NATIONAL INSTITUTE OF TECHNOLOGY SILCHAR

Bachelor of Technology Programmes

राष्ट्रीय प्रौद्योगिकी संस्थान, सिलचर

NATIONAL INSTITUTE OF TECHNOLOGY, SILCHAR

तेजस्विनावधीतमस्तु

Syllabi and Regulations for Undergraduate
PROGRAMME OF STUDY

(wef 2012 entry batch)

Course Structure for B.Tech (4years, 8 Semester Course) Civil Engineering

(to be applicable from 2012 entry batch onwards)

Course No	Course Name	L	T	P	C	Course No	Course Name	L	T	P	C
Semester-1						**Semester-2**					
CH-1101 /PH-1101	Chemistry/Physics	3	1	0	8	EC-1101	Basic Electronics	3	0	0	6
EE-1101	Basic Electrical Engineering	3	0	0	6	CS-1101	Introduction to Computing	3	0	0	6
MA-1101	Mathematics-I	3	1	0	8	MA-1102	Mathematics-II	3	1	0	8
CE-1101	Engineering Graphics	1	0	3	5	ME-1101	Engineering Mechanics	3	1	0	8
HS-1101	Communication Skills	3	0	0	6	PH-1101/ CH-1101	Physics/Chemistry	3	1	0	8
CH-1111 /PH-1111	Chemistry/Physics Laboratory	0	0	2	2	CS-1111	Computing Laboratory	0	0	2	2
ME-1111	Workshop	0	0	3	3	EE-1111	Electrical Science Laboratory	0	0	2	2
	Physical Training-I	0	0	2	0	PH-1111/ CH-1111	Physics/Chemistry Laboratory	0	0	2	2
	NCC/NSO/NSS	0	0	2	0		Physical Training –II	0	0	2	0
							NCC/NSO/NSS	0	0	2	0
		13	**2**	**8**	**38**			**15**	**3**	**6**	**42**
Semester-3						**Semester-4**					
MA-1201	Mathematics-III	3	1	0	8	CE-1205	Structural Analysis-I	3	1	0	8
CE- 1201	Building Materials and Construction	3	1	0	8	CE-1206	Hydraulics	3	1	0	8
CE -1202	Surveying	3	1	0	8	CE-1207	Environmental Engg-I	3	0	0	6
CE -1203	Strength of Materials	3	1	0	8	CE-1208	Structural Design-I	3	1	0	8
CE-1204	Engineering Geology	3	0	0	6	HS-1201	Managerial Economics	3	0	0	6
CE-1211	Surveying Laboratory	0	0	2	2	CE-1213	Engg. Geology Laboratory	0	0	2	2
	Physical Training –III	0	0	2	0	CE-1212	Hydraulics Laboratory	0	0	2	2
	NCC/NSO/NSS	0	0	2	0		Physical Training-IV	0	0	2	0
							NCC/NSO/NSS	0	0	2	0
		15	**4**	**2**	**40**			**15**	**3**	**4**	**40**
Semester-5						**Semester-6**					
CE-1301	Geotechnical Engineering	3	1	0	8	CE-1305	Structural Design-II	3	1	0	8
CE-1302	Structural Analysis -II	3	1	0	8	CE-1306	Structural Analysis-III	3	1	0	8
CE-1303	Transportation Engineering-I	3	0	0	6	CE-1307	Foundation Engineering	3	1	0	8
CE-1304	Environmental Engineering-II	3	0	0	6	CE-1308	Transportation Engineering-II	3	0	0	6
HS-1301	Business Management	3	0	0	6	CE-1309	Hydrology &Flood Control	3	0	0	6
CE-1311	Environmental Engineering Lab	0	0	2	2	CE-1314	Concrete Lab	0	0	2	2
CE-1312	Geotechnical Engineering Lab	0	0	2	2	CE-1315	Structural Engineering Lab	0	0	2	2
CE-1313	Transportation Engineering Lab	0	0	2	2						
		15	**2**	**6**	**40**			**15**	**3**	**4**	**40**
Semester-7						**Semester-8**					
CE-1401	Civil Engineering Estimation	3	0	0	6	CE-1441	Elements of Earthquake Engineering	3	0	0	6
CE-1402	Irrigation Engineering	3	0	0	6	CE-1442	Structural Design-III	3	0	0	6
CE-1403	Project-I	0	0	8	8	CE-1443	Project-II	0	0	10	10
CE-1404	Foundation Engineering Lab	0	0	2	2	CE-14XX	Dept. Elective-III	3	0	0	6
CE-14XX	Dept. Elective-I	3	0	0	6	CE-14XX	Dept Elective-IV	3	0	0	6
CE-14XX	Dept Elective-II	3	0	0	6	CE-14XX	Open Elective-II	3	0	0	6
XX-14XX	Open Elective-I	3	0	0	6						
		15	**0**	**10**	**40**			**15**	**0**	**10**	**40**

NB: Industrial Training after Sixth Semester for a period of 4-6 weeks as an audit course.

E1111 will be jointly offered by EE and EC Departments

LIST OF ELECTIVES -

7th SEMESTER

Elective-I

CE-1411   Open Channel Flow
CE-1412   Adv Environmental Engineering
CE-1413   Traffic Engineering
CE-1414   Optimization Methods in Engineering Design
CE-1415   Ground Water System Management

Elective-II

CE-1421   Advanced Structural Analysis
CE-1422   Remote Sensing and GIS
CE-1423   Ground Improvement
          Techniques
CE-1424   Urban Transportation
          System Planning
CE-1425   Water Resource Development

Open Elective-I

CE-1431   CAD in Engineering

8th SEMESTER

Elective-III

CE-1451   Construction Management
CE-1452   Advanced Hydrology

CE-1453   Advanced Foundation Engineering
CE-1454   Bridge Engineering
CE-1455   Analysis and Design of Pavements
CE 1456   Design of Special Structures

Elective-IV

CE-1461   Hydraulic Structures
CE-1462   Elementary Performance
          Based Seismic Design

CE-1463   Concrete Technology
CE-1464   Numerical Methods

Open Elective-II

CE-1481   ANN in Engineering
CE-1482   Evolutionary Algorithm in Search and Optimization
CE-1483   Finite Elements Methods in Engineering

CE 1101   **ENGINEERING GRAPHICS**   **L-T-P-C**
Pre-requisite: None   **1-0-3-5**
Semester: 1

Introduction: Introduction to Engineering Graphics. General instruction regarding instruments, lettering, type of lines
Geometric constructions: Division of lines, angles and curves. Construction of different polygons
Scales: Construction and reading of plain, diagonal, vernier and comparative scales.
Conic sections: Construction of parabola, ellipse, hyperbola, cycloid, trochoids, epicycloids and hypocycloid.
Orthographic projection: Angles of projections, Projection of points in different angles, projection of straight lines, Projection of plane and solid in different positions, Conversion of pictorial views of different types of simple objects into orthographic projections.
Isometric projection: Isometric projection and isometric views of different planes and solids**.**
Introduction to Auto-CAD: Introduction to Auto-CAD software, drawing of different two-dimensional and three-dimensional objects.

Suggested Reading
1.   Engineering Drawing, N.D.Bhatt & V.M.Panchal, Rupalee Publication, New Delhi.
2.   Engineering Drawing and Graphics+ AutoCAD, K. Venugopal, New Age International, New Delhi.

CE 1201   **BUILDING MATERIALS AND CONSTRUCTION**   **L-T-P-C**
Pre-requisite: None   **3- 1- 0- 8**
Semester: 3

Building and its Types: Principles of planning – Orientation, Functional requirements, Building Bye-Laws, Dead and Imposed loads. Types of foundation and their suitability. Bonds in Brick work, Rubble and Ashlar masonry, cavity wall, lintels, arches, corbels and. cornices.
Floors and Roofs: Construction details of timber, Jack arch, cement concrete, RCC, Ribbed floor, precast, Marble, Terrazzo and mosaic floors. Roofing and roof covering, exclusion of water, roof terracing, types of roof trusses.
Stair Case: Types, Planning of stair.
Doors and Windows: Types, construction details, fixing ventilators.
Misc: Damp proofing, Termite proofing, Classification and properties of Bricks, testing of bricks. Mechanical properties, seasoning and preservation of Timbers. Desirable properties, types, constituents of Paints.

Suggested Reading
1.   Building Construction, B.C. Punmia, *Laxmi Publication*.
2.   Element of Building Construction, S.C. Rangwala, *Charotar Publication, Pune*.
3.   A Text Book of Building Construction, S.K. Sharma, *S. Chand Publication, Roorkee.*
4.   Engineering Materials, S.C. Rangwala, *Charotar Publication, Pune*.
5.   Building Planning, Design and Scheduling, Gurucharan Singh. Standard Publication Distributor, Delhi.
6.   Building Bye Laws, *Silchar Development Authority*.
7.   NBC, BIS, New Delhi.
8.   IS 875, BIS, New Delhi.

CE 1202   **SURVEYING**   **L-T-P-C**
Pre-requisite: None   **3- 1- 0- 8**
Semester: 3

Principles of Surveying, Types of surveying, Chain and compass survey, Theodolite Traversing, Accuracy and errors, Triangulation, Leveling, Reciprocal leveling, Trigonometrical leveling, Contouring , Area and volume computation, Plane Table surveying , Setting out of Simple works, Tacheometric survey, Curves, Electronic Distance Measurement (EDM), Total Station and GPS, Introduction to Photogrammetry and Remote sensing.

Suggested Reading:
1.   Surveying (Vol I & II), B.C. Punmia, *Laxmi Publication, New Delhi.*
2.   Surveying (Vol-I & Vol-II), K. R.Arora, *Standard Book House*.
3.   Surveying & Leveling (Vol-I & Vol-II), T. P. Karnatkar, *Pune Vidyarthi Prakashan*.
4.   Engineering Surveying, G.W. Scholfield, Butterworth, Heinemann, *New Delhi.*

CE 1203	**STRENGTH OF MATERIALS**	**L-T-P-C**
	Pre-requisite: Engineering Mechanics (ME-1101)	**3- 1- 0- 8**

Semester: 3

Simple stresses and Strains: Stress, strain, type of stresses, elastic limit, Hooke's law, stress-strain curve, factor of safety, elastic constants, initial stiffness and secant stiffness, elongation of bars of varying sections, elongation of bars of composite sections, elongation due to self weight, bars of uniform strength, complementary shear stresses.

Bending moments and Shear forces: Beam – elastic curve, type of loads, type of supports, SF and BM, sign convention, SF and BM diagrams for cantilever, simple supported and overhanging beams, relationship between rate of loading, SF and BM.

Deflection of beams: Relationship amongst curvature, slope and deflections, slope and deflection for cantilever and simply supported beams, Macaulay's method.

Stresses in beams: Theory of bending, neutral axis and moment of resistance, bending stresses in symmetrical sections, section modulus, composite beams, shear stresses in beams.

Compound stresses: Stresses on inclined plane, stresses on inclined plane due to bi-axial normal stresses and shear stresses, principal plane, principal stresses and strains. Mohr's circle of stress.

Torsion: Analysis of torsional stresses in a plain circular shaft, power transmitted, combined bending and torsion, equivalent bending moment and torsion.

Combined Bending and Direct Stresses: Resultant stresses for rectangular and circular columns due to eccentric loads, limit of eccentricity for no tension, middle third rule.

Thin Shells: Thin cylindrical and spherical shells - Hoop stress and strain, volumetric changes.

Columns and Struts: Short and long columns, Failure of columns, slenderness ratio, Euler's theory, crippling load, Rankine's formula, Straight line and parabolic formula.

Mechanical Properties: Definitions of different properties and description of experiments for their determination.

Suggested Reading:
1. Strength of Materials, G.H.Ryder, *ELBS & Macmilan*.
2. Mechanics of Materials, Pytel and Singer, *Harper Collins Publications India Pvt. Ltd., New Delhi*.
3. Strength of Materials, U.C. Jindal, Umesh Publications, New Delhi.
4. Mechanics of Materials, Beer and Johnston, Tata McGraw-Hill, New Delhi.

CE 1204	**ENGINEERING GEOLOGY**	**L-T-P-C**
	Pre-requisite: None	**3- 0- 0- 6**

Semester: 3

Origin, age and interior of the earth, Crystallography, Mineralogy, Physical Geology, Petrology of igneous, sedimentary and metamorphic rocks, Structural Geology, Seismology, Exploration geology, Ground water, Indian stratigraphy, Economic geology.

Suggested Reading:
1. A text Book of Geology, P.K.Mukhacharjee, World Press Pvt Ltd., Kolkata.
2. Engineering Geology, Parbin Singh, S.K. Kataria & Sos, New Delhi.
3. Engineering Geology, Kesavulu, Mc Millan India Ltd. Delhi.
4. Text book of Mineralogy, Dana. Wiley Eastern Ltd., New Delhi.

CE 1211	**SURVEYING LAB**	**L-T-P-C**
	Pre-requisite: Surveying Theory (CE 1202)	**0- 0- 2- 2**

Semester: 3

List of Experiments:
1. Chain survey by perpendiculars offsets.
2. Chain survey by oblique offsets.
3. Open and closed traverse survey with chain prismatic compass.
4. Plane table survey by methods of radiation, intersection, resection.
5. Profile leveling with dumpy level, cross sections, reciprocal leveling, contouring.
6. Surveying with Theodolite – vertical and horizontal angles.

7. Use of total station.

CE 1205   **STRUCTURAL ANALYSIS-I**   **L-T-P-C**

Pre-requisite: Strength of Material (CE 1203)   **3- 1- 0- 8**

Semester: 4

Introduction to Structural Analysis: Difference between determinate and indeterminate structures, degree of indeterminacy, open tree concept, forms of structures, loads and forces, different types of supports, basic equilibrium equations, principle of superposition.
Statically Determinate Beams: Different types of beams, axial thrust, bending moment, torsion and shear force in beams with concentrated load and distributed loads.
Deflection and slope in beams: Computation of slope and deflection by double integration method, moment area method and conjugate beam method for simply supported, hinged, cantilever and overhang beams with prismatic and non-prismatic sections.
Strain energy and virtual work: Computation of strain energy for axial force, bending moment, shear force and torsion. Castigliano's theorems and their applications to find deflection and redundant forces in simple cases.
Analysis of pin joined structures: Different types of trusses, redundancy of trusses, method of joints, graphical method, deflection of joints, truss with single redundancy, Maxwell's reciprocal theorem, Betti's theorem and their applications.
Arches and Cables: Detailed analysis of three hinge arches, introduction to two hinge arches, cables, three hinged stiffening girder.
Columns and struts: Euler's theory of buckling, load carrying capacity of column under different support condition, eccentrically loaded column.

Suggested Reading:
1. Theory of Structural Analysis, Timoshenko and Young, *Mc.Graw Hill International*.
2. Structures, Marshall and Nelson, *Pritam Publishing,*
3. Structural Analysis, Norris and Wilbur, *Mc.Graw Hill International*.
4. Basic Structural Analysis, C S Reddy, *Tata Mc.Graw Hill, New Delhi*.
5. Analysis of Structures, V.N. Vazirani and M M Ratwani, *Khanna Publishers, New Delhi.*

CE 1206   **HYDRAULICS**   **L-T-P-C**

Pre-requisite: Engineering Mechanics (ME-1101)   **3- 1- 0- 8**

Semester: 4

Basic Concepts: Continuum Approach, Important physical properties: Density, Specific weight, Viscosity, Surface tension, Capillarity, Compressibility, Vapour pressure, Classification of fluids –ideal and real fluid, non-Newtonian fluids.
Fluid Statics: Pressure at a point-Pascal's Law, pressure variation in a static fluid. Scales of pressure – absolute and gauge pressure, Measurement of pressure-manometers, Forces on submerged plane and curved surfaces, Buoyant Force-centre of buoyancy, metacenter, determination of metacentric height, equilibrium of floating and submerged bodies.
Kinematics of Fluids: Study of fluid motion – Lagrangian and Eulerian methods, Classification of flow-steady and unsteady flow, uniform and non-uniform flow, rotation and irrotational flow, laminar and turbulent flow, 1-,2- & 3D flow, Concepts of streamlines, pathlines and streakline, stream tube, Continuity equation, Circulation, vorticity, Stream function, Velocity potential, Flownet.
Dynamics of fluid flow: Euler's equation of motion, Bernoulli's equation and its application-venturimeter, orificemeter, Pitot tube, momentum equation and its application to simple problems.
Orifice, mouthpiece, Notches and Weirs: Classification, discharge through a free orifice, orifice coefficients-experimental determination, External and internal mouthpiece, mouthpiece running full and free.
Classification, Velocity of Approach, Broad crested weir.
Flow through pipes: Losses in pipes flow-major loss (Loss due to friction) Darcy Weisbach equation, minor losses, Hydraulic gradient lines, Total Energy lines. Pipes in series, pipes in parallel, equivalent pipe, Siphon.
Dimensional Analysis: Dimensional-fundamental and derived qualities, Dimensional homogeneity, Methods of Dimensional analysis-Rayleigh's method and Buckingham's theorem.
Boundary layer Theory: Boundary layer Theory – its thickness, Momentum equation for boundary layer along a flat plate, Laminar and turbulent boundary layers, Boundary layer separation.
Flow around submerged Bodies: Drag and lift – types of drag, dimensional Analysis of drag and lift, drag on flat plate, sphere and cylinder, Karman trail, circulation, Lift on a cylinder with circulation – Magnus effect.

Suggested Reading:
1. Fluid Mechanics, John F. Douglas, Janusz M. Gasiorek and John A. Swaffield, *Pearson Education*.
2. Fluid Mechanics, K.L. Kumar, S. Chand & Co.

3. Fluid Mechanics, Streeter & Wily, Mc Graw Hill.
4. Fluid Mechanics and hydraulic Mechanics, R.K. Bansal, Laxmi Publisher.

CE 1207	**ENVIRONMENTAL ENGINEERING- I**	**L-T-P-C**
	Pre-requisite: None	**3- 0- 0- 6**

Semester: 4

Introduction: Sources of water, Water supply systems.
Water Demand and Quality: Population forecasting, Rate of Demand, Variation in the rate of demand.
Quality of water: Impurities and their effects. Surface and ground water pollution, water quality sampling, examination and standards for physical, chemical and bacteriological parameters.
Collection, Conveyance and Distribution of water: Intakes, Types of pipes, Methods of distributions and supply, Storages and distribution reservoirs, Methods for layout, Pressure requirements, Power requirements of pumps, Design of distribution systems.
Water Treatment: Introduction, Sedimentation, Coagulation and Flocculation, Filtration, Disinfection, Adsorption, Membranes, Water Plant Residual Management.

Suggested Reading:
1. Introduction to Environmental Engineering, Davis & Cornwell, SIE, *McGraw Hill Publication.*
2. Environmental Engineering, Peavy & Raow, *McGraw Hill Publication.*

CE1208	**STRUCTURAL DESIGN- I**	**L-T-P-C**
	Pre-requisite: Engineering Graphics (CE-1101) & Structural Analysis-I (CE 1205)	**3- 1- 0- 8**

Semester: 4

Design philosophies, Limit Sate design, Limit states of strength and serviceability, consideration of durability and fire resistance, partial safety factors, Design for flexure, shear, torsion. Design of compression members, interaction curves. Redistribution of moments. Two way and one way slab. Isolated footing, combined footing. Cantilever retaining wall. Introduction to Working stress method of design.

Suggested Reading:
1. Limit State Design of Reinforced Concrete, P.C. Varghese, *PHI, New Delhi.*
2. Reinforced Concrete Design, S.N. Sinha, *Tata McGraw Hill Pub, New Delhi.*
3. Reinforced Concrete, S.K. Mallick and A.P. Gupta, Oxford and IBH Pub., New Delhi.
4. Reinforced Concrete Design, S.U. Pillai and D. Menon, *Tata McGraw Hill Pub, New Delhi.*
5. Reinforced Concrete - Limit State Design, A.K. Jain, *Nem Chand and Co., Roorkee.*
6. Concrete Structures, V.N. Vazirani and M.M. Ratwani, *Khanna Pub, Delhi.*

CE 1213	**ENGINEERING GEOLOGY LAB**	**L-T-P-C**
	Pre-requisite: Engineering Geology Theory (CE 1204)	**0- 0- 2- 2**

Semester: 4

List of Experiments:
Study of crystal models, Study of mineral hand specimens, Study of hand specimens of igneous, sedimentary and metamorphic rocks, Study of thin sections of rocks and minerals, Study of geological maps.

CE 1212	**HYDRAULICS LAB**	**L-T-P-C**
	Pre-requisite: Hydraulics Theory (CE 1206)	**0- 0- 2- 2**

Semester: 4

List of Experiments:

Study of Bernoulli's theorem, Determination of co-efficient of Orifice, Determination of Metacentric height of vessels, Flow measurement by Venturimeter, Flow measurement by Orificemeter, Study of Force due to Impact of Jet, Flow measurement by Notches and Weirs, Study of Pressure measurement devices, Study of Free and Forced Vortex, Study of Flow Visualisation apparatus, Study of Hydraulic Jump, determination of Viscosity.

CE 1301   **GEOTECHNICAL ENGINEERING**   **L-T-P-C**

Pre-requisite: Strength of Materials (CE 1203) & Hydraulics (CE 1206)   **3- 1- 0- 8**

Semester: 5

Soil: Origin and types, Identification and classification of soil, Index Properties, phase relationship, consistency, sensitivity, clay mineralogy.

Seepage: Darcy's law of permeability, Determination of co-efficient of permeability, Equivalent permeability of stratified soil, Flow nets- principles, construction and application, effective stress analysis, quick sand condition, piping filtration criteria.

Compaction: Principle of compaction, Light and heavy compaction, field compaction control, factors affecting compaction.

Compressibility and Consolidation: Terzaghi's Theory of One Dimensional Consolidation, Secondary Consolidation, Estimation of Consolidation Settlement.

Shear Strength of Soil: Strength envelope, total and effective stress paths, pore pressure, evaluation of shear strength parameters, direct shear, triaxial shear, vane shear, unconfined compression test.

Lateral Earth Pressure: Earth pressure at rest, active and passive earth pressure, Rankine and Coulomb's earth pressure theories, Graphical Solutions.

Stability of Slope: Stability of infinite slope, stability of finite slope, slope protection.

Suggested Reading:
1. Introduction to Soil Mechanics, BM Das, *Galgotia Publication.*
2. Soil Mechanics and Foundation Engineering, BC Punmia, Dhanpat Rai & Sons.
3. Soil Mechanics, Gopal Ranjan & Rao, Dhanpat Rai & Sons.
4. Soil Mechanics, Whitman and Lambe, John Willey.
5. Soil Mechanics and Foundation Engineering, VNS Murthy, Dhanpat Rai & Sons.

CE 1302   **STRUCTURAL ANALYSIS- II**   **L-T-P-C**

Pre-requisite: Structural Analysis-I (CE 1205)   **3- 1- 0- 8**

Semester: 5

Redundant Structures: Determination of Static and Kinematic indeterminacy.

Indeterminate beams: Analysis of propped cantilever, fixed and continuous beams; effects of sinking of supports, temperature, use of three moment equation.

Classical displacement method of analysis: Application of slope deflection method, moment distribution method, Kanis method in the analysis of indeterminate beams and building frames.

Classical force method of analysis: Analysis of trusses and rigid frames by consistent deformation method, column analogy method and elastic centre method.

Miscellaneous: Two hinged arches, masonry dams and retaining walls, condition for no tension at base, chimneys, piers and abutments; introduction to fatigue, creep and stress concentration.

Suggested Reading:
1. Basic Structural Analysis, C S Reddy, *Tata Mc.Graw Hill, New Delhi.*
2. *Indeterminate Structural Analysis, C K Wang, Tata Mc.Graw Hill, New Delhi.*
3. *Theory of structures – Matrix Approach, G S Pundit, S P Gupta and R Gupta, Tata Mc.Graw Hill, New Delhi.*
4. Analysis of Structures, Vol. I & II, V N Vazirani and M M Ratwani, *Khanna Publishers, New Delhi.*
5. Structural Analysis, Debdas Menon, *Narosa Publishing House.*

CE 1303   **TRANSPORTATION ENGINEERING- I**   **L-T-P-C**

Pre-requisite: Nil   **3- 0- 0- 6**

Semester: 5

Introduction, modes and role of transportation system, transportation planning, surveying and alignment, road networking and urban transport planning. Highway materials, soils, aggregates, binders, various tests and their significances. Geometric design of highways, cross sections, sight distance, curves, hill roads. Traffic studies, traffic prediction, traffic controls, intersections, transport facilities. Pavement analysis and design, types of pavements, design factors, design methods, reliability. Relevant IRC and IS codes.

Suggested Reading:

1. Highway Engineering, SK Khanna & CEG Justo, *Nemchand Bros., Roorkee.*
2. Traffic Engg. & Transportation, LR Kaaliyali, *Khanna Publishers , Delhi.*
3. An Introduction to Transportation Engg., William W. Hay, *Toppan Co. Ltd, Tokyo.*
4. Principles of Pavement Design, E.J. Yoder & M.W. Nitterzal, *John willey & sons.*
5. Relevant IRC codes – *IRC, New Delhi*
6. Principles of Transportation Engineering., Chakraborty P. & Das A, *Prentice Hall India Pvt. Ltd., New Delhi.*

CE 1304	ENVIRONMENTAL ENGINEERING- II	L-T-P-C
	Pre-requisite: Environmental Engineering-I (CE 1207)	**3- 0- 0- 6**

Semester: 5

Introduction: Wastewater treatment systems, Terms and definitions.
Collection and Conveyance of sewage: Sewer systems, Planning and Hydraulic Design of sewers, Dry and wet weather flow, Design procedure, Sewer materials, Crown corrosion.
Wastewater Characteristics: Domestic sewage Characteristics, Physical and chemical parameters, Treatment standards, Municipal wastewater treatment systems, BOD, COD, Decomposition of sewage.
Wastewater Treatment: Unit operation and process, Method of treatment, Preliminary treatment, Primary treatment, Secondary treatment, Trickling filters, Activated sludge process, Miscellaneous Treatment systems, Disinfection, Rural sanitation, Septic tank.
Sludge Treatment and Disposal: Thickening, Digestion, Dewatering.
Suggested Reading:
1. Introduction to Environmental Engineering, Davis & Cornwell, SIE, *McGraw Hill Publication.*
2. Environmental Engineering, Peavy & Raow, *McGraw Hill Publication.*

CE 1311	ENVIRONMENTAL ENGINEERING LAB	L-T-P-C
	Pre-requisite: Environmental Engineering-I (CE 1207)	**0- 0- 2- 2**

Semester: 5

Sampling and preservation of water and wastewater samples. Examination of water /wastewater for determination of – solids, pH, turbidity, chloride, hardness ,acidity, alkalinity, sulphate, iron, residual chlorine, dissolve oxygen, BOD and COD.

CE 1312	GEOTECHNICAL ENGINEERING LAB	L-T-P-C
	Pre-requisite: Geo-Technical Engineering (CE 1301)	**0- 0- 2- 2**

Semester: 5

List of Experiments
1. Determination of field density and dry density by Core cutter Method.
2. Determination of field density and dry density by Sand replacement Method.
3. Determination of Specific gravity of soil solid.
4. Determination of Liquid limit and Plastic limit. Demonstration of Shrinkage Limit test.
5. Determination of Gradation of soil by Dry sieve analysis.
6. Determination of Gradation of soil by Hydrometer analysis.
7. Soil classification as per the Indian Standard Soil classification system.
8. Determination of Density Index/Relative density of soil.
9. Determination of Optimum moisture content and maximum dry density by Proctor Compaction Test.
10. California Bearing Ratio test..

CE 1313	TRANSPORTATION ENGINEERING LAB	L-T-P-C
	Pre-requisite: Transportation Engineering-I (CE 1303)	**0- 0- 2- 2**

Semester: 5

List of Experiments

Test on soils – LL, PL, gradation, CBR test. Test of aggregates – AIV, ACV, LAAV, shape test, Specific Gravity and water absorption test, stripping test. Test on bitumen – penetration test, viscosity test, Ring and Ball test, ductility test, Sp. Gravity test. Job mix formula and Bituminous mix design.

CE 1305	STRUCTURAL DESIGN- II	L-T-P-C
	Pre-requisite: Structural Analysis-III (CE 1306) and Structural Design-I (CE 1208)	**3- 1- 0- 8**

Introduction: Types of steel, types of connections, durability, classes of sections, steel sections, types of loads, load combinations, permissible deflection, permissible slenderness ratio, methods of design.
Limit state Design philosophy: characteristic load and strength, partial safety factors for material and load.
Connections: Riveted and welded connections, strength of rivet, eccentric connections. Pitch, gauge, lap joint and butt joint.
Tension member: types of failure, design strength, bolted/riveted and welded system.
Compression members: Column buckling, effective length of columns, permissible stress. Built up columns – laced and battened. Design of slab base and gusseted base.
Flexural members: Design for flexure, shear; torsional flexural buckling. Beams, purlin. Plate girder – section design, design of stiffeners, connections.
Miscellaneous: Design under combined stresses, Roof Trusses, Design for earthquake loads, Fatigue, Introduction to working stress method of design, Durability and fire resistance.

Suggested Reading:
1. Design of Steel Structures, N. Subramanian, *Oxford University Press*.
2. Structural Steel Design, J.E. Bowles, *McGraw Hill, New York*.
3. Design of Steel Structures, A.S. Arya and J.L. Ajmani, *Nem Chand & Sons, Roorkee*.
4. Design of Steel Structures, Ramchandra, *Standard Book House, New Delhi*.
5. Design of Steel Structures, S.K. Duggal, *McGraw Hill, New York*.
6. IS 800-2007, IS-816, SP-38, SP-6(6).

CE 1306	STRUCTURAL ANALYSIS- III	L-T-P-C
	Pre-requisite: Structural Analysis- II (CE 1302)	3- 1- 0- 8

Semester: 6

Analysis of building frames: Substitute frame, approximate method of analysis of building frames subjected to gravity loads and lateral loads, portal method, cantilever method.
Moving loads and influence lines: Construction and uses of influence lines for bending moment, shear force for determinate structures like beams and trusses; three hinge arches, application of Muller Breslau's principle for indeterminate structures.
Matrix method of structural analysis: Introduction to matrix method, flexibility method and stiffness method for beams, plane truss and frames. Definition of Plane stress and plane strain problem.
Plastic methods of structural analysis: Concept of plastic method, shape factor, beam, sway and combined mechanism, plastic moment distribution, deflection at point of collapse, introduction to finite element method.

Suggested Reading:
1. Matrix Method of Structural Analysis, W. Weaver and J.M. Gere, *CBS Publishers, New Delhi*.
2. Basic Structural Analysis, C S Reddy, *Tata Mc.Graw Hill, New Delhi*.
3. Indeterminate Structural Analysis, C.K. Wang, *Tata Mc.Graw Hill, New Delhi*.
4. Theory of Structures, G.S. Pundit, S.P. Gupta and R. Gupta, *Tata Mc.Graw Hill, New Delhi*.
5. Analysis of Structures Vol. I & II, V.N. Vazirani and M.M. Ratwani, *Kanna Publishers, Delhi*.
6. Plastic method of Structural Analysis, B.G. Neal, *Champian and Hall*.

CE 1307	FOUNDATION ENGINEERING	L-T-P-C
	Pre-requisite: Geotechnical Engineering (CE 1301)	3- 1- 0- 8

Semester: 6

Soil Exploration and site investigation, Shallow and Deep foundations, bearing capacity and settlement calculations. Vertical and lateral load capacity of piles, pile load tests, well foundation, Soil dynamics and Machine foundations. Ground improvement techniques for cohesive and cohesionless soils, foundations on expansive soils.

Suggested Reading:
1. Soil Mechanics and Foundation Engg, BC Punmia, *Dhanpat Rai & Sons.*
2. Basic and applied soil Mechanics, Gopal Ranjan & ASR Rao, *New Age Int. Pub.*
3. Soil Mechanics & Foundation Engineering.,VNS Murthy, *Dhanpat Rai & sons*.

CE 1308	TRANSPORTATION ENGINEERING- II	L-T-P-C
	Pre-requisite: Transportation Engineering -I (CE 1303)	3- 0- 0- 6

Semester: 6

Railway Engineering: Introduction, traction, gauges, tracks – components and functions. Cross section, coning of wheels, wear and tear, failures, joints, fittings and fixtures, ballast, sleepers and drainage. Geometric design, alignments, gradients, grade compensation, super-elevation, negative sup-elevation, cant, cant deficiency, negative cant, horizontal curves, transition curves. Points and crossing, signaling and interlocking, station yards.

Airport Engineering: Airport planning, aircraft characteristics and configurations, site selection, zoning laws, imaginary surfaces, approach zones, turning zones. Runway and taxiway, runway length and corrections, geometric elements, exit taxiway, separation clearance, ICAO and FAA specifications. Airport layout, holding apron, hangers, parking, terminals, traffic control, marking, lighting, heliports.

Suggested Reading:
1. A. Text Book of Railway Engg, S. C. Saxena & S. P. Arora, *Dhanpat Rai & sons, New Delhi.*
2. Indian Railway Track, Agarwal M.M., *Sachdeva Press, New Delhi.*
3. Airport Planning & Design, S. K. Khanna, M.G Arora & S. S. Jain, *Nemchand Bros., Roorkee*
4. Planning & Design of Airport, Hernjeff R & Makelvey, *Mc Graw Hill New York.*

CE 1309	**HYDROLOGY AND FLOOD CONTROL**	**L-T-P-C**
	Pre-requisite: Hydraulics (CE 1206)	**3- 0- 0- 6**

Semester: 6

Precipitation – Formation and types, forms; measurement, estimating missing precipitation data, average precipitation over area, depth-area-duration analysis.
Stream Flow – Water stage and its measurements, discharge current meter and current-meter measurements, stage-discharge relations, extension of rating curves.
Runoff - The component of runoff, hydrograph, hydrograph separation, factors affecting runoff, unit hydrograph concept, derivation of unit hydrograph, Estimation of peak discharge by Rational Method, Isochrones synthetic unit hydrograph, Definition if IUF. Design flood.
Groundwater - Aquifers, movement of ground water, discharge of groundwater, equilibrium hydraulics of wells.
Flood Routing - Definition, storage equation, routing in a simple reservoir, routing in gated reservoir, stream flow routing.

Sediment transport – Origin and formation of sediments, stream erosion and deposition, definition of regime of flow, plane bed, ripple and dune regime, transition regime, anti-dune regime, introduction to bed loads, siltation, suspended load and wash load.
Classification rivers on alluvial plains – degrading, aggrading and meandering.
Floor Damage Mitigation – reduction of peak flow, confinement of flow, reduction of peak stage, diversion of floodwater, flood proofing, reduction of flood runoff, temporary evaluation of flood prone, flood insurance.

Suggested Reading:
1.Hydrology, H.M. Raghunath, *New Age International, Delhi.*
2.Hydrology for Engineers, Linsley, Kohlew Paulhors, *McGraw Hill.*
3.Hand Book of Applied Hydrology, V.T. Chow, *McGraw Hill.*
4.Engineering Hydrology, K. Subramanya, *McGraw Hill.*

CE 1314	**CONCRETE LAB**	**L-T-P-C**
	Pre-requisite: Structural Design-I (CE 1208)	**0- 0- 2- 2**

Semester: 6

List of experiments:
1. Experimental determination of workability by slump test, compacting factor test, Vebe test and Flow table test.
2. Grading analysis of coarse and fine aggregates.
3. Determination of specific gravity of coarse and fine aggregates.
4. Determination of water content and water absorption of coarse and fine aggregates – free surface moisture.
5. Determination of Specific gravity, standard consistency, initial and final setting time of cement.
6. Determination of compressive strength of cement.
7. Determination of ACV, flakiness and elongation index of coarse aggregates.
8. Test on self compacting concrete
9. Determination of fineness and soundness of cement.
10 Mix design of Concrete.

CE 1315	**STRUCTURAL ENGINEERING LAB**	**L-T-P-C**
	Pre-requisite: Structural Design-I (CE 1208)	**0- 0- 2- 2**

Semester: 6

Determination of ultimate strength, elongation and proof stress of reinforcing bars. Bend and Re-Bend Test, Nominal Mass of reinforcing bars, NDT Tests (Ultrasonic Pulse Velocity, Rebound Hammer Test etc.), Tensile Strength of MS Pipe & various size of Channel / Angle sections (ISMC / ISA).

CE 1401	**CIVIL ENGINEERING ESTIMATION**	**L-T-P-C**
	Pre-requisite: Engineering Graphics (CE 1101) &	
	Building Materials & Construction (CE 1201)	**3- 0- 0- 6**

Semester: 7

Procedure of Estimating: Methods of Estimating, items of works, long-wall, short wall method of estimate, centre-line method, Types of estimate – preliminary, approximate, plinth area estimate, detailed estimate, revised estimate, supplementary estimate. Building Cost Index, Administrative Approval, Expenditure sanction, Technical sanction, Schedule of rates and Measurement Book.
Estimate of Building: Different items of works as per CPWD/APWD schedule such as earthwork, brickwork, cement-concrete, RCC-floors, roofs, openings, painting, white and colour washing, plastering etc.
RCC Works and structures: Different items of RCC work – RCC, shuttering, measurement of reinforcing bars, standard hooks & bends, Bar-bending schedule, Estimate of RCC beam, slab column, footing and staircase.
Roads & Bridges : Introduction to the different items as per CPWD/APWD schedule, estimate of earthwork of road, estimate of metalled road, estimate of RCC slab culvert, T-beam decking, Pier and well foundation, Pipe Culvert.

Analysis of Rates: Analysis of Rates of Building works – RCC, PCC, Brickwork, Plastering, flooring, colour wash, Distempering, cement painting, woodwork, DPC, Doors & Windows, Roofing.
Specifications: General specifications for building works – RCC, Brickwork, Plastering, Flooring, Painting, white & colour wash, Woodworks, Doors & windows, DPC, terracing, rainwater exclusion, specifications for Roadwork.
Valuations: The mathematics of valuation, valuation of freehold & leasehold properties, Fixation of Rent, Methods of valuation, Investment Method, Comparison Method, Residual Method, reinstatement Method, Contractors Method. Methods of valuation of land-comparative method, abstractive method and belting method.

Suggested Reading

1. Estimating & Costing, M. Chakraborty, *M. Chakraborty, Kolkata*.
2. Estimating & Costing, B.N. Dutta, *Kalyani Publication, Kolkata*.
3. Valuation of Real Properties, S.C. Rangwala, *Charoter Publisher, Pune*.
4. Civil Engineering Contracts & Estimates, B.S. Patil, *Orient-Longman Ltd., New Delhi*.
5. CPWD Specifications Vol-I, II, III, &IV, CPWD, *Jain Book Agency, New Delhi*.
6. CPWD Analysis of Rates, CPWD, *Jain Book Agency, New Delhi*.
7. APWD Schedule of Rates, Assam PWD, *Dispur*.

CE 1402	**IRRIGATION ENGINEERING**	**L-T-P-C**
	Pre-requisite: Hydraulics (CE 1206)	**3- 0- 0- 6**

Semester: 7

Introduction – Definition, necessity, types, advantages and disadvantages of irrigation.
Soil Water-plant Relationship – Soil-water plant relationship, soil-fertility and crop rotation, crop-water relationship, manure and fertilizers for improving soil characteristics, principal crops in India.
Water-requirements of Crops – factors affecting water-requirement of crops, consumptive use of water, determination of irrigation water requirement, command area, delta, duty, base period, relation between delta, duty and base period, Kor depth and Kor period.
Flow Irrigation – (a) Unlined canal-Lacey's theory, design of canal based on silt theory. (b) Lined canal-necessity of lining, selection of lining, types of canal lining and their brief description, design consideration for line canal, maintenance of irrigation canals, Economical considerations of lining a canal.
Water-logging – Definition, adverse effects of water-logging, causes of water-logging, anti-water logging measures, Drainage system design.
Canal Head Works – Definition of diversion works and storage weirs and barrages, general layout and the components of head-words, Application of Khosla's theory of independent variables.
Canal Fall – Necessity and location, types of fall, component of fall, design of fall with hydraulic consideration-vertical drop fall and glacis fall.
Cross Drainage Works – Necessity, types of cross drainage work, selection of suitable type of cross drainage works. Design principles only.

Suggested Reading:
1. Irrigation and Water Power Engineering, B C Punmia, *Standard Publishers*.
2. Irrigation and Hydraulics Structures, S K Garg, *Khanna Publishers*.

3. Principles and Practice of Irrigation Engg, S K Sharma, *S.Chand& Co.*
4. Structures Irrigation Engg., GL Asawa, *Willey.*

CE 1403	**PROJECT-I**	**L-T-P-C**
	Pre-requisite: Depends on Project taken	
	Semester: 7	**0- 0- 8- 8**

CE 1404	**FOUNDATION ENGINEERING LAB**	**L-T-P-C**
	Pre-requisite: Geo-Technical Engineering (CE 1301)	
	and Foundation Engineering (CE 1307)	**0- 0- 2- 2**
	Semester: 7	

List of experiments:
1. Determination of co-efficient of permeability by Constant head method.
2. Determination of co-efficient of permeability by Falling head method.
3. Determination of soil shear strength parameters by Direct shear Test.
4. Determination of soil shear strength parameters by Triaxial compression test.
5. Determination of soil shear strength parameters by Unconfined compression test.
6. Determination of soil shear strength parameters by Laboratory Vane shear test.
7. Determination of co-efficient of consolidation by Consolidometer test.
8. Standard Penetration Test.
9. Plate load test.

CE 1411	**OPEN CHANNEL FLOW**	**L-T-P-C**
	Pre-requisite: Hydraulics (CE 1206)	**3- 0- 0- 6**
	Semester: 7 (Deptt. Elective I)	

Basic Flow Concepts: Types of channels, Classification of flow, Basic equations, Velocity Distribution- Velocity Coefficients, Vertical Pressure distribution.
Energy and Momentum Principles: Specific energy, Critical flow, Section factor, First hydraulic exponent, computation of critical flow, specific force, Simple channel transition.
Uniform flow in rigid boundary: Shear stress on boundary, velocity distribution in turbulent flow, Chezy's equation, Manning's equation, section factor for uniform flow computation, second hydraulic exponent, computation of uniform flow.
Uniform flow in mobile boundary channels: Incipient motion condition- Sheild's analysis, Regimes of flow, prediction of regimes, Flow resistance
Design of Channel: Rigid boundary channels, non-scouring erodible boundary channels, alluvial channels.
Gradually varied flow: Differential equation of GVF, Classification and analysis of flow profiles, Computation of GVF for parametric and non parametric channels.
Rapidly varied flow: Analysis of hydraulic jump, Flow over weir and spillways, Flow under sluice gate, brink depth.
Unsteady flow: Waves- celerity of small gravity waves, GVUF-Saint Venant's equation, Method of characteristics, RVUF- surges in open channels.

Suggested Reading:
1. Flow in open channel,S. Subramanya, *Tata McGraw Hill, New Delhi.*
2. Open channel Hydraulics, V. T. Chow , *McGraw Hill, New York.*
3. Open channel Hydraulics, R.H French, *McGraw Hill, New York.*
4. Open channel Flow, M.H. Chaudry, *Prentice Hall of India, New Delhi.*
5. Flow through open channel, K. G. Ranga Raju, *Tata McGraw Hill, New Delhi.*

CE 1412	**ADVANCED ENVIRONMENTAL ENGINEERING**	**L-T-P-C**
	Pre-requisite: Environmental Engineering- II (CE 1304)	**3- 0- 0- 6**
	Semester: 7 (Deptt. Elective I)	

Industrial Wastewater Treatment: Introduction, Methods of treating Industrial Wastewater, Pollution Characteristics of certain typical Indian industries and case study.

Air Pollution: Sources and effects, Atmospheric stability, Dispersion, Plume rise and design of stack height, Air pollution control methods and equipment
Environmental Impact Assessment: EIS, Structure and components of EIA, Methods of EIA, Case study.

Suggested Reading:
1. Introduction to Environmental Engineering by Davis & Cornwell, SIE, McGraw Hill Publication.
2. Environmental Engineering by Peavy & Raow, McGraw Hill Publication.

CE 1413	**TRAFFIC ENGINEERING**	**L-T-P-C**
	Pre-requisite: Transportation Engineering-I (CE 1303)	**3- 0- 0- 6**

Semester: 7 (Deptt. Elective I)

Driver behaviour, traffic information and control systems, traffic studies- volume, speed and delay studies, elements of traffic flow theory, characteristics of uninterrupted traffic, capacity and LOS of Uninterrupted facilities, characteristics of interrupted traffic, traffic characteristic at unsignalised intersections, design of signalized intersections, capacity and LOS of signalized intersections, actuated signal control, signal coordination.

Suggested Reading:
1. Roger P. Roess, William R. McShane & Elena S. Prassas, Traffic Engineering, Prentice Hall, 1990
2. Pignataro L.J., Traffic Engineering- Theory and Practice, Prentice Hall, 1973
3. Khisty and B.K. Lall, Transportation Engineering: An Introduction, Prentice Hall India, 2003
4. Wohl M. and Martin B.V., Traffic System Analysis. McGraw Hill Book Company. 1967
5. P. Chakraborty and A. Das, Principles of Transportation Engineering, Prentice hall of India Pvt. Ltd., 2003
6. D. May, Traffic Flow Fundamentals. Prentice Hall, 1990
7. C.S. Papacostas, Transportation Engineering and Planning, Prentice Hall India, 2001.
8. Highway Capacity Manual (HCM), Transportation Research Board, USA, 2000

CE 1414	**OPTIMIZATION METHODS IN ENGINEERING DESIGN**	**L-T-P-C**
	Pre-requisite: Advanced Structural Analysis (CE 1421)	**3- 0- 0- 6**

Semester: 7 (Dept. Elective I)

Introduction to optimisation – Definitions, classification, overview of topics. Single variable optimisation algorithms – optimality criteria, bracketing methods, region elimination methods, point estimation methods, gradient based methods, root finding using optimisation techniques.
Multivariable optimisation algorithms – optimality criteria, direct search methods, gradient based methods.
Constrained optimisation algorithms – Kuhn-Tucker conditions, algorithms for solving Non-linear programming problems, LPP
Introduction to **Genetic algorithm**

Suggested Reading:
1. Introduction to Linear and Nonlinear Programming, DG Luenberger, *Addison Wesley*.
2. Non-linear Programming Theory and Algorithms by MS Bazarra, HD Sherali and CM Shetty, *John Wiley & Sons*.
3. Engineering Optimization: Theory and Practice, Singiresu S. Rao, *Wiley*.
4. Optimization for Engineering Design: Algorithms and Examples, Kalyanmay Deb, *PHI*.

CE 1415	**GROUND WATER SYSTEM MANAGEMENT**	**L-T-P-C**
	Pre-requisite: Hydrology & Flood Control (CE 1309)	**3- 0- 0- 6**

Semester: 7 (Dept. Elective I)

Ground Water Resources – Introduction, Overview of groundwater systems, Groundwater modelling
Groundwater Flow Equations- Darcy's law, continuity equation, partially saturated flow, Flow in confined, unconfined and leaky aquifers. Flow Equation - boundary and initial conditions for aquifer systems.
Groundwater Mass Transport equations – Mass transport in saturated and partially saturated systems.
Numerical methods applied to steady and transient groundwater systems. Introduction to optimisation (LPP) methods for Groundwater Management.

Suggested Reading:
     1. Ground water Hydrology, DK Todd, *John Wiley & Sons*.

2. Ground water Resource evaluation, WC Wattor, *McGraw Hill*.
3. Ground water Models for Resources Analysis and Management, IEL Kadi, *Lewis Publishers*.

CE 1421 **ADVANCED STRUCTURAL ANALYSIS** **L-T-P-C**

Pre-requisite: Structural Analysis-I, II & III (CE 1205, 1302, 1306) **3- 0- 0- 6**

Semester: 7 (Deptt. Elective II)

Matrix method of Analysis of Structures: Static and kinematics indeterminacy of structures. Review of Matrix algebra. Fundamentals of Flexibility and Stiffness method; analysis of beam, frame and truss using Flexibility and Stiffness Method.
Finite Element Method: Brief introduction to finite element method with its principles for two, three and four nodded elements; Shape function, Beam element problems.
Special Problem: Beam on elastic foundation, analysis of simply supported, propped cantilever and cantilever beam due to dynamic loads, Finite difference method, SDOF and MDOF System (Both damped and Un-damped Case).
Analysis of Special Structures: Analysis and Design of dome, Plate and Shell type structures, Design of circular Slab for concentrated, udl, triangular and parabolic loading, Cable stayed and Suspension bridge, Dynamic Analysis of suspension bridge.

Suggested Reading:
1. Matrix Computer analysis of structures , M.F. Rubinatein, *Prentice Hall.*
2. Pile foundation, R.D. Chellis, *Mc Grew Hill Book Co.*
3. Dynamics of Structures, A.K. Chopra, *Prentice Hall of India*.
4. Advanced R.C. Design, N.K. Raju, *CBS Publication, Delhi*.
5. Theory of Vibration with Application, William Timoshenko, *CBS Publishers*

CE 1422 **REMOTE SENSING AND GIS** **L-T-P-C**

Pre-requisite: Surveying (CE 1202) **3- 0- 0- 6**

Semester: 7 (Dept. Elective II)

Energy sources and radiation principles, Remote sensing system, multi spectral scanner. Thematic map, Return beam, thermal infra Red scanner, side looking Air borne radar, Spectral Pattern Recognition: visual and digital techniques, Data acquisition from ERS, Land-sat, SPOT, sea-sat, IRS. Interpretation of Digital data products for MSS and TM.
GIS: Introduction to Geographic Information system, Data encoding, Data management, Integration of Land sat and MSS Data with other spatial Data; Multi level GIS, Data manipulation- Demonstration of software packages and laboratory works for GIS applications with objectives such as transformation, storage, analysis and modeling of the data elements.

Suggested Reading:
1. Principles of Remote Sensing, A. N. Patel Surendra Singh, *Scientific Pub (India).*
2. Principles of Remote Sensing, Paul Curan, *ELBS/Longman (U.K).*
3. Remote Sensing Digital Image Analysis, J. A. Richards, *Springer-Verlag N-Y.*

CE 1423 **GROUND IMPROVEMENT TECHNIQUES** **L-T-P-C**
Pre-requisite: Geo-Technical Engineering (CE 1301)
and Foundation Engineering (CE 1307) **3- 0- 0- 6**

Semester: 7 (Dept. Elective II)

General Principles, soil stabilization – Cement stabilization, lime stabilization, bitumen stabilization, chemical stabilization, mechanical stabilization. Grouting. Preloading with and without sand drains, stone columns, vibro-compaction, compaction piles, blasting, Soil reinforcement, Geosynthetics, Reinforced earth walls.

Suggested Reading:
1. Foundation Engineering, J. Bowles, *McGraw Hills International.*
2. Principles of Grouting, Shah and Shroft.
3. Designing with Geosynthetics, Koerner
4. Ground Improvement Techniques, Purushothama Raj.

CE 1424   **URBAN TRANSPORTATION SYSTEM PLANNING**   **L-T-P-C**

Pre-requisite: Transportation Engineering-I (CE 1303)   **3- 0- 0- 6**

Semester: 7 (Dept. Elective II)

History of Transportation system development, Urban Transportation Planning Process, Urban Travel and Transportation Systems Characteristics
Travel Demands Forecasting - trip generation, trip distribution, modal split and trip assignment.
Transport Behaviour of Individuals and Households, Land use/ Transportation systems, Introduction to Transport Economics.
Introduction to Urban Freight Transportation and Urban Mass Transportation Systems.

Suggested Reading:
1.   Modelling Transport , J. de D. Ortuzar and L.G. Willumsen, *John Wiley and Sons.*
2.   Transportation Engineering – An Introduction , C.J. Khisty and B.K. Lall, , *Prentice Hall of India Pvt. Ltd..*
3.   Transportation Engineering and Planning , C.S. Papacostas and P.D. Prevedouros, *Prentice Hall of India Pvt. Ltd..*
4.   Principles of Transportation Engineering , P. Chakroborty and A. Das, *Prentice Hall of India Pvt. Ltd.*
5.   Principles of Urban Transport Systems Planning , B.G. Hutchinson, *McGraw-Hill Book Co., New York.*
6.   Traffic Engineering and Transport Planning , L.R. Kadiyali, , *Khanna Publishers, New Delhi,* 2000.
7.   Public Transportation , G. E. Gray and L. A. Hoel, *Prentice Hall, New Jersey*, 1992.

CE 1425   **WATER RESOURCES DEVELOPMENT**   **L-T-P-C**

Pre-requisite: Hydrology & Flood Control (CE 1309)   **3- 0- 0- 6**

Semester: 7 (Dept. Elective II)

Introduction: Fields of Water Resources Engineering, Purpose of Water Resources Development, classification of Water Resources Development projects, India's water Resources, scenario of water use of India.
Probability concepts in design: Frequency series, recurrence interval, statistical methods of estimating the frequency of rare events, duration curves and synthetic stream flow: Thomas &Yering model.
Reservoirs: Classifications, site investigations, Determination of storage capacity : sequent peak algorithm, mass curve; yield, Reservoir sedimentation : sediment inflow rate, Trap efficiency, density of sediment deposited, useful life of reservoir, control of sediment.
Engineering economics: Social Importance, steps in an Engg. Economy study, selecting an interest rate for an economy study, estimated lives of hydraulic structures.
Introduction to Planning for Water-resources development, Multipurpose water Resources Development.
Benefit - Cost analysis: Project evaluation, benefit-cost measurement, examples.

Suggested Reading:
1.   Water Resources Engineering, Linsley & Franzine, *McGraw Hill Ltd, N.Y.*
2.   Economics of Water Resources Planning, James and Lee, *Tata McGraw Hill, Pub. Co.*

CE 1431   **CAD IN ENGINEERING**   **L-T-P-C**
Pre-requisite: Structural Analysis-I, II & III (CE 1205, 1302, 1306) and Strength of
Material (CE 1203)   **3- 0- 0- 6**

Semester: 7 (Open Elective- I)

Computer languages and computer graphics. Transformation of objects. Design of RCC beams, slabs, columns, footings. Design of steel beams and columns. Analysis and design of Buildings frame and its components. Review of Auto CAD. Introduction to STAAD Pro, SAP2000, ANSYS, MIDAS, MATLAB software.

Suggested Reading:
1.   Computer Aided Design, C.S. Krishnamurthy and S. Rajeev, *Mc Graw Hill Pub.*
2.   Procedural Elements for Computer Graphics by D.F. Roger, *Mc Graw Hill Pub.*
3.   Matrix Analysis of framed Structures, W. Weaver and J.W. Gere, *CBS Publishers, Delhi.*
4.   Limit State Design of Reinforced Concrete, P.C. Varghese, *Prentice Hall of India, New Delhi.*
5.   Design of Steel Structures, Ramchandra, *Standard Book House, New Delhi.*

CE 1441 **ELEMENTS OF EARTHQUAKE ENGINEERING** **L-T-P-C**

Pre-requisite: Engineering Geology (CE 1204) and Structural Design-III (CE 1442) **3- 0- 0- 6**

Semester: 8

Elements of Seismology: Causes of earthquakes, faults, folds, plate tectonic features, magnitude, intensity, accelerograms, selection of sites for structures, ground motion characteristics.
SDOF Systems: Concept of damping, Motion of systems – Free undamped , Free damped, Forced. Harmonic excitation, dynamic amplification. Logarithmic decrement.
Non-harmonic loading: Response of systems under non-harmonic loadings – Duhamel's integral. Triangular load, rectangular load, blast loads.
MDOF Systems: Two degree of freedom systems – Vibration absorption, Vibration isolation. Transmissibility of force. Many DOF systems – eigen solutions, characteristic equation, Jacobi's method, Power method, Raleigh's method, Stodola's method.

Time step analysis: Linear and nonlinear response – elstoplastic and bilinear systems.
Response spectrum: concept and construction. Use of response spectrum in structural design.
Earthquake resistant design: Design as per IS 1893. Ductile detailing – study of IS 13920 and IS 4326, SP-6(6).

Suggested Reading:
1. Dynamics of Structures – Theory and Application in Earthquake Engineering., A.K. Chopra, *PHI*.
2. Dynamics of Structures, J.L. Humer, *AA Blakema Publishers, Tokyo*.
3. Dynamics of Structures, R.W. Clough and I. Penzien, *McGraw Hill Int, New Delhi*.
4. Seismic Design of R.C. and Masonry Buildings, T. Paulay and M.J.N. Priestley, *John Wiley & Sons, New York.*
5. Earthquake Resistant Design, G.G. Penelis and A.J. Kappos, E & FN Spon, New York.
6. Earthquake Resistant Design of Structures, P. Agarwal and M. Shrikhande, *PHI*.
7. IS 1893 (Five parts), IS 13920, IS 4326, SP-6(6).

CE 1442 **STRUCTURAL DESIGN- III** **L-T-P-C**

Pre-requisite: Structural Design-II (CE 1305) **3- 0- 0- 6**

Semester: 8

Introduction: Review of Limit State and Working Stress method of design.
Building: Staircase, Lateral load analysis – portal and cantilever method, Transfer of load from slab to beams equivalent load, continuous beams. Substitute Frame method for the Analysis of building frame, Live load on Building. Design for seismic load. Design of circular slab, design of circular and rectangular slab with concentrated load, circular beam; partition wall, Design for Torsional moment for simply supported slab.
Water Tanks And Domes – Circular, rectangular, overhead and underground water tanks – IS code method, Design of spherical dome.
Prestressed Concrete – Concept, IS code requirements (IS: 1343) systems of prestressing, losses, simple design. Concept of Design of end blocks, Magnate and Battens method.
Steel & Timber: Steel Bridges – pedestrian truss bridge. Industrial Building – Trusses, Portal, Knee braces. Timber structures – IS Code requirements, classification of timber, simple design.
Suggested Reading:
1. Advanced Reinforced Concrete Design, N. Krishna Raju, *CBS Publishers and Distributors, Delhi.*
2. Prestressed Concrete, Krishna Raju, *Tata McGraw Hill, New Delhi*
3. Design of Steel Structures, N. Subramanian, *Oxford University Press*.
4. Design of Steel Structures (Vol. I & II), Ram Chandra, *Standard Book House, Delhi.*
5. Masonry & Timber Structures, A.S. Arya, *Nem Chand & Brothers, Roorkee.*
6. Design of Wood Structures, Donald E. Breyer, *Tata McGraw Hill, New Delhi.*

CE 1443 **PROJECT-II** **L-T-P-C**

Pre-requisite: Depends on Project taken **0-0-10-10**

Semester: 8

CE 1451   **CONSTRUCTION MANAGEMENT**   **L-T-P-C**

Pre-requisite: Building Material & Constructions (CE 1201)   **3- 0- 0- 6**

Semester: 8 (Deptt. Elective-III)

Principles of project contracts, types of contract documents, types of contracts, tender & agreements, acceptance of tenders, earnest money & security deposits, breach of contracts and arbitration.
Project Management through network, critical path method, early and late time calculations, Float, resource allocation.
Programme evaluation & Review technique, expected times and slack, critical path, probability of completion time of a project.
Competitive bidding in construction industry, bidding strategy, Freidman's model, Gate's model, Fine's model, effect of estimating inaccuracy, margin lost in competition, effect of estimating accuracy, No. of bidders, success rate sensitivity analysis, Risk analysis & decision trees, Lime of balancing, network compression, Prefabrication, modular co-ordination and standardization.

Concrete production plants, batching, mixing and compaction of concrete, pumping of concrete, curing methods, concreting in hot and cold weather, concreting under water. Guniting and shortcreting , shoring and underpinning, formwork, building bye laws.

Suggested Reading

1. Construction Engineering and Management, S. Seetharaman, *Umesh Publication, 3b Nath Market, Nar Sarak, New Delhi-6.*
2. Construction Equipment its Planning land Application, Mahesh Verma, *Metropolitan Book Co. Ltd., 1, Netaji Subash Marg, New Delhi-2.*
3. Contract and Estimates, B.S. Patil.
4. Construction Equipments & Methods, S. Peurofoy, *McGraw Hill International.*
5. Optimization Theory & Application, S.S. Rao, *Wiley Eastern Ltd., New Delhi.*

CE 1452   **ADVANCED HYDROLOGY**   **L-T-P-C**

Pre-requisite: Hydrology & Flood Control (CE 1309)   **3- 0- 0- 6**

Semester: 8 (Deptt. Elective-III)

Hydrologic processes – Hydrologic cycle, systems concept, system models and its classification, Reynolds Transport Theorem, continuity equation, momentum equation.
Atmospheric circulation, water vapor, precipitation, Thunderstorm cell model, evaporation and evapo-transpiration. Unsaturated flow, infiltration, Green-Ampt method, pounding time. Stream flow hydrograph, stream networks.
Analysis of discrete and continuous hydrologic data. Harmonic analysis, statistical analysis including frequency analysis, correlation and regression analysis. Time series analysis and its application in hydrology.
Linear, nonlinear, lumped and distributed parameter systems. Hydrologic design of water resources systems.

Suggested Reading:
1. Hydrology, H.M. Raghunath, *New Age International, Delhi.*
2. Hydrology for Engineers, Linsley, KohlewPaulhors, *McGraw Hill.*
3. Hand Book of Applied Hydrology , V.T. Chow, *McGraw Hill.*
4. Engineering Hydrology, K subramanya, *McGraw Hill.*

CE 1453   **ADVANCED FOUNDATION ENGINEERING**   **L-T-P-C**

Pre-requisite: Foundation Engineering (CE 1307)   **3- 0- 0- 6**

Semester: 8 (Deptt. Elective-III)

Soil Exploration, report writing, geophysical investigations. Design of combined footing, strip footing, strap footing, footings on layered soils, uplift load. Rafts and floating rafts. Pile foundations, negative skin friction, Group capacity, settlement of pile group, uplift force, Laterally loaded piles Sheet piles, design of cantilever sheet

piles and anchored bulkheads, methods of reducing lateral pressure. Soil Dynamics, Barkan's methods, elastic halt space theories, vibration isolation. Ground improvement methods.

Suggested Reading:
1. Foundation Engineering, S P Brahma, *Tata Mc Graw Hills, NewDelhi.*
2. Foundation Engineering, J. Bowles, *Mc Graw Hills International.*
3. Designing with Geosynthetrcs, Koerner
4. Soil Dynamics, Barkan
5. Hand book of Machine foundation, Srinivasulu, *Tata McGraw Hills, New Delhi.*

CE 1454	**BRIDGE ENGINEERING**	**L-T-P-C**
	Pre-requisite: Structural Analysis- III (CE 1306) and Structural Design- III (CE1442)	**3- 0- 0- 6**

Semester: 8 (Deptt. Elective-III)

Introduction: Introduction to bridge engineering, types of bridges, basics design criteria of bridge engineering, seismic effect on bridges, ground response Analysis at the bridge site, IRC loading, MOST specifications for the guide line of design of minor bridges. Geotechnical aspects of bridge location and suitability of girder depending on the span of the bridge.

Pre-Stress Bridge: Introduction to Pre-stress Bridges, Pre-stress T-beam type bridge, Pre-stress Box-type Bridge, Losses of Pre-Stress of Bridges, Torsional Analysis of bridges, Transverse and Longitudinal Analysis.

Reinforced Concrete Bridge: RCC T-beam beam bridge, Box-type bridge, Solid Slab bridge, Skew type bridge, Cable and Suspension type bridge.

Foundation of Bridges: Different type of foundation of bridges, open foundation, Pile foundation and well foundation, Design of Abutment Shaft, Pier Shaft, Well Cap, Abutment Pile Cap, Design aspects of Pier Shaft Cap and Abutment Shaft Cap.

Dynamic Analysis of Bridges: Introduction to Dynamic analysis of bridges, Eigen value and mode shape of simply supported bridges.

Suggested Reading:
1. A Text Book of Bridge Engineering, K.S. Rakshit, *Oxford & IBH Publishing Co.*
2. Essentials of Bridge Engineering, Johson Victor, *Oxford & IBH Pub. Co.*
3. Design, Construction & Practice in Bridge Engineering, S. Ponnaswamy, *Tata McGraw Hill Pub., New Delhi.*
4. Theory of Vibration with Application, William Timoshenko, *CBS Publishers.*

CE 1455	**ANALYSIS AND DESIGN OF PAVEMENTS**	**L-T-P-C**
	Pre-requisite: Transportation Engineering-I (CE 1303) & Geo-Technical Engineering (CE 1301) and Structural Design- I & III (CE 1208, 1442)	**3- 0- 0- 6**

Semester: 8 (Deptt. Elective-III)

Philosophy of design of flexible and rigid pavements, analysis of pavements using different analytical methods, selection of pavement design input parameters – traffic loading and volume, material characterization, drainage, failure criteria, reliability, design of flexible and rigid pavements using different methods, comparison of different pavement design approaches, design of overlays and drainage system.

Suggested Reading:
1. Principles of Pavement Design, E.J. Yoder, *John Willey & Sons Ive, New York.*
2. Principles of Transportation Engg. , P. Chakraborty & A Das, *PHI Pvt. Ltd., New Delhi.*
3. Highway Engg By Khanna S. K. And Justo C.E.G., *Nemchand Bros., Roorkee.*
4. Pavement Analysis & Design By Huang Y. H., *Pearson Education Inc., NJ., USA.*
5. All relevant IS & IRC Codes and NORTH Guidelines

CE 1456	**DESIGN OF SPECIAL STRUCTUES**	**L-T-P-C**
	Pre-requisite: Structural Analysis-I, II, III (CE 1205, 1302, 1306) and Structural Design- I, II, III (CE 1208, 1305, 1442)	**3- 0- 0- 6**

Semester: 8 (Deptt. Elective-III)

Design of – Chimneys, Bunkers, Silos, Folded plates, Shells, Domes, Buried Pipes, Tubular Frame Buildings, RC Walls, Frame-wall system, Elevated Water tanks with dynamic effects. Frame-wall interaction, Shear Lag effect in buildings.

Suggested Reading:
1. Reinforced Concrete Design of Tall Buildings, B.S. Taranath, *CRC Press, New York.*
2. Advanced Reinforced Concrete Design, N. Krishna Raju, CBS Pub. & Distr., Delhi.
3. Advanced Reinforced Concrete Design, P.C. Varghese, *PHI, New Delhi.*
4. Reinforced Concrete, S.K. Mallick and A.P. Gupta, Oxford and IBH Pub., New Delhi.
5. Reinforced Concrete Design, S.U. Pillai and D. Menon, *Tata McGraw Hill Pub, New Delhi.*

CE 1461	HYDRAULIC STRUCTURES	L-T-P-C
	Pre-requisite: Open Channel Flow (CE 1411) & Irrigation Engineering (CE 1402)	3- 0- 0- 6

Semester: 8 (Deptt. Elective-IV)

Dams and their Characteristics: Classification of dams, features, advantages and disadvantages of each type, Selection of type of dam.
Investigation of dam sites: Various phases of investigation, geological investigation, Sub-surface exploration, choice of location, Foundation treatment, Economic height of dam.
River diversion: Diversion schemes, Phases of diversion, diversion flood, tunnels, Cofferdams.

Gravity dams: Forces acting on gravity dams, load combinations for design, models of failure and stability requirements, Structural competency of gravity dams, Practical profile, Stability analysis, Design of non-overflow and overflow sections by single-step method.
Arch dams: Types of arch dams, Forces acting on each arch dam, Method of analysis, most economical central angle, Design of each dams based on cylinder theory.
Embankment dams: Types of embankment dams, earth dams-types, causes of failure and stability requirements, Design criteria, Preliminary design, Seepage analysis-Flownet, Phreatic line, stability analysis-Safety of u/s slope against rapid draw-down, Safety of d/s slope against steady seepage.
Hollow and Buttress dams: Hollow gravity dams, Buttress dams- types of buttress dams, Forces acting on buttress dams Design of deck-slab type buttress dams.
Weirs and Barrages: Types of weirs, causes of failure, Design of weirs on permeable foundation, Bligh s creep theory, Khoslas theory-method of independent variables.
Instrumentation: Instrumentation in dams, types of Instruments, deformation measurement of dam body and its foundation, surveying instruments.

Suggested Reading:
1. Irrigation and Water Power Engineering, BC Punmia and Pande B.B. Lal, *Laxmi Publications.*
2. Irrigation Water Power Engineering and Water Resources Engineering, K.R. Aurora, *Standard Pub*.

CE 1462	ELEMENTARY PERFORMANCE-BASED SEISMIC DESIGN	L-T-P-C
	Pre-requisite: Elements of Earthquake Engineering (CE 1441)	3- 0- 0- 6

Semester: 8 (Deptt. Elective-IV)

Historical development of Design philosophies. Force-Based Design vs. Performance-Based Design. Limitations of Force-Based Method of Design. Limitations of IS 1893 (Part 1) – 2002. Moment-curvature relationship. Strength and stiffness relationship
Definition of Maximum earthquake and Design Basis earthquakes. Spectrum Compatible ground motion. Response spectrum review. Displacement spectra
The concept of Capacity design. Expected strength and extreme strength of materials.
Performance levels – Immediate Occupancy Level, Life Safety Level, Collapse Prevention Level. The concept of Operational Level building and Life Safety Building.
Displacement-Based design philosophies. Direct displacement-Based Design Methods. Drift in buildings and design for drift. Frame Buildings, Frame-wall buildings, Design for target performance objectives. Effect of Infill on building behaviour.

Suggested Reading
1. Displacement-Based Seismic Design of structures, M.J.N. Priestley, G.M. Calve and M.J. Kowalsky, 2007, *IUSS Press, Pravia.*
2. Seismic Design of Frame-Wall Structures, T.J. Sullivan, M.J.N. Priestley and G.M. Calvi, *Research Report No. ROSE-2006/02.*
3. Seismic Design of Reinforced Concrete and Masonry Buildings, T. Paulay and M.J.N. Priestley, *John Wiley & Sons, New York.*

4. Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering, Editor Y. Bozorognia, *CRC Press*.
5. ___ ATC-40, Applied Technology Council.
6. ___ FEMA 273, NEHRP.
7. ___ FEMA-356, NEHRP.
8. ___ FEMA-440, NEHRP.
9. ___ FEMA-450, NEHRP.

CE 1463	**CONRETE TECHNOLOGY**	**L-T-P-C**
	Pre-requisite: Building Materials and Constructions (CE 1202)	**3- 0- 0- 6**

Semester: 8 (Deptt. Elective-IV)

Cement and Admixtures: Types of Portland cement, hydration, setting and hardening process, special hydraulic cements, Admixtures, accelerators, and retarders, air-entraining agents, plasticizer and super-plasticizers.
Aggregates: Shape and texture, bond, strength, specific gravity, bulk-density and moisture content of aggregates, bulking of sand, deleterious substances in aggregates, alkali-aggregate reaction, sieve-analysis and grading curves, fineness modulus, practical grading, gap grades aggregates.

Fresh Concrete: Rheological aspects such as workability-flow ability, compatibility and mobility of concrete, factors affecting workability and lab determination, segregation, bleeding & laitance.
Strength of Concrete: Compressive strength and factors affecting it, behaviours or concrete under various stress states, testing of hardened concrete – cube and cylinder test, Platen effect, flexure test, non-destructive testing such as rebound hammer test, USPV test, core-cutting, stress-strain relation and modulus of elasticity, shrinkage, creep of concrete and its effect.
Durability of Concrete: Corrosion of reinforcing bars, sulphate attack, frost action, deterioration by fire, concrete in seawater, acid attack, carbonation.
Concrete Mix Design: Basic consideration – cost, workability, strength and durability, grading, method of mix design, acceptance criteria for concrete.
Advances in Construction Materials: Higher strength concrete, fibre-reinforced concrete, concrete containing polymers, heavy weight and light weight concrete, mass concrete, blended concrete, Ferro-cements and its applications.

Suggested Reading:
1. Concrete, Structure, Properties and Materials by P.K. Mehta*, Prentices-Hall, Inc., New Jersy, USA*.
2. Properties of Concrete, A.M. Neville, *Longman U.K.*
3. Concrete Technology, M.L. Gambhir , *Tata McGraw Hill*.
4. Testing of Concrete in Structures, J.H. Bungey, *Surrey University Press, New York.*
5. Polymers in Civil Engineering, L. Hollaway, *Thomas Telford Ltd., London*.
6. Special Techniques and Materials for Concrete, Dhir, *Thomas Telford Ltd., London.*

CE 1464	**NUMERICAL METHODS**	**L-T-P-C**
	Pre-requisite: Mathematics-III (MA 1201) and Structural Analysis-III (CE 1306)	**3- 0- 0- 6**

Semester: 8 (Deptt. Elective-IV)

Nonlinear system of equations, Curve fitting techniques, numerical differentiation and integration, Numerical solution of ordinary and partial differential equations, Introduction to finite difference methods, Application of numerical methods in solving Engineering Problems.
Basics of computer algorithms and flow charts, Introduction to application of high level computer programming in solving numerical problems.

Suggested Reading:
1. Numerical Mathematical Analysis, J.B. Scarborough, Oxford & IBH Pub. Co. Pvt. Ltd., Kolkata.
2. Numerical Methods for Engineers, S.C. Chapra and R.P. Canale, Tata McGraw-Hill., New Delhi.

CE 1481	**ANN IN ENGINEERING**	**L-T-P-C**
	Pre-requisite: Evolutionary Algorithm in Search and Optimization (CE 1482)	**3- 0- 0- 6**

Semester: 8 (Open Elective-II)

Introduction to Artificial Neural Network- Concept and issues, Multi layer Network, auto associative and hetero associative nets, Learning in Neural nets, supervised and unsupervised learning, Applications of ANN, ANN simulators

Suggested Reading:
   1. Fundamentals of Neural Networks, Faussett, *Prentice Hall.*
   2. An Introduction to Neural Networks, J.A Anderson, *MIT Press, Cambridge*.

CE 1482	**EVOLUTIONARY ALGORITHM IN SEARCH AND OPTIMIZATION**	**L-T-P-C**
	Pre-requisite: Optimization Methods in Engineering Design (CE 1414)	**3- 0- 0- 6**

Semester: 8 (Open Elective-II)

Traditional optimisation methods. Foundations of Genetics Algorithms – reproduction, crossover and mutation. Analysis of GA operators – mathematical foundations. Application of Genetic algorithms in Engineering, Concept Multi-objective optimisation - Engineering applications. Introduction to some other evolutionary algorithms.

Suggested Reading:
   1. Genetic Algorithms in Search, Optimisation and Machine Learning, DE Goldberg, *Addison Wesley.*
   2. Introduction to Evolutionary Algorithms, Xinjie Yu, Mitsuo Gen, *Springer.*
   3. Engineering Optimization: Theory and Practice by Singiresu S. Rao, *Wiley.*
   4. Optimization for Engineering Design: Algorithms and Examples, Kalyanmay Deb, *PHI.*

CE 1483	**FINITE ELEMENTS METHODS IN ENGINEERING**	**L-T-P-C**
	Pre-requisite: Advanced Structural Analysis (CE 1421)	**3- 0- 0- 6**

Semester: 8 (Open Elective-II)

Basic theory, advantages and disadvantages, convergence criteria, principle of virtual work, energy principles, variational formulations, weighted residual methods. Displacement models, shape functions, element stresses and strains, element stiffness matrix. One dimensional problems, bar elements. Two dimensional elements, triangular elements, quadrilateral elements, higher order elements, Axisymmetic elements. Pin joined trusses, beams, frames, plates. Practical problems.

Suggested Reading:
   1. Introduction to finite elements in Engineering, T. K. Chandraputla and A.D. Belegundu, *Prentice Hall of India Pvt. Ltd.*
   2. Finite Element analysis (Theory & Programming), C.S. Krishnamurthy, *Tata McGraw Hill Publishing Co. Ltd.*
   3. Finite Element methods, K.S. Bathe and E.L. Wilson, *Prentice Hall of India*.
   4. Finite Element methods in Engineering Sciences, O.C. Zeinkiewicz, *McGraw Hill Book Co*.