Scheme of Instruction and Syllabi
of
Choice Based Credit System (CBCS) of

BE / B.TECH V AND VI SEMESTERS
OF
FOUR YEAR DEGREE COURSE
IN

CIVIL ENGINEERING

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY™
(An Autonomous Institution)
Affiliated to OU; All U.G. and 5 P.G. Programmes (Civil, CSE, ECE, Mech. & EEE)
Accredited by NBA; Accredited by NAAC - 'A' Grade (UGC); ISO Certified 9001:2015
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SCHEME OF INSTRUCTION AND EXAMINATION
B.E. III -YEAR
CIVIL ENGINEERING

SEMESTER V

S. No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per Week		Duration in Hrs	Maximum Marks		
			L/T	D/P		Continuous Internal Evaluation (CIE)	Semester End Exam (SEE)	
THEORY								
1	16CE C18	Reinforced Concrete Design -I	3/1	-	3	30	70	4
2	16CE C19	Soil Mechanics	3	-	3	30	70	3
3	16CE C20	Theory of Structures-I	3/1	-	3	30	70	4
4	16CE C21	Concrete Technology	3	-	3	30	70	3
5	16CE C22	Fluid Mechanics-II	3	-	3	30	70	3
ELECTIVE – I								
6	16CE E01	Rock Mechanics	3	-	3	30	70	3
	16CE E02	Advanced Surveying						
	16CE E03	Advanced Strength of Materials						
PRACTICAL								
7	16CE C23	Fluid Mechanics Lab	-	3	3	25	50	2
8	16CE C24	Environmental Engg. Lab	-	3	3	25	50	2
9	16CE C25	Concrete Laboratory	-	3	3	25	50	2
Total			**20**	**09**		**255**	**570**	**26**

L=Lecture, T=Tutorial, D/P= Drawing/ Practicals
CIE - Continuous Internal Evaluation SEE - Semester End Examination

16CE C18

REINFORCED CONCRETE DESIGN - I

Instruction	4(3L+1T) Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: To enable the student

1. Understand general mechanical behavior of reinforced concrete, design philosophies, design requirements get introduced to IS: 456 code and working stress method of design applied to RC rectangular beams.
2. Understand the basic principles of Limit state design, assumptions made in theory of flexure and flexural design procedures for singly reinforced and doubly reinforced rectangular beam.
3. Grasp the fundamentals of analysis and design of rectangular beams for shear and torsion, checking for bond and applying serviceability check for beams.
4. Know the procedures for analysis and design of one-way simply supported and cantilever slabs and two-way simply supported and continuous slabs.
5. Learn the design and detailing of columns and footings of rectangular and circular sections.

Course Outcomes: At the end of the course, student is able to

1. Use and suggest Reinforced concrete for various practical applications, interpret the clauses of IS:456 and apply the working stress method of design for rectangular beams.
2. Design RC beams of rectangular and flanged sections/ for flexure using limit state method.
3. Design RC beams for shear and torsion and check for bond and serviceability.
4. Analyze and design solid rectangular RC slabs of one way (cantilever, simply supported and continuous) and two way (simply supported and continuous).
5. Design RC columns (short and long) and axially loaded footings of circular and rectangular sections.

Note: All relevant IS codes necessary for teaching their course may be introduced and referred in detail by the concerned faculty.

UNIT - I:

Introduction to Reinforced Cement concrete: Concrete - characteristics strength - Grade of Concrete - Workability, durability of concrete - Reinforced concrete

(RC) - Types of reinforcing steel - Yield stress - Advantages of reinforced concrete - basic requirement of RC structures.
Design Philosophies: Development of design philosophies - working stress method - Ultimate load method - Limit state method - Merit and demerits.
Introduction to IS:456:General design requirements and specifications.
Working Stress method: Assumptions made in design of flexural members - Cover to reinforcing steel - Theory of bending in RC beams - Balanced, under and over reinforced sections. Analysis and design for flexure of singly and doubly reinforced rectangular beams.

UNIT- II:
Limit state method of design:
Introduction to limit state method - classification of limit states - characteristic loads - partial safety factors – Factors for material and load - design stress - stress and strain diagram of concrete and steel - Assumptions made in design of flexural members - Stress block parameter - Analysis and flexural design of singly reinforced, doubly reinforced rectangular beams and flanged beams.

UNIT - III:
Limit state of collapse in shear and torsion: Types of shear reinforcement - analysis and design for shear and torsion in beams - Bond - development length and curtailment of reinforcement in beams and detailing of bars: IS code provisions.
Limit state of serviceability: Short term, long term, total deflection - check for deflection - cracking - IS code provisions.

UNIT - IV:
Analysis and design of slabs: Solid rectangular slabs - cantilever slab - simply supported and cantilever one way and two way slabs subjected to uniformly distributed loads - IS code method of design of these slabs - Detailing of reinforcement and check for serviceability in slabs.
Design of stair: Design and detailing of dog legged stair.

UNIT - V:
Analysis and design of columns: Short and long columns - End conditions- effective length of columns assumptions made in design - analysis - design and detailing of axially loaded square, rectangular and circular columns with lateral ties and helical bar - Design of axially loaded short columns subjected to uni-axial and bi-axial moments , using interaction diagrams – design principles for long columns.
Footings: Types of Foundations and IS Specifications, Design and detailing of isolated rectangular and circular footings for axial loads.

Text Books:

1. N. Subramanian, “Design of Reinforced Concrete Structures” Oxford University Press. First Published in 2013,Second impression 2014.

2. S Unni Krishnan Pillai and Devadas Menon, "Reinforced Concrete Design", Tata McGraw-Hill Publishing Co Ltd, (Third Edition), 2009.

Suggested Reading:

1. V.L.Shah and S.R.Karve, "Limit State Theory and Design of Reinforced Concrete", Structures Publications, 7th Edition,2014.
2. A.K. Jain, "Reinforced Concrete: Limit State Design", Nem Chand & Brothers-Roorkee; Seventh edition, paperback – 2012.
3. Sushil Kumar, "Treasure of RCC Designs", Standard Book House; Edition: 19th, Year-2014 edition (1 December 2009).
4. N. Krishna Raju, "Design of Reinforced Concrete Structures", CBS Publishers and Distributors, New Delhi,4th edition, 2016.

16CE C19

SOIL MECHANICS

Instructions	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: To enable the students

1. Understand the basic principles of soil mechanics and basic properties of soils and basic knowledge of identifying soil.
2. Understand the flow through soils and its behavior and gain a practical outlook of utilizing soil as construction materials.
3. To know the knowledge about the highly compressible soil settlements.
4. Capable of estimating the strength of soil to different loading conditions.
5. Deal with problem of earth pressures and slope stability and to utilize the knowledge with respect to practical orientation and R&D perspective.

Course Outcomes: At the end of the course, the student should

1. Be able to identify various types of soils, their properties and to apply the basic principles of soil mechanics to simple field problems.
2. Be able to prepare models for the behavior of soils, flow through soils and use / suggest soil as a construction material.
3. Be able to compute the settlements of the compressible soils.
4. Be able to estimate the strength of soil under different loading conditions.
5. Be able to deal with field problems of earth pressures and slope stabilities.

UNIT-I:

Physical and Index properties of soils: Introduction about origin and formation of soils, basic definitions from soil three phase diagram (weight ratios & volume ratio), Inter relationships of preliminary properties. Determination of laboratory tests for water content, field density, specific gravity by various methods, Index properties, sieve analysis, consistency of soils (Liquid limit, Plastic limit & shrinkage limit), Indian soil classification IS-1498-1970.

UNIT-II:

Permeability of soils: Darcy's. law of seepage water through soils- validity of determination of co-efficient of permeability (constant head, variable head permeability tests) – Field tests (Pumping in and pumping out tests) – Equivalent permeability of stratified soils.

Seepage in Soil: Seepage flow, seepage pressure – Flow nets – Locating phreatic line in a homogeneous earthen dam using Kogeny's parabola – computation of seepage quantity.

Stress in Soils: Total effective and neutral stress.
Quick Sand Phenomena**:** Critical Hydraulic gradient.

UNIT-III:
Compaction: Compaction Mechanism, factors affecting compaction. Laboratory determination of compaction characteristics- standard and modified Proctor tests – IS Light and Heavy compaction tests; Field surface compaction: compaction equipment, procedure, quality control.
Consolidation: Spring Analogy, Laboratory consolidation test, calculation of void ratio, compression characters (a_v, m_v & C_c) and settlement equation, differential equation for one dimensional consolidation, co-efficient of consolidation - square root & logarithm time fitting method and problems in consolidation settlements.

UNIT-IV:
Shear strength: Significance of Shear strength in soils – Mohr-Coulomb equation – shear parameters – Laboratory tests for determination of shear strength – Direct shear test, Tri-axial compression tests. (UU, CU and CD), Un-confined compression test, Vane shear test. Factors affecting shear strength of cohesion-less and cohesive soils. Determination of elastic Moduli.

UNIT-V:
Earth pressure: States of earth pressure – Active, Passive at rest condition; Rankin's theory; computation of active and passive earth pressure in cohesion-less & Cohesive Soils and c-ø soils; Coulomb's Wedge theory; Rehbhan's graphical solution.
Slope stability: Definition and classification of slopes – types of slope failures- Factors of safety with respect to cohesion, angle of shearing resistance, Height – Analysis of stability of slope using Swedish slip circle method and Taylor's stability number.

Text Books:

1. K. R. Arora, "*Soil Mechanics and Foundation Engineering*", Standard Publisher Dist.; 7th Edition, 2009.
2. B. C. Punmia, A. K Jain, and A. K. Jain "*Soil Mechanics and Foundations*", Laxmi Publications; Sixteenth edition, 2017.

Suggested Reading:

1. Relevant IS Codes
2. Gopal Ranjan, "*Basic and Applied Soil Mechanics*", New Age International Pvt Ltd; Third edition 2016.
3. C.Venkatramaiah, "*Geotechnical Engineering*", New Age Publications, revised Fifth edition, 2017.
4. B. M. Das and K. Sobhan, "*Principles of Geotechnical Engineering*", NPTEL study material.

16CE C20

THEORY OF STRUCTURES – I

Instruction	4(3L+1T) Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: To enable the student to

1. Understand the concept of influence line diagrams for determinate beams for various types of loads and to find maximum SF and BM in the beams.
2. Grasp the procedure to construct influence line diagrams for different truss girders for various types of loads and to find maximum forces in the members of trusses.
3. Study the behavior of arches (two and three hinged) and their analysis for point loads and uniformly distributed loads.
4. Know the concept and analysis of cables and suspension bridges with three hinged stiffening girder.
5. Understand the methods to find the deflections of determinate trusses and frames by different methods and to analyze the redundant frames by different methods.

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

1. Draw the ILD's and able to find the maximum SF and BM for various positions of the moving loads.
2. Draw the ILD's for forces in the members of trusses and to find the maximum forces for various positions of the moving loads.
3. Analyze three and two hinged arches for various loads.
4. Find maximum forces in the cables and able to analyze suspension bridges with stiffened girders.
5. Find deflections of joints plane frames and trusses and analyze redundant trusses.

UNIT– I:

Moving loads: Influence line diagrams for support reactions, bending moment and shear force for a simply supported beam/girder. Determination of maximum values of support reactions, bending moment and shear force at any section for various moving load systems on simply supported beam / girder.

Curves of maximum bending moment and shear force for simply supported girders traversed by (i) single point load, (ii) two point loads (iii) uniformly distributed load longer than the span, and (iv) uniformly distributed load shorter than the span. Focal length, enveloping parabola and EUDL.

UNIT– II:

Moving loads on truss girders: Influence lines for forces in the members of statically determinate trusses like Warren truss, Pratt truss, and Curved flange trusses. Determination of maximum forces in truss members due to moving point loads and uniformly distributed loads. Counter bracing.

UNIT– III:

Three hinged arches: Three hinged parabolic and segmental arches, determination of horizontal thrust, bending moment, normal thrust and radial shear for static loading. Influence lines for horizontal thrust, bending moment, normal thrust and radial shear.

Two hinged arches: Parabolic and segmental arches, determination of horizontal thrust, bending moment, normal thrust and radial shear for static loading and temperature effects.

UNIT– IV:

Cables and Suspension bridges: Stresses in suspended cables due to point loads and uniformly distributed loads, equation of the cable, length of cable and general cable theorem. Suspension bridge with 3-hinged stiffening girders for static loading, determination of maximum tension in the cable, bending moment and shear force.

UNIT– V:

Deflections of Determinate structures: Deflection of pin-jointed plane frames and rigid jointed plane frames using Castigliano's theorem –I and Unit Load method.
Redundant pin-jointed plane frames: Analysis of pin-jointed plane frames using Castiglione's theorem –II and Unit load method, with one degree of redundancy (internal / external), Assembly and temperature effects.

Text Books:

1. B.C Punmia, and A. K. Jain, "*SMTS - II Theory of Structures"*, Laxmi Publications, New Delhi, 2017.
2. S. Ramamrutham, "*Theory of Structures"*, Khanna Publishers, New Delhi, 2018.

Suggested Reading:

1. H. J. Shah, S. B. Junnarkar, "*Mechanics of Structures Vol. II [Theory and analysis of structures]*", 24th Edition, Charotar Publishing House Pvt. Ltd., 2015.
2. T. S. Thandava Moorthy, "*Structural Analysis"*, 2nd edition. Oxford University Press, 2012.
3. C. S. Reddy, "*Basic Structural Analysis"*, 3rd Ed., Tata McGraw Hill, New Delhi, 2017.
4. D.S. Prakash Rao, "*Structural Analysis*" - *A Unified Approach*, University Press, 2012.

16CE C21

CONCRETE TECHNOLOGY

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course objectives: To enable the students

1. Learn the properties of various ingredients of concrete.
2. Understand the behaviour of concrete in fresh and hardened states.
3. Understand concrete mix design and compare the quantities using various design methods.
4. To acquire knowledge on the properties and effective usage of various admixtures.
5. Gain knowledge of various special concretes and their applications.

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

1. Determine the properties of the ingredients of concrete and adjudge their suitability.
2. Determine the properties of fresh and hardened concretes.
3. Carryout concrete mix design and apply statistical quality control techniques for quality assurance.
4. Use admixtures in suitable doses for improvement in various properties of concrete and for use in ready-mix concrete preparation.
5. Employ a special type of concrete depending on the purpose.

UNIT-I:

Constituents of concrete- review: Manufacture of Cement, Types of cements, tests on cements and aggregates.

Properties of Fresh concrete: Batching and Mixing, Workability, factors affecting workability, Measurement of workability using slump cone, compaction factor and V-B time tests, Segregation and bleeding, Compaction of concrete and Types of vibrators.

UNIT-II:

Hardened concrete: Strength of concrete and influencing factors, water- cement ratio, Gel, space ratio, Role of water in the mix, Short term and long term properties of concrete - shrinkage & creep, Types of Shrinkage, Factors affecting shrinkage & creep, Relationship between various mechanical strengths of concrete, Curing of concrete, Methods of curing, Maturity concept, Stress-Strain behaviour of concrete, Durability of concrete.

UNIT-III:

Mix design of concrete: Basic considerations, Factors to be considered in the choice of mix proportions, Quality control, various methods of mix design- I.S. code method, British and ACI methods.

UNIT-IV:

Admixtures: Classification of admixtures, Mineral and Chemical admixtures, Influence of various admixtures on properties of concrete, Applications, Ready mix concrete (RMC), Fly ash concrete – properties and applications.

UNIT-V:

Special Concretes: High strength concrete, High density concrete, Light weight concrete, Ferro cement, Recycled aggregate concrete, Self compacting concrete (SCC).

Fiber Reinforced Concrete: Need, Mechanism and properties of Fiber reinforced concrete (FRC), Types of Fibers and applications of FRC.

Text Books:

1. A.M Neville., "Properties of Concrete", English Language Book Society / Longman Publications, 1996.
2. M.S. Shetty, "Concrete Technology", S. Chand Publishers, 2005.
3. A. R. Santhakumar, "Concrete Technology", Oxford University, Press 2006.

Suggested Reading:

1. A.M. Neville and J.J. Brooks, "*Concrete Technology*", Dorling and Kindersley Publications, 2006.
2. P. K. Mehta, and J. M. M. Paulo, "*Concrete- Microstructure – properties and Material*", Mc. Graw Hill Publishers, 1997.
3. N. Krishnaraju, "*Design of Concrete Mixes*", CBS Publishers, 2010.

16CE C22

FLUID MECHANICS - II

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: To enable the student

1. Understand and analyze the open channel flows, steady uniform flow and computation, friction and energy losses.
2. Understand and analyze the non-uniform flows and flow profile, energy dissipation.
3. Exposure to the basic principles of Aerodynamic forces, boundary layer formation and effects, pressure wave and compressibility effect in pipes.
4. Understand dimensional analysis, study of models, models applied to practical applications.
5. Familiarize with various types of hydraulic machinery (turbines and pumps), design and performance studies.

Course Outcomes: At the end of the course, the student will be

1. Able to apply the concepts of open channel flow and pipe flow to the field problems.
2. Able to apply the concepts of non-uniform open channel flow to the field problems.
3. Interprets the basics of computation of drag and lifts forces in the field of aerodynamics, boundary layer effect, effect of pressure wave in pipes.
4. Able to apply model studies to practical applications, should be able design and study models in labs.
5. Design the turbines and pumps, should be able to run the turbines and pumps for efficient conditions.

UNIT–I

Steady uniform flow through open channels: Definitions, difference between pipe flow and channel flow, velocity and pressure distributions in channel cross section, energy and momentum correction coefficients, uniform flow, Manning and Chezy formulae, most efficient channel cross-section, specific energy and specific force, concept of critical depth and its applications.

UNIT-II

Non-uniform flow through open channels: Critical flow, Significance of Froude Number, dynamic equation of gradually varied flow, classification of gradually varied flow profiles and computation of flow profiles. Hydraulic Jump- Momentum equation

for a jump in horizontal rectangular channel, energy dissipation in hydraulic jump. Introduction to surges.

UNIT-III

Boundary layer-Definition, laminar and turbulent boundary layers, boundary layer thickness, displacement thickness, momentum thickness and energy thickness, hydro dynamically smooth and rough boundaries, boundary layer separation.

Drag and lift: Fundamental concepts of drag and lift forces. Drag on sphere, cylinder, flat plate and aerofoil. Principles of streamlining, Magnus effect.

UNIT-IV

Unsteady flow in pipes: Water hammer phenomenon, pressure rise due to gradual and sudden valve closure, critical period of the pipeline.

Dimensional analysis and models studies: Dimensional analysis as a tool in experimental hydraulics, Rayleigh Method, Buckingham method; geometric, kinematic and dynamic similarity, similarity laws; significance of Reynolds, Froude and Mach numbers, different types of models and their scale ratios, distorted and undistorted models, scale effect in models.

UNIT-V

Hydraulic turbines: Classification, specific speed, unit quantities velocity triangles, power developed and efficiencies. Principles of design of reaction and impulse turbines, characteristics curves, selection of turbines.

Centrifugal Pumps: Components, work done and efficiency, minimum starting speed, Euler head equation, specific speed and characteristic curves of centrifugal pumps, Pumps in series and parallel.

Text Books:

1. P. N. Modi & S. M. Seth, "*Hydraulic and Fluid Mechanics*", Standard Book House, Delhi, 20th Edition, 2013.
2. K. Subramanya, "*Flow in Open Channels*", Tata McGraw-Hill Education, 2009.

Suggested Reading:

1. K. Subramanya, "*1000 Solved Problems in Fluid Mechanics*", Tata Mc-Graw Hill Publications 2005.
2. Ven Te Chow, "*Open-Channel Hydraulics*", The Blackburn Press; 57th edition, 2009.
3. A. K. Jain, "*Fluid Mechanics: Including Hydraulic Machines*", Khanna Publisher, 12th edition, 2016.
4. R. L. Streeter, G. Z. Watters, and J. K. Vennerd, "*Elementary Fluid Mechanics*", John Wiley International Publications, 7th Edition, , 1996.

16CE E01

ROCK MECHANICS
(Elective-I)

Instructions	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. The objective of the course is to provide basic knowledge of Rock Mechanics and its application.
2. To understand the properties of the rocks.
3. To know the strength of the rock.
4. To study the application of rocks in engineering.
5. To know and apply the preventive techniques in rocks.

Course Outcomes:

1. Able to know the basic knowledge about rocks.
2. Able to determine the rock properties.
3. Able to determine the strength and quality of the rocks.
4. Able to know the failure criteria of the rock.
5. Able to apply the preventive techniques for the rock.

UNIT- I:

Introduction, Importance and application of rock mechanics to engineering problems, Rock Mechanics and its relationship with soil mechanics and engineering geology. Definition of Rock masses. Rock masses as construction material, Main features constituting rock mass. Effect of alteration and weathering.

UNIT- II:

Engineering properties of rocks, Porosity, Density, Moisture content, Degree of saturation, Coefficient of permeability, Durability, Compressive strength, Tensile strength, Shear strength, Elasticity, Plasticity deformability. Sampling and samples preparations - IS codes, Uni-axial compressive strength, Tensile strength - Brazilian test, Shear strength test. Plate load test for deformability, shear test, Test for internal stresses - flat jack.

UNIT– III:

Classification - Litho logical classification of rocks, Rock mass classification, Rock Quality Designation, Rock Structure rating, RMR classification, Q classification. Inter relation between Q and RMR. Classification of fissures, Joints and faults.

UNIT– IV:
Geophysical Methods - Seismic Refraction & Electrical Resistivity methods, GPR, rock blasting.

UNIT– V:
Earthquake: Magnitude and intensity of earthquake. Seismic waves. Seismic zones in India. Geological Hazards - Rock Instability and slope movement: Concept of sliding blocks. Different controlling factors - Prevention by rock bolting and rock anchoring, retaining wall, slope treatment, grouting. Case studies.

Text Books:

1. B. P. Verma, "*Engineering Geology and Rock Mechanics"*, Khanna Publishers, 1998.
2. T. Ramamurthy, "*Engineering in Rocks for Slopes, Foundations and Tunnels*", Prentice Hall India Learning Private Limited; Third edition, 2014.

Suggested Reading:

1. J.C. Jaeger and N.G.W. Cook, "*Fundamentals of Rock Mechanics*", Wiley India Pvt Ltd, 4th edition, 2012.
2. D. Deb and A. K. Verma, "*Fundamentals and Applications of Rock Mechanics*", PHI, 2016.
3. R. E. Goodman, "*Introduction to Rock Mechanics*", Wiley India Pvt Ltd; Second edition, 2010.

16CEE02

ADVANCED SURVEYING

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours Semester
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To enable the student understand the basic principles of Aerial surveying and its role in civil engineering.
2. To expose the student to image interpretation and equipment used for the same.
3. To enable the student to get acquainted with digital image processing system.
4. To expose the student to understand about how microwave sensing can be used in surveying.
5. To understand about the errors in surveying and application various statistical procedures for adjusting the errors in different

Course out comes:

1. To be in a position to understand the Photogrammetric surveying techniques.
2. To know the techniques involved in image processing.
3. To get exposure to digital image processing.
4. To be able to understand microwave sensing and its application.
5. To be able to adjust the errors that are cropping while carrying surveying.

UNIT– I:

Aerial surveying : Aerial Photogrammetry -introduction, activities of Photogrammetry, Basic Geometric Characteristics of Aerial Photographs-element s of a vertical photograph-photo coordinate measurement-Photographic scale-problems, ground coverage of aerial photographs, area measurement, Relief displacement of vertical features-correction for relief displacement, image parallax, ground control aerial photography, mapping with aerial photographs, Flight planning.

UNIT– II:

Visual Image interpretation: Introduction, fundamentals, elements, strategies, interpretation keys, wavelengths of sensing, temporal aspects, process, preparation of images and viewing- basic visual interpretation equipment, concepts of land use land cover mapping- classification With remotes Sensor data.

UNIT– III:

Digital image Processing: Introduction, various types of image manipulations, image rectification and restoration-geometric correction— Radiometric correction-Noise removal, image enhancement, spatial feature manipulation -spatial filtering-low pass filters and high pass filters-convolution-edge enhancement, Multi image manipulation.

UNIT– IV:

Microwave sensing - introduction, Radar development- side looking radar system , operation, Range resolution ,synthetic aperture radar - geometric characteristics-transmission characteristics-other characteristics. Radar image interpretation, Lidar-introduction and applications.

UNIT– V:

Theory of errors and survey adjustments introduction, types of errors, laws of weights, Principles of Least squares, Most probable value, method of displacements, Method of correlates, probable errors , distribution error, Triangulation adjustment-station adjustment, figure adjustment- adjustment of a triangle, chain of triangles, quadrilaterals, polygon with central station -methods of equal shifts, adjustment of levels and adjustment of a closed traverse.

Text Books:

1. T. Lillesand, R. W. Kiefer, "*Remote Sensing and Image Interpretation*", Jhon Willey & Sons, 2015.
2. A. M. Chandra, "*Higher Surveying*", New Age international (P) Limited, 2015.

Suggested Reading :

1. A. M. Chandra, "Geo-informatics", New age international Publishers, 2016.
2. R. Subramanian, "*Surveying and Levelling*", Oxford University Press, 2nd edition, 2012.
3. C. Venkatramaiah, "*Textbook of Surveying*", Orient Blackswan Private Limited, 2nd edition, 2011.
4. K. R. Arora, "*Surveying Volume - II*", Standard Book House; 13th edition, 2015.

16CE E03

ADVANCED STRENGTH OF MATERIALS
(Elective-I)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To understand the flexural behaviour of curved bars and determining the stresses in various X-sections.
2. To understand the behaviour of beams curved in plan, subjected to different types of loads.
3. To learn the determination of stresses in rotating discs, rings & cylinders.
4. To realize the significance of experimental techniques in stress analysis & understand the brittle coating & strain gauge methods for stress analysis
5. To know the failure criteria of materials and various theories of elastic failure.

Course Outcomes: At the end of the course, the student is expected to be

1. Capable of designing curved bars of different X-sections.
2. Able to determine stresses in beams curved in plan.
3. Expert to determine stresses in discs, rings & cylinders.
4. Competent to employee methods of brittle coating and strain gauges for stress analysis.
5. Proficient in using an appropriate elastic theory of failure for the materials and determine principal stresses.

UNIT – I:

Bending of curved bars: Introduction, Bending of curved bars**,** stresses in curved bars with large curvature (Winkler-Bach Theory), calculation of stresses in curved bars of different sections-rectangular, circular and trapezoidal in crane hooks, rings and chain links.

UNIT-II:

Beams curved in plan: Introduction, circular beam loaded uniformly and symmetrically supported on columns, Semi-Circular beam simply supported on 3 equally spaced supports, fixed cantilever quarter circular beam with a point load at free end, A fixed ended segmented curved beam.

UNIT-III:

Rotating Rings, Discs & Cylinder: Introduction, thin rotating ring or cylinder, rotating solid thin disc, rotating disc with a central hole, rotating disc of uniform strength, rotating long cylinder, temperature stresses in a thin disc.

UNIT-IV:

Experimental stress analysis Techniques:- Introduction, Brittle Lacquers - Brittle coating techniques, Coating stresses, Theory of failure for Brittle coatings, crack patterns in brittle coating, crack detection, types of Brittle coating, Resin based brittle coating, equipment for Stress analysis by brittle coating method, specimen preparation, Testing & calibration of brittle coating.

Strain gauge: Introduction, strain sensitivity, metal foil gauge, temperature compensator, parameter influencing the behaviour of strain gauge.

UNIT-V:

Elastic theories of failure: Introduction - Failure by Yielding-Failure by Fracture - Yield and Fracture Criteria-Maximum Shearing Stress Theory-Maximum Distortion Energy Theory-Octahedral Shearing Stress Theory-Comparison of Yielding Theories-Maximum Principal Stress Theory- Mohr's Theory-Coulomb-Mohr Theory.

Text Books:

1. V. N. Vazirani and M. M Ratwani, "*Analysis of Structures Vol. 1: Analysis, Design And Details Of Structures*", Khan Publications, 2003.
2. U.C. Jindal, "*Advanced Topics of Strength of Materials (PART-II)*", Galgotia Publications Pvt.Ltd. 2001.

Suggested Reading:

1. Heinemann, "*Mechanics of Materials*" Butterworth, 3rd edition, 1997.
2. J. O. Seely and F. B. Smith, "*Advanced Mechanics of Ma*terials", 1967.
3. R. Subramanian, "*Strength of Materials*", Oxford University press, 2016.
4. U. C. Jindal, "*Strength of Materials*", Pearson Education; 2nd edition, 2017.

16CE C23

FLUID MECHANICS LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives:

1. To enable the student understand the governing parameters for the discharge measurement for flows through various measuring devices.
2. To verify the flow and velocity measurements by conducting different tests.
3. To understand Bernoulli's principle by conducting experiments.

Course Outcomes: At the end of the course, the student should have learnt

1. Ability to find the co-efficient of discharge for flows through various flow measuring devices.
2. To differentiate between laminar and turbulent flows and identify the governing parameters for both.
3. Applies the concept of Bernoulli's energy principle.

LIST OF EXPERIMENTS

1. Determination of C_d, C_v, and C_c for circular Orifice (constant Head method).
2. Determination of C_d for mouthpiece (constant Head method).
3. Determination of C_d for V notch.
4. Determination of minor losses in pipes.
5. Determination of C_d broad crested weir.
6. Determination of C_d for venturimeter.
7. Determination of C_d of a mouth piece for unsteady flow in a hemi – spherical tank.
8. Determination of types of flows using Reynolds apparatus.
9. Determination of Darcy's friction factor.
10. Verification of Bernoulli's principle.

Text Books:

1. M.N. Shesha Prakash, "*Experiments in Hydraulics and Hydraulic Machines – Theory and Procedures",* PHI Learning Private Limited, 2011.

16CE C24

ENVIRONMENTAL ENGINEERING LAB

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: To enable the students

Conduct physical and chemical analysis of water sample

1. Interpret laboratory results and report the values in comparison with environmental quality standards.
2. Find the optimum coagulant dosage for effective sedimentation.
3. Determine dissolved oxygen of water sample.
4. Determine the dosage for chlorination for disinfection of water supplies.

Course Outcomes: At the end of the course, the students should have learnt

1. To characterize the quality of water for suspended matter by physical tests.
2. To evaluate the quality of water for hardness, chlorides using chemical analysis.
3. To assess the alum dosage for effective sedimentation.
4. To measure Dissolved Oxygen concentration to assess the quality of water.
5. To measure the concentration of degradable organic matter.

List of Experiments:

1. Determination of alkalinity.
2. Determination of hardness.
3. Determination of chlorides.
4. Determination of pH.
5. Determination of electrical conductivity.
6. Determination of D.O.
7. Determination of B.O.D.
8. Determination of Iron.
9. Determination of Turbidity.
10. Determination of total solids, total inorganic solids.
11. Determination of residual chlorine.
12. Determination of optimum coagulant dosage by jar test.
13. Determination of C.O.D.

References:

1. Relevant IS codes and Specifications.

16CE C25

CONCRETE LABORATORY

Instruction	3 Hours per week
Duration of semester End Examination	3 Hours
Semester Examination	50 Marks
CIE	25 Marks
Credits	2

Course objectives:

1. To understand properties of constituent materials of concrete
2. To comprehend the behaviour of fresh concrete
3. To understand mechanical behaviour hardened concrete
4. To acquire knowledge of conducting Non-Destructive testing on concrete structures

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

1. Test different concrete mixing materials and issue test reports
2. Assess the workability of field concrete and guide the site supervisor in preparing a good concrete
3. Perform tests on mechanical characteristics of concrete and issue test reports.
4. Handle NDT equipment's and evaluate concrete by NDT methods

List of Experiments:

1. Determination of specific gravity and bulk density of cement.
2. Determination of normal consistency and initial setting time of cement.
3. Determination of compressive strength of cement.
4. Determination of fineness of cement by sieving and by air permeability methods.
5. Determination of specific gravity, bulk density, voids ratio and porosity of fine aggregate.
6. Determination of Bulking of sand by field and laboratory methods of coarse aggregate.
7. Determination of fineness moduli of fine & coarse aggregates.
8. Measurement of workability of design concrete mixes by slump & compaction factor tests.
9. Determination of Compressive, split tensile and flexural strengths of design concrete mixes.
10. Non-Destructive testing of concrete using Rebound hammer & UPV tests.

References:

1. Relevant IS codes and Specifications

SCHEME OF INSTRUCTION AND EXAMINATION
B.E. III -YEAR
CIVIL ENGINEERING

SEMESTER VI

S.No	Course Code	Title of the Course	Scheme of Instruction		Scheme of Examination			Credits
			Hours per Week		Duration in Hrs	Maximum Marks		
			L/T	D/P		Continuous Internal Evaluation (CIE)	Semester End Exam (SEE)	
THEORY								
1	16CE C26	Theory of Structures - II	3/1	-	3	30	70	4
2	16CE C27	Reinforced Concrete Design-II	3/1	-	3	30	70	4
3	16CE C28	Water Resources Engineering-I	3	-	3	30	70	3
4	16CE C29	Foundation Engineering	3	-	3	30	70	3
ELECTIVE – II								
5	16CE E04	Finite Element Method	3	-	3	30	70	3
	16CE E05	GIS & Remote Sensing						
	16CE E06	Artificial Neural Networks, Fuzzy logic & Expert Systems						
PRACTICALS								
6	16CE C30	Soil Mechanics Laboratory	-	3	3	25	50	2
7	16CE C31	Hydraulics & Hydraulic Machinery Lab	-	3	3	25	50	2
8	16CE C32	Transportation Engineering Lab	-	3	3	25	50	2
9	16CE C33	Industrial Visit	**Satisfactory / Unsatisfactory**					
Total			**17**	**09**		**225**	**500**	**23**

L=Lecture, T=Tutorial, D/P= Drawing/ Practical's
CIE - Continuous Internal Evaluation SEE - Semester End Examination

One extra hour may be permitted in the time table for Reinforced Concrete Design-II and Water Resources Engineering-I.

16CE C26

THEORY OF STRUCTURES-II

Instruction	4 (3L+1T) Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: To enable the student to

1. Understand the concept of indeterminate beams and frames and to analyze by slope deflection method due to point loads and udl load system.
2. Grasp the procedure for indeterminate beams and frames by moment distributed method due to point loads and udl load system.
3. Understand the concepts of Kani's Method for indeterminate beams and frames due to point loads and udl load system.
4. Grasp the procedure for indeterminate beams and frames by flexibility matrix method due to point loads and udl load system.
5. Analyze the indeterminate beams and frames by stiffness matrix method due to point loads and udl load system.

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

1. Analyze the indeterminate beams and frames by slope deflection method due to point loads and UDL load system.
2. Analyze the indeterminate beams and frames by moment distribution method due to point loads and UDL load system.
3. Analyze the indeterminate beams and frames by Kani's method due to point loads and UDL load system.
4. Analyze the indeterminate beams and frames by flexibility matrix method due to point loads and UDL load system.
5. Analyze the indeterminate beams and frames by stiffness matrix method due to point loads and UDL load system.

UNIT – I:

Slope deflection method: Introduction, Analysis of Continuous beams with and without sinking of supports. Single bay - single storied portal frames with and without side sway. Loading on each span may be point load(s) and uniformly distributed load on whole span.

UNIT-II:

Moment distribution method: Introduction, Analysis of Continuous beams with and without sinking of supports. Single bay - single storied portal frames with and without side sway. Loading on each span may be point load(s) and uniformly distributed load on whole span.

UNIT– III:

Kani's method: Introduction, Analysis of Continuous beams with and without sinking of supports. Single bay - single storied portal frames with and without side sway. Loading on each span may be point load(s) and uniformly distributed load on whole span.

UNIT– IV:

Flexibility method of Analysis: Introduction, Analysis of continuous beams, and rigid jointed plane frames with static indeterminacy not exceeding three. Analysis pin jointed plane frames with static indeterminacy not exceeding two.

UNIT– V:

Stiffness method of Analysis: Introduction, Analysis of continuous beams, pin jointed plane frames and rigid jointed plane frames with kinematic indeterminacy not exceeding three.

Text Books:

1. T. S. Thandava Moorthy, "*Structural Analysis"*, Oxford University Press, 2nd Edition, 2012.
2. C. S. Reddy, "*Basic Structural Analysis"*, Tata McGraw Hill, 3rd Edition 2017.

Suggested Reading:

1. B.C. Punmia, and A. K. Jain, "*SMTS - II Theory of Structures"*, Laxmi Publications, 2017.
2. S. Ramamrutham, "*Theory of Structures"*, Khanna Publishers, 2018.
3. D. S. Prakash Rao, "*Structural Analysis*" - *A Unified Approach*, University Press, 2012.
4. W. Weaver, JR. and J. M. Gere., "*Matrix Analysis of Framed Structures"*, CBS Publishers, 2nd edition, 2004.

16CE C27

REINFORCED CONCRETE DESIGN-II

Instruction	4 (3L+1T) Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	4

Course Objectives: To enable the student

1. Understand the design and detailing of rectangular and trapezoidal combined footings.
2. Learn the concepts of design and detailing of cantilever and counter fort retaining walls.
3. grasp the design and detailing of circular and rectangular water tanks
4. Comprehend the concepts of design and detailing of Solid slab bridges
5. Know the procedures for design and detailing of T-bean bridges

Course Outcomes: At the end of the course the student will be able to

1. Design and detail the rectangular and trapezoidal combined footing .
2. Design and detail the cantilever and counter fort retaining wall .
3. Design and detail circular and rectangular water tanks
4. Design and detail solid slab, bridges under given condition.
5. Design and detail the various components of T-Beam bridges.

(Note: All relevant IS and IRC codes necessary for teaching this course may be introduced and referred in detail by the Faculty concerned)

UNIT – I

Combined Footings: Limit state design & detailing of combined rectangular and trapezoidal footings.

UNIT – II

Retaining walls: Limit state design and detailing of cantilever and counter fort type of retaining walls.

UNIT – III

Water tanks: Elastic Design & Detailing of circular and rectangular ground level and over-head tanks, design of staging for wind loads.

UNIT – IV

Bridges: Basic components- Types of bridges -Loads on bridges- IRC standards; Elastic design and detailing of two lane, simply supported RC Solid Slab Bridge including Kerb.

UNIT- V

T-beam bridges: Components of a T-beam bridge- Elastic design and detailing of two lane, Simply Supported, Three girder T-beam bridge- Use of effective width method- Pigeaud's curves and Courbon's method.

Text Books:

1. N. Krishna Raju, "*Advanced Reinforced Concrete Design (IS: 456-2000)* ",CBS Publications 2nd Edition,2010.
2. Vazirani and Ratwani," *Design Of Concrete Bridges*", Khanna Publishers, 1998.

Suggested Reading:

1. D.S. Prakash Rao, "*Design Principles and Detailing of Concrete Structures*", Tata McGraw-Hill Publishing Co. Ltd., 1998.
2. D. Johnson Victor, "*Essentials of Bridge Engineering*", paperback, Oxford & IBH, Publishing Co., New Delhi, 6th Edition, 2015.
3. S. Ponnuswamy, "*Bridge Engineering*", Tata McGraw Hill, Third Edition, 2017.
4. N. Krishna Raju, "*Design of Bridges*", Oxford &IBH-Pubs Company-New Delhi, Fourth Edition, 2008.

16CE C28

WATER RESOURCES ENGINEERING - I

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. Understand surface & sub surface hydrology, peak flow estimation, computation of yield from an open well.
2. Learn flow irrigation, lift irrigation, Design of Canal sections, and efficient use of Irrigation water.
3. Acquaint with locating site of a reservoir, design of a reservoir capacity.
4. Grasp the Design procedure for a diversion head works.
5. Technical acquaintance of water regulation.

Course Outcomes:

1. Ability to design a Rain Gauge network, flood estimation, estimate yield from an open well.
2. Capability to design canals, Capacity to operate irrigation system efficiently.
3. Select an ideal site for a reservoir, estimate its optimum capacity and regulate a reservoir efficiently.
4. Design, Construct and operate a barrage.
5. Regulate Canal flows efficiently as an irrigation engineer.

UNIT- I :

Water Resources: India's water wealth-Regional, National -Inequity in distribution-Role of Water resources in National Development.

Hydrology: Scope of hydrology in civil engineering, Hydrologic cycle, Rainfall, measurement of rainfall and estimation of mean rainfall over a catchment, optimum number of rain gauges for a catchment- infiltration, evaporation, runoff, factors affecting runoff- peak flow estimation, unit hydrograph method, flood frequency and return period.

UNIT-II:

Irrigation: Duty, delta and base period of crops, crop water requirements, methods of irrigation, micro-irrigation, irrigation efficiencies, depth of irrigation, wilting point, consumptive use, irrigation interval-types of canals, alignment of canals, canal sections, balancing depth of cutting, Kennedy's and Lacey's theories, design of lined and unlined canals.

Lift Irrigation: Necessity, layout and component parts of Lift irrigation.

UNIT-III:

Reservoirs: Investigations and site selection criteria, Storage capacity design, sedimentation, Flood routing.

Ground water: Types of aquifers, Aquifer parameters, steady radial flow into a confined and unconfined aquifers, Darcy's law, yield of an open well, Safe yield, Water harvesting structures and augmentation of ground water, Sustainable Ground Water management.

UNIT-IV:

Diversion head works: Components, causes of failures, Design criteria, Difference between weir and barrage, Bligh's Creep theory, Khosla's theory and method of independent variables, design principles of barrage.

UNIT-V:

Regulation works: Canal falls, types, design principles of trapezoidal notch fall, types of regulators, Functions of cross regulator and head regulator, cross drainage works, types, Criteria for selection of CD work, and design principles of an aqueduct, types of outlets, flexibility, sensitivity and proportionality of outlets.

Text Books:

1. P. N. Modi, "*Irrigation Water Resources & Water Power Engineering",* Standard Publishers, 9th edition 2014.
2. S. K. Garg, "*Irrigation Engineering and Hydraulic Structures: Water Resources Engineering - Vol. II",* Khanna Publishers, 2017.

Suggested Reading:

1. M. M. Dandekar and K. N. Sharma, "*Water Power Engineering*", Vikas Publishers, New Delhi, 2013.
2. Ch. S. N. Murthy, "*Water Resources Engineering: Principles and Practice*", New Age International Publishers; 2nd edition, 2002.
3. B.C. Punmia and Ashok Kumar Jain, "*Irrigation and Water Power Engineering*, Laxmi Publishers, 2016.
4. K. C. Patra," Hydrology and Water Resources Engineering", Alpha Science, 2008.

16CE C29

FOUNDATION ENGINEERING

Instructions	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course objectives: To enable the students

1. Understand the stress distribution in the soils for different loading conditions.
2. Understand the principle of bearing capacity and settlement analysis.
3. Understand the principles of deep foundations.
4. Deal with the field problems.
5. Learn about coffer dams, caissons, and timbering of excavations.

Course outcomes: At the End of the course the students should be able to

1. Compute the stress distribution in the ground under different loading conditions.
2. Estimate the bearing capacity of different soils for shallow foundation.
3. Design the deep foundation by piles or wells.
4. Deal with the field problems in laying cofferdams and different dewatering techniques and sampling methods.
5. Interpret and implement the Concepts of Coffer dams , Caissons and Timbering of Excavations

UNIT-I:

Stress distribution in Soils: Boussinesq's and Westegaurd's equations for point load. Application of point load formulae for uniformly distributed load on circular area, Line load, Strip Load, rectangular area. Use of Newmark's chart for different areas using Boussinesq's equation, Contact pressure distribution.

UNIT-II:

Bearing capacity of soils: Terzaghi's equation for bearing capacity in soils –It's modification for continuous, square, rectangular and circular footings, general and local shear failure conditions. Plate load test as per IS specification. Allowable bearing capacity. Standard penetration test and use of N values for estimating soil conditions and bearing capacity.

Settlement Analysis: Computation of pressures before loading and after loading. Estimation of settlement – ultimate and after any given period.

UNIT-III:

Pile Foundations: Types of piles–Timber, steel, concrete, cast-in situ, precast piles, bearing piles, friction piles, compaction piles, large diameter piles. Pile capacity – Static formulae, dynamic formulae, pile load test, determination of point resistance

and skin friction as per IS code. Bearing capacity of pile groups, negative skin friction.

UNIT-IV:

Coffer dams: Earth embankments, cantilever sheet piles, braced coffer dams. Double wall cofferdams, cellular coffer dams – circular, diaphragm type, general description and construction methods.

Caissons: types of caissons–Open caissons, pneumatic caissons, box caissons(floating caissons). General description and construction methods. Dewatering techniques: sumps, ditches. Well points, deep walls. Geo-textile methods: Types and uses.

UNIT-V:

Site investigation: Principles of exploration, sampling methods, transportation and storage of samples, boring and drilling methods, log of bore holes, sampling tubes and samplers. Sampling records.

Timbering of excavation: Bracing for shallow and deep excavations. Computation of lateral earth pressure. Reaction of struts.

Text Books:

1. K. R. Arora, "*Soil Mechanics and Foundation Engineering*", 7th Edition, Standard Publishers, 2009.
2. Gopal Ranjan, "*Basic and Applied Soil Mechanics*", 3rd Edition, New Age International, 2016.

Suggested Reading:

1. B.C Punmia and Ashok Kumar Jain and Arun Kumar Jain, "*Soil Mechanics and Foundations*", Laxmi Publications, 16th Edition, 2017.
2. E. J. Bowles, "*Foundation Analysis and Design*", Tata Mc Graw Hill, 2017.

16CE E04

FINITE ELEMENT METHODS
(Elective-II)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives: To enable the student

1. Learn the fundamentals of Finite element method (FEM) and derive elasticity matrices fro 2-D and 3-D elasticity problems.
2. Understand basic principles of minimum potential energy methods and variational formulation of FEM know the stiffness matrix formulations using bar element and analyze simple problems.
3. Understand the FEM formulation using truss, beam, and plane frame elements and analyze simple problems with kinematic indeterminacy not greater than 3.
4. Get familiarized with displacement models, Isoparametric elements and quadrilateral elements and know the formulation of global stiffness matrices.
5. Know the formulation of stiffness matrices for Axi-Symmetric elements, Tetrahedron elements.

Course outcomes: At the end of the course, the student should have learnt

1. The fundamentals of FEM, elements of theory of elasticity.
2. Principle of minimum potential energy and variation formulation of FEM and analyze simple problems using bar elements.
3. The analysis of trusses, beams and rigid jointed plane frames.
4. The formulation of Global stiffness matrix, load matrix and analysis structures using 1st order triangular elements, isoparametric elements, and quadrilateral elements.
5. Application of Axi-Symmetric and Tetra-Hedron elements.

UNIT-I:

Introduction to FEM: General description of the method, brief history of the method, applications of the method, advantages of the finite element method, steps in the finite element method. Types of elements; Types of forces: body forces, surface tractions and point loads, Boundary conditions.

Strain displacement, and stress- strain relations for 2-D and 3-D problems. Equations of equilibrium and compatibility conditions for 2-D and 3-D problems. Plane stress and plane strain situations and derivation of elasticity matrices (D).

UNIT-II:

Finite Element Formulation: Principle of minimum potential energy, Principle of virtual displacement, Global coordinate system, local coordinate system, Raleigh Ritz method, Weighted Residual method- Galerkin's method, Boundary value problems- with one element and two elements.

Bar Elements: Shape functions, stiffness matrix for a 2- noded bar element, axial bar subjected to point loads-constant cross section and varying cross section bar.

UNIT-III:

Truss Elements: Transformation matrix, Stiffness matrix of truss member in local and global axis, analysis of trusses with kinematic indeterminacy not exceeding three.

Beam Elements: Shape functions, beam element stiffness matrix, element load vector, and analysis of continuous beams with kinematic indeterminacy not exceeding three.

Plane Frame elements: Element stiffness matrix in local coordinates, Transformation or Rotation matrix, and stiffness matrix and load vector in global coordinates.

UNIT-IV:

Displacement models: Selection of displacement models, geometric invariance, conforming and non-conforming elements.

2-D 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.

Iso-parametric elements: Iso-parametric concept, Iso-parametric, Sub parametric and Super parametric elements. Gauss Quadrature of numerical integration.

Quadrilateral elements: Construction of shape functions for 4 noded and 8 noded elements, determination of stiffness matrix, and nodal load matrices for 4-noded quadrilateral element.

UNIT-V:

Axi-symmetric elements: Strain-displacement relationship, stress-strain relationship, determination of stiffness matrix for 3-noded ring element and load matrices for body force and surface traction.

Tetrahedron elements: Volume coordinates, Strain-displacement matrix, and stiffness matrix.

Text Books:

1. David V. Hutton, "*Fundamentals of Finite Element Analysis"*, McGraw Hill Education (India) Private Limited, 2017.
2. P. N. Godbole, "*Introduction to Finite Element Method"*, I. K. International Publishing House Pvt. Ltd. New Delhi, 2013.

Suggested Reading:

1. T. R. Chandrupatla, and A.D. Belegundu, "*Introduction to Finite Elements in Engineering"*, Pearson Education India; 4 edition, 2015.
2. D. L. Logan, "*A First Course in the Finite Element Method"*, Cengage Learning India Private Limited; 5 edition, 2012.
3. O. C. Zienkiewicz, and R. L. Taylor, "*The Finite Element Method: Its Basis and Fundamentals*", Butterworth-Heinemann; 7 edition, 2013.
4. P. Seshu. "Textbook of *Finite Element Analysis*", PHI, 1st edition, 2010.

16CE E05

GEOGRAPHICAL INFORMATION SYSTEM AND REMOTE SENSING

(Elective - II)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course objectives: To enable the student

1. Understand the basics and applications of GIS, and to take decisions using GIS under uncertain Conditions.
2. Understands the basic difference between vector GIS and raster GIS.
3. Understand the various types of data, realize the importance of spatial data and also in a position to apply methods of data compression techniques.
4. Perform data analysis and modeling using GIS.
5. Understand the basics of remote sensing and apply the principles to watershed modeling, environmental modeling and watershed management.

Course Outcomes: At the end of the course, the student

1. Is able to apply the principles of GIS to various field problems and take decisions under uncertain conditions.
2. Is able to understand advantages and disadvantages of using vector GIS and raster GIS.
3. Is able to apply the methods of data Compression using GIS.
4. Can perform the data modeling and analysis using GIS.
5. Is able to apply the basic principles of Remote Sensing for Watershed modeling, Environmental Modeling and for Watershed Management.

UNIT– I:

Introduction: Map, definitions, representations–Point line, polygon, common coordinate systems, map projects – transformations – Coordinate systems- – map analysis. History of development of GIS – Applications of GIS: Soil and water resources, agriculture, land use planning, geology and municipal applications, using GIS for decision making under uncertainty.

UNIT-II:

Data entry, storage and maintenance: Data types–spatial non spatial (attribute data)–data-structure, data format – point line vector – Raster – Polygon – Object structural model – filters and files data in computer – keyboard entry, manual digitizing, scanner, remotely sensed data. Concepts of Geo referencing, Existing digital data – cartographic database. Digital elevation data – data compression.

UNIT-III:

Data analysis and modeling: Spatial analysis, data retrieval, query (SQL)–Simple analysis, recode overlay, vector analysis, raster data analysis – modeling in GIS – Digital elevation model– cost and path analysis – knowledge based systems.

GIS Analysis Functions: Organizing data for analysis, classification of GIS analysis function, maintenance and analysis of spatial data – transformation, conflation, edge matching and editing, Maintenance and analysis for non-spatial attribute data editing and query functions.

UNIT-IV:

GIS analysis function for integrated analysis of spatial and attribute data: Retrieval and classification function: Overlay operations, neighborhood operations, connectivity function, output formatting – Map annotations text pattern and line styles, graphic symbols, cartographic modeling by GIS analysis procedure with an example.

Presentation of Geo-data Analysis: Types of output data–types of errors elimination and accuracies – sampling - components of data quality.

UNIT-V:

Introduction of Remote Sensing: Electromagnetic radiation, characteristics, interaction with earth surface, sensors types, satellite characteristics IRS series, data products interpretation of data.

Software scenario – Functions: Watershed modeling, Watershed Management, Environmental modeling – Visibility analysis. Vehicle tracking.

Text Books:

1. K. T. Chang, "*Introduction to Geographic Information Systems*", McGraw-Hill Education, 1st edition, 2015.
2. P.A. Burrough, "*Principles of Geographical Information Systems for Land Resources Assessment (Monographs on Soil and Resources Survey)",* Oxford University Press, 1986.
3. Lillesand and Kiefer, "*Remote Sensing and Image Interpretation*", Wiley; Sixth edition, 2011.

Suggested Reading:

1. I. Heywood, S. Cornelius and Steve Carver, "*An Introduction to Geographical Information Systems*", Pearson, 4th Edition, 2012.
2. B. Bhatta, "*Remote Sensing and GIS*", Oxford, Second edition, 2011.
3. S. Kumar, "*Basics of Remote Sensing and GIS*", Laxmi Publications, First edition, 2016.
4. S. Aronoff, "*Geographic Information Systems: A Management Perspective*", WDL Publications Ottawa, 1991.

16CE E06

ARTIFICIAL NEURAL NETWORKS, FUZZY LOGIC & EXPERT SYSTEMS (ELECTIVE - II)

Instruction	3 Hours per week
Duration of Semester End Examination	3 Hours
Semester End Examination	70 Marks
CIE	30 Marks
Credits	3

Course Objectives:

1. To understand the importance of Artificial Intelligence and get introduced to Fuzzy Logic (FL), Artificial neural networks (ANN)& Expert systems (ES).
2. To get acquaintance with various components & types of Neural Networks.
3. To learn the fundamentals & applications of fuzzy sets to civil engineering problems.
4. To learn the concepts & various types of expert systems tools.
5. To get exposure of different software packages by solving a case study using FL, ANN & ES.

Course Outcomes: At the end of the course, the student is expected to

1. Have the overall idea &knowledge to employ FL, ANN & ES for specific applications.
2. Have fundamental knowledge of ANN.
3. Have rudimentary knowledge of Fuzzy sets & their applications.
4. Have the grasp of Expert System & its applications.
5. Apply FL, ANN & ES to the real cases of civil engineering and get the solutions to the problems, with the help of standard software packages.

UNIT– I:

Introduction: Brief introduction to the study of artificial intelligence:" An insight to the concept of natural intelligence followed by the development of artificial neural networks, fuzzy logic systems and expert systems tools. Demonstration of the importance of artificial neural networks, fuzzy logic, and expert systems with the help of at least two practical examples of Civil Engineering for each study. Importance of nuerofuzzy systems.

UNIT– II:

Neural Networks: Components of artificial neural networks neurons, inputs, outputs, error, error propagation, hidden layers threshold logic, weights: bias, noise, momentum, rate of learning, training and testingHebb's rule, Delta rule Supervised learning – Generalized delta rule unsupervised learning.

Types of Neural Networks Perceptions feed forward back propagation networks Hop field networks.

UNIT– III:

Fuzzy sets: Crispness vagueness, uncertainty, and fuzzy sets. Basic Definitions and operations of Fuzzy sets, approximate reasoning, and membership function.
Fuzzy Relations: Fuzzy relation and fuzzy composition, fuzzy aggregation procedures, Dominance Matrix, Weight ages, applications of Fuzzy sets to civil engineering problems, and pattern recognition.

UNIT- IV:

Expert systems: Structure of expert systems, Knowledge of acquisition, Knowledge organization, methods of representing knowledge, types of inference engines, reasoning under uncertainty, various types of expert system tools, heuristics, search mechanism, expert system Development and hybrid expert systems.

UNIT- V:

Exposure to Software Packages: Neural networks (Mat lab tool kit)–fuzzy logic expert systems (L5 object)Applications of Artificial Neural Networks, Fuzzy logic and expert systems in Civil Engineering Case studies with at least one problem on each aspect of ANN, FL and Expert systems.

Text Books:

1. H. J. Zimmerman, "Fuzzy Sets, Decision Making, and Expert Systems", Kluwer Academic Publications, Boston, 1987.
2. H. Adeli, "Expert Systems in Construction and Structural Engineering", Chapman & Hall, Ltd. London, UK, 1988.

Suggested Reading:

1. K. Knight, E. Rich, S. B. Nair "*Artificial Intelligence*", McGraw Hill Education; 3rd edition, 2017.
2. J. A. Freeman and D. M. Skapura, "*Neural Networks: Algorithms, Applications and Programming Techniques (Computation and Neural Systems Series)*", Addison Wesley, 1991.

16CE C30

SOIL MECHANICS LABORATORY

Instruction	3Hours per week
Duration of semester End Examination	3 Hours
Semester Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives:

1. To prepare the students with good skills in the laboratory procedures in soil mechanics.
2. To empower the students to deal with the field and laboratory, procedures in soil Explorations and sampling procedures.

Course Outcomes: At the end of the course the student should have learnt

1. The basic skills of conducting experiments on Soils for knowing their properties, identifying its type and interpret the results.
2. To apply the experimentation skills to the field problems such as site investigations and Soil Exploration techniques.

Determination of Basic and Index properties (Any Five Tests)

1. Determination of specific gravity of soil solids using "Density bottle" method.
2. Determination of specific gravity of soil solids using "Pycnometer" method.
3. Determination of water content using "Pycnometer" method.
4. Determination of liquid limit using Casgrandes standard LL device.
5. Determination of liquid limit using cone penetration apparatus.
6. Determination of plastic limit.
7. Sieve Analysis for plotting Particle size distribution curve.
8. Determination of Field Density using Sand Replacement Method.
9. Determination of Relative Density of Sand.

Determination of Engineering properties (Any Five Tests)

10. Determination of Compaction Characteristics.
11. Determination of Co-efficient of Permeability by "Constant Head Permeameter test".
12. Determination of Co-efficient of Permeability by "Variable Head Permeameter test".
13. Determination of shear strength parameters by "Direct Shear Test".
14. Determination of shear strength of cohesive soils by "Unconfined compression Test".
15. Determination of shear strength of conducting "Vane shear test".

Test Procedures:

16. Consolidometer test.
17. Tri-axial Shear test.

Suggested Reading:

1. Relevant IS Codes of Practice.
2. T.W. Lambe, "*Soil Testing for Engineers (Wiley Series in Geotechnical Engineering)*, 1966.
3. Relevant ASTM Codes of Practice.

16CE C31

HYDRAULICS AND HYDRAULIC MACHINERY LAB

Instruction	3Hours per week
Duration of semester End Examination	3 Hours
Semester Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: To enable the student

1. Understand uniform and non-uniform flows and the importance of Froude number in open channel flows.
2. Determine super elevation in a curved channel.
3. Determine the force exerted by fluid jet on vane, determine efficiency and performance of turbines and centrifugal pumps.
4. Study streamline patterns in a fluid flow system and air pressure distribution around an Airfoil.

Course Outcomes: At the end of the course, the student should have learnt

1. To compute the open channel rugosity coefficient in uniform flows and Froude number, energy losses in non- uniform flows.
2. To differentiate between uniform, non-uniform flows and flow in curved channel.
3. To determine work done by fluid jet on vane, compute work done and draw performance characteristic curves for turbines and centrifugal pumps.
4. To find the discharge between stream lines and pressure variations around an airfoil.

List of experiments

1. Uniform flow in channels - Determination of Manning's Rugosity coefficient, Chezy's constant.
2. Curved Channel flow - Determination of super elevation
3. Hydraulic Jump - Determination of Froude number, loss of energy, type of jump.
4. Impact of Jets - Determination of force on flat vane and curved vane.
5. Centrifugal Pump-Determination of efficiency and performance characteristics of a constant speed pump.
6. Pelton Wheel turbine-Determination of efficiency and performance characteristics of a Pelton wheel turbine.
7. Franics Turbine-Determination of efficiency and performance characteristics of a Francis turbine.
8. Kaplan Turbine-Determination of efficiency and performance characteristics of a Kaplan turbine.
9. Hele Shaw's Apparatus - Study of stream line pattern.

Text Books:

1. M.N. Shesha Prakash, "*Experiments in Hydraulics and Hydraulic Machines – Theory and Procedures",* PHI Learning Private Limited, 2011.

16CE C32

TRANSPORTATION ENGINEERING LAB

Instruction	3Hours per week
Duration of semester End Examination	3 Hours
Semester Examination	50 Marks
CIE	25 Marks
Credits	2

Course Objectives: To enable the student

1. Assess the quality of the material used in pavement construction and compare with IRC specifications.
2. Identify the field data required for assessing the traffic parameters.

Course Outcomes:

1. To apply methods for assessing various types of material to be used in the pavement construction.
2. To plan for the collection of field data and to present the same data for the analysis and take decisions for smooth movement of the traffic.

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 road aggregates

7. Aggregate crushing value test.
8. Los Angeles abrasion test.
9. Aggregate impact value test.
10. Aggregate shape test(flakiness & elongation).
11. Water Absorption.
12. Soundness.

C) Traffic Studies (demonstration only)

13. Traffic volume study.
14. Spot Speed Study.
15. O & D Study concepts.
16. Speed and delay studies.

D) Miscellaneous Tests

17. Determination of C.B.R.
18. Preparation of representative sample by coning and quartering.
19. Bitumen extraction test.
20. Marshal stability concepts and Tests.

Suggested Reading:

1. IRC codes and specifications.

16CE C33

INDUSTRIAL VISIT

Sessional Examination
*Grade

Students are expected to visit at least two works of Civil Engineering importance in and around Hyderabad and submit a detail report on the same to the department. The Department should evaluate the reports and presentation through a Committee consisting of Head of the Department and two more members of the senior faculty.

*** Satisfactory / Unsatisfactory.**