept of equal displacement and equal energy principles, capacity design; seismic design consideration in buildings with irregularities. 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, codal provisions. Materials, connections, joints and fasters; Columns, ordinary, intermediate and special moment resisting frame; concentrically and eccentrically braced frames. Introduction to earthquake resistant design of masonry structure.

Text Book:

1. Agrawal, P. and Shrikhande, Manish; Earthquake resistance design of structures.

Additional Books:

1. Pauley, T. and Priestley, M.J.N. Seismic Design of Reinforced Concrete and Masonry Buildings. John-Wiley & Sons.
2. Penelis, George G., and Kappos, Andreas J. Earthquake Resistant Concrete Structure. E & F. N., Spon.
3. Drysdale, R.G., Hamid, A. H. and Baker, L.R. Masonry Structure: Behaviour and Design. Prentice Hall, Englewood Cliffs.
4. Booth, Edmund. Concrete Structure in earthquake regions –Design & Analysis. Longman Scientific & Technical.

CEL503 THEORY OF PLATES AND SHELLS STRUCTURE (3-0-0-3)

Pre-requisite: CEL425 THEORY OF ELASTICITY

Contents: Governing differential equations of thin rectangular Plates with various boundary conditions and loadings. Bending of long thin rectangular plate to a cylindrical surface, Kirchhoff plate theory, Introduction to orthotropic plates, Circular plates with various boundary conditions and loadings. Numerical methods for solution of plates, Navier's, Levy's solutions. General shell geometry, classifications, stress resultants, equilibrium equation, Membrane theory for family of Shells (Parabolic, Catenary, Cycloid, Circular, hyperbolic), Classical bending theories of cylindrical shells with and without edge beams such as approximate analysis of cylindrical shells.

Text Book:

1. Timoshenko, S. P. and Krieger, S. W. Theory of Plates and Shells. McGraw-Hill, 1959.

Additional Books:

1. Szilard, R. Theory and Analysis of Plates: Classical and Numerical Methods. Prentice Hall, New York, 1974.
2. Bairagi, N. K. Shell Analysis. Khanna Publishers, New Delhi, 1990.
3. Novozhilov, V.V. Thin Shells. Groringen Publications, Netherlands, 1959.
4. Ramaswamy, G. S. Design of Concrete Shells. Krieger Publ. Co, 1984

CEL504 THEORY OF PLASTICITY (3-0-0-3)

Prerequisite: CEL501 CONTINUUM MECHANICS

Contents:

Stresses and Strains: Introduction, analysis of stress, Mohr's Representation of Stress, Strain Rate. Foundations of Plasticity: The Criterion of Yielding, Strain-Hardening Postulates. The Rule of Plastic Flow, The Total Strain Theory, Theorems of Limit Analysis, Uniqueness Theorems, Extremum Principles. Elastoplastic Bending: Plane Strain Compression and Bending, Pure Bending of Prismatic Beams, Bending of Beams Under Transverse Loads. Plastic Analysis of Beams and Frames: Limit Analysis of Beams, Limit Analysis of Plane Frames, Displacements in Plane Frames, Variable Repeated Loading, Minimum Weight Design, Influence of Axial Forces. Theory of the Slipline Field: Formulation of the Plane Strain Problem, Properties of Slipline Fields and Hodographs, Stress Discontinuities in Plane Strain, Construction of Slipline Fields and Hodographs, Analytical and Matrix Methods of Solution, Explicit Solutions for Direct Problems, Superposition of Slipline Fields.

Text Book:

1. Chakrabarty, Jagabanduhu. Theory of plasticity. Butterworth-Heinemann, 2012.

Additional Books:

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