Faculty of Engineering & Technology
Department of Civil Engineering
KAKATIYA UNIVERSITY, WARANGAL-506009

SCHEME OF INSTRUCTION FOR B.Tech. (CIVIL ENGG) - VI SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction			Lectu rehrs/ week	Scheme of Examination		Cre dits
			L	T	P		CIE	SEE	
Theory of Subjects									
1	PC 3201 CE	Environmental Engineering	3	-	-	3	30	70	3
2	PC 3202 CE	Design of Steel Structures	3	-	-	3	30	70	3
3	PC 3203 CE	Foundation Engineering	3	-	--	3	30	70	3
3	PC 3204CE	Transportation Engg	3	-	-	3	30	70	3
2	PE - I*	Professional Elective – I	3	-	-	3	30	70	3
5	PE – II**	Professional Elective – II	3	-	-	3	30	70	3
6	PE – III***	Professional Elective-III	3	-	-	3	30	70	3
7	PE3211 CE	Green Building Technology	3	-	-	3	30	70	3
Practicals									
8	PC 3213 CE	Environmental Engg lab	-	-	2	2	25	50	1
10	PC 3214 CE	Transportation Engg Lab	-	-	2	2	25	50	1
11	PW3215 CE	Summer Internship	**6 Weeks**						
			24	**0**	**04**	**28**	285	690	**26**

(PE-I) PROFESSIONAL ELECTIVE-I*			**(PE-II) PROFESSIONAL ELECTIVE-II****		
1	PE 3205 CE	Design of Irrigation Structures	1	PE 3208 CE	Advanced Design Of Concrete Structures
2	PE 3206 CE	Air & Noise Pollution and Control	2	PE 3209 CE	Ground Improvement Techniques
3	PE 3207 CE	Pavement Construction And Management	3	PE 3210 CE	Finite Element Method
(PE-III) PROFESSIONAL ELECTIVE-III*					
1	PE 3211 CE	Structural Analysis			
2	PE 3212 CE	Pre-Stressed Concrete			
3	PE 3213 CE	Geographic Information System			

PC 3201 CE ENVIRONMENTAL ENGINEERING

Instruction: 3 periods per week *Duration of Semester End Examination: 3 hours*
Credits : 3 *CIE: 30 marks, SEE: 70 marks*

UNIT-I
Water Supply: Need for planned water supply schemes, water demand for industrial and agricultural water requirements, sources of water, water quality requirements for different beneficial uses, population forecast, water treatment through aeration, coagulation flocculation, and sedimentation.

UNIT – II
Water Treatment: Filtration, Disinfection, and Softening, methods of layout of distribution pipes, design of distribution by Hardy Cross method for simple net works, various types of pipes and valves used in water supply systems.

UNIT – III
Sewage: Domestic and storm water, Quantity of Sewage, Sewage flow variations. *Conveyance of sewage*: Sewers shapes, design of sewerage systems, operation and maintenance of sewers, sewage pumping, sewer appurtenances

UNIT-IV
River cleaning plans: Self purification of streams, BOD and COD concepts, wastewater treatment, aerobic and anaerobic treatment system, suspended and attached growth systems, quality requirements of recycled water for various purposes. Principles of Septic Tank

UNIT-V
Advanced WWT concepts: Theory and design concepts of Activated Sludge process, Mechanically Aerated Lagoons, Sequencing Batch Reactor (SBR), waste stabilization ponds, basic concepts of bio-remediation.

Suggested Reading:
1. Fair, G. M. and Geyer, J. C. *Water and Wastewater Engineering, vol. I and II*, John Wiley & Sons, Inc., New York, 1954
2. Hammer, M.J. and Hammer, M.J. Jr., *Water and Wastewater Technology*, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998
3. Metcalf & Eddy, *Wastewater Engineering, treatment, disposal, and reuse*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1995
4. Norris, Robert, *Handbook of Bioremediation,* CRC Press, 1993.

PC 3202CE DESIGN OF STEEL STRUCTURES

Instruction: 3 periods per week — Duration of Semester End Examination: 3 hours
Credits : 3 — CIE: 30 marks, SEE: 70 marks

UNIT - I

Materials and Specifications: Chemical composition of steel, types of Structural Steel, Residual stresses, Stress Concentration.

Basis of Structural Design: Codes and Specifications, Design Philosophies, working Stress Method, Limit State Method.

Loading and Load Combinations: Characteristic Loads, Dead Loads, Imposed Loads, Earthquake Loads, Wind Loads and Load Combinations. Partial safety factors for materials and loads.

Bolted Connections (Limit state method): Bolted Connections, Behavior of Bolted Joints, Design Strength of Ordinary Black Bolts, Design Strength of High Strength Friction Grip Bolts, Pin Connections, Simple Connections and Eccentric Connections.

Welded Connections (Limit State Method): Advantages of Welding, Types of Welds and Joints, Simple Connections and Eccentric Connections.

UNIT - II

Design of Tension Members (Limit State Method): Types of Tension Members, Design of Strands, Slenderness Ratio, Modes of Failure, Factors Effecting Strength of Tension Members, Design of Tension Members (Angles, Other sections and Rods), Lug Angles, TensionMember Splice.

UNIT - III

Design of Compression Members (Limit state method): Introduction, Possible Failure Modes, Behavior of Compression Members, Elastic Buckling of Slender Compression Members, Behavior of Real Compression Members, Sections of Compression Members, Effective Length, Design of Compression Members with Single Section and Built-up Sections (Symmetric in both directions), Lacing and Battening, Column Splices. Design of Column Bases (Limit state method): Design of Slab Base and Gusseted Base for Columns.

UNIT - IV

Design of Beams (Limit state method): Types of Beams, Section Classification, Lateral Stability of Beams, Buckling of Real Beams, Behaviour of Beams in Bending, Design of Laterally Supported and Unsupported Beams, Design of Compound Beams, Shear Strength of Beams, Maximum Deflection, Web Buckling and Web Crippling, Biaxial Bending and Unsymmetrical Bending.

UNIT - V

Design of Roof Trusses (Limit state method): Types of Trusses, End Bearings, Spacing of Trusses and Purl ins, Estimation of Loads with different Roof Coverings, Self-weight of Truss, Wind Effects, Design of Purlins for Dead Load, Imposed Load and Wind Loads. Detailed Design of Roof Trusses including Joints and Supports (only Angular Trusses).

References:

1. Subramanian. N, *Design of Steel Structures*, Oxford University Press, 2008.
2. Duggal S.K., *Design of Steel Structures*, Tata McGraw Hill Publishing, 2009.
3. Shiyekar M.R., *Limit State Design in Structural Steel*, PHI Learning Pvt. Ltd., 2010.
4. Bhavikatti, S.S., "*Design of Steel Structures*", I.K. International Publishing House Pvt. Ltd. 2010.
5. *IS-800-2007, BIS Publication*

PC 3203 CE FOUNDATION ENGINEERING

Instruction: 3 periods per week Duration of Semester End Examination: 3 hours
Credits : 3 CIE: 30 marks, SEE: 70 marks

UNIT - I

Stress distribution in Soils: Boussinesq's theory – Computation of increment in vertical stress due to application of a point load (its distribution on horizontal, vertical planes), uniformly distributed circular and rectangular areas –Pressure bulb – Significant depth - Construction and use of Newmark's chart – Westergaard's theory – Validity of elastic theories – Contact pressure distribution.

UNIT - II

Introduction to Foundations: Functional requirements – types – differentiation of shallow and deep foundations – suitability

Safe Bearing Capacity of Shallow foundations: Definitions - (a) Based on theories –Types of shear failures - Terazaghi's theory for safe bearing capacity of shallow foundations – Effect of type of shear failure / shape of the footing / water table – Provisions of IS : 6403-1981 (b) Based on field tests : Plate load test / Standard Penetration test.

Allowable bearing Capacity of Shallow foundations: Settlement Analysis – Total settlement – Elastic settlement – Consolidation settlement (ultimate & after any given period – correction for construction period) – Permissible uniform & differential settlements – Proportioning of footings.

UNIT - III

Pile Foundations: Necessity – types based on load transfer mechanism / material / method of installation / functional use – Estimation of vertical load carrying capacity of a single pile – static formulae / Dynamic formulae / Pile load tests – Cyclic pile load test for separation of total capacity in to bearing and friction components – Pile groups – necessity – efficiency of Pile groups - estimation of group capacity – Settlement analysis of individual and group of Piles - Negative Skin friction – Concept of Piled raft foundation.

UNIT – IV

Caissons: Necessity – types – Essential components of open (well) / box (floating) / Pneumatic caissons - suitability – Sinking of caissons – correction for tilt & shift – Scour analysis – Fixing depth of Caisson – Provisions of IS:3955 and IRC:78.

Machine foundations: differentiation with static foundations – vibration characteristics (frequency / amplitude/ resonance) – types of machines and machine foundations – additional design requirements

Geotechnical Investigations: Necessity – Principles of exploration - objectives – Soil profile – collection of disturbed & undisturbed soil samples – samplers & quality of samples - methods – Trial pit / Bore hole method – Log of bore hole details

UNIT – V

(A) Foundation construction related aspects :

Timbered / braced excavations: Necessity - methods – suitability – distribution of pressure – reaction of struts.

Dewatering: Necessity – methods – sumps (ditches) / well point system (single /multi-stage) / deep well system / electro-osmonsis method – merits & demerits – suitability

Coffer dams: necessity – types – suitability

(B) Foundation repair related aspects

Grouting : Uniqueness – Aspects – Grout Materials – Groutability ratio – Classification of grout materials – Application of grouting in enhancement of bearing capacity and stability of foundations.

Underpinning: Necessity – methods (pin / pile) - suitability

(C) Introduction to Ground Improvement Techniques – Improvement of Cohesionless and Cohesive grounds –Classification –Functions – Application of **Geosynthetics**.

Suggested Reading :

1. Bowles, E. (2012). "*Foundation analysis and Design*", McGraw-Hill Publications.
2. Das, B.M. (2012). "*Principles of Foundation Engineering*", Sengrece Publications.
3. Arora, K.R. (2012). "*Soil Mechanics & Foundation Engineering*" Standard Publications.
4. Verghese, P.C. (2012). "*Foundation Engineering*", PHI Publications.
5. Purushotham Raj, N (2016), "Ground Improvement Techniques", Laxmi Publications.
6. Relevant Indian Standards

PC 3204 CE TRANSPORTATION ENGINEERING

Instruction: 3 periods per week — Duration of Semester End Examination: 3 hours
Credits : 3 — CIE: 30 marks, SEE: 70 marks

UNIT-I

Highway development and planning-Classification of roads, road development in India, Current road projects in India; highway alignment and project preparation.

Geometric design of highways- Introduction; highway cross section elements; sight distance, design of horizontal alignment; design of vertical alignment; design of intersections, problems

UNIT-II

Traffic Engineering & control- Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control; Type of road markings & Signs; design of design of signals, capacity analysis and design of rotary intersections, parking facilities; accident studies; highway lighting; problems.

UNIT-III

Pavement materials- Materials used in Highway Construction; desirable properties, tests, requirements for different types of pavements: Soils, Stone aggregates, bituminous binders, bituminous paving mixes, introduction to Marshall Mix method; Portland cement, types of and cement concrete: desirable properties, tests on cement and hardened concrete, requirements for different types of pavements. Problems.

UNIT IV

Flexible Pavements-Types of pavements and factors affecting design of flexible pavement, performance; stresses in flexible pavements; design of flexible pavements as per IRC:37-2018; Surface and Sub-surface drainage systems, Thickness design problems. Distresses in flexible pavement, causes and performance indicators.

UNIT-V

Rigid pavements- components and functions; factors affecting design stresses in rigid pavements; types of joints, design of concrete pavements as per IRC:58-2015; Design of dowel bars and tie bars, Distresses, causes and performance of CC pavements. Design problems.

Suggested Reading:

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017
2. Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski,'Principles of Highway Engineering and Traffic Analysis', 4th Edition, John Wiley
3. Paul H. Wright and Karen K. Dixon, Highway Engineering, 7th Edition, Wiley Student Edition, 2009.
4. R. Srinivasa Kumar, 'Transportation Engineering', Universities Press, 2020
5. IRC: 37 (2018), 'Guidelines for the design of flexible pavements', Indian Roads Congress, New Delhi
6. IRC: 58 (2015), 'Guidelines for the design of plain jointed rigid pavements', Indian Roads Congress, New Delhi

PROFESSIONAL ELECTIVE-I

PE 3205 CE DESIGN OF IRRIGATION STRUCTURES

Instruction: 3 periods per week | Duration of Semester End Examination: 3 hours
Credits : 3 | CIE: 30 marks, SEE: 70 marks

UNIT-I

Weirs*:* Components of diversion head works, types of weirs – fixation of still level of head sluice, scouring sluice and crest level of weir, afflux and top level of flood banks, design of vertical drop and sloping glacis weir, design for surface flow and sub - surface flow, length, level and thickness of downstream apron, upstream and downstream cutoffs, protection works.

UNIT – II

Seepage forces*:* Causes of failure of structures on permeable foundations, piping, rupture of floor, undermining, remedial measures, computation of uplift forces by Bligh's theory, Khoshla's theory, analytical method, and significance of exit gradient.

UNIT-III

Canals*:*Alignment, classification of alluvium canals and their functions, Regime concept of Kennedy's and Lacey's theories, design of canals based on Kennedy's and Lacey's method, use of Garrett's diagrams for the design of canals, lining of canals, methods of lining and design of lined canals.

UNIT- IV

Canal falls*:* Definition, location, types of falls, design principles of trapezoidal notch fall, vertical drop fall, glacis fall.

Regulators and modules: Head regulator and cross regulators, canal escapes, canal outlets and modules-proportionality, sensibility and flexibility.

UNIT- V

Cross drainage works*:* Definition, classification, design principles of aqueducts, syphon aqueducts, canal syphons, super passages, inlets and outlets-selection of cross drainage works.

Suggested Reading:

1. B.C. Punmia and Pande B.B. Lal, *Irrigation and Water Power Engineering*, Standard Book House, 1991.
2. S.K. Garg, *Irrigation and Hydraulic Structures*, Khanna Publishers, 1993.
3. Modi P.N., *Irrigation and Water Resources and Water PowerEngineering,* Standard Book House, 1983.
4. S. K. Sharma "*Irrigation Engineering & Hydraulic Structures*" S. Chand Publishers, New Delhi 2016
5. Punmia, B.C., Pande B. and Lal, B, Ashok Kumar Jain & Arun Kumar Jain., *'Irrigation and Water Power Engineering'*, Laxmi Publishers, 2003

PROFESSIONAL ELECTIVE-I

PE 3206 CE AIR&NOISE POLLUTION and CONTROL

Instruction: 3 periods per week — Duration of Semester End Examination: 3 hours
Credits : 3 — CIE: 30 marks, SEE: 70 marks

UNIT-I

Sources and Effects of Air Pollutants: Sources, classification, combustion processes and pollutant emission, effects on health, vegetation, materials and atmosphere, reactions of pollutants in the atmosphere and their effects – Smoke, smog

UNIT – II

Sampling and Analysis: Air sampling and pollution measurement methods, principles and instruments, Ambient air quality and emission standards, Air pollution indices. Indoor Air Quality Management: Sources, types and control of indoor air pollutants

UNIT – III

Air Quality Models: micrometeorological processes, wind rose, dispersion, coefficients and stability classes, Gaussian and dispersion model, stack height computation, regional air quality models, source inventories and significance

UNIT-IV

Concepts of Pollution Control: Particulate emission control - settling chambers, cyclone separation, Wet collectors, scrubbing, fabric filters, electrostatic precipitators, selection criteria for equipment, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods.

UNIT-V

Noise pollution: Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; psychoacoustics and noise criteria, effects of noise on health, annoyance rating schemes.

Suggested Reading:

1. Rao M.N., and Rao H. V. N., Air Pollution Control, Tata McGraw Hill, New Delhi, 1996
2. Anjaneyulu, D., Air Pollution and Control Technologies, Allied Publishers, Mumbai, 2002
3. Rao, C.S. Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 1996.
4. Peavy S.W., Rowe D.R. and Tchobanoglous G. Environmental Engineering, McGraw Hill, New Delhi, 1985.
5. B.C. Punmia. Arun Kumar Jain & Ashok Kumar Jain “Waste Water Engineering (Including Air Pollution)” M/S Laxmi Publishers, 2011
6. M. Anji Reddy, “Environmental Impact Assessment Theory and Practice” BS Publications, Hyderabad, 2017

PROFESSIONAL ELECTIVE-I

PE 3207 CE PAVEMENT CONSTRUCTION AND MANAGEMENT

Instruction: 3 periods per week — Duration of Semester End Examination: 3 hours
Credits : 3 — CIE: 30 marks, SEE: 70 marks

UNIT-1

Flexible Pavement Construction: Earthwork, compaction and construction of embankments, specifications of materials, construction methods and field control checks for various types of flexible pavement materials in subbase, base, binder and surface course layers and their choice

UNIT-II

Cement Concrete Pavement Layers: Specifications and method of cement concrete pavement construction; Construction of interlocking block pavements, Quality control tests; Construction of various types of joints;

UNIT-III

Soil Stabilized Pavement Layers: Principles of gradation/proportioning of soilaggregate mixes and compaction; Design factors, mix design, construction control and quality control checks for mechanical, soil-cement, soil-bitumen and soil-lime stabilization methods. Use of additives, Numerical problems on mix design and applications

UNIT-IV

Pavement Evaluation - Pavement Distress - Functional and structural condition of pavements, Pavement distress survey, Functional condition evaluation of pavements-Roughness, Skid Resistance. Structural evaluation of pavements - nondestructive testing, Benkelman beam and Falling Weight Deflectometer, Pavement strengthening based on deflection as per IRC, Maintenance and rehabilitation techniques

UNIT-V

Pavement Management Systems - Pavement Management Systems- Components, structure, data requirements, Project level and Network level needs, Pavement performance, prediction – concepts, modelling techniques– AASTHO, CRRI and HDM models, Budget forecasting for maintenance and rehabilitation, Ranking and optimization methodologies, life cycle costing,

Suggested Reading

1. 'Highway Engineering', Paul H.Wright, Karen K.Dixon, John Wiley& Sons,.7th edition.2004.
2. 'The Asphalt Handbook', MS-4, Asphalt Institute, Maryland, 1989

PROFESSIONAL ELECTIVE-II

PE 3208 CE ADVANCED DESIGN OF CONCRETE STRUCTURES

Instruction: 3 periods per week Duration of Semester End Examination: 3 hours
Credits : 3 CIE: 30 marks, SEE: 70 marks

UNIT - I

Introduction to Columns and footings, Definition, IS codes. Elastic design and detailing of combined rectangular footings.

UNIT - II

Design of Ribbed slabs and Flat slabs: Introduction to ribbed and flat slabs**,** Analysis of the Slabs for Moment and Shears, Ultimate Moment of Resistance, Design for shear, Deflection, Arrangement of Reinforcements. Flat slabs: IS specifications and general notes on flat slabs Direct design method – Distribution of moments in column strips and middle strip-moment and shear transfer from slabs to columns – Shear in Flat slabs-Check for one way and two way shears – Introduction to Equivalent frame method. Limitations of Direct design method, Distribution of moments in column strips and middle strip.

UNIT - III

Retaining Walls- Different types of Retaining Walls. Proportioning the retaining walls Determining the Lateral earth pressure on Retaining walls. Perform the Stability checks: overturning, sliding, bearing capacity, and settlement .Elastic design and detailing of retaining walls-cantilever and counter fort types.

UNIT - IV

Types of water tanks, Definition, IS codes. Elastic design and detailing of rectangular and circular, ground and over head tanks including Intz tanks. Design of staging.

UNIT - III

Bridges: Introduction to Bridges, Classification of Bridges, Recent advances in Bridge Engineering, IRC loading – impact factor – effective width method and Pigeaud's method. Elastic design and detailing of (i) R.C. Slab bridges and (ii) T-beam bridges for IRC loadings.

Suggested Reading:

1. Krishna Raju, N. (2009). "Structural Design and Drawing (third Edition)." Universities press.
2. Punmia, B. C., Jain, A.K and Jain, A. K. (2006). "RCC designs (Reinforced concrete structures). Laxmi publications (10th edition).
3. Phatak,(1990). "Bridge Engineering." Satya Prakashan Publishers.
4. Johnson D. Victor. (2006). "Essentials of Bridge Engineering." Oxford &IBH Publishers, Pvt.Ltd., New Delhi.
5. **Note:** All latest relevant IS codes necessary for teaching this course may be introduced and referred in detail by the Faculty Concerned
6. IS : 456 : 2000, Code of Practice for Plane and Reinforced Cement Concrete,
7. SP 16, SP 34.
8. IS 3370 Part I to Part IV

PROFESSIONAL ELECTIVE-II

PE 3209 CE GROUND IMPROVEMENT TECHNIQUES

Instruction: 3 periods per week Duration of Semester End Examination: 3 hours
Credits : 3 CIE: 30 marks, SEE: 70 marks

UNIT - I

Introduction : Objectives and necessity of Ground Improvement – Formation of Rock and soils – Alteration of ground after its formation – Reclaimed soils – , Types and distribution of Soils in India - marine, black cotton soils (expansive), lateritic, alluvial, desert, peaty Soils etc - Ground improvement potential – Geotechnical processes.

UNIT - II

Surface Compaction methods : Compaction Mechanism - moisture density relationship – Factors affecting compaction – Laboratory evaluation of Compaction Characteristics – Field Surface Compaction Methods – Compaction procedure – Specification – Quality Control aspects.

In-situ Densification of Cohesionless Soils : Necessity for Deep compaction – Vibration methods – Vibro-compaction methods (Blasting, Vibratory probe, Dynamic compaction / heavy tamping), Vibro-displacement Methods (Displacement Piles, Sand Compaction Piles), vibro-replacement cum displacement methods (Vibro-floatation, Stone Columns).

UNIT - III

In-situ Densification of Cohesive Soils:

Drainage methods – Methods of dewatering systems - selection of pumps and accessories

Pre-compression methods – Concept & benefit of pre-compression -consolidation of Clayey soils – Pre-loading technique – consolidation acceleration methods - consolidation aided with vertical drains – Sand Drains - Pre-fabricated vertical drains, Consolidation by Electro-osmosis and vacuum compression methods - Compression monitoring.

UNIT - IV

Grouting: Aspects of grouting – Types of grout materials – Classification based on Groutability Ratio - grouting procedure – Applications of grouting in ground improvement.

Soil Stabilisation: Types and suitability of stabilization methods - Mechanical, Cementing methods – Aggregants and dispersants – Stabilization procedure – quality control in Soil Stablization.

UNIT - V

Geo-Synthetics: Classification of Geosynthetics – Functions and applications – Concept of design by function.

Reinforced Soil Walls – Components of a RSW – Types of facia – Types of Reinforcement & factors influencing the selection - Design of RSW – construction procedure - Gabions.

Suggested Reading:

1. H.R. Hausmann, (2013), *Principles of Ground Modification,* Mc-Graw Hill Publications.
2. P.Nicholson, (2015), *Soil Improvement and Ground Modification Methods,* Butterworth-Heinemann Ltd.
3. Purushotham Raj, (2016), *Ground Improvement Techniques*, Laxmi Publications.
4. R.M.Koerner, (2012), *Designing with Geosynthetics Vol-1&2*, Prentice Hall Inc.
5. Indrarathna, Chu, Cholachat, (2015), *Ground Improvement Case Histories*, Butterworth-Heinemann Publications.

PROFESSIONAL ELECTIVE-II

PE 3210 CE FINITE ELEMENT METHOD

Instruction: 3 periods per week Duration of Semester End Examination: 3 hours
Credits : 3 CIE: 30 marks, SEE: 70 marks

UNIT - I

Introduction to FEM: Types of Problems – Types of Materials – Elastic / Inelastic situations – Types of forces: Body forces / Surface Traction / Point loads – Deformable bodies – Types of Deformations – Homogeneous / Non homogeneous Problems – Equations of equilibrium for elastic 2-D / 3-D continua - Equilibrium equations for 2-D / 3-D boundary elements – Boundary conditions – Strain-displacement relation for 2-D / 3-D – Stress-strain relation for 2-D / 3-D – Plane stress / Plane strain problems.

Virtual Work Formulation: Application to problems of plane trusses with static indeterminacy not exceeding three.

Finite Difference Method with Central Differences: Solving ODE's and PDE's with central differences. Application to beam and plate bending problems of simple geometry.

UNIT - II

Variational Formulation : Finite Element Formulation - Stationarity of Functional – Given the Functional or Differential equation – Number of elements limited to two.

1-D Elements: Strain-displacement relation matrix / stiffness matrix / Minimum Potential Energy Approach / Rayleigh-Ritz Method / introduction to natural coordinates / stiffness matrix of second order bar element / Axial bar subjected to point loads, body forces and surface traction forces / Problems with kinematic indeterminacy not exceeding two.

2-D Triangular Elements: Displacement models / criterion for convergence / geometric invariance / conforming and non conforming elements - 3-node triangular elements (CST) / determination of strain-displacement matrix / area coordinates-shape functions / determination of element stiffness and load matrices, assembling global stiffness and load matrices / Problems with kinematic indeterminacy not exceeding three.

2nd Order triangular elements: Shape functions – degradation technique / strain-displacement matrix / Expression for stiffness matrix / Load matrices due to body forces and surface traction.

UNIT - III

Iso-parametric elements:

Quadrilateral elements: Construction of shape functions using natural coordinates/Strain-displacement matrices/Load matrices for body force and surface traction/Expressions for stiffness matrix,load matrices for 4-noded quadrilateral elements/ Gauss Quadrature of numerical integration / Problems with rectangular elements, kinematic indeterminacy not exceeding three.

2nd Order Quadrilateral elements: - Determination of shape functions for 2nd order quadrilateral elements and for elements of with serendipity / Strain-displacement matrices / Load matrices for body force and surface traction.

UNIT - IV

Method of Weighted Residuals:

Galerkin's Method of Weighted Residuals: Application to problems of mathematics / structural engineering, number of trial functions not exceeding two.

Galerkin's Finite Element Method: Weak form of Trial Function - Application to problems of mathematics / structural engineering, number of elements limited to two.

UNIT - V

Axi-symmetric Problems: Strain-displacement relationship/stress-strain relationship / determination of stiffness matrix for 3-noded ring element and load matrices for body force and surface traction/ Problems with kinematic indeterminacy not exceeding three for 3-noded ring elements only.

Tetrahedron elements: Volume coordinates, Strain-displacement matrix, stiffness matrix, load matrices due to body force and surface traction/ introduction to Hexahedron (brick) elements.

Introduction to MSC Nastran: Illustration on different modules of Nastran / Structural engineering applications of the package/Creation of a simple 1-D model, 2-D model and a 3-D model/ analysis and post processing of the results.

Suggested Reading:

1. Cook, R. D. (1981). "Concepts and Application of Finite Element Analysis", John Wiley and Sons.
2. Zienkiewicz, O. C. And Taylor, R. L, (1989). "The Finite Element Method", Vol.1, McGraw Hill Company Limited, London.
3. Reddy, J. N, (1993). "An Introduction to the Finite Element Method", McGraw Hill, New York.
4. Chandrupatla, T. R. And Belegundu, A. D, (2001). "Introduction to Finite Elements in Engineering", Prentice Hall of India, New Delhi.
5. Seshu. P, (2003). "Finite Element Analysis", Prentice Hall of India Private Limited, New Delhi.
6. David V. Hutton, (2005). "Fundamentals of Finite Element Analysis", Tata McGraw-Hill Publishing Company Limited, New Delhi.

PROFESSIONAL ELECTIVE-III

PE 3211 CE STRUCTURAL ANALYSIS

Instruction: 3 periods per week
Credits : 3

Duration of Semester End Examination: 3 hours
CIE: 30 marks, SEE: 70 marks

UNIT - I

Moving loads: Influence line for support reaction, bending moment and shear force at any location for simple beams. Determination of maximum bending moment and shear force for moving load systems on simply supported girders.

Maximum bending moment and shear force Diagrams: for simply supported girders traversed by (l) single point load, (2) two point loads, (3) uniformly distributed-load longer/shorter than span, enveloping parabola and EUDLL.

UNIT - II

Moving loads on trusses / **girders:** Influence lines for forces in members of statically determinate plane framed structures under moving loads for Warren girder, Pratt truss, and Curved flange truss.

Suspension bridges: Stresses in suspended loaded cables, length of cable, simple suspension bridge with 3-hinged stiffening girders for static load, Influence lines for horizontal and vertical components of tension in the cable, tension in the cable, bending moment and shear force.

UNIT - III

Flexibility Matrix Method: Determination of Static and kinematic indeterminacy - Equilibrium and compatibility conditions-Principles of superposition, Application of Flexibility Matrix Method to continuous beams, plane trusses, plane frames and ortho grid structures (Static indeterminacy not exceeding three) - Effect of temperature, Lack of fit and Pre-stressing forces

UNIT - IV

Stiffness Matrix Method: Application of Stiffness Matrix Method to continuous beams, plane trusses, plane frames and ortho grid structures (Degree of freedom not exceeding three). Construction of stiffness matrix for frames - Direct Method.

UNIT - V

Direct Element Method: Development of stiffness matrices for bar, truss and beam elements. Application of direct element method to problems of axially loaded bars, continuous beams, plane trusses and plane frames to obtain joint displacements and member end forces. Developing shear force and bending moment diagrams. Introduction to software package STAAD Pro.

Suggested Reading:

1. S.B. Junarkar and Shah, *"Mechanics of structures"*, Charotar Pub, House, 2001
2. D.S. Prakash Rao, "*Structural Analysis - a Unified Approach"*, University Press, 1991
3. B.C. Punmia and A.K. Jain, "*Theory of structures"*, Laxmi Publications, New Delhi, 2004
4. Pandit, G .S., S. P. Gupta and R. Gupta, *"Theory of Structures," Vol. I* , Tata McGraw Hill, New Delhi, 1999.
5. J. M. Gere & William Weaver, "*Matrix Analysis of Framed Structures"*, 2nd Ed., D Van Nostand, New Jersey, 1980.

PROFESSIONAL ELECTIVE-III

PE 3212 CE PRESTRESSED CONCRETE

Instruction: 3 periods per week
Credits: 3
Duration of Semester End Examination: 3 hours
CIE: 30 marks, SEE: 70 marks

UNIT - I

Introduction to prestressed concrete: Historical development, principles of prestressed concrete. Definition, classification and systems of prestressing. Materials for prestressed concrete.

Loss of prestress: Losses of prestress in pre-tensioned and post-tensioned members.

UNIT - II

Analysis of prestress: Basic assumptions, analysis of prestress, resultant stress, pressure line, kern points, cable profiles, load balancing concept, stress diagrams for prestress, dead load and live load.

UNIT - III

Simply supported and continuous beams: concordant cable profile, analysis of continuous prestressed concrete beams.

Design of sections: Flexural strength design of rectangular, I and T sections using IS code provisions.

UNIT - IV

Design for shear: Basic concept of shear design, shear failure, flexural shear failure, shear compression failure, shear tension failure, shear strength of beams (a) unfrocked in flexure and (b) cracked in flexure.

UNIT - V

Deflections: Necessity of deflection estimation, limitations of deflections. Deflections of pre-stressed concrete beams with uniformly distributed and point loads.

End Block: Types of end blocks and Importance of end block, Analysis and design of end block by Guyon method and IS method for not more than two cables.

Suggested Reading:

1. T.Y. Lin and N.H. Burns, *Design of prestressed concrete structure*, Jon Wildy and sons, 1982.
2. A.H. Nilson, *Design of prestressed concrete*, John Wiley and Sons, 1982.
3. N. Krishna Raju, *Design of prestressed concrete structure*, Tata McGraw Hill Book Co., 1996.
4. G.S. Pandit and S.P. Gupta, *Prestressed Concrete*, CBS Publishers, 1995.

PROFESSIONAL ELECTIVE-III

PE 3213 CE GEOGRAPHIC INFORMATION SYSTEMS

Instruction: 3 periods per week
Credits: 3
Duration of Semester End Examination: 3 hours
CIE: 30 marks, SEE: 70 marks

UNIT I

Introduction: Basic concepts, socioeconomic challenges, fundamentals of geographical information systems (GIS), history of geographical information system, components of geographical information systems.

Projections and Coordinate Systems*:* Map definitions, representations of point, line, polygon, common coordinate system, geographic coordinate system, map projections, transformations, map analysis.

UNIT II

Data Acquisition and Data Management*:* data types, spatial, non spatial (attribute) data, data structure and database management, data format, vector and raster data representation, object structural model filters and files data in computer, key board entry, manual digitizing, scanner, aerial photographic data, remotely sensed data, digital data, cartographic database, digital elevation data, data compression, data storage and maintenance, data quality and standards, precision, accuracy, error and data uncertainty.

Data Processing*:* Geometric errors and corrections, types of systematic and non systematic errors, radiometric errors and corrections, internal and external errors.

UNIT III

Data Modeling: Spatial data analysis, data retrieval query, simple analysis, recode overlay, vector data model, raster data model, digital elevation model, cost and path analysis, knowledge based system.

GIS Analysis and Functions*:* Organizing data for analysis, analysis function, maintenance and analysis of spatial data, buffer analysis, overlay analysis, transformations, conflation, edge matching and editing, maintenance and analysis of spatial and non spatial data

UNIT IV

Applications of GIS: Environmental and natural resource management, soil and water resources, agriculture, land use planning, geology and municipal applications, urban planning and project management, GIS for decision making under uncertainty, software scenario functions, standard GIS packages, introduction to Global Positioning Systems (GPS) and its applications.

UNIT V

Introduction to Remote Sensing: General background of remote sensing technology, objectives and limitations of remote sensing, electro-magnetic radiation, characteristics, interaction with earth surface and atmosphere, remote sensing platforms and sensors, satellite characteristics, digital image processing, IRS series and high resolution satellites, software scenario functions, remote sensing applications to watershed modeling, environmental modeling, urban planning and management.

Suggested Readings:

1. Burrough, P. A., and McDonnell R. A. (1998), 'Principles of Geographical Information Systems', Oxford University Press, New York
2. Choudhury S., Chakrabarti, D., and Choudhury S. (2009), 'An Introduction to Geographic Information Technology', I.K. International Publishing House (P) Ltd, New Delhi
3. Kang-tsung Chang. (2006), 'Introduction to Geographical information Systems',Tata McGraw-Hill Publishing Company Ltd., Third Edition, New Delhi
4. Lilysand T.M., and Kiefer R.W. (2002), 'Remote Sensing and Image Interpretation', John Wiley and Sons, Fourth Edition, New York
5. Sabins F.F. Jr. (1978), 'Remote Sensing Principles and Interpretations', W.H. Freeman and Company, San Francisco
6. Tor Bernhardsen. (2002), 'Geographical Information System', Wiley India (P) Ltd., Third Edition, New Delhi
7. Hoffman-Wellenhof, B, et al. (1997), 'GPS Theory and Practice',Fourth Edition, Springer Wein, New York.

PC3211CE GREEN BUILDING TECHNOLOGY

Instruction : 3 periods per week | Duration of Semester End Examination 3 hours
Credit 3 | SEE 70marks CIE 30marks

UNIT-I
Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

UNIT-II
Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

UNIT-III
Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT-IV
End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer.

UNIT-V
Energy management options - Energy audit and energy targeting - Technological options for energy management.

Suggested Readings:
1. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.
3. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections,
4. Prentice Hall of India, New Delhi.
5. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

LABORATORY COURSES

PC 3213 CE ENVIRONMENTAL ENGINEERING LABORATORY

Instruction: 2 periods per week
Credits : 1,

Duration of Semester End Examination: 3 hours
CIE: 25 marks, SEE: 50 marks

LIST OF EXPERIMENTS

1. a) Determination of total dissolved solids
   b) Determination of total suspended solids
   c) Determination of fluorides
2. Determination of total hardness
3. Determination of alkalinity
4. Determination of chlorides
5. Determination of sulphates
6. Determination of MPN
7. Determination of residual chlorine
8. Determination of optimum alum dosage
9. Determination of BOD
10. Determination of COD

LABORATORY COURSES

PC3214CE TRANSPORTATION ENGINEERING LABORATORY

Instruction : 2 hrs per week **Duration of Semester End Examination : 3 Hrs**

Credits : 1 **CIE : 25 marks, SEE : 50 marks**

A) **Tests on Bitumen:**
1) Penetration test
2) Ductility test
3) Softening point test
4) Specific Gravity test
5) Viscosity test,
6) Flash and Fire point test

B) **Tests on Aggregate:**
1) Aggregate Crushing test,
2) Los Angles Abrasion test,
3) Aggregate Impact test,
4) Shape test,
5) Specific gravity and Water Absorption,
6) Soundness

C) **Experiments on Traffic:**
1) Traffic Volume study
2) Spot speed study
3) Speed and delay study
4) Origin & Destination study

D) **Miscellaneous Tests (Demo):**
1) Marshall Stability,
2) Bitumen Extraction
3) Stripping test
4) DCP test

Suggested Reading:

1. Khanna SK and Justo CEG, 'Highway material testing' (Lab manual), Nem Chand & Bros
2. Relevant IS and IRC Codes of practice
3. Relevant ASTM and AASHTO codes of practice

SUMMER INTERNSHIP

Objectives:

- To give an experience to the students in solving real life practical problems with all its constraints.
- To give an opportunity to integrate different aspects of learning with reference to real life problems.
- To enhance the confidence of the students while communicating with industry engineers and give an opportunity for useful interaction with them and familiarize with work culture and ethics of the industry

.

Summer Internship is introduced as part of the curricula for encouraging students to work on problems of interest to industries. A batch of two or three students will be attached to a person from an Industry / R & D Organization / National Laboratory for a period of 6 weeks. This will be during the summer vacation following the completion of the VI semester course. One faculty member will act as an internal guide for each batch to monitor the progress and interacts with the Industry guide.

After the completion of the project, students will submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the department.

*Students have to undergo summer internship of 6 Weeks duration at the end of VI semester