Course No.	Course Name	L-T-P – Credits	Year of Introduction
CE201	MECHANICS OF SOLIDS	3-1-0-4	2016

Pre requisite: BE 100 Engineering Mechanics

Course Objectives: To enable the students to calculate stresses and strains generated in material due to external loads for various types of loading conditions

Syllabus: Concept of stress. Concept of strain. Stress-strain relations. Calculating internal forces (Normal force, shear force and bending moment diagrams) Behavior of axially loaded members. Behavior of members subjected to bending moments. Behavior of circular members subjected to Torsion. Shear stresses in beams. Transformation of plane stresses. Mohr circle. Concept of design of beams. Buckling of columns. Indeterminacy.

Expected outcome .

1. Ability to calculate internal forces in members subject to axial loads, shear, torsion and bending and plot their distributions
2. Ability to calculate normal, shear, torsion and bending stresses and strains
3. Ability to transform the state of stress at a point and determine the principal and maximum shear stresses using equations as well as the Mohr's circle
4. Understanding of column buckling and ability to calculate critical load and stress

Text Books:

1. Timoshenko , Strength of Materials Vol. I & Vol. II , CBS Publishers & Distributers, New Delhi
2. Rattan, Strength of Materials 2e McGraw Hill Education India 2011

Data Book (Approved for use in the examination): Nil

References:

1. Crandall, An Introduction to Mechanics of Solids 3e McGraw Hill Education India 2014
2. Egor P Popov , Mechanics of solids, Prentice Hall of India, New Delhi
3. M.L. Gambhir, Fundamentals of structural Mechanics and analysis, Prentice Hall India
4. Stephen H Crandall, N C Dahi, Thomas J L, M S Sivakumar, an introduction to Mechanics of Solids , McGraw hill Education, 3rd edition
5. Cheng, Statics and Strength of Materials 2e McGraw Hill Education India 2013
6. Hearn E.J., *Mechanics of Materials*, Pergamon Press, Oxford
7. Nash W A, Strength of Materials (SIE) (Schaum's Outline Series) 5e McGraw Hill Education India 2010
8. Rajput R.K. Strength of Materials, S.Chand&company Ltd., New Delhi
9. James M Gere & Stephen P Timoshenko , Mechanics of Materials , CBS Publishers & Distributers, New Delhi
10. Punmia B. C., A. K. Jain and A. K. Jain, Mechanics of Materials, Laxmi Publications(P) Ltd, New Delhi

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	**Review of Statics** Types of external loads - internal stresses - normal and shear stresses - strain - Hooke's law - working stress - stress strain diagrams - Poisson's ratio - relationship between elastic constants	9	15%
II	Elongation of bars of constant and varying sections – statically indeterminate problems in tension and compression –Temperature effects – strain energy and complementary energy-strain energy due to tension, compression and shear	9	15%
FIRST INTERNAL EXAMINATION			
III	**Bending Moment & Shear force:** Different types of beams- various types of loading –Relationship connecting intensity of loading , shearing force and bending moment- shear force and bending moment diagrams for cantilever beams and Simply supported beams for different types of loading.	9	15%
IV	**Stresses in beams of symmetrical cross sections:** Theory of simple bending –assumptions and limitations – Normal stresses in beams- Moment of resistance - beams of uniform strength - beams of two materials – strain energy due to bending - shearing stresses in beams.	9	15%
SECOND INTERNAL EXAMINATION			
V	**Analysis of stress and strain on oblique sections:** Stress on inclined planes for axial and biaxial stress fields - principal stresses - Mohr's circle of stress **Thin and Thick Cylinders:** Stresses in thin cylinders – thick cylinders - Lame's equation – stresses in thick cylinders due to internal and external pressures **Torsion:** Torsion of solid and hollow circular shafts.-Pure shear- strain energy in pure shear and torsion. **Springs**: Close coiled and open coiled helical springs.	9	20%
VI	**Deflection of statically determinate beams:** Differential equation of the elastic curve - Method of successive integration, Macaulay's method, Method of superposition, moment area method. **Theory of columns:** Direct and bending stresses in short columns- Kern of a section. Buckling and stability-Euler's buckling/crippling load for columns with different end conditions- Rankine's formula	11	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks: 100 Exam Duration: 3 Hrs

The question paper shall have three parts.

Part A -Module I & II : Answer 2 questions out of 3 questions (15 marks each)

Part B - Module III & IV: Answer 2 questions out of 3 questions (15 marks each)

Part C - Module V & VI: Answer 2 questions out of 3 questions (20 marks each)

Note: 1.Each part should uniformly cover the two modules in that part.

2. Each question can have a maximum of 4 subdivisions (a,b,c,d), if needed.

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE203	FLUID MECHANICS - I	3-1-0-4	2016

Pre requisite : Nil

Course Objectives

1. To understand the basic properties of the fluid, fluid statics, kinematics, and fluid dynamics so as to analyse and appreciate the complexities involved in solving the fluid flow problems.
2. To give an introduction to the fundamentals of fluid flow and its behavior so as to equip the students to learn related subjects and their applications in the higher semesters.
3. To develop the skill for applying the fluid statics, kinematics and dynamics of fluid flow concepts for solving civil engineering problems.

Syllabus

Fluid Statics, Fluid pressure, Buoyancy and floatation, Fluid Kinematics, Dynamics of fluid flow, Flow through orifice and notches, Flow through pipes, Boundary layer, Drag and lift on Immersed bodies

Course Outcomes:

1. Students will be able to get a basic knowledge of fluids in static, kinematic and dynamic equilibrium, so as to solve real life problems in fluid mechanics.
2. Students will gain the knowledge of the applicability of physical laws in addressing problems in hydraulics.

Text Books

1. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002.
2. Subramanya K., Theory and Applications of Fluid Mechanics, Tata McGraw-Hill, 1993.

References

1. Streeter.V.L. Fluid Mechanics, Mc Graw Hill Publishers.
2. Bruce R Munson, Donald F Young . Fundamentals of Fluid Mechanics, John Wiley & sons, 2011.
3. Jain A. K., Fluid Mechanics, Khanna Publishers, Delhi, 1996.
4. Joseph Katz, Introductory Fluid Mechanics, Cambridge University Press, 2015
5. Arora.K.R. Fluid Mechanics, Hydraulics and Hydraulic Machines, Standard Publishers, 2005.
6. Narasimhan S., A First Course in Fluid Mechanics, University Press (India) Pvt. Ltd., 2006.
7. Frank.M.White, Fluid Mechanics, Mc Graw Hill, 2013.
8. Mohanty.A.K. Fluid Mechanics, Prentice Hall, New Delhi, 2011
9. Narayana Pillai,N. Principles of Fluid Mechanics and Fluid Machines, University Press, 2011.
10. Kumar.D.N. Fluid Mechanics and Fluid power Engineering, S.K.Kataria & sons, 2013.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem. Exam Marks %**
I	Fluid properties - density – specific gravity - surface tension and capillarity - vapour pressure - viscosity and compressibility - Classification of Fluids (No questions to be asked) . Fluid statics: Fluid pressure, variation of pressure in a fluid, measurement of pressure using manometers- simple manometers, differential manometers, Pressure head. Forces on immersed plane and curved surfaces. Pressure distribution diagram for vertical surfaces, Practical application of total pressure (spillway gates). Buoyancy and Floatation: Buoyant force, stability of floating and submerged bodies, metacentre and metacentric height, Analytical and experimental determination of metacentric height.	8	15
II	Kinematics of fluid flow: Methods of describing fluid motion, Lagrangian and Eulerian methods, Types of fluid flow: steady and unsteady flow, uniform and non-uniform flow, one, two and three dimensional flow, laminar and turbulent flow, rotational and irrotational flow. Types of flow lines: stream line, path line, streak lines, conservation of mass, equation of continuity in one, two and three dimensions, (Derivation in Cartesian co-ordinate system only) Velocity & Acceleration of fluid particle, convective and local acceleration, Deformation of fluid elements: circulation and vorticity, velocity potential, stream function, equipotential lines, flow net, uses of flow net; Vortex motion, free and forced vortex (no problems).	8	15
FIRST INTERNAL EXAMINATION			
III	Dynamic of fluid flow: Euler's equation of motion and integration of Euler's equation of motion along a streamline. Bernoulli's Equation, Energy correction factors, Applications of Bernoulli's equation : Pitot tube, Venturimeter and orifice meter. Momentum Principle- Steady flow momentum equation- Momentum correction factor, Force computation on a pipe bend	8	15
IV	Flow through orifices: Different types of orifices, Flow over a sharp edged orifice, Hydraulic coefficients – Experimental determination of these	8	15

	coefficients, flow through large rectangular orifice, Flow through submerged orifices, flow under variable heads, time of emptying. Flow over weirs: flow over rectangular, triangular and trapezoidal sharp crested weir, Cipolletti weir, Broad crested weir, Submerged weirs, Proportional weir.		
SECOND INTERNAL EXAMINATION			
V	Flow through pipes: Viscous flow - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen Poiseulle's Eqn) - Hydraulic and energy gradient - flow through pipes - Darcy -Weisbach's equation - pipe roughness -friction factor- Moody's diagram- Major and minor losses of flow in pipes - Pipes in series and in parallel.	12	20
VI	Boundary layer theory-no slip condition, boundary layer thickness, boundary layer growth over long thin plate, laminar, turbulent boundary layer, laminar sub layer, Momentum integral equation of boundary layer (no derivation), Blasius boundary layer equations for laminar and turbulent boundary layer. Drag and lift on Immersed bodies-Pressure drag and friction drag, profile drag, Drag and lift co-efficient-computation of drag on a flat plate. Separation of boundary layer and control.	12	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks: 100 Exam Duration: 3 Hrs

The question paper shall have three parts.

Part A - Module I & II : Answer 2 questions out of 3 questions (15 marks each)

Part B - Module III & IV: Answer 2 questions out of 3 questions (15 marks each)

Part C - Module V & VI: Answer 2 questions out of 3 questions (20 marks each)

Note: 1.Each part should uniformly cover the two modules in that part.

2. Each question can have a maximum of 4 subdivisions (a,b,c,d), if needed.

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Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE205	ENGINEERING GEOLOGY	3-0-1-4	2016

Prerequisite: NIL

Course Objectives

Awareness about earth resources and processes to be considered in various facets of civil engineering

1. Appreciation of surface of earth as the fundamental foundation structure and the natural phenomena that influence its stability

Syllabus :

Relevance of geology in Civil Engineering. Subdivisions of Geology. Interior of the earth. Weathering, its engineering significance and laboratory tests used in civil engineering. Soil profile.
Hydrogeology-occurrence of groundwater, Types of aquifers and their properties. Engineering significance of subsurface water in construction. Methods to control of subsurface water.
Minerals- Properties that affect the strength of minerals. Physical properties and chemical composition of common rock forming minerals
Earth quakes- in relation to internal structure of earth and plate tectonics
Types of rocks. Brief account of selected rocks. Rock features that influence the strength of rocks as construction material. Rock types of Kerala. Engineering properties of rocks.
Attitude of geological structures- strike and dip. Deformation structures and their engineering significance. Geological factors considered in the construction of engineering structures.
Introduction to natural hazards and their management. Coastal Processes and protection strategies. Soil erosion and conservation measures.

Expected Outcomes:

1. The course would help the student to understand of the factors that determine the stability of earth's surface
2. The student would comprehend better the earth resources used as building materials

Text Books / References:

1. Duggal, SK,Rawal,N and Pandey, HK (2014) Engineering Geology, McGraw Hill Education, New Delhi
2. Garg, SK (2012) Introduction to Physical and Engineering Geology, Khanna Publishers, New Delhi
3. Gokhale, KVGK (2010) Principles of Engineering Geology, BS Pubications, Hyderabad
4. Kanithi V (2012) Engineering Geology, Universities Press (India) Ltd., Hyderabad
5. Singh, P (2004) Engineering and General Geology, S. K. Kataria and Sons, New Delhi
6. Bennison, GM, Olver, PA and Moseley, KA (2013) An introduction to geological structures and maps, Routledge, London
7. Gokhale, NW (1987) Manual of geological maps, CBS Publishers, New Delhi

COURSE PLAN			
Module	**Contents**	**Hours**	**End Sem.Exam Marks %**
I	Relevance of geology in Civil Engineering. Subdivisions of Geology. Weathering, types and its engineering significance. Laboratory tests used in civil engineering for assessing intensity of weathering. Engineering classification of weathered rock masses. Soil profile. Geological classification of soils.	8	15
II	Hydrogeology-occurrence of groundwater, Types of aquifers, permeability / hydraulic conductivity. Engineering significance of subsurface water-problems created in construction, as an erosional agent. Methods to control of subsurface water-barriers and liners, drains and wells.(Resistivity survey of groundwater may be demonstrated)	11	15
FIRST INTERNAL EXAMINATION			
III	Minerals- Properties that affect the strength of minerals. Physical properties and chemical composition of following minerals -quartz, feldspars (orthoclase and plagioclase), micas (biotite and muscovite), amphibole (hornblende), pyroxene (augite and hypersthene), gypsum, calcite, clay minerals (kaolinite), their chemical formulae. Earth quakes- in relation to internal structure of earth and plate tectonics	8	15
IV	Rocks as aggregates of minerals. Basic concepts-igneous, sedimentary and metamorphic rocks, Brief account of following rocks- granite, basalt, sandstone, limestone, shale, marble and quartzite. Rock features that influence the strength of rocks as construction material-concepts of lineation and foliation-schistosity and gneissosity. Rock types of Kerala. Brief account of engineering properties of rocks used as construction material (building and foundation) and road aggregates. Assessment of these properties.(Students should be taught to identify common rock forming minerals and common rocks based on their physical properties).	10	15
SECOND INTERNAL EXAMINATION			
V	Attitude of geological structures- strike and dip. Brunton compass. Deformation structures and	11	20

	their engineering significance- folds, faults and joints. Geological factors considered in the construction of dams and reservoirs, tunnels. (Simple exercises based on geological/topographic maps for determination of dip, apparent dip and thickness of lithological beds and preparation of geological cross sections should be performed. The students should be instructed in handling clinometer/Brunton compass to determine strike and dip)		
VI	Introduction to natural hazards-Mass movements (Landslides), floods, their common management strategies. Coastal Processes- waves, currents and landforms. Types of coastal protection strategies. Soil erosion- causes and types and soil conservation measures.	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100 Exam Duration: 3 Hrs

The question paper shall have three parts.

Part A -Module I & II : Answer 2 questions out of 3 questions (15 marks each)

Part B - Module III & IV: Answer 2 questions out of 3 questions (15 marks each)

Part C - Module V & VI : Answer 2 questions out of 3 questions (20 marks each)

Note : 1.Each part should uniformly cover the two modules in that part.

2. Each question can have a maximum of 4 subdivisions (a,b,c,d), if needed.

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE207	SURVEYING	3-0-0-3	2016

Prerequisite : Nil

Course objectives:

- To introduce the principle of surveying
- To impart awareness on the various fields of surveying and types of instruments
- To understand the various methods of surveying and computations

Syllabus: Basics of Surveying, Levelling and Contouring, Area and Volume Computation, Theodolite Survey, Mass Diagram, Triangulation, Theory of Errors, Electronic Distance Measurement, Total Station Survey

Course Outcomes: After successful completion of the course, the students will possess knowledge on the basics of surveying and different methods of surveying

Text Books :

1. Prof. T.P.Kenetkar & Prof.S.V.Kulkarni - Surveying and Levelling , Pune Vidyarthi Griha Prakashan,2004
2. N N Basak, Surveying and Levelling, Mc GrawHill Education

References :

1. R.Agor - A Text book of Surveying and Levelling, Khanna Publishers, 2005
2. C. Venkatramaiah, Textbook of Surveying, Universities Press (India) Private Limited 2011
3. James M Andersen, Edward M Mikhail, Surveying Theory and Practice, McGraw Hill Education
4. Dr. B.C.Punmia , Ashok Kumar Jain &Arun Kumar Jain - Surveying , Laxmi publications (P)Ltd , 2005
5. S.K.Duggal - Surveying Vol. I, Tata Mc Graw Hill Ltd ,Reprint 2015.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem.Exam Marks %**
I	**Introduction to Surveying**- Principles, Linear, angular and graphical methods, Survey stations, Survey lines- ranging, Bearing of survey lines, Local attraction, Declination, Dip, Latitude and Departure, Methods of orientation, Principle of resection	7	15
II	**Levelling:** Principles of levelling- Dumpy level- booking and reducing levels, Methods- simple, differential, reciprocal leveling, profile levelling and cross sectioning. Digital and Auto Level, Errors in levelling **Contouring**: Characteristics, methods, uses.	7	15
FIRST INTERNAL EXAMINATION			
III	**Area and Volume**: Various methods of computation. **Theodolite survey**: Instruments, Measurement of horizontal and vertical angle. **Mass diagram**: Construction, Characteristics and Uses.	6	15
IV	**Triangulation:** Triangulation figures, Strength of figure, Triangulation stations, Inter visibility of stations, Towers and signals – Satellite Stations and reduction to centre.	8	15
SECOND INTERNAL EXAMINATION			
V	**Theory of Errors** – Types, theory of least squares, Weighting of observations, Most probable value, Application of weighting, Computation of indirectly observed quantities - method of normal equations.	8	20
VI	**Electromagnetic distance measurement (EDM) –** Principle of EDM, Modulation, Types of EDM instruments, Distomat **Total Station –** Parts of a Total Station – Accessories – Advantages and Applications, Introduction to Astronomical terms, Field Procedure for total station survey, Errors in Total Station Survey.	6	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam) :

Maximum Marks :100 Exam Duration: 3 Hrs

The question paper shall have three parts.

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should uniformly cover the two modules in that part.

2. Each question can have a maximum of 4 subdivisions (a,b,c,d), if needed

Course No.	Course Name	L-T-P - Credits	Year of Introduction
CE231	CIVIL ENGINEERING DRAFTING LAB	0-0-3-1	2016

Prerequisite : BE 110 - Engineering Graphics

Course Objectives :

1. To introduce the fundamentals of Civil Engineering drawing.
2. To understand the principles of planning
3. To learn drafting of buildings.
4. To impart knowledge on drafting software such as AutoCAD.

List of Exercises : (at least 10 exercises / plates are mandatory **)**

1. Paneled Doors
2. Glazed Windows and Ventilators in wood
3. Steel windows
4. Roof truss in steel sections
5. Reinforced concrete staircase
6. Residential buildings with flat roof
7. Residential buildings with tiled roof
8. Preparation of site plan and service plans as per building rules
9. Building Services (for single and two storied buildings only). Septic tanks and soak pit detailed drawing
10. Two storied and multi storied buildings
11. Public buildings like office, dispensary, post office, bank etc.
12. Industrial buildings with trusses

Expected outcome.

To accomplish the abilities/skills for the following.

1. To understand the drawings of various components of buildings
2. Preparation of building drawings.
3. Interpretation of building drawings.
4. Use of a drafting software.

Text Books:

1. National Building Code of India.
2. Kerala Municipal Building Rules.
3. Dr. Balagopal T.S. Prabhu, Building Drawing and Detailing, Spades Publishers, Calicut
4. AutoCAD Essentials, Autodesk official Press, John Wiley & Sons, USA

References:

1. Shah, M.G., Kale, C. M. and Patki, S.Y. Building Drawing With An Intergrated Approach to Built Environment, Tata McGraw Hill Publishing Company Limited, New Delhi

Points to note:

1. Equal weightage to be given for manual drafting and drafting using computer aided drafting software.
2. Evaluation of drawing, along with a viva-voce, to be done at the end of every day class.

Internal Continuous Evaluation - 100 marks

Best 10 plates	- 60 marks
Viva-voce	- 10 marks
Final Examination	- 30 marks

Course No.	Course Name	L-T-P - Credits	Year of Introduction
CE233	SURVEYING LAB	0-0-3-1	2016

Prerequisite : Nil

Course Objectives:

1. To equip the students to undertake survey using tacheometer
2. To equip the students to undertake survey using total station
3. To impart awareness on distomat and handheld GPS

List of Exercises/Experiments : (10 to12 exercises are mandatory)

1. Introduction to conventional surveying -1 class
2. Levelling (dumpy level) -2 class
3. Theodolite surveying (Theodolite) -3class
4. Total Station survey (Total Station) -5 class
   a. Heights and Distance
   b. Area computation
   c. Downloading
5. Study of instruments –Automatic level, digital level, Handheld GPS -2 class
6. Test -2 class

Expected outcome .

Ability to undertake survey using level and theodolite and total station

Internal Continuous Evaluation - 100 marks

Record/output (Average) - 60 marks

Viva-voce (Average) - 10 marks

Final practical examination – 30 marks

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE202	STRUCTURAL ANALYSIS -I	3-1-0-4	2016

Prerequisite: CE201 Mechanics of Solids

Course objectives:

- To equip the students with the comprehensive methods of structural analysis with emphasis on analysis of elementary structures.

Syllabus :

Truss analysis, Displacement response of statically determinate structural systems using energy methods, Principle of virtual work, Statically indeterminate structures, Strain Energy methods, Moving loads and influence lines, Cables and Suspension bridges, Arches.

Expected Outcomes:

The students will be able to

i. analyse trusses and study displacement response of statically determinate structural systems using energy methods:
ii. apply unit load method and strain energy method for determination of deflection of statically determinate beams, frames & pin jointed trusses
iii. analyse statically indeterminate structures using strain energy method and method of consistent deformation
iv. know about moving loads and influence lines
v. know about Statically determinate and indeterminate suspension bridges and arches

Text Books:

1. Gere and Timoshenko, Mechanics of materials, CBS. Publishers
2. Kenneth Leet,Chia M Uang& Anne M Gilbert., Fundamentals of Structural Analysis, McGraw Hill
3. R.Vaidyanathan and P.Perumal, Comprehensive Structural Analysis Volume I & II, Laxmi Publications (P) Ltd
4. Wang C.K., Intermediate Structural Analysis, McGraw Hill

References:

1. Aslam Kassimali., Structural Analysis, Cenage Learning
2. Chandramouli P N, Structural Analysis I –Analysis of Statically Determinate Structures, Yes DeePublishing Pvt Ltd.,Chennai,Tamil Nadu.
3. DevdasMenon, Structural Analysis, Narosa Publications
4. Hibbeler., Structural Analysis, Pearson Education
5. Kinney S., Indeterminate Structural Analysis, Oxford & IBH
6. M.L. Gambhir, Fundamentals of structural Mechanics and analysis, Printice Hall India
7. Reddy C.S., Indeterminate Structural Analysis, Tata McGraw Hill
8. Timoshenko S.P.& Young D.H., Theory of Structures, McGraw Hill

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks
I	**TRUSS ANALYSIS:** Analysis of determinate truss-Methods of	8	15%

	joints and sections (Numerical problems) Elastic theorems and energy principles - strain energy due to axial load, bending moment, shear and torsion - strain energy method, Castigliano's method for deflection (Derivations only)		
II	**Principle of virtual work** – Unit load method-Betti's theorem – Maxwell's law of reciprocal deflections - principle of least work - application of unit load method and strain energy method for determination of deflection of statically determinate beams, frames - pin jointed trusses (simple numerical problems) Concepts of temperature effects and lack of fit.(No numerical problems) **Statically indeterminate structures:** Degree of static and kinematic indeterminacies – Introduction to force and displacement method(step by step procedure)	9	15%
FIRST INTERNAL EXAMINATION			
III	**Strain Energy methods:** Analysis of beams, frames and trusses with internal and external redundancy – (Simple problems with maximum two redundants) Concepts of effect of prestrain, lack of fit, temperature changes and support settlement.(No numerical problems) **Method of Consistent deformations:** Analysis of beams frames and trusses with internal and external redundancy(Simple problems with maximum two redundants) Concepts of effect of prestrain, lack of fit, temperature changes and support settlement.(No numerical problems)	9	15%
IV	**Moving loads and influence lines**. Introduction to moving loads - concept of influence lines - influence lines for reaction, shear force and bending moment in simply supported beams and over hanging beams - analysis for different types of moving loads - single concentrated load - several concentrated loads, uniformly distributed load on shorter and longer than the span.	10	15%
SECOND INTERNAL EXAMINATION			
V	**Cables:** Analysis of forces in cables under concentrated and uniformly distributed loads - Anchor Cables **Suspension Bridges :** Un-stiffened suspension bridges, maximum tension in the suspension cable and backstays, pressure on towers.	10	20%
VI	**Arches :** Theory of arches - Eddy"s theorem - analysis of three hinged arches-Support reactions-normal thrust and Radial shear at any section of a parabolic and segmental arch due to simple cases of loading. Moving loads on three hinged arches (simple problems)	10	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination) :

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE204	CONSTRUCTION TECHNOLOGY	4-0-0-4	2016

Prerequisite : Nil

Course objectives:

- To study details regarding properties and testing of building materials,
- To study details regarding the construction of building components
- To study properties of concrete and concrete mix design
- To impart the basic concepts in functional requirements of building and building services.
- To develop understanding about framed construction and building failures

Syllabus:

Construction Materials –. Timber -Mortar – Iron and Steel –. Structural steel – Modern materials. Concrete–Admixtures –Making of concrete -Properties of concrete– mix proportioning

Building construction - foundations -Introduction to Cost-effective construction –Masonry – Lintels and arches –Floors and flooring –

Roofs and roof coverings -Doors, windows and ventilators -Finishing works. Tall Buildings – steel and concrete frame –prefabricated construction – slip form construction. Vertical transportation – Stairs –Elevators – Escalators –ramps.

- Building failures and Retrofitting–failures in RCC and Steel structures– Foundation failure-

Expected Outcomes:

The students will be able to

i. understand construction materials, their components and manufacturing process
ii. know the properties of concrete and different mix design methods
iii. understand the details regarding the construction of building components
iv. analyse and apply learning of materials, structure, servicing and construction of masonry domestic buildings.
v. define and describe the concepts and design criteria of tall framed and load bearing buildings.

Text books

1. Arora and Bindra, Building construction, Dhanpath Rai and Sons.
2. Punmia B. C, Building construction. Laxmi Publications
3. Rangwala S C., Engineering Materials, Charotar Publishers
4. Shetty M.S., Concrete Technology, S. Chand & company.

Reference Books

1. Adler R, Vertical Transportation for Building, American Elsevier Pub.
2. G C Sahu & Joygopal Jena., Building Materials and construction, McGraw Hill Education
3. Gambhir M L, Concrete Technology, Tata McGrawHill.
4. Krishna Raju N, Design of Concrete Mixes, CBS publishers.
5. Mcking T.M, Building Failures, Applied Science Pub.
6. National Building Code.
7. Neville A.M. and Brooks.J.J, Concrete Technology, Pearson Education.
8. Smith P & Julian W. Building services, Applied Science Pub.
9. Tall building systems & concepts, Monograph on planning and design of Tall building,

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Properties of masonry materials – review of specifications; **Mortar** – Types – Sand – properties – uses. **Timber products**: properties and uses of plywood, fibre board, particle board. **Iron and Steel** –Reinforcing steel – types – specifications. **Structural steel** – specifications **Miscellaneous materials** (only properties, classifications and their use in construction industry): Glass, Plastics, A.C. Sheets, Bitumen, Adhesives, Aluminium	9	15%
II	**Concrete** – Aggregates – Mechanical & Physical properties and tests – Grading requirements – Water quality for concrete – **Admixtures** – types and uses – plasticizers – accelerators – retarders –water reducing agents **Making of concrete** - batching – mixing – types of mixers – transportation – placing – compacting – curing **Properties of concrete** – fresh concrete – workability – segregation and bleeding - factors affecting workability & strength – tests on workability – tests for strength of concrete in compression, tension & flexure **Concrete quality control** – statistical analysis of results – standard deviation –acceptance criteria – **mix proportioning** (B.I.S method) – nominal mixes.	9	15%
FIRST INTERNAL EXAMINATION			
III	**Building construction** - Preliminary considerations for shallow and deep foundations **Masonry** – Types of stone masonry – composite walls - cavity walls and partition walls -Construction details and features – scaffoldings **Introduction to Cost-effective construction** - principles of filler slab and rat-trap bond masonry	9	15%
IV	**Lintels and arches** – types and construction details. **Floors and flooring** – different types of floors and floor coverings **Roofs and roof coverings** – different types of roofs – suitability – types and uses of roofing materials **Doors, windows and ventilators** – Types and construction details **Finishing works** – Plastering, pointing, white washing, colour washing, distempering, painting. Methods of providing DPC. Termite proofing	9	15%
SECOND INTERNAL EXAMINATION			

V	**Tall Buildings –** Framed building – steel and concrete frame – structural systems –erection of steel work–concrete framed construction– formwork – construction and expansion. joints Introduction to prefabricated construction – slip form construction **Vertical transportation:** **Stairs** – types - layout and planning- **Elevators** – types – terminology – passenger, service and goods elevators – handling capacity - arrangement and positioning of lifts – **Escalators** – features –use of ramps	10	20%
VI	**Building failures –** General reasons – classification – Causes of failures in RCC and Steel structures, Failure due to Fire, Wind and Earthquakes. **Foundation failure** – failures by alteration, improper maintenance, overloading. Retrofitting of structural components - beams, columns and slabs	10	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination):

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1. Each part should have at least one question from each module

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE206	FLUID MECHANICS -II	3-0-0-3	2016

Prerequisite : CE203 Fluid Mechanics I

Course objectives

- To study the Basic principles and laws governing fluid flow to open channel flow including hydraulic jump & gradually varied flow.
- To understand basic modeling laws in fluid mechanics and dimensional analysis.
- To apply the fundamental theories of fluid mechanics for the analysis and design of hydraulic machines

Syllabus

Hydraulic machines, Turbines, Pumps, Open channel flow, uniform flow, Hydraulic Jump, Gradually varied flow, Dimensional analysis and model testing.

Expected Outcome

The students will

i. become capable of analysing open channel flows & designing open channels.
ii. get an insight into the working of hydraulic machines.
iii. become capable of studying advanced topics such as design of hydraulic structures.

Text Books:

1. Kumar D.S., Fluid Mechanics and Fluid power Engineering, S. K. Kataria & Sons, New Delhi, 2013
2. Modi P. N. and S. M. Seth, Hydraulics and Fluid Mechanics (Including Hydraulic Machines), Standard Book House, New Delhi, 2013.
3. Narayana Pillai,N. Principles of Fluid Mechanics and Fluid Machines, University Press, 2011.

References:

1. Arora.K.R. Fluid Mechanics, Hydraulics and Hydraulic Machines, Standard Publishers, 2005.
2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2010.
3. C S P Ojha, P N Chandramouli and R Brendtsson, Fluid Mechanics and Machinery, Oxford University Press , India , New Delhi
4. Hanif Choudhary, Open channel flow, Prentice Hall, 2010
5. Jain A. K., Fluid Mechanics, Khanna Publishers, Delhi, 1996.
6. Subramanya K., Open Channel Hydraulics, Tata McGraw Hill, 2009.
7. Ven Te Chow, Open channel Hydraulics, 2009.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks
I	Hydraulic Machines - Impulse momentum principle, impact of jets, force of a jet on fixed and moving vanes. Turbines- classification and comparison of velocity triangles for Pelton wheel and reaction turbines (Francis and Kaplan), work done and efficiency, specific speed, draft tube- different types, penstock, surge tank - types, cavitation in turbines (Concepts only).	7	15%

II	Pumps- classification of pumps - Centrifugal pumps- types, work done, efficiency, minimum speed, velocity triangle for pumps, specific speed, priming, limitation of suction lift, net positive suction head, cavitation in centrifugal pump (Concepts only).	7	15%
FIRST INTERNAL EXAMINATION			
III	Introduction : Open channel flow and its relevance in Civil Engineering , Comparison of open channel flow and pipe flow . Flow in open channels-types of channels, types of flow, geometric elements of channel section, velocity distribution in open channels, uniform flow in channels, Chezy's equation, Kutter's and Manning's formula, Most economic section for rectangular and trapezoidal channels. Condition for maximum discharge and maximum velocity through circular channels, computations for uniform flow, normal depth, conveyance of a channel section, section factor for uniform flow.	6	15%
IV	Specific energy, critical depth, discharge diagram, Computation of critical flow, Section factor for critical flow. Specific force, conjugate or sequent depths, hydraulic jump, expression for sequent depths and energy loss for a hydraulic jump in horizontal rectangular channels, types of jump, length of jump, height of jump, uses of hydraulic jump.	6	15%
SECOND INTERNAL EXAMINATION			
V	Gradually varied flow - dynamic equation for gradually varied flow, different forms of dynamic equation, Approximation for a wide rectangular channel, classification of surface profiles, Backwater and drawdown curves, characteristics of surface profiles in prismatic (Rectangular and trapezoidal only). Computation of length of surface profiles, direct step method. Design of lined open channels : trapezoidal cross-sections only	8	20%
VI	Dimensional analysis and model studies - dimensions, dimensional homogeneity, methods of dimensional analysis, Rayleigh method, Buckingham method, dimensionless numbers, Similitude - geometric, kinematic and dynamic similarities. Model laws - Reynold's and Froude model laws, scale ratios, types of models, Concepts of distorted and undistorted models.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination) :

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1. Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE208	GEOTECHNICAL ENGINEERING I	3-0-0 -3	2016

Prerequisite : CE 205 Engineering Geology

Course objectives:

- To impart to the fundamentals of Soil Mechanics principles;
- To provide knowledge about the basic, index and engineering properties of soils.

Syllabus:

Major soil deposits of India, Basic soil properties, Relationship between basic soil properties, Index properties-Sieve analysis, Hydrometer analysis, Atterberg Limits and Relative density, Soil classification, Permeability of soils, Principle of effective stress, Quick sand condition, Critical hydraulic gradient, Shear strength of soils, Mohr-Coulomb failure criterion, Different types of shear tests, Liquefaction of soils, Compressibility and Consolidation, Void ratio versus pressure relationship, Normally consolidated, under consolidated and over consolidated states, Estimation of magnitude of settlement, Terzaghi's theory of one-dimensional consolidation, Coefficient of consolidation , Stability of finite slopes, Swedish Circle Method- Friction circle method ,use of Stability, Compaction of soils, light and heavy compaction tests , Control of compaction

Expected Outcomes:

The students will be able to

i. understand the basic principles governing soil behavior.
ii. understand the procedure, applicability and limitations of various soil testing methods.

Text Books:

1. Das B. M., Principles of Geotechnical Engineering, Cengage India Pvt. Ltd., 2010.
2. Ranjan G. and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2002.

References:

1. A V Narasimha Rao and C Venkatramaiah, Numerical Problems, Examples and Objective questions in Geotechnical Engineering, Universities Press (India) Ltd., 2000
2. Arora K. R., Geotechnical Engineering, Standard Publishers, 2006.
3. Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Kindersley(India) Pvt. Ltd., 2013
4. Taylor D.W., Fundamentals of Soil Mechanics, Asia Publishing House, 1948.
5. Terzaghi K. and R. B. Peck, Soil Mechanics in Engineering Practice, John Wiley, 1967.
6. Venkatramaiah, Geotechnical Engg, Universities Press, 2000.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Introduction to soil mechanics -Major soil deposits of India Basic soil properties - Void ratio, porosity, degree of saturation, air content, percentage air voids, moisture content, specific gravity, unit weight - Relationship between basic soil properties – Sensitivity – Thixotropy - numerical problems	6	15%
II	Index properties - Sieve analysis – Well graded, poorly graded and gap graded soils - Stoke's law - Hydrometer analysis (no derivation required for percentage finer and diameter) - numerical problems- – Relative density Consistency-Atterberg Limits - Practical Applications - numerical problems I.S. classification of soils.	6	15%
FIRST INTERNAL EXAMINATION			
III	Permeability of soils - Darcy's law – Factors affecting permeability - Practical Applications - Constant head and falling head permeability tests - Average permeability of stratified deposits (no derivation required) - numerical problems. Principle of effective stress - Total, neutral and effective stress variation diagrams - Quick sand condition - Critical hydraulic gradient - - numerical problems– Definition of phreatic line and exit gradient	7	15%
IV	Shear strength of soils- Practical Applications - Mohr-Coulomb failure criterion – Mohr circle method for determination of principal planes and stresses- numerical problems – relationship between shear parameters and principal stresses [no derivation required} Brief discussion of direct shear test, tri-axial compression test, vane shear test and unconfined compression test – Applicability - numerical problems -UU and CD tests [Brief discussion only]	7	15%
SECOND INTERNAL EXAMINATION			
V	Compressibility and Consolidation - Void ratio versus pressure relationship - Coefficient of compressibility and volume compressibility – Compression index Practical Applications - Change in void ratio method - Height of solids method - Normally consolidated, under consolidated and over consolidated states - Estimation of pre consolidation pressure - Practical Applications - Estimation of magnitude of settlement of normally consolidated clays - Numerical problems Terzaghi's theory of one-dimensional consolidation(no derivation required) - average degree of consolidation – Time	8	20%

	factor - Coefficient of consolidation - Practical Applications - Square root of time and logarithm of time fitting methods - Numerical problems		
VI	Stability of finite slopes - Toe failure, base failure, slip failure - Swedish Circle Method- Friction circle method- Factor of safety with respect to cohesion and angle of internal friction - Stability number - Stability charts. Compaction of soils - Standard Proctor, Modified Proctor, I.S. light & Heavy Compaction Tests – OMC - Zero Air voids line - Control of compaction - numerical problems	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination):

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1. Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course No.	Course Name	L-T-P-Credits	Year of Introduction
CE230	MATERIAL TESTING LAB	0-0-3-1	2016

Course Objectives:

1. To provide knowledge on mechanical behaviour of materials
2. To acquaint with the experimental methods to determine the mechanical properties of materials.

Syllabus

List of experiments:

1. Tension test on mild steel/ tor-steel/ high strength steel and cast iron using Universal Testing Machine and extensometers.
2. Tests on springs (Open and closed coiled)
3. Torsion pendulum (mild steel, aluminium and brass wires)
4. Hardness test (Brinell, Vickers and Rockwell)
5. Impact test (Izod and Charpy)
6. Torsion test on mild steel rods.
7. Shear test on mild steel rods.
8. Fatigue test – Study of testing machine.
9. Bending test on wooden beams.
10. Strut test (Column buckling experiment)
11. Verification of Clerk Maxwell's law of reciprocal deflection and determination of Young's modulus of steel.
12. Photo elastic methods for stress measurements.
13. Jominy hardenability test
14. Measurement using strain gauges
15. Determination of moment of inertia of rotating bodies

Note: A minimum of 10 experiments are mandatory.

Expected outcome: At the end of the course the students will be able to

1. Acquire the knowledge on mechanical behaviour of materials
2. Conduct experiments determine the mechanical properties of materials.

References Books:

1. G E Dieter. Mechanical Metallurgy, McGraw Hill,2013
2. Dally J W, Railey W P, Experimental Stress analysis , McGarw Hill,1991
3. Baldev Raj, Jayakumar T, Thavasimuthu M., Practical Non destructive testing, Narosa Book Distributors,2015

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE232	MATERIAL TESTING LAB -I	0-0-3-1	2016

Prerequisite : CE201 Mechanics of Solids

Course objectives:
The experimental work involved in this laboratory should make the student understand the fundamental modes of loading of the structures and also make measurements of loads, displacements and strains. Relating these quantities, the student should be able to obtain the strength of the material and stiffness properties of structural elements.

Course Outcomes:
The students will be able to undertake the testing of materials when subjected to different types of loading.

List of Experiments: (10 Experiments mandatory)

1. Tension test on Structural Materials: Mild Steel and Tor steel (HYSD bars) (Universal Testing machine and suitable extensometer)
2. Shear test on mild steel rod (Compression Testing Machine and Shear Shackle)
3. Bending test on mild steel (I sections) (Universal Testing Machine)
4. Torsion test on Mild steel circular bars (Torsion Testing Machine)
5. Torsion test on Steel/Copper/ Aluminum wires
    a. Using Torsion Pendulum with Central disk
    b. Using Torsion Pendulum with distributed Mass
6. Impact test
    a. Izod test (Impact Testing Machine)
    b. Charpy test (Impact Testing Machine)
7. Hardness test
    a. Brinell Hardness test (Brinnel Hardenss Testing Machine)
    b. Rockwell Hardness test (Rockwell Hardness Testing Machine)
    c. Vickers Hardness test (Vickers Hardness Testing Machine)
8. Test On Springs
    a. Open coil (Spring Testing Machine)
    b. Close coil (Spring Testing Machine)
9. Bending Test on Timber (Universal Testing Machine and dial Gauge)
10. Bend & Rebend test on M S Rods
11. Verification of Clerk Maxwells Theorem
12. Demonstration of Fatigue Test
13. Study/demonstration of Strain Gauges and load cells

Books/Manuals /References:-

1. Testing of Engineering Materials by George E Troxell, Harmer E Davis, G Hauck,McGraw-Hill,Newyork
2. Testing of Metallic Materials by Prof. A V K Suryanaraya, Prentice Hall, India, Pvt Ltd.
3. Mechanical Behavior of Materials, by N Dowling,Prentice Hall, 1993.

Internal Continuous Evaluation - 100 marks

Record/output (Average) - 60 marks Viva-voce (Average) - 10 marks

Final practical exam – 30 marks

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE234	FLUID MECHANICS LABORATORY	0-0-3-1	2016

Prerequisite : CE203 Fluid Mechanics- I

Course objectives

1. Students should be able to verify the principles studied in theory by performing the experiments in laboratory

Expected Outcome

1. The students will be able to understand the different flow measurement equipment's and their procedures.
2. The students will be able to analyze the performance characteristics pumps/turbines.
3. Able to develop the skill of experimentation techniques for the study of flow phenomena in channels/pipes.

List of Experiments (Minimum 12 nos. mandatory)

1. Study of taps, valves, pipe fittings, gauges, pitot tubes, water meters and current meters.
2. Calibration of Pressure gauges
3. Determination of metacentric height and radius of gyration of floating bodies.
4. Verification of Bernoulli's theorem
5. Hydraulic coefficients of orifices and mouth pieces under constant head method and time of emptying method.
6. Calibration of Venturimeter.
7. Calibration of Orifice meter
8. Calibration of water meter.
9. Calibration of rectangular and triangular notches.
10. Time of Emptying : unsteady flow
11. Determination of Darcy's and Chezy's constant for pipe flow.
12. Determination of Chezy's constant and Manning's number for open channel flow.
13. Plotting Specific Energy Curves in Open Channel flow
14. Study of Parameters of Hydraulic Jump in Open channel Flow.
15. Determination of friction co-efficient in pipes
16. Determination of loss co-efficient for pipe fittings

17. Performance characteristics of centrifugal pump.
18. Performance characteristics of Pelton wheel.
19. Performance characteristics of Francis turbine.
20. Performance characteristics of Kaplan turbine.

Internal Continuous Evaluation - 100 marks

Record/output (Average) - 60 marks

Viva-voce (Average) - 10 marks

Final practical exam -30 marks

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE301	DESIGN OF CONCRETE STRUCTURES I	3-1-0-4	2016

Pre-requisites: CE202 Structural Analysis I

Course objectives:

- To provide the students with the knowledge of the behavior of reinforced concrete structural elements in flexure, shear, compression and torsion
- To enable them to design essential elements such as beams, columns, slabs staircases and footings under various loads.

Syllabus:

Introduction- Limit State method of design- Analysis of singly reinforced rectangular beams- shear strength of RC beam-design of shear reinforcement-bond and development length- curtailment of reinforcement-design of singly reinforced beams-analysis and design of doubly reinforced beams – simply supported , cantilever- analysis of singly reinforced T-beams -design for torsion-design of one-way slab- cantilever slab- continuous slab (detailing only)- two way slabs- design using code coefficients- Limit State of Serviceability-deflection-cracking -Stair cases- design & detailing- Columns-effective length-design of axially loaded short columns with rectangular ties and helical reinforcement.

Expected Outcomes:

The students will be able to

i. Apply the fundamental concepts of limit state method
ii. Use IS code of practice for the design of concrete elements
iii. Understand the structural behavior of reinforced concrete elements in bending, shear, compression and torsion.
iv. Design beams, slab, stairs, columns and draw the reinforcement details.
v. Analyze and design for deflection and crack control of reinforced concrete members.

Text Books / References:

1. Pillai S.U & Menon D – Reinforced Concrete Design, Tata McGraw Hill Publishing Co ., 2005
2. Punmia, B. C, Jain A.K and, Jain A.K ,RCC Designs, Laxmi Publications Ltd., 10e, 2015
3. Varghese P.C, Limit State Design of Reinforced Concrete, Prentice Hall of India Pvt Ltd,, 2008
4. Relevant IS codes (I.S 456, I.S 875, SP 34)

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction- Plain and Reinforced concrete- Properties of concrete and reinforcing steel-Objectives of design-Different design philosophies- Working Stress and Limit State methods-Limit State	9	15

	method of design-Introduction to BIS code- Types of limit states-characteristic and design values-partial safety factors-types of loads and their factors. Limit State of Collapse in Bending-assumptions-stress-strain relationship of steel and concrete- analysis of singly reinforced rectangular beams-balanced-under reinforced-over reinforced sections-moment of resistance codal provisions		
II	Limit state of collapse in shear and bond- shear stresses in beams-types of reinforcement-shear strength of RC beam-IS code recommendations for shear design-design of shear reinforcement-examples Bond and development length - anchorage for reinforcement bars - code recommendations regarding curtailment of reinforcement	9	15
FIRST INTERNAL EXAMINATION			
III	Design of Singly Reinforced Beams- basic rules for design- design example of simply supported beam- design of cantilever beam-detailing Analysis and design of doubly reinforced beams – detailing, T-beams- terminology- analysis of T beams- examples - Design for torsion-IS code approach- examples.	9	15
IV	Design of slabs- introduction- one-way and two-way action of slabs - load distribution in a slab- IS recommendations for design of slabs- design of one-way slab- cantilever slab- numerical problems – concepts of detailing of continuous slab –code coefficients.	9	15
SECOND INTERNAL EXAMINATION			
V	Two- way slabs- simply supported and restrained slabs – design using IS Code coefficients Reinforcement detailing Limit State of Serviceability- limit state of deflection- short term and long term deflection-IS code recommendations- limit state of cracking- estimation of crack width- simple numerical examples	10	20
VI	Stair cases- Types-proportioning-loads- distribution of loads – codal provisions - design and detailing of dog legged stair- Concepts of tread-riser type stairs (detailing only) Columns- introduction –classification- effective length- short column - long column - reinforcement-IS specifications regarding columns- limit state of collapse: compression -design of axially loaded short columns-design examples with rectangular ties and helical reinforcement	10	20
END SEMESTER EXAMINATION			

Note

1. All designs shall be done as per current IS specifications
2. Special importance shall be given to detailing in designs
3. During tutorial hours detailing practice shall be done.
4. SI units shall be followed.
5. IS 456-2000 shall be permitted for the End Semester Examination

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1. Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE303	STRUCTURAL ANALYSIS -11	3-0-0-3	2016

Pre-requisite: CE201 Mechanics of Solids

Course objectives:

- To equip the students with the force and displacement methods of structural analysis with emphasis on analysis of rigid frames and trusses

Syllabus :

Slope Deflection Method, Moment Distribution Method, Clapeyrons Theorem (Three Moment Equation) , Kani's method of analysis, Beams curved in Plan, Plastic Theory

Expected Outcomes:

The students will be able to

i. analyse structures using force method
ii. analyse structures using displacement method
iii. analyse curved beams in plan
iv. analyse structures using plastic theory

Text Books :

1. Kenneth Leet, Chia M Uang & Anne M Gilbert., Fundamentals of Structural Analysis, McGraw Hill, 4e, 2010
2. R. Vaidyanathan and P. Perumal, Structural Analysis Volume I & II, Laxmi Publications (P) Ltd., 2017
3. Reddy . C.S., Basic Structural Analysis, Tata McGraw Hill, 3e, 2011

References:

1. Daniel L Schodak, Structures, Pearson Education, 7e, 2014
2. Hibbeler, RC, Structural analysis, Pearson Education, 2012
3. Kinney J. S., Indeterminate Structural Analysis, Oxford & IBH, 1966
4. Negi L. S. and Jangid R. S, Structural Analysis, Tata McGraw Hill, 1997
5. Rajasekaran S. and Sankarasubramanian G., Computational Structural Mechanics, PHI, 2008
6. S.S. Bhavikatti, Structural Analysis II, Vikas Publication Houses (P) Ltd, 2016
7. SP:6 (6): Application of Plastic Theory in Design of Steel Structures, Bureau of Indian Standards, 1972
8. Timoshenko S. P. and Young D. H., Theory of Structures, McGraw Hill, 2e, 1965
9. Utku S, Norris C. H & Wilbur J. B, Elementary Structural Analysis, McGraw Hill, 1990
10. Wang C. K., Intermediate Structural Analysis, Tata McGraw Hill, 1989

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	**Clapeyrons Theorem (Three Moment Equation) :**Derivation of three	7	15

	moment equation - application of three moment equation for analysis of continuous beams under the effect of applied loads and uneven support settlement.		
II	**Slope Deflection Method : A**nalysis of continuous beams- beams with overhang- analysis of rigid frames - frames without sway and with sway - different types of loads -settlement effects	7	15
FIRST INTERNAL EXAMINATION			
III	**Moment Distribution Method:** Moment Distribution method – analysis of beams and frames – non sway and sway analysis .	7	15
IV	**Kani's Method:** Kani's Method of analysis applied to continuous beams and single bay single storey rigid frames rigid frames – frames without sway and with sway.	6	15
SECOND INTERNAL EXAMINATION			
V	**Beams curved in plan**: Analysis of cantilever beam curved in plan, analysis of circular beams over simple supports.	7	20
VI	**Plastic Theory:** Introduction – plastic hinge concepts – plastic modulus – shape factor – redistribution of moments – collapse mechanisms – Plastic analysis of beams and portal frames by equilibrium and mechanism methods.(Single Storey and Single bay Frames only)	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note :

1. Each part should have at least one question from each module.
2. Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE305	GEOTECHNICAL ENGINEERING - II	3-0-0-3	2016

Pre-requisite CE208 Geotechnical Engineering - I

Course objectives:

- To impart to the students, in-depth knowledge about the basic concepts and theories of foundation engineering;
- To enable the students to acquire proper knowledge about various methods of foundation analysis for different practical situations.

Syllabus:

Stresses in subsoil due to loaded areas of various shapes, Boussinesq's formula, Newmark's chart, Lateral earth pressure, Rankine's and Coulomb' theories, Influence of surcharge, inclined backfill, water table and layering, Terzaghi's bearing capacity theory for isolated footings, Local and general shear failure, Total and differential settlements, soil improvement techniques, combined footings, raft foundations, well foundation, Problems encountered in well sinking, Pile foundations, Bearing capacity of single pile static and dynamic formulae, Capacity of Pile groups, Machine foundation, Methods of vibration isolation, site investigation, Guidelines for choosing spacing and depth of borings, boring methods, Standard Penetration Test.

Expected Outcomes:

The students will be able to understand

i. the basic concepts, theories and methods of analysis in foundation engineering;
ii. the field problems related to geotechnical engineering and to take appropriate engineering decisions.

Text Books :

1. Braja M. Das, "Principles of Foundation Engineering", Cengage Learning India Pvt. Ltd., Delhi, 2011.
2. K. R. Arora, Soil Mechanics and Foundation Engineering, Standard Publishers, 2011
3. Murthy V N S., "Advanced Foundation Engineering", CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2007

References:

1. Alam Singh., "Soil Engineering in Theory and Practice", Vol.1, CBS Publishers & Distributors Pvt. Ltd., New Delhi. 2002
2. Gopal Ranjan and and Rao A.S.R., " Basic and Applied Soil Mechanics", New Age International (P) Limited, New Delhi, 2002.
3. Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Kindersley(India) Pvt. Ltd., 2013
4. TengW.E., "Foundation Design", Prentice Hall , New Jersey, 1962.
5. Venkataramiah, "Geotechnical Engineering", Universities Press (India) Limited, Hyderabad, 2000.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem. Exam Marks %**
I	Stresses in soil due to loaded areas - Boussinesq's formula for point loads – assumptions [no derivation required] – Comments - numerical problems Vertical stress beneath loaded areas of strip, rectangular and circular shapes(no derivation required)- Newmark's chart[construction procedure not required] - Isobars- Pressure bulbs- numerical problems	6	15
II	Lateral earth pressure – At-rest, active and passive earth pressures – Practical examples Rankine's and Coulomb' theories[no derivation required]-Influence of surcharge, inclined backfill and water table on earth pressure- numerical problems Earth pressure on retaining walls with layered backfill- numerical problems	6	15
FIRST INTERNAL EXAMINATION			
III	Bearing capacity of shallow foundations – Ultimate, safe and allowable bearing capacity. - Failure mechanism, assumptions and equation of Terzaghi's bearing capacity theory for strip footing[no derivation required] – Terzaghi's formulae for circular and square footings numerical problems Local and general shear failure - Factors affecting bearing capacity – Influence of water table - numerical problems Total and differential settlement- Causes - Methods of reducing differential settlement–Brief discussion on soil improvement through installation of drains and preloading.	7	15
IV	Combined footings- Rectangular and Trapezoidal combined footings - numerical problems Raft foundations (Design Concepts only) - Allowable Bearing capacity of Rafts on sands and clays - Floating foundation. Deep foundations - Elements of a well foundation – Problems encountered in well sinking – Methods to rectify tilts and shifts	6	15
SECOND INTERNAL EXAMINATION			
V	Pile foundations - Point bearing and friction piles - Bearing capacity of single pile in clay and sand[I.S. Static formulae] - numerical problems Dynamic formulae(Modified Hiley formulae only) - I.S. Pile load test [conventional]- Negative skin friction - numerical problems Group action - Group efficiency - Capacity of Pile groups- numerical problems	8	20

VI	Brief introduction to Machine foundation –Mass spring model for undamped free vibrations - Natural frequency – Coefficient of uniform elastic compression – Methods of vibration isolation Brief introduction to site investigation –Objectives - Guidelines for choosing spacing and depth of borings [I.S. guidelines only] - Auger boring and wash boring methods - Standard Penetration Test – procedure, corrections and correlations.	9	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE307	GEOMATICS	3-0-0-3	2016

Prerequisite : CE207 Surveying

Course objectives:

- To impart awareness on the advanced surveying techniques
- To understand the errors associated with survey measurements
- To provide a basic understanding on geospatial data acquisition and its process

Syllabus:

Traverse Survey, Curve Surveying, Global Navigation Satellite System, Global Positioning Systems, Remote Sensing, Geographical Information System

Course Outcomes:

- The students will possess knowledge on the advanced methods of surveying, the instruments and the spatial representation of data.

Text Books / References:

1. Dr. B.C. Punmia , Ashok Kumar Jain & Arun Kumar Jain - Surveying , Laxmi publications (P) Ltd , 2005
2. Prof. T.P. Kenetkar and Prof. S.V. Kulkarni - Surveying and Levelling, Pune Vidyarthi Griha Prakashan,2004
3. R.Agor - A Text book of Surveying and Levelling, Khanna Publishers, 2005
4. S.K. Duggal - Surveying Vol. II, Tata McGraw Hill Ltd ,Reprint 2015

References :

1. Burrough P , Principles of Geographical Information systems, Oxford University Press, 1998
2. Chang,K , "Introduction to Geographic Information Systems", Tata McGraw-Hill Publishing Co. Ltd, 2008
3. George Joseph, "Fundamentals of Remote Sensing", University Press, 2003
4. Iliffe, C.J., Datums and Map Projections for Remote Sensing, GIS and Surveying, Whittles Publishing, 2006
5. James M Andersen, Edward M Mikhail, Surveying Theory and Practice, McGraw Hill education, 7e, 1998
6. Kang-tsung Chang, 'Introduction to GIS' , Tata McGraw-Hill Publishing Co. Ltd, 8e, 2016
7. Lillesand M and Kiefer W, "Remote Sensing and Image Interpretation". John Wiley and Sons,Inc., 2000

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	**Traverse Surveying** - Methods of traversing, Checks in closed traverse, Traverse computations, Balancing the traverse- methods	6	15

II	C**urve Surveying** – Elements of simple and compound curves – Method of setting out– Elements of Reverse curve (Introduction only)– Transition curve – length of curve – Elements of transition curve - Vertical curve (introduction only)	8	15
FIRST INTERNAL EXAMINATION			
III	**Global Navigation Satellite System-** Types**, Global Positioning Systems**-Components and Principles, Satellite ranging-calculating position, Satellite signal structure, code phase and carrier phase measurements, GPS errors and biases, Application of GPS	6	15
IV	**GPS Surveying methods**-Static, Rapid static , Kinematic methods – DGPS, Phases of GPS Survey -Planning and preparation, Field operation-horizontal and vertical control, data sheet, visibility diagram, Processing and report preparation,	6	15
SECOND INTERNAL EXAMINATION			
V	**Remote Sensing** : Definition- Electromagnetic spectrum-Energy interactions with atmosphere and earth surface features-spectral reflectance of vegetation, soil and water- Classification of sensors-Active and Passive, Resolution-spatial, spectral radiometric and Temporal resolution, Multi spectral scanning-Along track and across track scanning	8	20
VI	**Geographical Information System**-components of GIS, GIS operations, Map projections- methods, Coordinate systems-Geographic and Projected coordinate systems, Data Types- Spatial and attribute data, Raster and vector data representation-Data Input methods-Geometric Transformation-RMS error, Vector data Analysis-buffering, overlay.	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE309	WATER RESOURCES ENGINEERING	3-0-0-3	2016

Pre-requisite : NIL

Course objectives

- To impart knowledge regarding the availability of water on hydrosphere, its distribution and quantification
- To convey the knowledge on the scientific methods for computing irrigation water requirements
- To communicate fundamental knowledge on reservoir engineering and river engineering

Syllabus

Hydrologic cycle, Precipitation, Infiltration and Evaporation-measurement and data analysis. Runoff-components and computation, Hydrograph, Unit Hydrograph and S-Hydrograph. Irrigation types and methods-Soil water plant relationships, Frequency of irrigation, Computation of crop water requirement. Stream flow measurement -Stage-discharge curve. Meandering of rivers, river training works. Surface water systems: diversion and storage systems, reservoir - estimation of storage capacity and yield of reservoirs - reservoir sedimentation -useful life of reservoir. Groundwater - Aquifer types and properties - Steady radial flow into a well. Estimation of yield of an open well.

Expected Outcome

After successful completion of this course, the students will be able to :

i. Describe the hydrologic cycle and estimate the different components
ii. Determine crop water requirements for design of irrigation systems
iii. Compute the yield of aquifers and wells.
iv. Know the features of various river training works
v. Estimate the storage capacity of reservoirs and their useful life.

Text Books:

1. Arora, K.R., "Irrigation, Water Power and Water Resources Engineering", Standard Publishers Distributors, New Delhi, 2009.
2. Garg S.K, Irrigation Engineering and Hydraulic Structures Khanna Publishers New Delhi 2006.
3. Modi. P. N. Irrigation, Water Resources and Water Power Engineering, S.B.H Publishers and Distributors New Delhi 2009.
4. Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering, Laxmi Publications (P) Ltd. 2010.

References:

1. Asawa. G.L. Irrigation and Water Resources Engineering, New Age International, 2000
2. Ojha.C.S.P., R.Berndtsson, P. Bhunya, Engineering Hydrology, Oxford university Press, 2015.
3. Patra. K.C., Hydrology and Water Resources Engineering, CRC Press, 2010.
4. Sahasrabudhe S.R., Irrigation Engineering & Hydraulic Structures, S.K. Kataria & Sons, 2013.
5. Subramanya. K., Engineering Hydrology, Tata Mc Graw Hill, 2011
6. Todd D. K., Ground Water Hydrology, Wiley, 2005.
7. Ven Te Chow, David R Maidment, L.W Mays., Applied Hydrology, McGraw Hill, 1988
8. Warren Viessman, G.L. Lewis, Introduction to Hydrology, Pearson Education, 2003.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem. Exam Marks %**
I	Hydrologic cycle-precipitation-mechanism, types and forms. Measurement of rainfall using rain gauges-optimum number of rain gauges. Estimation of missing precipitation. Representation of rainfall data-mass curve and hyetograph. Computation of mean precipitation over a catchment. Design rainfall - probable maximum rainfall. Infiltration-measurement by double ring infiltrometer. Horton's model. Evaporation-measurement by IMD land pan, control of evaporation.	8	15
II	Runoff-components of runoff-methods of estimation of runoff-infiltration indices, Hydrograph analysis-Hydrograph from isolated storm-Base flow separation. Unit hydrograph –uses. Assumptions and limitations of unit hydrograph theory. Computation of storm/flood hydrograph of different duration by method of superposition and by development of S– Hydrograph.	8	15
FIRST INTERNAL EXAMINATION			
III	Irrigation– Necessity, Benefits and ill effects. Types: flow and lift irrigation - perennial and inundation irrigation. Methods: flooding, furrow, sprinkler and drip irrigation (concepts only, no design aspects/problems), Soil water plant relationships, soil moisture constants, Computation of crop water requirement: depth and frequency of Irrigation, Duty and delta, relationship, variation of duty, factors. Computation of design discharge of conveyance channels, Irrigation efficiencies. Consumptive use of water: concept of Evapotranspiration. (No detailed discussion on estimation procedures)	6	15
IV	Stream flow measurement: methods, Estimation of stream flow by area velocity method only, Stage discharge curve. Meandering of rivers, River training – objectives and classification, description of river training works.	6	15
SECOND INTERNAL EXAMINATION			
V	Surface Water system: diversion and storage systems, necessity. River flow: Flow duration Curve, Firm yield. Reservoirs-types of reservoirs, zones of storage reservoir, reservoir planning-storage capacity and yield of reservoirs-analytical method and mass curve method. Reservoir sedimentation: trap efficiency, methods for control. Computation of useful life of reservoir.	7	20
VI	Ground water : vertical distribution of groundwater, classification of saturated formation, water table, Aquifer properties : Porosity, Specific yield, specific retention, Types of aquifers. Darcy's law, co-efficient of permeability, Transmissibility. Wells- Steady radial flow into a fully penetrating well in Confined and Unconfined aquifers. Estimation of yield of an open well, pumping and recuperation tests. Tube wells – types.	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2 Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE331	MATERIAL TESTING LAB -II	0-0-3-1	2016

Pre-requisite: CE204 Construction Technology

Course objectives:

- To enable experimental evaluation of properties of the materials used for concrete
- To obtain the characteristics of the materials.

List of Experiments:

1. Determination of the Specific Gravity and Soundness of cement
2. Determination of the Standard Consistency, Initial and Final Setting Times of Cement and the compressive strength of Cement.
3. Tests on fine aggregate – specific gravity, bulking, sieve analysis, fineness modules, moisture content , bulk density
4. Tests on coarse aggregate - specific gravity, sieve analysis, fineness modulus, bulk density.
5. Tests on Fresh Concrete: Workability : Slump, Vee-Bee, Compaction factor tests ,flow test
6. Determination of the Compressive Strength of Concrete by Cube and Cylinder.
7. Carrying out the Split Tensile and Flexural strength of Concrete.
8. Compressive strength of Brick as per IS
9. Transverse strength of tiles
10. Demonstration of Mix Design of Concrete by IS methods
11. Non destructive tests (rebound hammer & ultrasonic pulse velocity**)**

Books/Manuals /References:-

1. Concrete Lab Manual, TTTI Chandigarh
2. M.L. Gambhir, Concrete Manual, Dhanpat Rai & Sons, Delhi.
3. M.S.Shetty , Concrete Technology, Theory and Practice , S.Chand& Company, 2014
4. Relevant latest IS codes on Aggregates, Cement & Concrete [269, 383, 2386, 10262(2009), SP23]

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE333	GEOTECHNICAL ENGINEERING LAB	0-0-3-1	2016

Pre-requisite : CE208 Geotechnical Engineering - I

Course objectives:

- To understand the laboratory tests used for determination of physical, index and Engineering properties of soil.

List of Experiments:

1. Determination of Water Content, Specific Gravity and Shrinkage Limit
2. Field Density determination and Sieve Analysis
3. Atterberg Limits (Liquid Limit and Plastic Limit)
4. Hydrometer Analysis
5. Direct Shear test
6. Standard Proctor Compaction Test
7. Permeability Test and Unconfined Compression Test
8. Consolidation Test
9. Swelling Test
10. Heavy compaction
11. California Bearing Ratio Test.

Expected Outcomes:

The students will

i. have thorough knowledge about the procedures of laboratory tests used for determination of physical, index and engineering properties of soils
ii. have the capability to classify soils based on test results and interpret engineering behavior based on test results
iii. be able to evaluate the permeability and shear strength of soils
iv. be able to evaluate settlement characteristics of soils
v. be able to evaluate compaction characteristics required for field application

Text Books / References:

1. IS codes relevant to each test
2. C. Venkatramaiah, Geotechnical Engineering, New Age International publishers, 2012
3. Gopal Ranjan and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International Publishers, 2012
4. K. R. Arora, Soil Mechanics and Foundation Engineering, Standard Publishers, 2011

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE361	ADVANCED CONCRETE TECHNOLOGY	3-0-0-3	2016

Prerequisite: CE204 Construction Technology,

Course objectives:

- To understand the behaviour of fresh and hardened concrete.
- To make aware the recent developments in concrete technology
- To understand factors affecting the strength, workability and durability of concrete
- To impart the methods of proportioning of concrete mixtures

Syllabus:

Review of Materials for concrete making. chemical and physical processes of hydration , Properties of fresh concrete - Mineral admixtures - Chemical Admixtures - Proportioning of concrete mixtures. Properties of hardened concrete- Durability of concrete, Non-destructive testing of concrete – special concretes

Expected Outcomes:

The students will be able to:

i. Understand the testing of concrete materials as per IS code
ii. Know the procedure to determine the properties of fresh and hardened of concrete
iii. Design the concrete mix using ACI and IS code methods
iv. Select and Design special concretes depending on their specific applications
v. Gain ideas on non-destructive testing of concrete

Text books:

1. Neville A.M.,"Properties of Concrete", Trans-Atlantic Publications, Inc.; 5e, 2012
2. Job Thomas., " Concrete Technology", Cenage learning,
3. R. Santhakumar „ Concrete Technology", Oxford Universities Press, 2006
4. Shetty M. S., Concrete Technology", S. Chand & Co., 2006

References:

1. Mehta and Monteiro, „Concrete-Micro structure, Properties and Materials", McGraw Hill Professional
2. Neville A. M. and Brooks J. J., Concrete Technology, Pearson Education, 2010
3. Lea, Chemistry of Cement and Concrete", Butterworth-Heinemann Ltd, 5e, 2017
4. Bungey, Millard, Grantham – Testing of Concrete in Structures- Taylor and Francis, 2006

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	**Aggregates:** Review of types; sampling and testing; effects on properties of concrete, production of artificial aggregates. **Cements:** Review of types of cements, chemical composition; properties and tests, chemical and physical process of hydration,	6	15

	.Blended cements.		
II	**Properties of fresh concrete** - basics regarding fresh concrete – mixing, workability, placement, consolidation, and curing, segregation and bleeding **Chemical Admixtures:** types and classification; actions and interactions; usage; effects on properties of concrete.	7	15
FIRST INTERNAL EXAMINATION			
III	**Mineral Admixtures:** Flyash, ground granulated blast furnace slag, metakaolin, rice-husk ash and silica fume; chemical composition; physical characteristics; effects on properties of concrete; advantages and disadvantages. **Proportioning of concrete mixtures:** Factors considered in the design of mix . BIS Method, ACI method.	6	15
IV	**Properties of hardened concrete**: Strength- compressive tensile and flexure - Elastic properties - Modulus of elasticity - Creep- factors affecting creep, effect of creep - shrinkage- factors affecting shrinkage, plastic shrinkage, drying shrinkage, autogeneous shrinkage, carbonation shrinkage	6	15
SECOND INTERNAL EXAMINATION			
V	**Durability of concrete**: Durability concept; factors affecting, reinforcement corrosion; fire resistance; frost damage; sulfate attack; alkali silica reaction; concrete in sea water, statistical quality control, acceptance criteria as per BIS code. **Non-destructive testing of concrete**: Surface Hardness, Ultrasonic, Penetration resistance, Pull-out test, chemical testing for chloride and carbonation- core cutting - measuring reinforcement cover.	9	20
VI	**Special concretes** - Lightweight concrete- description of various types -High strength concrete - Self compacting concrete -Roller compacted concrete – Ready mixed concrete – Fibre reinforced concrete - polymer concrete **Special processes and technology for particular types of structure** - Sprayed concrete; underwater concrete, mass concrete; slip form construction, Prefabrication technology	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE363	GEOTECHNICAL INVESTIGATION	3-0-0-3	2016

Pre-requisite : CE208 Geotechnical Engineering - I

Course objectives:

- To impart to the students, a clear idea about how a geotechnical investigation programme is to be planned and executed;
- To impart in-depth knowledge about the various methods of geotechnical investigation and the field tests to be conducted in different situations.

Syllabus:

Objectives of soil exploration – Planning of a sub-surface exploration programme –Methods of exploration - Sounding methods – Standard Penetration Test - Cone Penetration Tests - Plate load test – Pressure meter test - Geophysical methods —pile load tests -Factors affecting sample disturbance and methods to minimise them –Types of samplers and Core retainers –Rock Quality Designation– Sub-soil investigation report

Expected Outcomes:

i. The students will be able to understand the procedure, applicability and limitations of various methods of geotechnical investigation;
ii. Ability of the students in making proper engineering judgments and in taking appropriate decisions related to geotechnical investigations will be significantly improved.

Text Books:

1. Gopal Ranjan and Rao A.S.R., " Basic and Applied Soil Mechanics", New Age International (P) Limited, New Delhi, 2002.
2. Venkataramaiah, "Geotechnical Engineering", Universities Press (India) Limited, Hyderabad, 2000.

References:

1. Arora K.R., " Geotechnical Engineering", Standard Publishers Distributors, New Delhi, 2006.
2. Joseph E. Bowles, 'Foundation Analysis and Design', Mc. Graw Hill Inc., New York, 1988.
3. Purushothamaraj P., Soil Mechanics and Foundation Engineering, Dorling Kindersley(India) Pvt. Ltd., 2013
4. Terzaghi K. and R. B. Peck, Soil Mechanics in Engineering Practice, John Wiley, 1967.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction and practical importance - Objectives of soil exploration – Planning of a sub-surface exploration programme –Collection of existing information, reconnaissance, preliminary and detailed investigation - I.S. and other guidelines for deciding the number, size, spacing and depth of boreholes	7	15

II	Methods of exploration - Open pits – Auger boring- -Wash boring, percussion drilling, rotary drilling – Comparison of the methods of exploration- Stabilization of bore holes Plate load test – Procedure, uses and limitations – modulus of subgrade reaction- Solution of numerical problems using plate load test data	6	15
FIRST INTERNAL EXAMINATION			
III	Sounding methods Standard Penetration Test – Procedure – corrections to be applied to observed N values – Procedure for estimation of representative average N value – Numerical examples - Factors influencing the SPT results and precautions to obtain reliable results – Merits/drawbacks of the test – Correlations of N value with various engineering and index properties of soils Static Cone Penetration Test – Procedure – Merits/drawbacks – Correlation of static CPT results with soil properties -Dynamic Cone Penetration Test – Procedure – Merits/drawbacks – Critical comparison of SPT, static CPT and dynamic CPT	8	15
IV	Geophysical methods – Seismic refraction method – Procedure, uses, limitations – Solution of numerical problems to estimate the velocity of seismic waves and the thickness of upper layer of a two-layered soil system - Electrical resistivity method – Electrical profiling and electrical sounding – Procedure, uses, limitations Pressure meter test - Procedure –Uses - limitations	6	15
SECOND INTERNAL EXAMINATION			
V	Soil sampling – Undisturbed, disturbed, and representative samples – Chunk and tube samples – Factors affecting sample disturbance and methods to minimise them –Area ratio - Inside clearance - Outside clearance - Recovery ratio –Ball check valve – Handling and transportation of samples – Extrusion of samples Types of samplers – Thin walled sampler – Piston sampler – Split spoon sampler – Methods for collection of sand samples from beneath the water table - Core retainers	8	20
VI	Rock Quality Designation –Bore log – Soil profile – Sub-soil investigation report Static pile load test – procedure for estimation of safe load - Cyclic pile load test –Procedure for separation of end bearing and skin friction resistance- solution of numerical problems using static and cyclic pile load test data	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE365	FUNCTIONAL DESIGN OF BUILDINGS	3-0-0-3	2016

Prerequisite : CE204 Construction Technology

Course objectives:

- To understand the acoustical design concepts and noise control techniques
- To impart the fundamental concepts of natural and artificial lighting designs
- To provide principles of climatic conscious design of buildings with special emphasis on tropical climates.
- To understand the apparent position of sun with respect to earth during different periods of the year and apply it in computation of solar radiation and design of shading devices.

Syllabus:

Acoustics : Physics of sound- Behavior of sound- Sound insulation and reverberation control
Lighting: Principles- Day lighting and artificial lighting – design methods
Thermal design of buildings: Climatic elements – classification- thermal comfort and indices-solar radiation calculations and design of shading devices.
Thermo physical properties of building materials and thermal control- passive and active building design- Steady and periodic heat flow through building envelope. Concept of green building.

Expected Outcomes:

On completion of the course, the students will be able to:

i. Analyze and make effective decisions in use of principles of functional planning of the buildings with respect to Acoustics and Lighting and Thermal design of buildings in various climatic zones that the student may encounter in his/her professional career.
ii. Select different building materials and explain the manner in which they can be used in different types of buildings with respect to various functional requirements like acoustics, lighting and thermal comfort.
iii. Apply the techniques learned to the estimate solar radiation falling on different surfaces of the buildings, design shading devices to protect from direct sunlight, design of energy efficient, functionally comfortable buildings, low energy buildings and green buildings.

References :

1. Ajitha Simha.D, Building Environment, Tata McGraw Hill Publishing Co., New Delhi, 1985
2. Bureau of Indian standards, Handbook on Functional Requirement of Buildings – SP:41(S and T) – 1987
3. Givoni. B Man,. Climate and Architecture, Applied Science Publication, 1976
4. Knudsen V.O. and Harris C.M., Acoustical Design in Architecture, John Wiley, 1980
5. Koenigseberger, Manual of tropical Housing and Building Part I – Climatic design, Orient Longman, 2011
6. Krishnan, Climate responsive architecture, Tata McGraw Hill, 1999
7. M David Egan , Architectural Acoustics, J.Ross Publishing, 2007
8. Olgay Victor, Design with climate-A bioclimatic approach to architectural regionalism- Princeton University press-1963

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem. Exam Marks %**
I	**Acoustics, fundamentals:** Physics of sound-Frequency, period amplitude. Intensity of sound- Watts/m^2- Bel- Decibel scales- dBA-Phon. Addition of sound levels. Human Audibility range. Behavior of sound in free and reverberant fields. Noise- allowable limits-effect of noise on human-Air and structure born noises-equivalent noise levels-day and night equivalent.	7	15
II	**Acoustics, applications:** Measures of noise control- Source-path and receiving end. TL value and computation of TL value, Flanking paths. Sound absorption-materials and fixings. Reverberation-Sabines formula-Eyrings modification. Acoustical defects- acoustical design of auditoriums and small lecture halls. Acoustical considerations of offices, hospitals and Industrial buildings.	7	15
FIRST INTERNAL EXAMINATION			
III	**Lighting, Natural:** Visual tasks – Natural lighting- illumination requirements for various buildings –principles of day lighting – day light factor and its components- Design of side-lit windows-BIS and CBRI methods-skylights	6	15
IV	**Lighting, Artificial**: Artificial lighting- illumination requirements-lux meter – lamps and luminaries – polar distribution curves– Colour temperature and colour rendering index- glare -Design of artificial lighting – lumen method – point by point method. Basic idea of street lighting and outside lighting	6	15
SECOND INTERNAL EXAMINATION			
V	**Thermal comfort:** Factors affecting thermal comfort Effective temperature –Thermal comfort indices-ET-CET Charts-Bioclimatic chart- Psychrometry and Psycrometric chart. **Earth-Sun relationship**: Sun's apparent movement with respect to the earth. Solar angles-Computation of solar radiation on different surfaces-solar path diagram-shadow-throw concept and design of shading devices	8	20
VI	**Heat flow through building envelope**: Thermo physical properties of building materials: Thermal quantities – heat flow – thermal conductivity – resistance and transmittance and surface coefficient - Sol- air temperature concept- solar gain factor. Thermal transmittance of structural elements – thermal gradients – heat gain/loss calculation. Periodic heat flow – time lag and decrement factor. **Design approaches**: Climate conscious designs- Climatic zones in India- orientation and shape of buildings in different climatic zones-Passive solar-Active solar and Active approaches. Requirements of buildings in tropical areas-Thermal insulation-Introduction to the concept of green-building	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2 Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE367	WATER CONVEYANCE SYSTEMS	3-0-0-3	2016

Pre requisite : CE206 : Fluid Mechanics - II

Course objectives:

- To understand the mechanics of flow through open channel.
- To develop the ability to analyse the flow in a channel in order to design canals and canal structures.
- To enable identification of the components of pipe network system.
- To familiarize with analysis of water distribution systems.

Syllabus :

Open channel flow- Pressure distribution in curvilinear flows. Channel transitions with hump or change in width. Uniform flow-composite sections, Hydraulic exponents N and M Design of channels for uniform flow-Non erodible channel-Minimum permissible velocity-channel slopes-best hydraulic section. Erodible channels which scour but do not silt-. Gradually varied flow computations. Unsteady flow-Gradually and Rapidly varied unsteady flow.

Head loss due to friction in pipes , Friction factor for smooth and rough pipes, Reservoirs, pumps and special valves, pipe network types and parameter interrelationships Analysis of water distribution network using Hardy cross method

Expected Outcomes:

i. The students will be able to predict the behaviour of flow in a channel under different conditions.

ii. The students will understand the underlying principles and the design parameters involved in analysis of water distribution system and become capable of analysing a typical pipe network.

Text Books :

1. Bhave P. R. and R. Gupta, Analysis of Flow in Water Distribution Networks, Narosa Publishing House, 2013

2. Rajesh Srivastava, Flow through Open Channels, Oxford University Press, 2007.

3. Subramanya.K. Flow in Open Channels, Tata McGraw Hill Publishing Co. 2009

References :

1. Chow V. T., Open Channel Hydraulics, McGraw Hill Book Co. New York, 1990.
2. Hanif Chaudhry.M., Open Channel Flow, Springer, 2008.
3. Hubert Chanson, Hydraulics of Open channel flow, Elsevier Butterworth-Heinemann, 2004.
4. Lary W Mays, Water distribution system Hand book, Mc Graw Hill, 2000.
5. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002
6. Richard H French, Open Chanel Hydraulics, Mc Graw Hill, 2000
7. Walksi T M, Analysis of water distribution System, Van Nostrand Reinheld G, New York, 1984

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %

I	Open channel flow- Pressure distribution in curvilinear flows. Application of specific energy principle to channel transitions with hump or change in width. Uniform flow-composite sections, Equivalent roughness, Hydraulic exponents N and M	6	15
II	Design of channels for uniform flow-Non erodible channel-Minimum permissible velocity-channel slopes-best hydraulic section. Erodible channels which scour but do not silt-Methods of approach-Method of permissible velocity-Tractive force – Method of tractive force-stable hydraulic section.	6	15
FIRST INTERNAL EXAMINATION			
III	Gradually Varied flow computations- Direct integration method, standard step method, Unsteady flow-Gradually varied unsteady flow, Rapidly varied unsteady flow channels- Positive surges, Negative surges.(No numerical problem from negative surges)	7	15
IV	Head loss due to friction in pipes-Nikuradse experiment with artificially roughened pipe, Moody diagram, Friction coefficient for laminar and turbulent flows, reduction of carrying capacity with age. Hazen William's formula. Reservoirs-Impounding reservoir, Service and Balancing reservoir. Two reservoir system, Three Reservoir system. Pumps- system head discharge curve and pump head discharge curve. Special valves-Check valve, Pressure reducing valve-modes of operation(No numerical problem with pressure reducing valve)	6	15
SECOND INTERNAL EXAMINATION			
V	Pipe Network types and parameter interrelationships. Rules for solvability of pipe networks.Formulation of equations-Basic unknown parameter, Pipe discharge equations, Nodal Head equations, Pipe discharge correction equations, Nodal Head correction equations	8	20
VI	Analysis of water distribution network- Single and multisource networks with known pipe resistances- Hardy cross method- Method of balancing head, Method of balancing flow.	9	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE369	DISASTER MANAGEMENT	3-0-0-3	2016

Prerequisite: NIL

Course objectives:

- To provide an overview of the common hazards and their dynamics
- To inculcate the basic concepts of disaster management

Syllabus :

Fundamental concepts of hazards and disasters: Relationship between disasters and development, implications. Introduction to key concepts and terminology of hazard, vulnerability, exposure, risk, crisis, emergencies, Disasters, Resilience.

Types of Natural Disasters I- Earth quakes, Landslides. Classification of Disasters and nature of Impacts.

Types of Natural Disasters II- Floods, Coastal disasters-Tidal waves, Cyclones, Tsunamis. Classification of Disasters and nature of Impacts.

Types of Anthropogenic Disasters I – Soil degradation and desertification.

Types of Anthropogenic Disasters II- Fundamental concepts of water and atmospheric pollution.

Hazard and disaster management plans for floods, cyclones, tidal waves.

Expected Outcomes:

The students will

i. gain the general ideas about the processes involved in natural and anthropogenic disasters
ii. understand the concepts of disaster management and measures taken to mitigate and contain common episodes of disasters

References :

1. Andrew, S., "Environmental Modeling with GIS and Remote Sensing", John Willey, 2002
2. Ariyabandu, M. and Sahni P. "Disaster Risk Reduction in South Asia", Prentice-Hall (India), 2003.
3. Bell, F.G., "Geological Hazards: Their assessment, avoidance and mitigation", E & FN SPON Routledge, London. 1999
4. Bossler, J.D., "Manual of Geospatial Science and Technology", Taylor and Francis, 2001
5. David Alexander, "Natural Disasters", Research Press, New Delhi, 1993
6. Matthews, J.A., "Natural hazards and Environmental Change", Bill McGuire, Ian Mason, 2002
7. Mitigating Natural Disasters, Phenomena, Effects and options, A Manual for policy makers and planners, United Nations. New York, 1991
8. Nick Carter. W., "Disaster Management - A Disaster Manager's Handbook". Asian Development Bank, Philippines. 1991

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %

I	Fundamental concepts of hazards and disasters: Relationship between disasters and development, implications. Introduction to key concepts and terminology of hazard, vulnerability, exposure, risk, crisis, emergencies, Disasters, Resilience.	7	15
II	Types of Natural Disasters I- Earth quakes, Landslides. Classification and nature of impacts.	7	15
FIRST INTERNAL EXAMINATION			
III	Types of Natural Disasters II- Floods, Coastal disasters- Cyclones, Tsunamis. Classification and nature of impacts.	7	15
IV	Types of Anthropogenic Disasters I– soil and soil degradation, desertification.	7	15
SECOND INTERNAL EXAMINATION			
V	Types of Anthropogenic Disasters II-Fundamental concepts of water and atmospheric pollution.	7	20
VI	Hazard and disaster management plans for floods, cyclones, tidal waves.	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE371	**Environment and Pollution**	3-0-0-3	2016

Prerequisites: Nil

Course objectives:

- To understand the various types of environmental and industrial pollution, pollutants, related diseases and their causes
- To impart the various management techniques available for pollution abatement

Syllabus

Pollution, Environmental and industrial, Types. Air pollution-sources, effects, types of pollutants. Water pollution, characteristics of water pollutants, water borne diseases, water quality standards. Solid wastes, sources, types, control methods, soil pollution, urbanization, land degradation, pesticide pollution. Noise pollution, sources, effects, control measures, industrial pollution, occupational health hazards, industrial hygiene

Expected Outcomes:

i. To have a basic knowledge of various pollution sources and their effects
ii. To have an awareness of the various methods of prevention and reduction of pollutant

Text Books / References:

1. B.C.Bhartia, Environmental Pollution and Control in Chemical Process Industries, Khanna Publishers, Delhi, 2001.
2. Danny D Reible, Fundamentals of Environmental Engineering, CRC Press, 1998
3. Gilbert M Masters, Wendell P Ela, Introduction to Environmental Engineering and Science, Pearson Education, 2007
4. Howard S Peavy, Donald R Rowe, George Tchobanoglous, Environmental Engineering, McGrawHill Education , 1984
5. Kurian Joseph & R.Nagendran, Essentials of Environmental Studies, Pearson Education (Singapore) Pvt.Ltd, New Delhi, 2004.
6. N.N Basak, Environmental Engineering, McGrawHill Education, Reprint 2015
7. P.AarneVesiland, Introduction to Environmental Engineering, PWS publishing company Boston, 1997.
8. Suresh K Dhameja, Environmental Engineering and Management, S.K.Kataria& Sons, Delhi, 2010.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Environment-Introduction-Multidisciplinary Nature Components of Environment, Ecology, Ecosystem- Material Cycling-Carbon and Nitrogen cycles Introduction: Classification of Pollution and Pollutants of environment, Pollution related Diseases, Basic requirements for healthy environment	6	15

II	Air Pollution: Primary and Secondary Pollutants, Industrial Pollution, Ambient Air Quality Standards, Types of air pollutants-sulfur dioxide, nitrogen dioxide, carbon monoxide, particulate matter. Effects of air pollutants on human, vegetation and environment	6	15
FIRST INTERNAL EXAMINATION			
III	Water Pollution: Point and Non-point Source of Pollution, Major Pollutants of Water, Physical, chemical and biological characteristics of water , Water borne diseases, Water Quality standards	7	15
IV	Solid Waste: Classification of Solid Waste, Composition and Characteristics of Solid Waste, Plastic wastes; Segregation of Solid waste, recycling and reuse of solid wastes, E-waste: Sources of generation,.	7	15
SECOND INTERNAL EXAMINATION			
V	Land/Soil Pollution: Effects of urbanization on land degradation, Impact of Modern Agriculture on Soil, pesticide pollution, Effect on Environment and Life sustenance, Abatement measures	8	20
VI	Noise pollution: Sources of Noise, Effects of Noise, measurement of noise, Equivalent sound pressure level, Control measures	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE373	ADVANCED MECHANICS OF MATERIALS	3-0-0-3	2016

Prerequisite: CE201 Mechanics of Solids

Course objectives:

- To review and make more useful the methods and results presented in the first course on Mechanics of Materials.
- To show the limitations of the ordinary formulas of Strength of Materials, to consider the conditions under which these limitations are significant and to extend the subject to include a variety of important topics more complex than those usually involved in a first course.

Syllabus: Stress, Principal stresses, Strain energy, Failure & Failure criteria, Elements of theory of elasticity, strains and compatibility, Beams on elastic foundation, Curved Beams, Torsion

Expected Outcomes:

The students will be able to

i. apply the concepts of stress, strain and strain energy
ii. use failure criteria and fracture mechanics and buckling in analysis
iii. apply plane state of stress and strains to problems
iv. use strain and compatibility conditions in analysis
v. use the concept of beams on elastic foundations and curved beams
vi. use the principles of torsion for analysis

Text Books

1. R.D. Cook and W.C. Young, Advanced Mechanics of Materials, 2nd edition, Prentice Hall Intl,Inc.1999
2. Srinath L.S, Advanced Mechanics of Solids, Tata McGraw Hill, 3e, 2009

References :

1. A.P. Boresi and O.M.Sidebottom, Advanced Mechanics of Materials, 4th edition, John Wiley & Sons,Inc.1985
2. Edward Tsudik, Analysis of structures on Elastic Foundations, Cengage Learning , J.Ross Publishing, 2012
3. S P Timoschenko, Strength of Materials Vol II ,CBS Publishers, 2002
4. Shames, E.H., Mechanics of Deformable solids, Prentice Hall Inc., 1964
5. Timoshenko S.P and Goodier J.N, Theory of elasticity, McGraw Hill, 3e, 1970

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	**Stress, Principal stresses, Strain energy:** Stress at a point – stress on an arbitrarily oriented plane-stress transformations- strain theory-principal stresses & strains (2d & 3d)- Generalized Hooke's law-Equations of thermo-elasticity for isotropic materials-strain energy density- stress concentration.	6	15

II	**Failure & Failure criteria:** Modes of failure –yield failure criteria-introduction to fracture mechanics-cracks & brittle fracture-fatigue-elastic and inelastic buckling.	6	15
FIRST INTERNAL EXAMINATION			
III	**Elements of theory of elasticity :**Transformation of stress and strains: Plane state of stress - equations of transformation - principal stresses. Plane state of strain – analogy between stress and strain transformation - Mohr's circles of stress and strain – strain rosettes.	6	15
IV	Displacements-strains and compatibility-equilibrium equations and boundary conditions- stress field solutions for plane stress problems-polynomial solutions in Cartesian coordinates-displacements calculated from stresses-plane stress problems in polar coordinates.	6	15
SECOND INTERNAL EXAMINATION			
V	**Beams on elastic foundation:** General theory-infinite beam subjected to concentrated load- beams with uniformly distributed loads- short beams **Curved Beams:** Winkler Bach formula-Equivalent area method-Circumferential stresses in Curved beams with I and T sections- Closed ring with circumferential load and uniform loads -deflections of sharply curved beams.	9	20
VI	**Torsion :**Torsion of a cylindrical bar of circular cross section- St. Venant's semi inverse method-stress function approach-elliptical, equilateral triangle & narrow rectangular cross sections - Prandtl's membrane analogy-Hollow thin wall torsion members-multiply connected cross sections- thin wall torsion members with restrained ends.	9	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

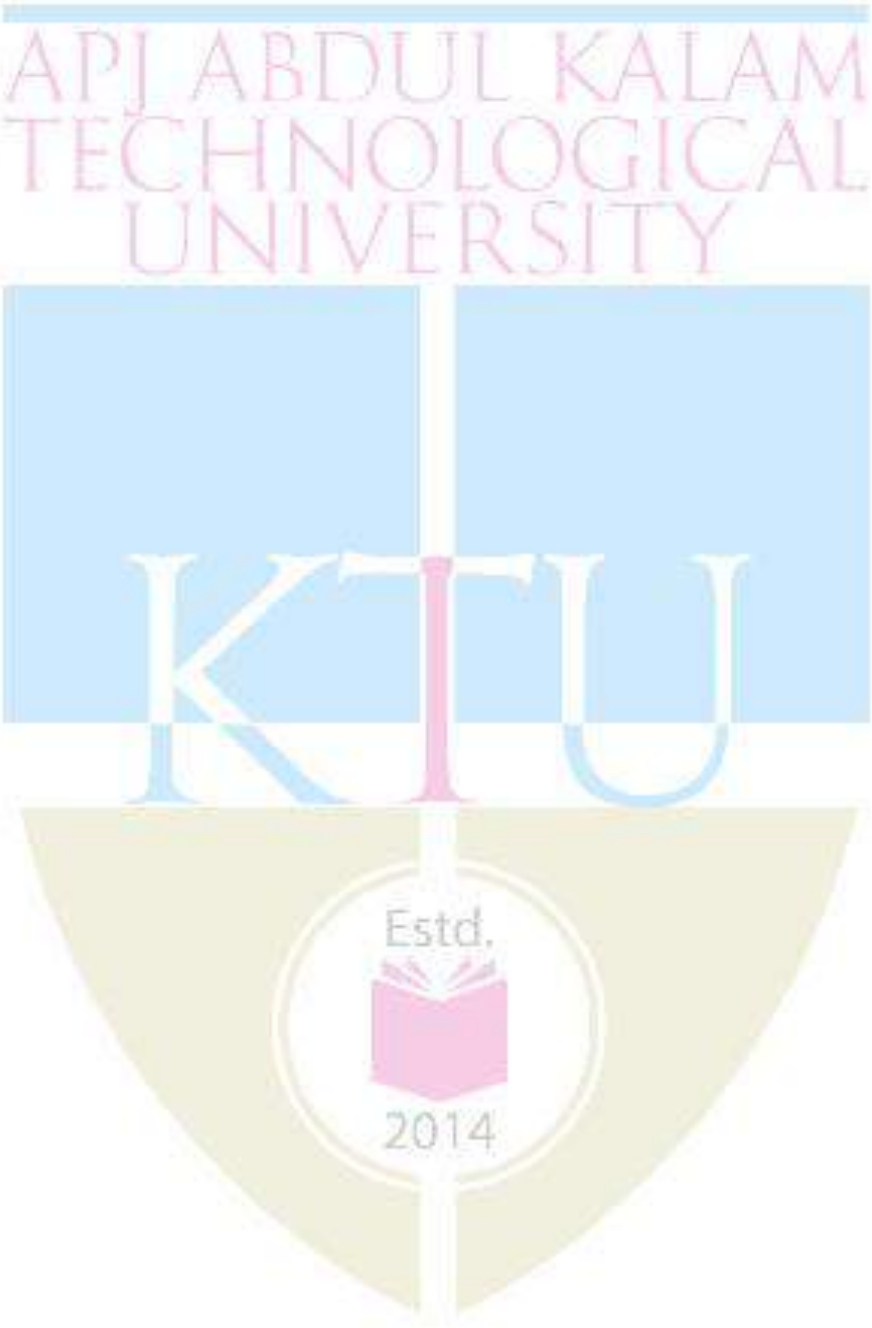
Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)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TECHNOLOGICAL
UNIVERSITY
KTU
Estd.
2014

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE302	DESIGN OF HYDRAULIC STRUCTURES	4-0-0-4	2016

Prerequisite : CE309 Water Resources Engineering

Course objectives:

- To impart knowledge regarding the design of the various minor irrigation structures
- To convey the knowledge on the causes of failure, design criteria and stability analysis of different types of dams

Syllabus :

Diversion head works - layout and functions of components. Causes of failure of weirs on permeable soils, Bligh's theory and Khosla's theory. Irrigation canals- Design of unlined canals through alluvial soils-Kennedy's theory and Lacey's theory. Minor irrigation structures- Cross drainage works, Canal Regulation works : Falls and Regulators, Design of Hydraulic Structures: Aqueduct, siphon aqueduct, Canal falls-notch type, well type, Sarda type, and Cross regulator. Dams-Types, Gravity dam - forces acting - stability analysis and modes of failure - theoretical and practical profiles- Functions of shafts, galleries, keys and water stops. Arch dams-types, Thin cylinder theory. Earth dams-types, causes of failure and design criteria. Spillways-Types. Ogee type spillway-profile.

Course Outcomes:

The students will be able to

i. Perform the stability analysis of gravity dams
ii. Explain the causes of failure of different types of dams and their design criteria
iii. Design minor irrigation structures such as regulators, cross drainage works and canal falls

Text Books :

1. Garg S.K, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2006.
2. Modi. P. N., Irrigation Water Resources and Water Power Engineering, Standard Book House, 2009.
3. Punmia B.C. Ashok K Jain, Arun K Jain, B. B. L Pande, Irrigation and Water Power Engineering, Laxmi Publications (P) Ltd. 2010.

References:

1. Arora, K.R., "Irrigation, Water Power and Water Resources Engineering", Standard Publishers Distributors, 2010.
2. Asawa. G.L. Irrigation and Water Resources Engineering, New Age International, 2000
3. Sahasrabudhe S.R., Irrigation Engineering & Hydraulic Structures, S.K. Kataria & Sons, 2013
4. Sathyanarayana M. C. Water Resources Engineering-Principles and Practice, New Age International Publishers. 2009
5. Varshney, R.S. Theory & Design of Irrigation Structures - Vol III, Nem Chand & Bros., Roorkee.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Diversion head works- layout and functions of components, Weir and barrage- Causes of failure of weirs on permeable soils - Bligh's theory. Design of vertical drop weir. Khosla's theory of independent variables- Khosla's corrections-Use of Khosla's charts.	6	15

II	Irrigation canals, canal alignment- cross section of unlined canals- Design of canals through alluvial soils-Kennedy's theory and Lacey's theory. Cross drainage works-Types, selection of suitable type, Type of aqueducts. Regulation Works - Canal falls-necessity, classification. Canal regulators- Regulator cum road bridge- Head regulators and cross regulators.	8	15
FIRST INTERNAL EXAMINATION			
III	Design and Drawing of the following hydraulic structures: 1. Aqueduct (Type III) 2. Syphon Aqueduct (Type III) 3. Canal Fall (Trapezoidal Notch type) 4. Siphon Well Drop 5. Sarda Type Fall (High Discharge only) 6. Cross Regulator (Using Khoslas Theory)	30	50
SECOND INTERNAL EXAMINATION			
IV	Dams-Types, Gravity dam – selection of site- forces acting - stability analysis and modes of failure – Principal and shear stresses- Problems - Elementary profile –limiting height of gravity dams- high and low dams- Practical profiles, Functions of various components shafts, keys, water stops, and different types of gallery, Grouting. Instrumentation in dams (Concept only).	6	10
V	Arch dams-types, methods for design (list only)-Thin cylinder theory. Earth dams-types, causes for failure and design criteria. Spillways-Types. Effective length of spillway- Ogee type spillway- profile. Energy dissipation below spillways - Stilling basins- Indian standard Type I and Type II (design not necessary).	6	10
END SEMESTER EXAMINATION			

Note: In Internal Evaluation the marks for assignment shall be awarded based on the submission of drawings.

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks : 100 **Exam Duration: 4 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III : One question out of 2 questions carrying 50 marks ; with weightage for design as 25 marks and sketching of two views of design specified in question : 25 marks

Part C - Module IV & V : 2 questions out of 3 questions carrying 10 marks each.

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE304	DESIGN OF CONCRETE STRUCTURES - II	3-0-0-3	2016

Pre-requisites : CE301 Design of Concrete Structures - I

Course objectives:

- To provide knowledge in the structural design of selected advanced structures of concrete and enable them to design reinforced concrete structures for real-world applications.

Syllabus :

Columns subjected to compression , uniaxial bending and biaxial bending- design using SP16 charts for limit state-design of slender columns- design of wall/strip footing- design of rectangular footings-eccentrically loaded rectangular footing- circular footings-detailing-combined footings-rectangular and trapezoidal (design principles only)- design of cantilever retaining wall without surcharge-detailing - design principles of counter fort retaining wall and detailing- Circular slabs-simply supported, fixed and partially fixed subjected to udl- design of water tanks-design philosophy and requirements-joints-IS code recommendations- design of rectangular and circular water tanks using IS code coefficients (IS 3370)- Pre-stressed concrete-concept of prestressing- materials-methods of prestressing – prestressing systems- losses of prestress. analysis of prestressed beams (rectangular and I-sections) at stages of transfer and service

Expected Outcomes:

The students will be able to

i. Design eccentrically loaded and slender columns using SP 16 design charts and different
ii. types of foundations
iii. Design and detail cantilever retaining wall and understand the design principles of Counter fort retaining wall
iv. Design and detail circular slabs and domes
v. Design rectangular and circular water tanks using IS code coefficients (IS 3370).
vi. Gain knowledge of prestressed concrete fundamentals and analyse pre and post tensioned beams.

Text Books / References:

1. N. Krishnaraju, Prestressed Concrete , Tata McGraw- Hill, 5e, 2012
2. Pillai S.U & Menon D – Reinforced Concrete Design, Tata McGraw Hill Book Co., 2009
3. Punmia, B. C, Jain A.K and, Jain A.K , R C C Designs, Laxmi Publications Ltd., 10e, 2015
4. Relevant IS codes (IS 456, IS 875IS 1343, IS 3370, SP 16, SP 34)

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Analysis and design of short columns under eccentric loading- Columns subjected to compression and uniaxial bending- design using SP16 charts for limit state Columns subjected to combined axial load and biaxial bending moments-code procedure for design- design using SP16 charts for	8	15

	limit state Slender columns- behavior of slender columns-braced and unbraced columns-design procedure- design using SP16 charts for limit state		
II	Foundations- classification-IS code provisions for design of isolated footings- design principles of rectangular footings- Design of rectangular footings-uniform thickness and sloped- eccentrically loaded rectangular footing of uniform thickness-detailing. Combined footings (design principles only)- analysis of combined footings-rectangular and trapezoidal.	8	15
FIRST INTERNAL EXAMINATION			
III	Retaining walls-Types- Cantilever retaining wall- earth pressure and forces acting-stability-proportioning-structural behavior of components -design example of cantilever retaining wall without surcharge-detailing Counterfort retaining wall- design principles of components and detailing (design not required)	6	15
IV	Circular slabs- stresses- reinforcements- simply supported, fixed and partially fixed subjected to uniformly distributed loads Design and detailing of spherical and conical domes	6	15
SECOND INTERNAL EXAMINATION			
V	Introduction to design of water tanks-design philosophy and requirements-joints- IS code recommendations Design of rectangular water tanks using IS code coefficients (IS 3370). Design of circular water tanks using- IS code coefficients (IS 3370)	7	20
VI	Introduction to Pre-stressed concrete: Concept of pre-stressing-Materials-High strength concrete and high tensile steel. Analysis of pre-stressed beams (Rectangular and I-sections) at stages of transfer and service. Losses in Prestress	7	20
END SEMESTER EXAMINATION			

Note: 1. All designs shall be done as per current IS specifications
2. Special importance shall be given to detailing in designs
3. SI units shall be followed.
4. Students shall submit a term project on design and detailing of any structure of real- world application at the end of the semester.

QUESTION PAPER PATTERN (End semester examination) :

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each
Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each
Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1. Each part should have at least one question from each module
2. Each question can have a maximum of 4 subdivisions (a,

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE306	COMPUTER PROGRAMMING AND COMPUTATIONAL TECHNIQUES	3-0-0-3	2016

Pre-requisites : Nil

Course Objectives:

- To provide adequate knowledge for coding in C++ language
- To give awareness about the different computational methods and their implementation to analyze basic Engineering problems

Syllabus

Computer programming - Elements of C++ programming language - control statements - Basic concepts of object oriented programming

Computational Techniques – Roots of transcendental equation- Interpolation -Functional approximation- Numerical Integration, Solution of simultaneous linear equations.

Expected Outcome:

- The students will be able to develop computer programs and implement numerical techniques for solving basic engineering problems using C++ language.

Text Books:

1. Balaguruswamy, Object Oriented programming with C++. Tata Mcgraw Hill., 2008
2. Gerald C. F. and P. O. Wheatley, Applied Numerical Analysis, Pearson Edu., 2004
3. Robert Lafore ., C++ Programming., Sams publishers.,4th Edition, 2001

Reference Books:

1. Barkakati N., Object Oriented Programming in C++, SAMS, 1991.
2. Kamthane A. M., Object Oriented Programming with ANSI & Turbo C++, Pearson Education, 2009.
3. Lippman S. B. and J. Lajoie, C++ Primer, Pearson Education, 2005.
4. Maria Litvin.and Gary Litvin, C++ for You++, Skylight Publishing, 1998.
5. Ravichandran D., Programming with C++, Tata McGraw Hill, 2007.

COURSE PLAN

Modules	Contents	Hours	Sem. Exam Marks %
I	Introduction to C++: Structure of C++ program; Character set; Keywords; Identifiers; Data types – integer, real, character, string, Boolean, Enumerated data types, Constants and Variables; Operators – assignment, arithmetic, relational, logical, increment, decrement and conditional operators; Statements – simple & compound, declaration statements. Input and output streams. Selection statements: if, if-else, switch statements	7	15
II	Looping statements - for, while, do-while statements, Jump statements – break, continue, goto, exit (). Arrays - single and multi-dimensional arrays, initializing array elements, pointers & arrays, Character arrays, string functions, Unformatted console I/O functions, Unformatted Stream I/O	6	15

	functions. Preparation of programs for evaluation of factorial of a number, Infinite series, Sorting, Searching and Matrix manipulations.		
FIRST INTERNAL TEST			
III	User defined functions – Arguments, return values, call by value, call by reference, functions calling functions, functions and arrays - Global variables, automatic, static and register variables, recursive functions.	6	15
IV	Structures - functions and structures - Arrays of structures - structures within structures, Structures containing arrays. Files - Input & Output, sequential & random access. Basic concepts of object oriented programming - class, objects, constructors and destructors, inheritance (Programs not required)	7	15
SECOND INTERNAL TEST			
V	Roots of Transcendental equations - Successive approximations, Regula - Falsi, Newton Raphson Methods, Interpolation-Lagrange interpolation method.	8	20
VI	Functional approximation - Fitting straight line & parabola, Numerical Integration - Trapezoidal, Simpson's rule & Gauss quadrature Method. Solution of simultaneous linear algebraic equations – Gauss elimination method. Solution of Partial differential Equation - Finite Difference Method	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE308	TRANSPORTATION ENGINEERING - I	3-0-0-3	2016

Pre-requisite : NIL

Course objectives:

- To introduce the principles and practice of Highway Engineering and Airport Engineering.
- To enable students to have a strong analytical and practical knowledge of geometric design of highways.
- To introduce pavement design concepts, material properties, construction methods and to design highway pavements.
- To understand the principles of traffic engineering and apply this for efficient management of transportation facilities.

Syllabus:

Classification and alignment of highways- Geometric design of highways- Properties and testing of pavement materials- CBR method of flexible pavement design- Construction and maintenance of pavements- Design of runways, taxiways and aprons.

Traffic characteristics- Traffic studies and analysis- Traffic control devices

Airport characteristics- Aircraft component parts- Site selection-Design of runways, taxiways and aprons- Terminal area planning- Airport marking and lighting

Expected Outcomes:

The students will be able to

i. Design various geometric elements of a highway
ii. Determine the characteristics of pavement materials and design flexible pavements
iii. Conduct traffic engineering studies and analyze data for efficient management of roadway facilities, Plan and design basic airport facilities

Text Books :

1. Khanna, S.K. & Justo E.G., Highway Engineering, Nem Chand & Bros., 2000
2. Kadiyali, L. R., Principles of Highway Engineering, Khanna Publishers, 2001
3. Khanna, S. K. & Arora. M. G., Airport Planning and Design, Nemchand& Bros.

References:

1. Horonjeff R. & McKelvy, F., Planning and Design of Airports, McGraw Hill, 5e, 2010
2. IRC: 37-2001, Guidelines for the Design of Flexible Pavements, IRC 2001, New Delhi
3. IRC:37-2012, Tentative Guidelines for the Design of Flexible Pavements
4. O' Flaherty, C.A (Ed.)., Transport Planning and Traffic Engineering, Elsevier, 1997
5. Rangwala, S. C. , Airport Engg. Charotar Publishing Co., 16e, 2016
6. Yoder, E. J & Witezak, M. W, Principles of Pavement Design, John Wiley & Sons, 1991

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %

I	Introduction to Transportation Engineering, Classification of roads, Typical cross sections of roads in urban and rural area, Requirements and factors controlling alignment of roads, Engineering surveys for highway location- Introduction to geometric design of highways, Design controls and criteria, Design of highway cross section elements.	6	15
II	Sight distance, Stopping sight distance, Overtaking sight distance, Design of horizontal alignment and Vertical alignment	7	15
FIRST INTERNAL EXAMINATION			
III	Introduction to highway materials, design and construction, Desirable properties and testing of road aggregates, bituminous materials and sub grade soil. Flexible and rigid pavements, Factors influencing the design of pavements, CBR method and IRC guidelines for flexible pavements	7	15
IV	Introduction to performance grading and superpave, Construction of bituminous pavements, Types and causes of failures in flexible and rigid pavements, Highway drainage. Introduction to Traffic Engineering, Traffic characteristics, Traffic studies and their applications.	6	15
SECOND INTERNAL EXAMINATION			
V	Types of road intersections, Traffic control devices, Traffic signs, Road markings and Traffic signals, Design of isolated signals by Webster's method. Introduction to Airport Engineering, Aircraft characteristics and their influence on planning of airports, Components of airport, Selection of site for airport	8	20
VI	Runway orientation, basic runway length and corrections required, Geometric design of runways, Design of taxiways and aprons, Terminal area planning, Airport markings, Lighting of runway approaches, taxiways and aprons, Air traffic control	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE332	TRANSPORTATION ENGINEERING LAB	0-0-3-1	2016

Pre-requisite : CE308 Transportation Engineering - I

Course objectives:

- To enable the students to conduct different tests to find various properties of aggregates, bitumen and soil subgrade and hence to assess their suitability in pavement construction.

List of Experiments (All experiments shall be conducted as per BIS/ASTM/AASHTO procedures)

I. Tests on aggregates

1. Aggregate crushing value
2. Aggregate impact value
3. Los Angeles abrasion value
4. Shape tests-Flakiness index and Elongation index
5. Angularity of course aggregates and fine aggregates
6. Specific gravity and water absorption of course aggregate
7. Stripping value of road aggregates
8. *Dry Packing characteristics of aggregates (ASTM C29/ C29 M – 97)*

II. Test on soil

1. California Bearing Ratio test (*Soaked and Un-soaked CBR*)
2. *Dynamic cone penetration test (ASTM D6951 (2015) procedure)*

III. Tests on bitumen

1. Penetration value of bitumen
2. Softening point of bitumen
3. Ductility of bitumen
4. Flash and Fire point of bitumen
5. *Measurement of mixing and compaction temperature of bitumen (Brookfield viscometer) (The test was previously written in the draft syllabus as Viscosity test on bitumen, but we have specified it)*

IV.Test on bituminous mixes

1. *Determination of theoretical specific gravity of loose mix and bulk specific gravity of*

compacted mix (ASTM D2041, ASTM D1188)

2. *Moisture sensitivity test of bituminous mixes (AASHTO T283 procedure)*

V. Functional evaluation of pavements

1. *Use of MERLIN apparatus to determine road roughness*

Expected outcome:

- The students will be able to assess the quality of various pavement materials and their suitability in highway construction.

Reference books :

1. L .R. Kadiyali, Principles and Practices of Highway Engineering, Khanna Publishers, 2009
2. MoRTH (2013) Specification for Road and bridge works (5th revision)
3. MS-2 manual (2015) Seventh edition, Asphalt Institute.
4. S. K. Khanna, C. E. G. Justo, A Veeraragavan, Highway Engineering, Khanna Publishers, 10e.

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE334	COMPUTER AIDED CIVIL ENGINEERING LAB	0-0-3-1	2016

Prerequisite : CE231 Civil Engineering Drafting Lab

Course objectives:

1. To introduce the fundamentals of Civil Engineering drafting and drawing.
2. To familiarize with the FEA software packages for analysis and Design of structures
3. To understand the Total Station data transfer and interpretation.
4. To enable the usage of Project Management Software

List of Experiments :

1. Structural Drawings for
   a) Slabs and Beams
      i. One Way / Two way Slab/Continuous Slabs
      ii. Singly reinforced /Double reinforced Beams
      iii. Continuous / Flanged Beams
   b) Stair Case (Doglegged and Tread and Riser Type)
   c) Foundations (Isolated and Combined Rectangular)

II Analysis and design of steel and RCC elements using STAAD/SAP 2000/ ETABS/any FEM software package.

a) Continuous and Cantilever beams
b) Plane truss and Frames

III Use of Project Management Software (MS Project/Primavera)

a) Preparation of Bar Chart/Gantt Charts/CPM/PERT Charts and finding Critical Path
b) Practice on Resource allocation (and Project Monitoring(Cost and Time)

IV. Conduct of Survey camp using Total Station (minimum 3 days duration) and its plotting.

Expected Outcomes:

- The students are expected to accomplish the abilities/skills for the use of Civil Engineering Drafting/Analysis, Design and Project Management Software.

Text Books / References:

1. N Krishna Raju, Structural Design and Drawing, Second Edition, Universities Press (India), Private Limited, Hyderabad, 2009
2. Reference Manual of the Relevant Software
3. Satheesh Gopi, Dr. R Sathikumar, N Madhu, Advanced Surveying: Total Station, GIS and Remote Sensing, Pearson Education India, 2006
4. AutoCAD Essentials, Autodesk official Press, John Wiley & Sons, US, 2015

Note:

(1) Evaluation of drawing, along with a viva, to be done at the end of every class.

(2) A survey camp of minimum 3 days duration using total station is to be conducted in the semester, and is compulsory

(3) Evaluation Criteria :

Best 8 plate/Exercises - 40 marks
Survey Camp - 30 marks
.End semester examination - 30 marks

TOTAL - 100 marks

Course code	Course Name	L-T-P-Credits	Year of Introduction
CE336	STRENGTH OF MATERIALS LAB	0-0-3-1	2016

Prerequisite : SB201 Mechanics of solids

Course Objectives:

- To study various types of failures occurring in service life of ductile metals.
- Provide an environment to enable students to correlate theoretical knowledge gained in the class room with the physical world.
- To study the properties of various materials under various working conditions.

List of Exercises/ Experiments (Minimum 12 Mandatory)

1. Tests on Open Coiled Spring
   Equipment: Spring Testing Machine, Vernier Calliper.
2. Tests on Closed Coiled Spring
   Equipment: Spring Testing Machine, Vernier Calliper.
3. Bending Test on Wooden Beams Using U. T. M.
   Equipment: Universal Testing Machine, Deflection Gauges, Measuring Tape.
4. Verification of Clerk Maxwell's Law of Reciprocal Deflection and Determination of Young's Modulus 'E' for Steel.
   Equipment: Apparatus for verification of Clerk Maxwell's Law of Reciprocal Theorem, Deflection gauges, Weights, Scale, Vernier Calliper.
5. Torsion Pendulum Test for M.S. wires.
   Equipment: Torsion Pendulum, Cylindrical Weights, Stop Watch.
6. Torsion Pendulum Test for Aluminium Wires.
   Equipment: Torsion Pendulum, Cylindrical Weights, Stop Watch.
7. Torsion Pendulum Test for Brass Wires.
   Equipment: Torsion Pendulum, Cylindrical Weights, Stop Watch.
8. Tension Test Using U. T. M. on M. S. Rod.
   Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.
9. Tension Test Using U. T. M. on Torsteel rod
   Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.
10. Tension Test Using U. T. M. on High Tensile Steel rod.
    Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.
11. Compression test on concrete specimen.
    Equipment: Compression Testing Machine.
12. Compression test on brick.
    Equipment: Compression Testing Machine.
13. Torsion Test on M. S. Rod.
    Equipment: Torsion Testing Machine, Vernier Caliper.
14. Shear Test on M.S. Rod.
    Equipment: Universal Testing Machine, Deflection gauges, Measuring Tape, Vernier Caliper.
15. Impact Test Using Izod Apparatus and Charpy.
    Equipment: Charpy/ Izod Impact Testing Machine.
16. Impact Test Using Charpy Apparatus
    Equipment: Charpy/ Izod Impact Testing Machine.

17. Hardness Test using Brinell Hardness Apparatus
    Equipment: *Brinell Hardness Testing Machine.*
18. Strut Test.
    Equipment: *Strut Testing Machine, Vernier Calliper.*

Course Outcome:

Upon successful completion of the course, the student will be:

i. Familiar with the arrangement and conduct of experiments in the Material Testing laboratory environment.
ii. Able to note down relevant readings and perform calculations while an experiment is in progress thereby correlating theoretical concepts of materials and their practical implications..
iii. Able to comprehend the factors responsible for variation between theoretical and experimental results pertaining to the domain of Material Science.

Text books:

1. R.K. Bansal; Strength of Materials; Laxmi Publications.
2. Wonsiri Punurai; Mechanics of Materials-Laboratory and Experiments; LAP LAMBERT Academic Publishing.

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE362	GROUND IMPROVEMENT TECHNIQUES	3-0-0-3	2016

Pre-requisite :CE305 Geotechnical Engineering - II

Course objectives:

- To impart fundamental knowledge of Ground Improvement Techniques
- To make capable of choosing and designing the appropriate method of Ground Improvement according to site conditions and requirement

Syllabus :

Classification of Ground Modification Techniques- Soil distribution in India- Reclaimed soils- Ground Improvement Potential- Grouting – Aspects – Groutability, Grouting materials, Suspension grouts and solution grouts, Compaction grouting. Procedure and applications of grouting- Chemical stabilization – Granular admixtures, Cement, Lime, Calcium Chloride, Fly Ash, Bitumen, Chemical admixtures. Construction Methods-Ground Anchors – Applications, types and components, Anchor tests. Rock bolts – Applications and types- Rock bolt action around an excavation. Soil Nailing – construction sequence – analysis of nailed soil-Compaction- Moisture Density relationship. Shallow surface compaction-Rollers – operational aspects. Deep Compaction – Explosion- heavy tamping- vibro compaction and vibro replacement. Properties of compacted soil, Compaction control tests- Hydraulic modification- Methods of dewatering- open sumps and ditches, Well point systems, deep well drainage, Vacuum dewatering, Electro osmosis. Design of dewatering for excavations

Expected Outcomes:

i. An understanding about types of ground improvement techniques and soil distribution in India
ii. Knowledge about various types of grouts and their applications
iii. Knowledge about types of chemical stabilization and their construction method
iv. Understanding about Ground Anchors, Rock Bolts and Soil Nailing
v. Knowledge about Compaction of soil
vi. Understanding about various methods of dewatering of soil

Text Books / References:

1. Manfred. R. Hausmann, Engineering Principles of Ground Modification, McGraw Hill, 1989
2. P. Purushothamaraj, Ground Improvement Techniques ,University Science Press, 2005

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction to Engineering Ground Modification- Classification of Ground Modification Techniques- Soil distribution in India- Reclaimed soils- Ground Improvement Potential.	6	15

II	Grouting – Aspects – Groutability, Grouting materials, Suspension grouts and solution grouts, Compaction grouting. Procedure and applications of grouting.	6	15
FIRST INTERNAL EXAMINATION			
III	Chemical stabilization – Granular admixtures, Cement, Lime, Calcium Chloride, Fly Ash, Bitumen, Chemical admixtures. Construction Methods.	6	15
IV	Ground Anchors – Applications, types and components, Anchor tests. Rock bolts – Applications and types- Rock bolt action around an excavation. Soil Nailing – construction sequence – analysis of nailed soil	7	15
SECOND INTERNAL EXAMINATION			
V	Compaction- Moisture Density relationship. Shallow surface compaction-Rollers – operational aspects. Deep Compaction – Explosion- heavy tamping- vibro-compaction and vibro-replacement. Properties of compacted soil, Compaction control tests.	9	20
VI	Hydraulic modification- Methods of dewatering- open sumps and ditches, Well point systems, deep well drainage, Vacuum dewatering, Electro osmosis. Design of dewatering for excavations.	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE364	ADVANCED FOUNDATION ENGINEERING	3-0-0-3	2016

Prerequisite: CE305 Geotechnical Engineering - II

Course objectives:

- To impart to the students, the advanced topics in foundation engineering
- To enable the students to acquire proper knowledge about the design and analysis in real life situations.

Syllabus :

Advanced topics in shallow foundations- bearing capacity, settlement and allowable bearing pressure. Allowable bearing pressure from penetration test data. Consolidation settlement of footings. Raft foundations and combined footings. Problems of excavations. Deep foundations – need. Types. Classification of piles. static equation – Single piles -– Critical depth concept. Pile capacity in clay and sand by the I.S. code method . Piles in layered soils. Piles with enlarged base in clays (under reamed piles). Pile capacity from SPT and CPT values. Piles for resisting uplift – straight shaft and under reamed piles in clays and sands – Dynamic formulae . Different types of pile load tests. ultimate load from pile load tests. Pile groups –Negative skin friction of single piles and pile groups – Settlement of pile groups in clays and sands –Equivalent raft approach –- Skempton's and Meyerhof's methods- Drilled piers with enlarged base. Well foundations

Expected Outcomes:

i. The students will be equipped to design foundations for field situations.
ii. The students will gain **d**etailed knowledge of shallow foundations and deep foundations.

Text Books:

1. Murthy, V.N. S. Advanced Foundation Engineering, CBS Publishers, New Delhi, 2007
2. Ranjan G. and A. S. R. Rao, Basic and Applied Soil Mechanics, New Age International, 2002.

References:

1. Gulhati, S. K. and Datta, M. Geotechnical Engineering, Tata McGraw Hill Education, 2005
2. Tomlinson, M. J. and Booman, R. Foundation Design and Construction, Prentice Hall Publishing, 2001.
3. Tomlinson, M. J. and Woodwrd, J. Pile Design and Construction Practice. CRS Press, 2015.
4. Kurien, N. P. Design of foundation systems: principles and practices. Alpha Science International, 2005

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Shallow foundations- estimating bearing capacity- Meyerhof's, Hansen's and I.S code methods- Effect of water table, eccentricity, and inclination of load on Bearing Capacity – Numerical problems using IS method Elastic settlement –Effect of size of footing on settlement. Steinbrenner's method of calculating settlement– Numerical problems.	7	15

II	Allowable bearing pressure from penetration test data – Meyerhoff's and Teng's expressions. Consolidation settlement of footings - Combined footings and raft foundations (only concepts)– brief discussions on methods of analysis of raft, concept of floating raft, excavations.	6	15
FIRST INTERNAL EXAMINATION			
III	Deep foundations –need. Types. Classification of piles. static equation – Single piles -– Critical depth concept. Pile capacity in clay and sand by the I.S. code method . Piles in layered soils. Piles with enlarged base in clays (under reamed piles). Problems. Pile capacity from SPT and CPT values. problems	6	15
IV	Piles for resisting uplift – straight shaft and under reamed piles in clays and sands – Dynamic formulae – Engineering News formula – Modified Hiley formula – Different types of pile load tests –initial and routine tests maintained load test, CRP test, pullout test, lateral load test and cyclic pile load test. Separation of skin friction and end bearing. – ultimate load from pile load tests.	7	15
SECOND INTERNAL EXAMINATION			
V	Pile groups – Efficiency of pile groups- Group capacity in clays– Minimum spacing of piles in a group – Negative skin friction of single piles and pile groups –Settlement of pile groups in clays – Equivalent raft approach – Settlement of pile groups in sands - Skempton's and Meyerhof's methods- Drilled piers with enlarged base.	8	20
VI	Well foundations– Components of a well foundation–Procedure for construction and sinking of wells–Thickness of well steining for sinking under self weight - Grip length- Problems encountered in well sinking–Tilts and Shifts– Causes – Permissible tilts and shifts - Methods to rectify tilts and shifts – Forces acting on a well foundation –Allowable bearing pressure – Lateral stability of well foundations - Terzaghi's analysis	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE366	TRAFFIC ENGINEERING AND MANAGEMENT	3-0-0-3	2016

Pre-requisite: NIL

Course objectives:

- To set a solid and firm foundation in traffic engineering management, traffic regulation, highway capacity, design of introduction and traffic flow theory concepts.

Syllabus:

Scope and objective of traffic engineering and management, Traffic regulation rules, Highway capacity and introduction to 2010 manual, Design of at grade, grade separated, rotary and signals, traffic safety , influencing factors and preventive measures for traffic accidents, basic diagrams of traffic flow theory, introduction to car following and queuing.

Expected Outcomes:

- This course will enable students to learn advanced topics in traffic engineering and management

Text Books:

1. Kadiyali L.R. Traffic Engineering and Transport planning, Khanna Tech Publishers, 2011
2. Khanna O.P and Justo C.G; Highway Engineering, Nem Chand Publishers, 9e.
3. Donald Drew, Traffic Flow Theory Chapter 14 in Differential Equation Models, Springer, 1983

References:

1. Martin Whol, Brian V Martin , Traffic system Analysis for Engineers and Planners, McGraw Hill, NY, 1967
2. HCM 2010 (3 volume set), TRB Publications, 2010

Module	Contents	Hours	Sem. Exam Marks %
I	Traffic management – scope of traffic management measures – restrictions to turning movements – one way streets – tidal flow operations-Traffic segregation –Traffic calming- Exclusive bus lanes, Introduction to ITS	7	15
II	Regulation of traffic – Need and scope of traffic regulations- Motor Vehicle Act – Speed limit at different locations- regulation of the vehicle – regulations concerning the driver rules of the road enforcement	7	15
FIRST INTERNAL EXAMINATION			

III	Highway capacity: Its importance in transportation studies – basic, possible and practical capacity – determination of theoretical maximum capacity -passenger car units – level of service – concept in HC manual – factors affecting level of service.	**7**	**15**
IV	Design of Intersection: Design of at grade & grade separated intersection – rotary intersection – capacity of rotary intersection – traffic signals – warrants of traffic signals,-types of signals, signal coordination, design of fixed time signal –Websters approach	**7**	**15**
SECOND INTERNAL EXAMINATION			
V	Traffic Safety: causes of road accidents – collection of accident data – influence of road, the vehicle .the driver, the weather and other factors on road accident – preventive measures	**7**	**20**
VI	Traffic Flow: theory of traffic flow – scope – definition and basic diagrams of traffic flow- basic concepts of light hill – Whitham's theory – Introduction to Car 'following theory and queuing'	**7**	**20**
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE368	PRESTRESSED CONCRETE	3-0-0-3	2016

Pre-requisite: CE201Mechanics of Solids

Course objectives:

- To make students familiar with the concepts and design of typical pre-stressed concrete structural elements and to have a knowledge of the codal provisions

Syllabus :

Basic concept and principles of pre-stressed concrete systems- analysis for flexure- loss of pre-stress, Design philosophy and design for flexure, codal provisions , Shear and torsional behavior – analysis and design - calculation of deflection (short & long term), Anchorage Zone stresses in post tensioned members, Prestressed concrete poles and sleepers, Partial pre-stressing, composite beams – analysis and design, Statically indeterminate structures

Expected Outcomes:

The students will be able to

i. analyse prestressed concrete members
ii. design prestressed concrete members using codal provisions
iii. design for shear and torsion of prestressed concrete members
iv. design end blocks and provide detailing of reinforcements
v. design composite members and other applications
vi. design continuous members

Text Books :

1. G S Pandit & S P Gupta, " Prestressed Concrete", CBS Publishers,2014
2. Krishna Raju N., Prestressed concrete, Tata McGraw Hill Company, New Delhi 1998
3. Rajagopalan, N, "Prestressed Concrete", Alpha Science, 2002

References:

1. Lin T.Y. Design of prestressed concrete structures, Asia Publishing House, Bombay 1995
2. Mallic S.K. and Gupta A.P., Prestressed concrete, Oxford and IBH publishing Co. Pvt. Ltd., 1997
3. Ramaswamy G.S., Modern prestressed concrete design, Arnold Heinimen, New Delhi, 1990
4. IS 1343 – 1998 ISCode Bureau of Indian Standards

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Review- Basic concept and principles of pre-stressed concrete, materials, prestressing systems – Analysis of prestress and bending stresses loss of pre-stress Stresses at transfer and service loads.	6	15

II	Limit state design criteria: Inadequacy of elastic and ultimate load method, criteria for limit states, strength and serviceability. Design of sections for flexure codal provisions- ultimate strength in flexure	6	15
FIRST INTERNAL EXAMINATION			
III	Shear and torsional resistance: design of shear reinforcement, design of reinforcement for torsion, shear and bending.	7	15
IV	Deflections of prestressed concrete members: Importance, factors, short term and long term deflection. Codal provisions	7	15
SECOND INTERNAL EXAMINATION			
V	Anchorage Zone stresses in post tensioned members: Stress distribution in end block, anchorage zone reinforcement. Prestressed concrete poles and sleepers: Design of sections for compression and bending Partial pre-stressing- Definitions, principles and design approaches and applications	8	20
VI	Composite beams –Analysis and design – Ultimate strength – applications, Elementary idea of composite construction for tee beams in bridges. Statically Indeterminate structures: advantages of continuous member(Concepts and steps for analysis)-	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE372	ENGINEERING HYDROLOGY	3-0-0-3	2016

Pre-requisite : CE309 : Water Resources Engineering

Course objectives:

- To have a good understanding of all the components of hydrologic cycle
- To understand the mechanics of rainfall, its spatial and temporal distribution.
- To understand the fitting of probability distribution and statistical analysis of rainfall and Runoff.

Syllabus :

Basic concept of Hydrology and Hydrologic cycle - Test for consistency of rainfall records - Analysis of rainfall data - Hydrologic abstractions-infiltration-Evapotranspiration - methods of estimation-catchment characteristic-stream gauging - stage-discharge curve - its extension and adjustment. Computation of runoff- Rainfall- runoff correlation using linear regression techniques- Partial differential equation governing unsteady groundwater flow- Evaluation of aquifer parameters- Well flow near aquifer boundaries - Method of images - surface investigation of groundwater- Graphical representation of hydrochemical data- Pollution of ground water, sources, Seawater intrusion, Artificial recharge of groundwater- Design flood –Estimation of design flood- Flood frequency studies-Gumbel's method- Flood routing through reservoirs and Channel routing- Flood control methods, Flood forecasting and warning.

Expected Outcomes:

The students will be able to

1. understand the procedure, applicability and limitations of various methods of geotechnical investigation;
2. make proper engineering judgments and take appropriate decisions related to geotechnical investigations.

Text Books:

1. Deodhar.M.J., Elementary Engineering Hydrology, Pearson, 2009
2. Ojha, C.S.P, R. Berndtsson, P.Bhunya, Engineering Hydrology, Oxford University Press, 2015.
3. Reghunath. H M, Hydrology, New Age International Publications, 1987.
4. Subramanya. K, Engineering Hydrology, Tata McGraw Hill, 1984

References:

1. Garg S. K. Hydrology and Water Resources Engineering, Khanna Publishers, 2005
2. Ghanshyam Das, Hydrology and soil conservation Engineering, Prentice-hall of India, 2004.
3. Jayarami Reddy P, A Text Book of Hydrology, Laxmi Publications, 2005.
4. Maidment D.R., Hand book of Hydrology, Mc Graw Hill, 1993
5. Todd D. K., Ground Water Hydrology, Wiley, 2005
6. Ven Te Chow, David R Maidment, L. W. Mays, Applied Hydrology, McGraw Hill, 1988
7. Warren Viessman, Gary L Lewis, Introduction to Hydrology, Pearson, 2015.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %

I	Basic concept of Hydrology and Hydrologic cycle -Test for consistency of rainfall records - Analysis of rainfall data - correlation between intensity and duration – intensity, duration and frequency - depth area duration (DAD) curve. Hydrologic abstractions- infiltration- - Green Ampt method-Evapotranspiration – different methods - Blaney Criddle method - penman method.	7	15
II	Catchment characteristics - classification of streams - stream pattern-stream order – stream gauging – rating of current meter - Extension of stage discharge curve - Adjustment of stage discharge curve-selection of site for stream gauging stations.	6	15
FIRST INTERNAL EXAMINATION			
III	Runoff - Computation of runoff– Hydrograph analysis-Rational method –- S-hydrograph - unit hydrograph from complex storm - synthetic unit hydrograph- Instantaneous unit hydrograph (Brief description only) – linear reservoir model.	7	15
IV	Partial differential equation governing unsteady groundwater flow- Evaluation of aquifer parameters - Theis method -Jacob's approximation method. Well flow near aquifer boundaries - Method of images - surface investigation of groundwater - Electrical resistivity method. Graphical representation of hydrochemical data - Pollution of groundwater, sources. Seawater intrusion- Ghyben-Herzberg relationship –Method of control of seawater intrusion- Artificial recharge of groundwater.	6	15
SECOND INTERNAL EXAMINATION			
V	Rainfall- runoff correlation using linear regression and multiple linear regression analysis. Design flood and their Estimation - Different methods - Flood frequency studies -Gumbel's method.	8	20
VI	Flood routing through reservoirs - ISD method- Modified Pulse method. Flood routing through channels by Muskingum method. Flood control methods - Flood forecasting and warning (Brief descriptions only)	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE374	AIR QUALITY MANAGEMENT	3-0-0-3	2016

Pre-requisites: Nil

Course objectives:

- To understand the various forms of air pollutants and their effects on human and environment
- To know the various methods of controlling air pollutants

Syllabus : Air pollution-sources, effects on human, vegetation, environment, air pollutants. Indoor pollution. Meteorology, factors affecting dispersion of pollutants, Plume behaviour. Modelling of air pollutants, Dispersion modelling. Monitoring of pollutants-Particulate and gaseous, Control of air pollutants-Methods for particulate and gaseous pollutants, Air quality legislations

Course Outcomes:

- Create an awareness among students regarding air pollution problems
- To understand the various techniques that can be adopted for managing air pollution related problems.

Text Books

1. C.S.Rao, "Environmental Pollution Control Engineering", New Age International Pub., 2006
2. M.N. Rao & H.V.N Rao ,Air Pollution, Tata McGraw Hill Co. Ltd, Delhi, 1990.
3. Peavy H S, Rowe, D.R. Tchobanaglous "Environmental Engineering" McGraw Hill Education, 1985

References:

1. Chhatwal G.R, Encyclopedia of Environmental Pollution and Control, Volumes 1,2,3, Anmol Publications, 1996
2. J. R. Mudakavi, Principles and Practices of Air Pollution Control and Analysis, IK International Pvt Ltd, 2012
3. Perkins H.C, "Air Pollution" McGraw Hill Publications, 2004
4. S C Bhatia, Textbook of Air Pollution and Its Control , Atlantic publishers, 2007
5. S P Mahajan, Air Pollution Control, Common Wealth of Learning, Canada, Indian Institute of Science, Bangalore, 2006
6. Stern.A, "Air Pollution" (Volume I ,II & III) ,Academic Press New York, 1962

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction- Components of Environment- Definition –Air Pollution- History of air pollution episodes-Various Sources of Air pollution – Air Pollutants- Types of Air Pollutants	6	15
II	Effect of air pollutants on health, vegetation, animals and materials and environment, Green house effect - Indoor Air Pollution, sources of indoor air pollutants	6	15

FIRST INTERNAL EXAMINATION			
III	Meteorological aspects of Air Pollutant Dispersion - Temperature and Pressure relationships-Atmospheric Stability- Temperature Lapse Rate- Inversions- Types, Plume behavior	7	15
IV	Dispersion of Air pollutants-Plume dispersion theory- Gaussian plume model (Derivation not required)- Assumptions-Advantages and Disadvantages- Pasquill's stability curves , Dispersion problems involving point source and line source - Estimation of plume rise.	7	15
SECOND INTERNAL EXAMINATION			
V	Air Quality monitoring - Ambient air sampling - Collection of gaseous air pollutants-Collection of particulate Pollutants- Ambient Air Quality standards	8	20
VI	Control of Air Pollutants- Particulate emission control-methods, Scrubbing-Cyclones- Filtration- Electrostatic Precipitation-Gaseous emission control- adsorption, absorption, thermal methods	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2 Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE401	DESIGN OF STEEL STRUCTURES	4-0-0-4	2016

Prerequisite : CE202 Structural Analysis II

Course objectives:

- To introduce the limit state design of steel structural components subjected to bending, compression and tensile loads including the connections
- To enable design of structural components using timber

Syllabus:

Steel and steel structures – bolted and welded connections- tension members – compression members – beams – roof trusses – purlins – timber structures – columns- composite beams

Expected Outcomes:

The students will be able to

i. design bolted and welded connections
ii. design tension members and beams using the IS specifications
iii. design columns under axial loads using IS specifications
iv. design beams and plate girders
v. assess loads on truss and design purlins
vi. design structural components using timber.

Text Books:

1. L S Jayagopal, D Tensing., Design of steel structures, S Chand & Company, 2015
2. S K Duggal., Limit State design of steel structures, Tata McGraw Hill, 2010
3. Subramanian N, Design of steel Structures, Oxford University Press, 2011

References :

1. P. Dayaratnam., Design of Steel Structures ,Wheeler Publishing, 2003
2. Punmia B. C., Jain A. K. and Jain A. K., Design of Steel Structures, Laxmi Publications (P) Ltd, 2017
3. Raghupathi, Steel Structures, Tata McGraw Hill, 2006
4. Ramchandra S and Virendra Gehlot, Design of Steel Structures Vol. II, Standard Book House, 2007
5. V L Shah & Veena Gore, Limit State Design of steel Structures , Structures Publications, 2009
6. William T Segui., Steel Design , Cenage Learning, 6e, 2017
7. IS 800 – 2007, Code of practice for Structural steel design, BIS

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction to steel and steel structures, properties of steel, structural steel sections. Introduction to design: Design loads and load combinations, limit state design concepts. Connections bolted and welded (direct loads)	9	15

II	Tension members-Types of sections – net area- design of tension members- concept of shear lag-use of lug angle-connections in tension members	9	15
FIRST INTERNAL EXAMINATION			
III	Compression members- design of struts- solid and built up columns for axial loads-- design of lacings and battens-column bases- slab base – gusseted base	10	15
IV	Design of beams- laterally restrained and unrestrained – simple and compound beams- plate girders subjected to uniformly distributed loads – design of stiffeners.	9	15
SECOND INTERNAL EXAMINATION			
V	Design of roof trusses- types-design loads and load combinations-assessment of wind loads- design of purlins. Moment resistant/Eccentric connections (in plane and out of plane)	10	20
VI	Design of timber structures: types of timber - classification - allowable stresses-design of beams-flexure, shear, bearing and deflection considerations-Design of columns. Design of composite beam sections with timber and steel.	9	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks : 100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1. Each part should have at least one question from each module

2 .Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE403	STRUCTURL ANALYSIS - III	3-0-0-3	2016

Prerequisite :CE303 Structural Analysis - II

Course objectives:

- To enable the students to have a comprehensive idea of matrix structural analysis with emphasis on the relative advantages of the flexibility method and the stiffness method
- To enable the students to visualize structural dynamics problems with a proper blend of structural analysis and vibration theory

Syllabus :

Approximate Methods of Analysis of Multistoried Frames, Matrix analysis of structures, Flexibility method, Stiffness method, Introduction to direct stiffness method, Structural dynamics

Expected Outcomes:

The students will be able to

i. analyse structures using approximate method
ii. analyse trusses, continuous beams and rigid frames using flexibility method
iii. analyse trusses, continuous beams and rigid frames by stiffness method
iv. conceive Finite element procedures by direct stiffness method
v. use the basics of structural dynamics and analyse the response of SDOF systems

Text Books :

1. G S Pandit and S P Gupta, Structural analysis a Matrix approach, McGraw Hill Education (India), 2e, 2008
2. Gere, J.M. and William Weaver, Matrix Analysis of framed structures, CBS Publishers, 1990
3. Kenneth M Leet, Chia Ming Uang, Anne M Gilbert, Fundamentals of structural analysis, Tata McGraw Hill Pvt Ltd., 4e, 2010
4. Reddy C.S., Basic structural analysis, Tata McGraw Hill, third edition, 3e, 2012

References :

1. Anil. K. Chopra, Dynamics of structures, Pearson Education/ Prentice Hall India, 5e, 2016
2. Clough R.W. and Penzein, J., Dynamics of structures, Tata McGraw Hill, 1995
3. Madhujith Mukhopadhyay and Abdul Hamid Sheikh, Matrix and Finite Element Analysis of Structures, Ane Books India, 2009
4. Mario Paz , Structural Dynamics: Theory & Computation, 2e, CBS Publishers, 2004
5. Rajasekharan. S. and Sankarasubramanian G., Computational structural Mechanics, PHI, 2009
6. Wang C.K., Matrix method of structural analysis, International Text book company, 1970

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Approximate Methods of Analysis of Multistoried Frames: Analysis for vertical loads-substitute frames-loading condition for maximum hogging and sagging moments in beams and maximum bending moment in columns- wind load analysis of multistoried frames – portal method and cantilever method for lateral load analysis.	6	15

II	Matrix analysis of structures: static and kinematic indeterminacy-force and displacement method of analysis-definition of flexibility and stiffness influence coefficients Concepts of physical approach	6	15
FIRST INTERNAL EXAMINATION			
III	Flexibility method: flexibility matrices for truss and frame elements-load transformation matrix-development of total flexibility matrix of the structure-analysis of simple structures-plane truss and plane frame-nodal loads and element loads-lack of fit and temperature effects	7	15
IV	Stiffness method: Development of stiffness matrices by physical approach-stiffness matrices for truss and frame elements-displacement transformation matrix-analysis of simple structures-plane truss and plane frame-nodal loads and element loads-lack of fit and temperature effects	7	15
SECOND INTERNAL EXAMINATION			
V	Introduction to direct stiffness method-Rotation of axes in two dimensions, stiffness matrix of elements in global co- ordinates from element co-ordinates- assembly of load vector and stiffness matrix, solution of two span continuous beam-single bay single storey portal frame.	8	20
VI	Structural dynamics-introduction-degrees of freedom-single degree of freedom subjected to harmonic load -linear systems- equation of motion, D'Alembert's principle-damping- free response of damped and undamped systems- logarithmic decrement- transient and steady state responses, Dynamic magnification factor – Vibration isolation –Concept of two degree of freedom systems (No derivation and numerical problems)	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2. Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE405	ENVIRONMENTAL ENGINEERING- I	3-0-0-3	2016

Pre-requisites: CE203 Fluid Mechanics -I

Course objectives:`

- To study the significance of water resources and the factors affecting the quality and quantity of water
- To study the various types of treatment techniques adopted for a public water supply system

Syllabus :

Water sources, demand, factors, Quantity estimation, Population forecasting, Quality of water. Water treatment- Physical methods, Chemical methods. Design of sedimentation tank, flocculator, clariflocculator, filters, Membrane treatment techniques. Disinfection- methods. Distribution of water, Pumps, Hardy Cross method of analysis

Expected Outcomes:

The students will

i. become aware of the various pollutants affecting water quality

ii. know about the different treatment units available in a water treatment plant and their design procedures

Text Books:

1. B.C Punmia, "Water Supply Engineering", Laxmi Publications Pvt. Ltd., 2016
2. G S Birdie, Water Supply and Engineering, Dhanapat Rai Publishing Company, 2014
3. P.N. Modi, "Water Supply Engineering", Standard Book House, NewDelhi
4. Peavy H S, Rowe, D.R. Tchobanaglous "Environmental Engineering" Mc GrawHill Education, 1984
5. S.K.Garg, "Water Supply Engineering", Khanna Publishers. 2010

References

1. K N Dugal, Elements of Environmental Engineering, S Chand and Company Pvt Ltd, 2007
2. Mackenzie L Davis, Introduction to Environmental Engineering, McGrawhill Education (India), 2012
3. Metcalf & Eddy , "Waste Water Engineering", Tata Mc Grawhill Publishing Co Ltd, 2003
4. P Venugopala Rao, Environmental Engineering, PHI Learning Pvt Ltd, 2002
5. Subhash Verma, Varinder Kanwar, Siby John, Water supply Engineering, Vikash Publishing, 2015

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction of environment- sources of water supply-Water demand, quantification of water demand through population forecasting – Factors affecting consumption-Fluctuations in demand	7	15

II	Types of intakes-Conveyors, pumps and location of pumping station-Quality of water - Drinking water standards - Physical, chemical and biological analysis.	6	15
FIRST INTERNAL EXAMINATION			
III	Treatment of water-Theory and principles of Sedimentation tanks-Stoke's law-Types of settling (Type I & Type II only)-Coagulation-Mixing-Flocculation, Design of Sedimentation tanks (circular and rectangular)-Clariflocculators	7	15
IV	Filtration-Types of filters- Working and Design of Rapid and Slow sand filters. Loss of head in filters, Pressure filters	7	15
SECOND INTERNAL EXAMINATION			
V	Disinfection of water - Methods, Chlorination-Types, Factors affecting - Chlorine demands. Miscellaneous treatment-Ion exchange, Lime-soda process, Electro dialysis - Colour, Taste and Odour removal-Adsorption-Aeration-Fluoridation-Defluoridation	7	20
VI	Lay out of water distribution network-Methods of distribution-Hardy cross method-Equivalent pipe method-Pipe appurtenances.	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note :

1. Each part should have at least one question from each module
2. Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE407	TRANSPORTATION ENGINEERING - II	3-0-0-3	2016

Prerequisite : CE308 Transportation Engg.-I

Course Objectives:

- To set a solid and firm foundation in Railway engineering, including the history development, modern trends, maintenance, geometric design and safety of railways.
- To introduce dock, harbour and tunneling

Syllabus :

Introduction to railways in India and its evolution, modern technologies, geometric design of tracks, railway operation control, maintenance and an introduction to the railway accidents. Alignment, surveying, driving, ventilation and drainage of tunnels and types of harbours and docks.

Course Outcome:

- This course will enable students to gain knowledge in railway and water transportation.

Text Books:

1. Mundrey J. S, Railway Track Engineering, Tata McGraw Hill, 2009
2. Rangawala, S.C. , Railway Engineering, Charotor Publishing House
3. Rao G. V, Principles of Transportation and Highway Engineering, Tata McGrawHill, 1996
4. Srinivasan,R., Harbour, Dock & Tunnel Engineering, Charotor Publishing House, 28e, 2016

References:

1. Bindra, S.P., A course in Docks and Harbour Engineering, Dhanpat Rai& Sons
2. Chandra, S. and Agarwal, M.M. ,Railway Engineering, Oxford University Press, New Delhi, 2008
3. Saxena, S. C and Arora, S. P, Railway Engineering, Dhanpat Rai& Sons, 7e, 2010
4. Subhash C. Saxena, Railway Engineering, Dhanpat Rai& Sons

Module	Contents	Hours	Sem. Exam Marks %
I	**Introduction to Railways in India**: Role of Indian Railways in National Development – Railways for Urban Transportation – Modern developments- LRT & MRTS, tube railways, high speed tracks. Alignment- basic requirements and factors affecting selection, Component parts of a railway track - requirements and functions - Typical cross-section	7	15
II	**Permanent Way**: Components and their Functions: Rails - Types of Rails, Rail Fastenings, Concept of Gauges, Coning of Wheels, Creeps and kinks . Sleepers – Functions, Materials, Density , Ballast less Tracks. Geometric design of railway track: Horizontal curves, radius – super	7	15

	elevation -cant deficiency - transition curves - gradients - different types - Compensation of gradients.		
FIRST INTERNAL EXAMINATION			
III	**Railway operation and control:** Points and Crossings – Design features of a turnout – Details of station yards and marshalling yards – Signaling, interlocking of signals and points - Principles of track circuiting - Control systems of train movements – ATC, CTC – track circuiting	**6**	**15**
IV	**Maintenance**:- Introduction to track maintenance, Items of track maintenance, packing and over hauling, screening **Railway accidents:** Human and system contribution to catastrophic accidents, Human Factors in Transport Safety.	**6**	**15**
SECOND INTERNAL EXAMINATION			
V	**Tunnel Engineering: Tunnel** - sections - classification - tunnel surveying -alignment, transferring centre, grade into tunnel – tunnel driving procedure - shield method of tunneling, compressed air method, tunnel boring machine, Tunnel lining, ventilation - lighting and drainage of tunnels.	**8**	**20**
VI	**Harbours**– classification, features, requirements, winds and waves in the location and design of harbours. **Break waters** - necessity and functions, classification, alignment, design principles, forces acting on break water – construction, general study of quays, piers, wharves, jetties, transit sheds and warehouses - navigational aids - light houses, signals - types - Moorings **Docks** – Functions and types - dry docks, wet docks – form and arrangement of basins and docks	**8**	**20**
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2 Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE409	QUANTITY SURVEYING AND VALUATION	3-0-0-3	2016

Pre-requisites: CE334 Computer Aided Civil Engg. Lab

Course objectives:

- To have an awareness regarding specifications, analysis of rates, valuation etc. in connection with construction
- To prepare detailed estimates, bar bending schedules of various items of work

Syllabus :

Specifications- Analysis of rates- CPWD data book and schedule of rates- Detailed specification, preparation of data and analysis of rates for various items of work- Quantity Surveying- Types of Estimate - Valuation- Methods of valuation-Depreciation- Fixation of rent- Detailed estimate including quantities, abstract and preparation of various items of works, Preparation of bar bending schedules for various RCC works

Expected Outcomes:

The students will be able to

i. work out the quantities of materials and labour required for different types of civil works
ii. prepare schedule of rates for various items of work

Text Books

1. B N Dutta, Estimating and costing in Civil Engineering, USB publishers and distributers Ltd. New Delhi
2. D D Kohli, RC Kohli, A textbook of Estimating and costing, S Chand Publishing, 2011
3. Dr. S. Seetharaman, M. Chinnasamy, Estimation and Quantity Surveying, Anuradha Publications , Chennai.

References:

1. BS Patil, Civil Engineering contracts and estimates, Universities press
2. V N Vazirani & S P Chandola, Civil engineering Estimating and Costing, Khanna Publishers.
3. IS 1200-1968; Methods of measurement of Building & Civil Engineering works.
4. CPWD data book and schedule of rates.

Note:

For analysis of rate and cost estimation, unit rate and labour requirement should be given along with the questions in the question paper.. No other charts, tables, codes are permitted in the Examination Hall. If necessary, relevant data shall be given along with the question paper.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	General Introduction- Quantity Surveying- Basic principles-Types of Estimates - Specifications- purposes and basic principles-general specifications - Detailed specifications-Method of measurement of various items of work. Analysis of rates- Introduction to the use of CPWD data book and schedule of rates- conveyance and conveyance statement -	6	10

	Miscellaneous charges.		
II	Preparation of data and analysis of rates for various items of work connected with building construction and other civil engineering structures with reference to Indian Standard Specification.	6	10
FIRST INTERNAL EXAMINATION			
III	Detailed estimate including quantities, abstract and preparation of various items of works- buildings- centerline method and long wall short wall method- sanitary and water supply works- soak pits, septic tanks, overhead tanks, culverts, Retaining walls, road construction. Bar-bending schedule-preparation of bar-bending schedule for RCC works connected with building construction, culverts and minor irrigation works.	18	50
SECOND INTERNAL EXAMINATION			
IV	Valuation - Explanation of terms, types of values, sinking fund, years purchase, Depreciation - Straight line method, constant percentage method, S.F method .Obsolescence. Valuation of real properties-rental method, profit based method, depreciation method. Valuation of landed properties -belting method, development method, hypothecated building scheme method. Rent calculation. Lease and Lease hold property	12	30
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks: 100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 10 marks each

Part B - Module III : 2 questions out of 3 questions carrying 25 marks each

Part C - Module IV : 2 questions out of 3 questions carrying 15 marks each

Note : 1. Part A should have at least one question from each module

2. Part B three full questions carrying 25 marks on building estimate, preparation of bending schedule, or estimation of any other structure.

3. Part A and C each question can have a maximum of 2 subdivisions (a, b)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE431	ENVIRONMENTAL ENGINEERING LAB	0-0-3-1	2016

Prerequisites: CE405 Environmental Engineering - I

Course objectives:

- To equip the students in doing analysis of water and wastewater samples

List of Experiments: (Minimu 10 experiments are mandatory)

1. To analyse the physical characteristics viz. colour, turbidity, and conductivity of a given water sample and to determine its suitability for drinking purposes
2. To analyse the chemical characteristics of a given water sample viz. pH, acidity, alkalinity for assessing its potability
3. To analyse the chemical characteristics of a given water sample viz. chlorides and sulphates content to assess its suitability for drinking purposes and building construction
4. To determine the Dissolved Oxygen content of a given water sample for checking its potability
5. To determine the available chlorine in a sample of bleaching powder
6. To analyse the various types of solids in a given water sample
7. To determine the BOD of a given wastewater sample
8. To determine the COD of a given wastewater sample
9. To determine the optimum dosage of alum using Jar test
10. To determine the Nitrates / Phosphates in a water sample
11. To determine the iron content of a water sample
12. To determine the MPN content in a water sample and assess the suitability for potability

Expected outcome:

- The students will be able to assess quality of water for various purposes

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE461	WAVE HYDRODYNAMICS AND CAOSTAL ENGINEERING	3-0-0-3	2016

Pre-requisite : CE206 : Fluid Mechanics II

Course objectives:

1. To introduce the fundamentals in ocean wave mechanics and coastal engineering.
2. To impart knowledge and comprehension over the basic aspects of wave hydrodynamics.
3. To equip the students with the state-of-the-art in coastal zone protection.

Syllabus :

Linear Wave Theory-Derivation for Velocity potential, Wave kinematics, Wave kinetics, Wave Power. Wave propagation in Shallow water region. Wave pressure, Wave forces-Morrison equation, Froude –Krylov force, Linear diffraction theory. Coastal process, Coastal protection works, Environmental parameters.

Expected Outcomes:

- The students will be able to develop skills and knowledge to solve the issues connected with ocean wave interaction with offshore and coastal features.

Text Book :

Dominic Reeve, Andrew Chadwick, Chris Fleming. Coastal Engineering : Processes, Theory and Design Practice, CRC Press, 2015

References:

1. Narashimhan, S.and S. Kathiroli(Ed.), Harbour and Coastal Engineering(Indian Scenario), -NIOT Chennai, 2002
2. US Army Corps of Engineers, Coastal Engineering Manual, 2002
3. US Army Corps of Engineers, Shore Protection Manual, Coastal Engineering Research Centre, Washington, 1984.
4. V.Sundar, Ocean wave Mechanics Applications in Marine Structures, Ane Book Pvt Ltd, New Delhi, 2016.
5. William Kamphuis ; Introduction to Coastal Engineering and Management, World Scientific, 2002.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	A brief overview on fundamental principles of fluid mechanics (No questions for examination). Characteristics of a regular ocean wave (Wave length, Wave period and wave celerity).Difference between regular and random waves, Linear Wave theory-Assumptions. Boundary Conditions-Kinematic free surface, Dynamic free	7	15

	surface. Separable solution of Laplace Equation for velocity potential. Dispersion equation derivation, Dispersion relationship in different water depth conditions (Shallow, intermediate and deep). Worked out exercises.		
II	Particle velocity and acceleration under wave transport. Particle Displacement. Orbital motion of water particles at different water depth. Derivation for potential energy and kinetic energy. Worked out exercises. Energy flux/Wave power, Derivation for group celerity.	7	15
FIRST INTERNAL EXAMINATION			
III	Wave propagation in shallow water- Wave shoaling –Derivation for shoaling coefficient- Worked out exercises. Wave refraction-analytical expression for refraction coefficient, Combined effect of shoaling and refraction-worked out exercises. Wave diffraction –its significance in harbor planning. Wave reflection-effect of surf similarity parameter. Wave breaking- in shallow water, Breaker types. Wave set up and set down, Wave run up.	6	15
IV	Pressure field under progressive wave, Pressure response factor, Dynamic pressure component. Wave force formulation, force regimes. Wave forces on slender circular members-Morrison Equation. Worked out exercises.	6	15
SECOND INTERNAL EXAMINATION			
V	Discussion on Wave Forces on large bodies, Froude –Krylov force-general theory. Diffraction theory-Linear diffraction problem-general theory and solution formulation. Wave forces on coastal structures-A brief overview on small amplitude wave theories – only at conceptual level. Wave force by Hirori Formula, Sainflou formula, Nagai Formula. Discussion only on Goda Formula.	8	20
VI	Introduction to beach and Coastal process-terms describing beach profile. Coastal erosion process-Natural and man made factors. Shallow water effects in coastal erosion. Long shore sediment transport and its effects on coastal process (only discussion). Near shore currents, cross shore sediment transport. Coastal protection (Only discussion, design is not expected)-important factors to be considered. Coastal protection methods-shore parallel and shore perpendicular structures, beach nourishment, Environmental parameters considered in design.	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE463	BRIDGE ENGINEERING	3-0-0-3	2016

Prerequisite: CE 301 Design of Concrete structures I

Course objectives:

- To impart knowledge on important types of bridge structures, their selection and planning, structural configurations, assessment of loads and perform design.

Syllabus :

General considerations for road bridges, Standard specifications for road bridges, Design of slab bridges and box culverts, T beam bridges, Prestressed concrete bridges, substructures, bearings, bridge foundations

Course Outcomes:

The students will be able to

i. use IRC standards and design the deck slab
ii. analyse, design and detail Box culverts for the given loading
iii. design and detail T-Beam bridges
iv. design and check the stability of piers and abutments
v. design bridge bearings
vi. detail bridge foundations and prepare the bar bending schedule

Text Books :

1. Jagadish T.R. & M.A. Jayaram, "Design of Bridge Structures",2nd Edition, 2009.
2. Johnson victor D, "Essentials of Bridge Engineering", 7th Edition, Oxford, IBH publishing Co.,Ltd, 2006
3. N.KrishnaRaju " Prestressed Concrete Bridges" CBS Publishers 2012

References:

1. Krishna Raju N., "Design of Bridges", 4th Edition, Oxford and IBH Publishing Co., Ltd., 2008
2. Ponnu Swamy, "Bridge Engineering", 4th Edition, McGraw-Hill Publication, 2008.
3. Swami Saran, "Analysis and Design of sub-structures",2nd Edition, Oxford IBH Publishing co ltd., 2006.
4. Vazirani, Ratvani & Aswani, "Design of Concrete Bridges",5th Edition, Khanna Publishers, 2006.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction :Definition and Basic Forms, Component of bridge, classification of bridge, short history of bridge development, Site selection-Soil Exploration for site Importance of Hydraulic factors in Bridge Design. General arrangement drawing.	6	15

II	Standard specification for Road bridges : Width of carriageway- Clearances- Loads to be considered- Dead load – I.R.C. standard live loads- Impact effect – Wind load –Longitudinal forces- Centrifugal forces- Horizontal forces due to water currents – Buoyancy effect- Earth pressure.	6	15
FIRST INTERNAL EXAMINATION			
III	Solid slab bridges : Introduction, General design features, Effective width method. Simply supported and cantilever Slab Bridge, analysis and design. Box Culverts : Introduction to analysis, design and detailing, Loading conditions (detailed design not expected)	7	15
IV	Beam and slab bridges: Introduction, Design of interior panel of slab. Pigeaud's method, Calculation of longitudinal moment Courbon's theory, Design of longitudinal girder, design example. and Reinforcement detailing	7	15
SECOND INTERNAL EXAMINATION			
V	Introduction to pre-stressed concrete bridges (Design Concepts only) Determination of SMinimum Section Modulus, Prestressing Force and eccentricity (Derivation not required) Substructures : Analysis and Design of Abutments and pier- detailing.	8	20
VI	Bridge bearings: forces on bearings, design of elastomeric bearings, basics for selection of bearings. Types of foundations, well foundation–open well foundation, components of well foundation, pile foundations (designs not included) - detailing only	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (External Evaluation)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE465	GEO-ENVIRONMENTAL ENGINEERING	3-0-0-3	2016

Pre-requisite: CE 305 Geotechnical Engineering- II

Course objectives:

- To create a awareness in the field of Geo-Environmental Engineering
- To impart the knowledge on Geotechnical aspects in the disposal of waste materials and the remediation of contaminated sites
- To familiarise design of landfill and know the effect of change in environment on soil properties.

Syllabus :

Introduction and Soil-water-environment interaction, Geotechnical applications of waste materials, Geotechnical characterization of waste and disposal, Site characterization, Landfill Components its functions and design, Compacted clay liner, selection of soil, methodology of construction, Geosynthetics in landfill- types and functions, geosynthetic clay liners - Leachate and Gas Management, Soil remediation, Investigation of contaminated soil, insitu/exiture mediations, bio remediation, thermal remediation, pump and treat method, phyto remediation and electro kinetic remediation, Leachate disposal and Post closure of landfill, Variation in properties of soil due to change in environment

Expected Outcomes:

The students will be able to:

i. Deal with geoenvironmental engineering problems
ii. Utilize waste in Geotechnical applications
iii. Design Landfill
iv. Mange leachate and landfill gas
v. Do investigation on contaminated site and soil remediation
vi. Assess variation in engineering properties of soil due to change in environment

Text Books / References

1. Daniel, D.E. (1993). Geotechnical Practice for Waste Disposal. Chapman, and Hall, London.
2. Koerner, R.M. (2005). Designing with Geosynthetics. Fifth Edition. Prentice Hall, New Jersey.
3. Reddi L.N and Inyang HI (2000) Geoenvironmental Engineering: Principles and Applications, Marcel Dekker Inc Publication
4. R. N. Yong (2000) Geoenvironmental Engineering: Contaminated Soils, Pollutant Fate, Mitigation Lewis Publication.
5. Dr. G V Rao and Dr. R S Sasidhar (2009) Solid waste Management and Engineered Landfills, Saimaster Geoenvironmental Services Pvt. Ltd. Publication.
6. Ayyar TSR (2000) Soil engineering in relation to environment, LBS centre for Science and Technology, Trivandrum.
7. Hari D. Sharma, Krishna R. Reddy (2004) Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, Publisher: John Wiley & Sons Inc.
8. Donald L. Wise, Debra J. Trantolo, Hilary I. Inyang, Edward J. Cichon (2000) Remediation Engineering of Contaminated Soils, Publisher: Marcel Dekker Inc.

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem. Exam Marks %**
I	Introduction and Soil-water-environment interaction : Introduction to geoenvironmental Engineering, Soil-water-environment interaction relating to geotechnical problems, Waste:-source, classification and management of waste, Physical, chemical and geotechnical characterization of municipal solid waste, Impact of waste dump and its remediation	6	15
II	Geotechnical application of waste and disposal: Geotechnical use of different types such as Thermal power plant waste, MSW, mine waste, industrial waste. Waste disposal facilities, Parameters controlling the selection of site for sanitary and industrial landfill. Site characterization. MoEF guidelines.	7	15
FIRST INTERNAL EXAMINATION			
III	Landfill Components :Landfill layout and capacity, components of landfill and its functions. Types and functions of liner and cover systems, Compacted clay liner, selection of soil for liner, methodology of construction.	6	15
IV	**Leachate, Gas Management and Geosynthetics**: Management of Leachate and gas. Various components of leachate collection and removal system and its design., gas disposal/utilization. Closure and post closure monitoring system Geosynthetics- Geo membranes - geosynthetics clay liners -testing and design aspects.	6	15
SECOND INTERNAL EXAMINATION			
V	Soil remediation : Investigation of contaminated soil, sampling, assessment Transport of contaminants in saturated soil. Remediation of contaminated soil- in-situ / exit remediation, bio remediation, thermal remediation, pump and treat method, phyto remediation and electro-kinetic remediation	9	20
VI	Change in engineering properties due to change in environment. Variation in Engineering properties of soil –atterberg limit, shear strength, permeability and swelling due to change in environment/pore fluid.	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

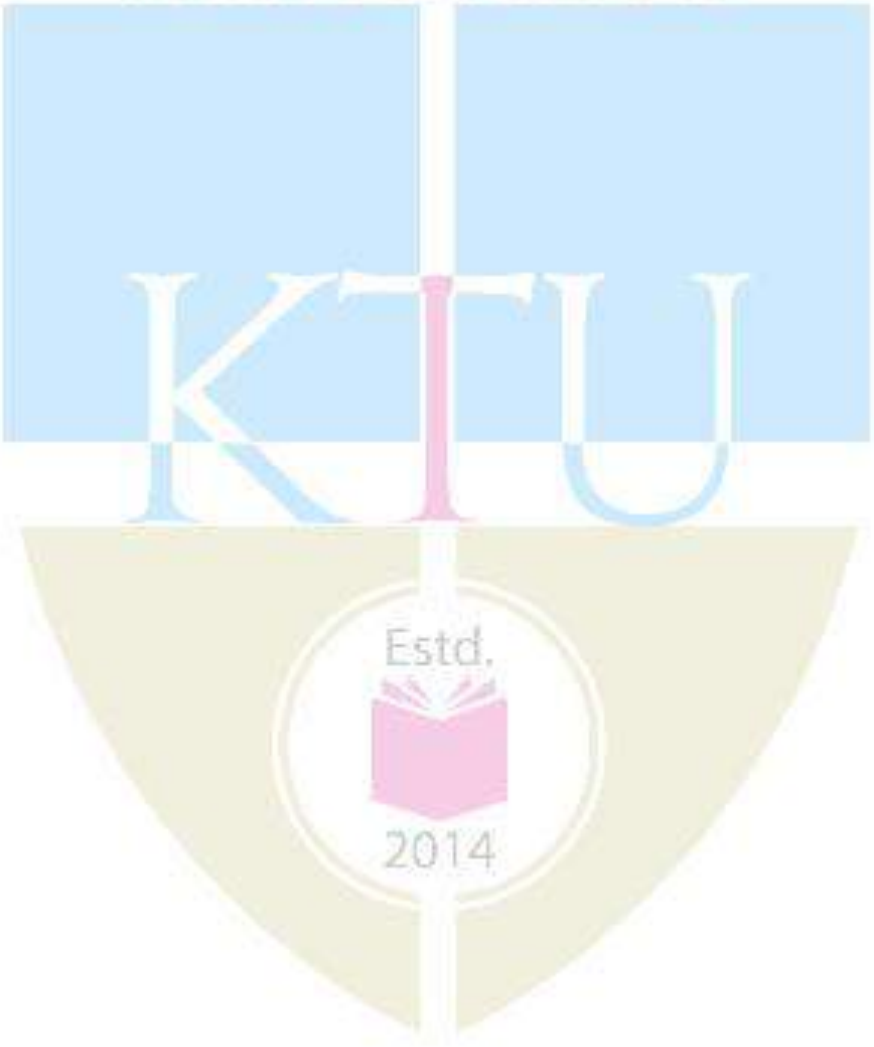
Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)



Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE467	HIGHWAY PAVEMENT DESIGN	3-0-0-3	2016

Pre-requisite : CE208 Geo Technical Engineering - I

Course Objectives:

- To introduce highway pavements, design concepts and material properties,
- To understand and enable students to carry out design of bituminous mixes, analyse and design flexible and rigid highway pavements
- To introduce the concepts of pavement evaluation and rehabilitation.

Syllabus :

Introduction to highway pavements – Subgrade soil properties – Design of bituminous mixes- Analysis of flexible pavements- Design of flexible pavements- Analysis of rigid pavements- Design of rigid pavements-Pavement evaluation- Introduction to design of pavement overlays.

Course Outcome:

The students will be able to

i. identify the pavement components and design bituminous mixes,
ii. analyze and design flexible and rigid pavements
iii. evaluate structural condition of pavement.

Text Books:

1. Yoder and Witezak, Principles of Pavement design, John Wiley and sons, second edition,1975.
2. Yang, Design of functional pavements, McGraw- Hill,1972.
3. Khanna S. K. & Justo C. E. G., Highway Engineering, Nemchand & Bros, 9e.
4. Hass & Hudson, 'Pavement Management System', McGraw Hill Book Co, 1978.

References:

1. IRC: 37 - 2001, 'Guidelines for the Design of Flexible Pavements'.
2. IRC: 58 – 2002, 'Guidelines for the Design of Rigid Pavements'.
3. IRC: 37-2012, 'Tentative Guidelines for the Design of Flexible Pavements'.
4. IRC: 58-2011, Guidelines for Design of Plain Jointed Rigid Pavements for Highways.

Module	Contents	Hours	Sem. Exam Marks %
I	Introduction to highway pavements, Types and component parts of pavements, Factors affecting design and performance of pavements, Functions and significance of sub grade properties, Various methods of assessment of sub grade soil strength for pavement design Mix design procedures in mechanical stabilization of soils,	6	15

	Design of bituminous mixes by Marshall, Hubbard - field and Hveem's methods		
II	Introduction to analysis and design of flexible pavements, Stresses and deflections in homogeneous masses, Burmister's 2 layer and 3 layer theories, Wheel load stresses, ESWL of multiple wheels, Repeated loads and EWL factors	**6**	**15**
FIRST INTERNAL EXAMINATION			
III	Empirical, semi - empirical and theoretical approaches for flexible pavement design, Group index, CBR, Triaxial, Mcleod and Burmister layered system methods	**7**	**15**
IV	Introduction to analysis and design of rigid pavements, Types of stresses and causes, Factors influencing stresses, General conditions in rigid pavement analysis, Warping stresses, Frictional stresses, Combined stresses	**7**	**15**
SECOND INTERNAL EXAMINATION			
V	Joints in cement concrete pavements, Joint spacings, Design of slab thickness, Design and detailing of longitudinal, contraction and expansion joints, IRC methods of Design	**8**	**20**
VI	Introduction to pavement evaluation, Structural and functional requirements of flexible and rigid pavements, Quality control tests for highway pavements, Evaluation of pavement structural condition by Benkelman beam, rebound deflection and plate load tests, Introduction to design of pavement overlays and the use of geosynthetics	**8**	**20**
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b ,c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE469	ENVIRONMENTAL IMPACT ASSESSMENT	3-0-0-3	2016

Prerequisites: Nil

Course objectives:

- To know the various types of environmental pollution
- To make aware the impact due to various types of pollutants and their assessment technique

Syllabus : Pollution, Types. Air pollution-sources, effects, types of pollutants. Water pollution, characteristics of water pollutants, Solid wastes, sources, types, soil pollution, pesticide pollution. Noise pollution, Impacts, positive and negative Environmental impact assessment, steps of doing EIA, methodology adopted, EIA procedure in India, Case studies.

Expected Outcomes:

- The students will gain basic knowledge of various pollution sources and their impacts

Text Books / References:

1. A K Srivastava, Environment impact Assessment, APH Publishing, 2014
2. John Glasson, Riki Therivel & S Andrew Chadwick "Introduction to EIA" University College London Press Limited, 2011
3. Larry W Canter, "Environmental Impact Assessment", McGraw Hill Inc. , New York, 1995.
4. Ministry of Environment & Forests, Govt. of India 2006 EIA Notification
5. Rau G J and Wooten C.D "EIA Analysis Hand Book" Mc Graw Hill
6. Robert A Corbett "Standard Handbook of Environmental Engineering" McGraw Hill, 1999.

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	INTRODUCTION: Classification of Pollution and Pollutants, – Evolution of EIA (Global and Indian Scenario)- Elements of EIA — Screening – Scoping - Public Consultation - Environmental Clearance process in India - Key Elements in 2006 EIA(Govt. of India) Notification	6	15
II	AIR POLLUTION: Primary and Secondary Types of Pollutants, sulfur dioxide- nitrogen dioxide, carbon monoxide, WATER POLLUTION: Point and Non-point Source of Pollution, Major Pollutants of Water, Impact of pollutants	6	15
	FIRST INTERNAL EXAMINATION		
III	SOLID WASTE: Classification and sources of Solid Waste, Characteristics, effects, e waste, : Effects of urbanization on land degradation, pesticide pollution NOISE POLLUTION: Sources of Noise, Effects of Noise,	7	15

	Control measures		
IV	Impacts of pollutants, types, scale of impact-Global, local pollutants. Climate change, Ozone layer depletion, Deforestation, land degradation , Impact of development on vegetation and wild life	7	15,
SECOND INTERNAL EXAMINATION			
V	Socio-economic impacts - Impact assessment Methodologies- Overlays, Checklist, Matrices, Fault Tree Analysis, Event Tree Analysis- Role of an Environmental Engineer- Public Participation	8	20
VI	Standards for Water, Air and Noise Quality - Environmental Management Plan- EIA- Case studies of EIA	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (External Evaluation) :

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE471	ADVANCED STRUCTURAL DESIGN	3-0-0-3	2016

Prerequisite : CE304 Design of Concrete Structures- II

Course objectives:

- To enable the students to assess the loads on some important types of structures, choose the method of appropriate analysis according to the situation and perform design
- To analyse and design the special structures in steel and understand the new concepts of design

Syllabus :

Design of deep beams, corbels, ribbed slabs, flat slabs, Yield line theory, Design of multi storey buildings, Design of Gantry girder, Design of Industrial structures, beam column connections, Analysis and design of light gauge structures ,Tall structures, Shear wall ductility detailing

Course Outcomes:

The students will be able to

i. design deep beams, corbels. Ribbed slabs
ii. design and detail a flat slab and multistory buildings
iii. analyse and design light gauge structures
iv. calculate the loads on gantry girder and its design
v. design beam column Connections
vi. analyse, design and detail multistory building for lateral loads

Text Books / References:

1. Krishnaraju.N., Advanced Reinforced Concrete Design, CBS Publishers, 2013
2. Mallick S.K. & Gupta A.P., Reinforced Concrete, Oxford & IBH Publishing Co, 6e, 1996.
3. Pankaj Agarwal and Manish Shrikandhe, Earthquake Resistant Design of Structures, PHI, 2006
4. Punmia B. C., Jain A. K. Comprehensive Design of Steel Structures, Laxmi Publications (P) Ltd, 2017.
5. Ramchandra S & Veerendra Gehlot, Design of Steel Structures Vol. II, Standard Book House, 2007
6. S.K.Duggal., Design of steel Structures, Tata McGraw-Hill, 2014
7. Subramanian N, Design of steel Structures, Oxford University Press, 2015
8. Varghese P.C., Advanced Reinforced Concrete Design , PHI, 2005
9. William T Segui., Steel Design , Cenage Learning, 6e, 2017
10. IS 456 -2000 Code of practice for reinforced concrete design, BIS
11. IS 800 – 2007, Code of practice for Structural steel design, BIS

COURSE PLAN

Module	Contents	Hours	Sem. Exam Marks %
I	Design of Deep beams & Corbels. Design of Ribbed Slabs. Yield line theory of slabs – Design of Rectangular and Circular slabs for UDL and point load at centre.	6	15
II	Design of flat slabs by direct design method and equivalent	6	15

	frame method as per IS 456-2000. Design of multi-bay multi storied portal frames for gravity loads, Pattern loading - Use of SP 16 (Substitute Frame method of analysis may be followed).		
FIRST INTERNAL EXAMINATION			
III	Design of Light Gauge members - behavior of compression elements- effective width for load and deflection determination- behavior of stiffened and unstiffened elements- moment of resistance of flexural members- design of compression members	7	15
IV	Design of Gantry Girder :Introduction - Loading consideration & maximum load effect Selection of Gantry girder – Design of gantry girders for primary loads only. Codal provisions	7	15
SECOND INTERNAL EXAMINATION			
V	Design of Industrial structures : Introduction – Classification of Industrial structures- load estimation and steps for Analysis and design. Beam column connections (Unstiffened and stiffened)	8	20
VI	Tall Buildings –Introduction, Structural Systems, Principles of design and detailing of Shear wall. Design of Multistoried framed structures for wind and Earthquake Loads- Equivalent static load method of IS 1893.Ductility detailing for earthquake forces- IS 13920	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE473	ADVANCED COMPUTATIONAL TECHNIQUES AND OPTIMIZATION	3-0-0-3	2016

Prerequisite : CE306 Computer Programming and Computational Techniques

Course objectives:

- To introduce different numerical solutions and importance of optimization
- To impart ability to apply mathematics and optimizing techniques for finding solutions to real time problems.

Syllabus :

Introduction to numerical methods- errors in numerical methods-Systems of linear algebraic equations- Elimination and factorization methods- Gauss Seidel iteration. Eigen Value problems- power method. General Optimisation procedures - and features of mathematical programming as applicable to Civil engineering problems. Unconstrained and constrained optimization problems - Formulation of objective function and constraints. Lagrangian interpolation- Quadratic and Cubic splines (Problems on quadratic splines only)- Data smoothing by least squares criterion- Non-polynomial models like exponential model and power equation- Multiple linear regression. Numerical integration- Newton – Cotes open quadrature- Linear Programming - Simplex method standard form - Simplex algorithm - Two phase solution by simplex method - Duality of linear programming Formulation of geometric programming. Ordinary differential equations- 1st order equations- Solution by use of Taylor series- Runge- kutta method- Ordinary differential equations of the boundary value type- Finite difference solution- Partial differential equations in two dimensions- Parabolic equations- Explicit finite difference method- Crank-Nicholson implicit method- Ellipse equations Non- Linear Programming problems – one dimensional minimisation. Unconstrained optimization Techniques Direct search method. Random search Univariate pattern search. Descent methods.

Course Outcomes:

The students will be able to:

i. Find different numerical solutions of complicated problems
ii. Determine solutions of real time problems applying numerical methods in mathematics
iii. Understand the importance of optimization and apply optimization techniques in real time problems

Text Books / References:

1. Grewal B.S. “Numerical Methods in Engineering and Science” Khanna Publishers.
2. Chapra S.C. and Canale R.P. “Numerical Methods for Engineers” Mc Graw Hill 2006.
3. Smith G.D. “Numerical solutions for Differential Equations” Mc Graw Hill
4. Ketter and Prawel “Modern Methods for Engineering Computations” Mc Graw Hill
5. Rajasekharan S. “Numerical Methods in Science and Engineering”S Chand & company 2003.
6. Rajasekharan S. “Numerical Methods for Initial and Boundary value problems,” Khanna publishers 1989.
7. Terrence .J.Akai “Applied Numerical Methods for Engineers”, Wiley publishers 1994.
8. R.L. Fox , Optimisation methods in Engineering Design, Addison Wesely
9. S.S. Rao , Optimisation Theory and applications , ,Wiley Eastern.
10. Belegundu., Optimisation concepts and Applications Engineering,

11. Andrew B Templeman, Civil Engineering Systems

COURSE PLAN			
Module	**Contents**	**Hours**	**Sem. Exam Marks %**
I	Introduction to numerical methods- errors in numerical methods- Systems of linear algebraic equations- Elimination and factorization methods- Gauss Seidel iteration. Eigen Value problems- power method.	7	15
II	General Optimisation procedures - and features of mathematical programming as applicable to Civil engineering problems. Unconstrained and constrained optimization problems - Formulation of objective function and constraints.	6	15
FIRST INTERNAL EXAMINATION			
III	Lagrangian interpolation- Quadratic and Cubic splines (Problems on quadratic splines only)- Data smoothing by least squares criterion- Non- polynomial models like exponential model and power equation- Multiple linear regression. Numerical integration- Newton – Cotes open quadrature	7	15
IV	Linear Programming - Simplex method standard form - Simplex algorithm - Two phase solution by simplex method - Duality of linear programming Formulation of geometric programming	6	15
SECOND INTERNAL EXAMINATION			
V	Ordinary differential equations- 1st order equations- Solution by use of Taylor series- Runge- kutta method- Ordinary differential equations of the boundary value type- Finite difference solution- Partial differential equations in two dimensions- Parabolic equations- Explicit finite difference method- Crank-Nicholson implicit method- Ellipse equations	7	20
VI	Non- Linear Programming problems – one dimensional minimisation. Unconstrained optimization Techniques Direct search method. Random search Univariate pattern search. Descent methods	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (External Evaluation) :

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V & VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a, b, c, d)