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**

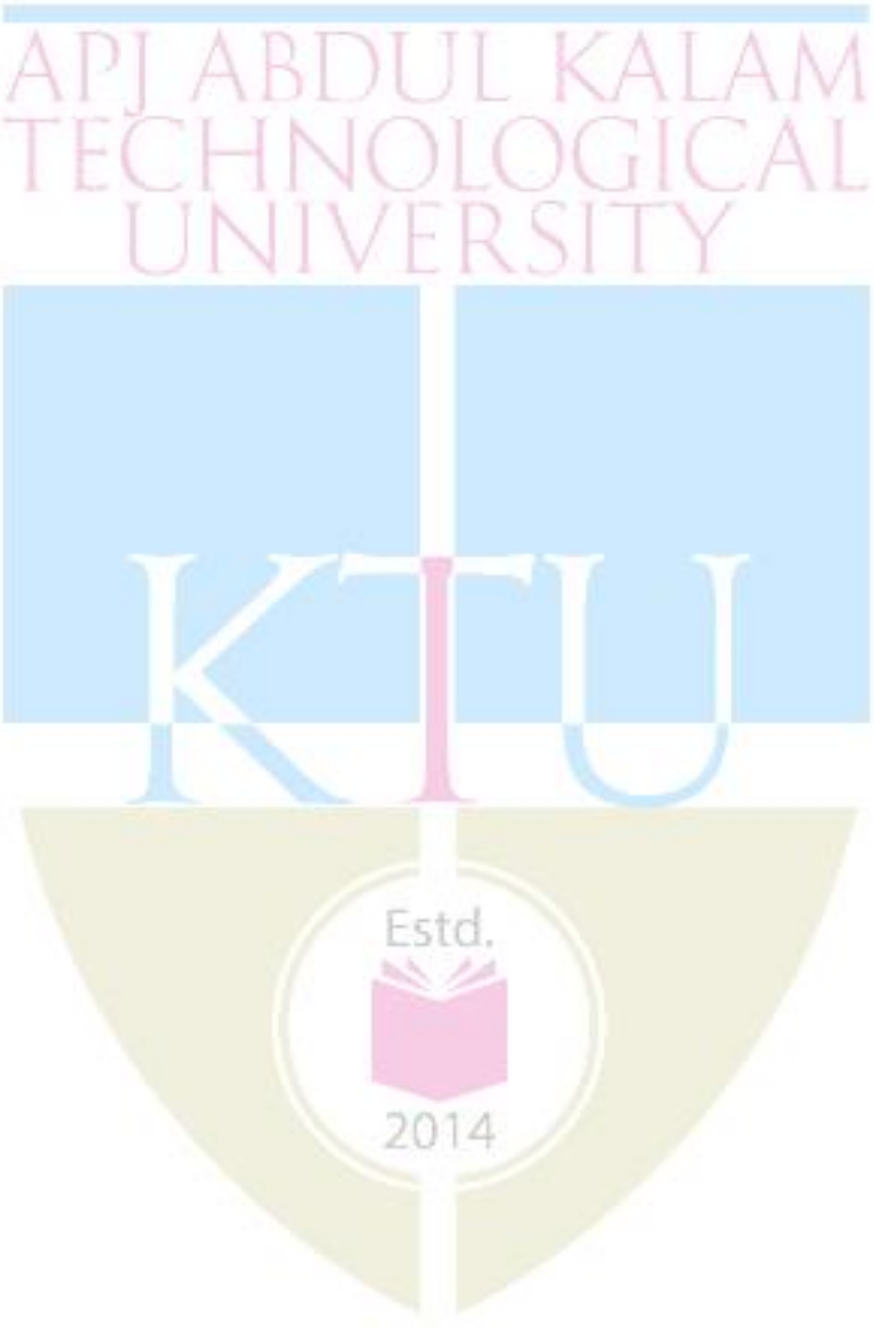
Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

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
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)