COURSES OF STUDY
FOR
UNDERGRADUATE DEGREE
in
Civil Engineering

Effective for the students admitted in the years 2021-22 and onwards.

B.Tech. : Civil Engineering
3rd Year - VI Semester

S.N.	Category	Course Code	Course Title	Hours			Marks			Credit
				L	T	P	IA	ETE	Total	
THEORY										
1	DC	6CE4-01	Structural Analysis-II	3	0	0	30	70	**100**	**3**
2		6CE4-02	Concrete Structures -II	3	0	0	30	70	**100**	**3**
3		6CE4-03	Steel Structures-II	3	0	0	30	70	**100**	**3**
4		6CE4-04	Transportation Engineering-II	3	0	0	30	70	**100**	**3**
5		6CE4-05	Design of Hydraulic Structures	3	0	0	30	70	**100**	**3**
6	DE-III*		**Departmental Elective III**	2	0	0	30	70	**100**	**2**
		6CE5-11	Water and Wastewater Engineering: Design & Applications							
		6CE5-12	Design of Bridge Structures							
		6CE5-13	Structural Dynamics and Earthquake Engineering design							
		6CE5-14	Analysis and Design of Bituminous Pavements							
		6CE5-15	Water Resources Management							
			Sub Total	**17**	**0**	**0**	**180**	**420**	**600**	**17**
PRACTICAL & SESSIONAL										
7	DC	6CE4-20	Structural Design and Detailing	0	0	3	60	40	**100**	**1.5**
8		6CE4-21	Design of Hydraulic Structures Lab	0	0	3	60	40	**100**	**1.5**
9	UI	6CE7-50	Mini project			4**	60	40	**100**	**2**
10	CCA	6CE8-00	SODECA/NCC/NSS/ANANDA M/IPR	-	-	-	-	100	**100**	**2**
			SUB TOTAL	**0**	**0**	**10**	**180**	**220**	**400**	**7**
	TOTAL OF VI SEMESTER			**17**	**0**	**10**	**360**	**640**	**1000**	**24**

L = Lecture, **T** = Tutorial, **P** = Practical, **IA**=Internal Assessment, **ETE**=End Term Exam, **Cr**=Credits

** For calculation of contact hours

* **It will be mandatory for the department to offer all the electives to the students. However, in case of scarcity of faculty members to offer the DEs, at least 3 electives from DE-III categories must be offered.**

6CE4-01: Structural Analysis-II

Credit: 3Max **Marks: 100 (IA=30, ETE=70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To obtain a fundamental understanding of the concepts of rotation and translation of joints.
2. To obtain an understanding of various classical methods of structural analysis and their relative advantages and limitations.
3. To understand different methods for analysis of Cable, Arch and analysis of suspension bridges.
4. To understand the concept of elastic and plastic analysis of structure.
5. To understand the concept of application of matrix in structural analysis.

Course Outcomes: Upon completion of this course the students will be able to:

1. To find out the amount of rotation and translation of joints in indeterminate structure due to loading.
2. To find out the end moment of the member, shear force, bending moment at any cross section of indeterminate structure.
3. To analyze arch, cable and suspension bridges,
4. To get ideas about plastic analysis and failure mechanisms.
5. To analyze structural members such as beams, frames, trusses using the Matrix method of analysis.

S.N.	Contents	Hours
1	**Slope Deflection Method**: Introduction, Development of slope-deflection equations, analysis of continuous beams, analysis of frames, box culverts.	7
2	**Moment Distribution Method:** Introduction, Definition of terms- Distribution factor, carry over factor, analysis of fixed and continuous beams, Portal frames with and without translation of joints, box culverts.	7
3	**Analysis of Arches:** Structural form of Arches, classification of arch; Analysis of three hinged parabolic arch, moving loads & influence lines. Cables and Suspension Bridge: Introduction, length of the cable for supports at the same level and at different levels; Tension in the cable, analysis of cables under point loads and UDL; Stiffening girders, two and three-hinged stiffening girders, influence lines for bending moments, shear force in stiffening girders and horizontal reaction in cable.	12
4	**Plastic Analysis:** Introduction, Stress-strain curve, Upper and lower bound theorem, Concept of plastic moment, plastic hinge, shape factor etc., Plastic analysis of beams and portal frames with Static method and Mechanism method.	6
5	**Matrix Method:** Introduction to stiffness and flexibility method, Direct stiffness method, Nodal and global coordinate transformation matrix, element stiffness matrix for truss members, Beam element, Frame element, Assembly of element stiffness matrix, element load vector, Global load vector, Application of direct stiffness method in case of plane	10

	truss, Beam and Portal frame.	
	Total	**42**

SUGGESTED READINGS

1. Reddy, C.S. (2017). Basic structural Analysis . Tata McGraw Hill.
2. Wang, C.K. (2017). Indeterminate structural Analysis, McGraw Hill.
3. Pandit and Gupta , Structural Analysis Vol- II, McGraw Hill.
4. Hibbeler, R.C. (2017) Structural Analysis, Pearson.

6CE4-02: Concrete Structures -II

Credit: 3Max **Marks: 100 (IA=30, ETE=70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives:

1. To know about various types of combined footing and design of rectangular footing.
2. To know about various types of retaining wall and the procedure of design of a cantilever and counterfort retaining wall.
3. To understand the procedure of design of a water tank resting on the ground.
4. To know the serviceability requirement of RC structure and limiting values of serviceability parameters.
5. To get an overview of prestressed concrete and methods of prestressing.

Course Outcome: Upon completion of this course the students will be able to:

1. To understand the requirement of any specific type of retaining wall and design the same.
2. To design a water tank resting on the ground.
3. To find out the deflection and crack width of RC flexural members and check their adequacy.
4. Knowledge prestressed concrete structure.

S.N.	Contents	Hours
1	**Combined footing:** Types of combined footing- strip footing, rectangular and trapezoidal combined footing, Raft foundation; Design of rectangular combined footing.	6
2	**Design of RC Retaining Walls:** Types of retaining wall, Suitability of different types of retaining walls, Design of Cantilever retaining wall and Counterfort retaining wall.	10
3	**Design of Water Tanks:** Design of circular water tanks resting on ground (Rigid and Flexible base); Design of rectangular water tanks resting on ground as per IS: 3370 (Part IV).	8
4	**Limit state of serviceability:** Limiting deflection, Short term deflection, Long term deflection, Calculation of deflection of singly and doubly reinforced beam; Cracking in reinforced concrete members, Calculation of crack width of RC beam. Side face reinforcement, slender limits of beams for stability.	8
5	**Prestressed concrete:** Introduction, Merits and demerits, Pretensioning and post tensioning method, Materials for prestressed concrete, Stress analysis in beam, Load balancing concept, Pressure line, Cracking moment, Kern distance and Kern zone, Losses in prestress.	10
	Total	**42**

SUGGESTED READINGS

1. Pillai ,S.U., Menon, D. (2021). Reinforced Concrete Design, McGraw Hill, New Delhi.

2. Sinha, S.N. (2021). Reinforced Concrete Design, McGraw Hill Publication.
3. N. Krishnaraju (1995). Prestressed Concrete Structure, Tata McGraw Hill, New Delhi
4. Lin, T.Y., Burns ,N. H. (2010). Design of prestressed concrete, John Wiley and Sons

6CE4-03: Steel Structures-II

Credit: 3Max **Marks: 100 (IA=30, ETE=70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To understand the behavior of various steel structures
2. Analyze and design advanced steel members and structures.

Course Outcomes: Upon completion of this course the students will be able to:

1. Analyze various steel structures subjected to wind and seismic loads in addition to gravity loads.
2. Design steel structures such as gantry and cross girders, and a shed type full scale steel structure with trussed roof and portals.

S.N.	Contents	Hours
1	**Review of Steel Structures** Material Behavior and Models: Cyclic behavior and fatigue behavior of steel, Ramberg-Osgood model **Design Philosophies** Probability-based approach as basis of LSM, Loads and Load Combinations for design of buildings, Code provisions in IS 875 Part 5, Load flow in buildings. **Review of component design** Tension members, compression members, and flexure members	3 3 2
2	**Wind load calculations on structures as per IS 875 Part 3** Background: Nominal pressure due to flowing fluid on surfaces, Interaction of wind flowing past different shaped objects Wind speed: Basic wind speed from historical wind data at different locations, Flow profile of wind with height from ground (boundary effect), Factors affecting the design wind speed (k_i) Wind pressure: Design wind pressure due to flow, Factors affecting the wind pressure, wind pressure coefficients on different orientations of buildings on internal and external surfaces of building. Wind forces: Calculation of wind forces on walls of buildings, calculation of wind forces on pitched and flat roofs of building	8
3	**Design of members for shear** **Design of members subjected to combined loadings** - Axial and bending (beam-column), Torsion (beam), Biaxial bending (column)	3 5
4	**Design of Gantry-crane systems** Design of gantry girders and cross-girders in gantry crane system	8
5	**Design of shed-type structure (withPortals and Trussed roof)**	10
	Total	**42**

SUGGESTED READINGS

1. Subramanian, N (2016). "Design of Steel Structures – Limit State Method", Oxford Higher Education. ISBN10 – 9780199460915
2. Duggal, S. K. (2014). "Limit State Design of Steel Structures", McGraw Hill Education.

6CE4-04: Transportation Engineering-II

Credit: 3Max **Marks: 100 (IA=30, ETE=70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide students with a comprehensive understanding of railway transport.
2. To learn the aircraft characteristics, planning and design of airport.
3. To study about the types and components of water transport.
4. To know about various urban and sustainable transportation systems.

Course Outcomes: Upon completion of this course the students will be able to:

1. To understand the importance of railway, airports and water transport infrastructure planning and design.
2. To know about the basics and scope of various components of railway, airports and water transport.
3. To design the basic elements of railway and airport and water transport system.
4. To understand the advanced transportation systems.

S.N.	Contents	Hours
1	**Railway transport:** History: Indian railways, international perspective; Railway track gauge: factors affecting gauge choice, multi gauge; New project planning and surveys; Alignment of railway track; Structure of railway track: rails, sleepers, ballast, subgrade, track fittings; Structural design of railway track: stresses, creep; Geometric design of rail track: gradients, curves, superelevation; Locomotives and rolling stock: resistance and tractive power; Points and crossings; Railway stations and yards; Traffic control; Signalling and interlocking; Public rail transportation in urban centres.	11
2	**Air transport:** Forecasting demand-passenger, freight; Aircraft characteristics; Airport planning-requirements site selection, layout plan; Geometric design of runway, taxiway and aprons; Airport capacity-airside, landside; Passenger terminal-functions, passenger and baggage flow; Airport pavement design and drainage; Parking and apron design; Air cargo facilities; Air traffic control lighting and signing; Airport safety; Environmental impact of airports; Airport financing and economic analysis.	11
3	**Water transportation:** Introduction and planning of harbour: historical development of water transportation in India and policy, classification of harbours, major port in India and administrative set up, harbour economics. Harbor classification, characteristics of good harbour, and principles of harbour planning, site selection criteria and lay out of harbours.	11
4	**Urban transportation:** Urban transportation systems - Bus transit - Mass Rapid Transit System - Light Rail Transit. Transport economics and Financing -, Multimodal Urban Transportation Systems (MUTS)	5

5	**Other applications in transportation engineering:** Introduction to Geo-informatics in Transportation Engineering; Intelligent Transportation Systems (ITS); Introduction to Environmental Impact Assessment (EIA) and Transportation systems; Sustainable transportation systems	4
	Total	**42**

SUGGESTED READINGS

1. Chandra, Satish and Agarwal, M. M. (2013). Railway Engineering, Oxford University Press, New Delhi.
2. Saxena S.C. and Arora S. P. (2010). A Course of Railway Engineering, Dhanpat Rai, New Delhi
3. Bindra S.P. (2012). A course in Docks & Harbor Engineering, Dhanpat Rai, New Delhi
4. R Shrinivasan (2022). Harbor Dock and Tunnel Engineering, Charotar Publishing House.
5. Rao G.V., Airport Engineering, Tata McGraw Hill, New Delhi.
6. Mcklerey ,F., Horonjeff, R.,Young, S., Sproule ,W. & (2010). Planning & Design of Airport, Tata McGraw Hill.
7. Kadiyali, L.R.,(2006). Traffic Engineering and Transport Planning, Khanna Publishers, New Delhi.
8. Thill, J.C. (2000). Geographical Information Systems in Transportation Research, Pergamon.
9. Chakroborty ,P.,Das,A. “Principles Of Transportation Engineering” PHI Learning Pvt. Ltd., 1 Jan 2003

6CE4-05: Design of Hydraulic Structures

Credit: 3Max **Marks: 100 (IA=30, ETE=70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To get a knowledge of various types of dams
2. Discuss the forces acting on gravity dam
3. To understand the seepage and stability analysis of Embankment dam under various hydraulic conditions
4. Demonstrate and understanding the various types of spillways
5. Understanding the various types of cross drainage works

Course Outcomes: Upon completion of this course the students will be able to:

1. Calculate forces, stresses on gravity dam and check various factor of safety
2. Locate phreatic line and carryout seepage and stability analysis of Embankment dam under various hydraulic conditions
3. Understand and manage the hydraulic structures project evaluation under various conditions of data availability and field constraints
4. Gain the in-depth knowledge on various types of spillways used in dams and their design guidelines
5. Explain and Design of various types of cross drainage structures.

S.N.	Contents	Hours
1	**Types of Dams and Foundation Treatment:** Classification of dams, Investigations for dam sites, Selection of site for dams, Selection of type of dam, Merits and demerits of all types of dams, Importance of subsurface exploration, Foundation treatment methods.	4
2	**Gravity Dams:** Definition, Forces acting on the dam, Combinations of load on the dam, Causes of failure of dams, Design criteria for Gravity dams, Principal and shear stresses, Elementary and practical profile of a Gravity dam, High and low dam, Stability analysis of a Gravity dam, Design of Gravity dams, Control of temperature in dams, Construction of dam, and joints in dams, Galleries in dams.	10
3	**Embankment Dams:** Introduction, Classification of Non – Rigid Dams, Causes of failure of Earth dams, Design principles of Earth dams, Profile of an Earth dam, , Core and casing for Earth dams, Construction materials for Earth dams, Cut off and seepage control measures in Earth dams, Drainage system for Earth dams, Typical sections of Earth dams, Selection of dam	10

	section, Construction of Earth dams, Determination of phreatic line, Stability of slopes, Stability of foundation against shear, Design considerations in earthquake regions.	
4	**Spillways:** Definition and types of spillways, Components of spillway, Chute spillway, Side channel spillway, Shaft spillway, Siphon spillway, Design of Ogee spillway, Profile of Ogee spillway, Cavitation erosion of spillway surface, Design of Chute spillway.	6
5	**Canal Regulation Works and Cross Drainage Structure:** Classification of falls, Hydraulics design of canal falls, Canal head regulators, Cross regulators, Canal outlets. Necessity of Cross drainage structures, their types and selection, comparative merits and demerits, design of various types of cross drainage structure- aqueducts, syphon aqueduct, super-passage syphon, level crossing.	12
	Total	**42**

SUGGESTED READINGS

1. Arora, K.R., (2010). Irrigation Water Power and Water Resources Engineering, Standard Publishers Distributors, Delhi.
2. Garg, S.K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers, Delhi.
3. Asawa G L (2005). Irrigation and Water Resources Engineering, New Age Int. Ltd. Delhi.
4. Modi, P.N.(2020). Introduction to Water Resources and Waterpower Engineering, Standard Publication, Delhi.
5. Sharma S K (2017). Irrigation Engineering and Hydraulic Structures, S Chand, New Delhi.
6. Willi H. Hager, Robert M. Boes, Michael Pfister, Anton J. Schleiss (2020). Hydraulic Engineering of Dams, CRC Press, London.
7. Rajnikant M Khatsuria (2005). Hydraulics of Spillways and Energy Dissipators, CRC Press, London
8. Varshney, R.S., Gupta S.C. & Gupta R.L. (2009). Theory and Design of Hydraulic Structures Vol. 1 and 2, Nemi Chand and Bro. New Delhi.

6CE5-11: Water and Wastewater Engineering: Design & Applications

Credit: 2Max **Marks: 100 (IA=30, ETE=70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To introduce basic concepts of water engineering and design and understand the meaning and standards of Characteristics of Water
2. To educate the student on the working principles and design of various physical,chemical, and biological treatment systems for water and wastewater.
3. To educate the students about the various modes of conveyance of wastewater from the source of its generation to the treatment plant.

Course Outcomes: Upon completion of this course the students will be able to:

1. The basic fundamentals of water engineering and design including factors which effect the water properties.
2. To learn the procedure to design sedimentation tank and miscellaneous methods of water treatment
3. To understand the fundamentals of waste water treatment and design principles of various physical treatment processes, chemical treatment processes and biological treatment processes.
4. To improve the knowledge on the Selection of unit operation and processes and to study the design-oriented aspects of sand filters and other treatment processes.

S.N.	Contents	Hours
1	**Introduction to Water Supply Engineering:** Hydrological concepts, planning of water supply projects. ground water and its development, design of well and tubewell, Water Intakes- types and design aspects	5
2	**Water Treatment:** Design principles and criteria: aeration, Parshall flume, flash mixer, coagulation – flocculation systems, types of settling, sedimentation, tube settlers, pulsators, design of slow sand and gravity filter.	6
3	**Disinfection:** Disinfection processes – numerical problems. Cross flow systems, Green flocculants. Intermittent residual chlorine boosting in the water distribution system, water quality in distribution system with special reference to bio films, Corrosion prevention and control.	4
4	**Distribution System**: Types of Distribution system. Hardy- cross and Newton-Raphson methods of pipe network analysis - Simple problems.	4
5	**Introduction to Waste Water Treatment:** Introduction to advanced treatment like adsorption, ion-exchange, membrane processes. planning of waste water projects.	3

6.	**Secondary Treatment:** Design of secondary treatment units, Activated sludge process, Trickling filter, Oxidation ditch, oxidation pond. Design of Imhoff Tank, Septic Tank, RBC etc. Upflow Anaerobic Sludge Blanket, Design of sludge digestion.	6
	Total	**28**

SUGGESTED READINGS

1. Garg S. K. (2014). Water Supply Engineering (Environmental Engineering Vol.-I)
2. Manual on Sewerage and Sewage disposal-CPHEEO, Govt. of India.
3. Garg S.K. (2014). Sewage Disposal and Air pollution Engineering (Environmentaal Engineering Vol. – II), Khanna Publishers, New Delhi
4. Metcalf and Eddy, Wastewater Engineering: Treatment, disposal, and reuse. TMH,New Delhi.
5. Wastewater Treatment Concept and design approach – G.L. Karia and R.A. Christian, PHI Publications

6CE5-12: Design of Bridge Structures

Credit: 2Max **Marks: 100 (IA=30, ETE=70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To learn the components of bridges, classification of bridges, importance of bridges and to understand the investigation for bridges.
2. To study the specification of road bridges and design loads.
3. To familiarize students with various types of bridges and their design procedure.
4. To get exposure to evaluation of sub structures and foundations.
5. To understand the importance of bearings, expansion and construction joints in bridges.

Course Outcomes: Upon completion of this course the students will be:

1. Having knowledge of components of bridges, classification of bridges, importance of bridges and understand the methods of investigation for bridges, subsoil exploration, choice of bridge type.
2. Having understanding of specification of road bridges and loads to be considered.
3. Familiar with various types of bridges such as slab-bridge, T-beam bridge, continuous bridge, balanced cantilever bridge, arch bridge, box girder bridge and design procedure of slab and T-girder bridges.
4. Able to evaluate sub-structures and foundations.
5. Familiar with importance of bearings, expansion and construction joints.

S.N.	Contents	Hours
1	**Introduction:** Historical development of Bridge – Components of Bridges – Classification – Importance of Bridges – Investigation for Bridges – Selection of Bridge site – Economical span – Location of piers and abutments – Subsoil exploration – Scour depth – Traffic projection – Choice of bridge type.	6
2	**Specification of road bridges:** Width of carriageway – Loads to be considered - Dead load – IRC standard live load – Impact effect.	3
3	**General design considerations:** Design of Slab Bridge – Design of T-beam bridge. Overview on: Continuous bridge – Balanced cantilever bridge- Arch Bridge – Box girder bridge decks.	9
4	**Evaluation of sub-structures:** Pier, abutment and their caps, Design of pier, Types of foundations.	6

5	**Bearings and joints:** Importance of Bearings – Types of bearings, their advantages and limitations- Uses of different types of bearings; Joints – Expansion joints- Construction joints.	4
	Total	**28**

SUGGESTED READINGS

1. Ponnuswamy, S. (2017). Bridge Engineering, Tata McGraw – Hill, New Delhi.
2. Victor, D. J (2019). Essentials of Bridge Engineering, Oxford and IBH Publishers Co., New Delhi.
3. Design of Bridge Structures - Jagadeesh. T. R. and Jayaram. M. A. - Prentice Hall of India Pvt. Ltd..
4. Raina. V. K (2014). Concrete Bridge Practice: Analysis, Design & Economics, Tata McGraw Hill Publishing Company, New Delhi.

6CE5-13: Introduction to Structural Dynamics and Earthquake Engineering

Credit: 2Max **Marks: 100 (IA=30, ETE=70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. Learn fundamentals of vibrations of SDOF, MDOF and continuous systems.
2. Analyze concrete structures subjected to dynamic behavior.
3. Analyze structures subjected to earthquake excitations.

Course Outcomes: Upon completion of this course the students will be able to:

1. Analyze (SDOF) systems and for multi-degree of freedom systems (MDOF) and evaluate their free vibration characteristics.
2. Evaluate the response of SDOF and MDOF systems subjected to forced vibrations.
3. Appreciate the need and role of engineering seismology concepts in building design.
4. Describe the construction of response/design spectra and be able to apply these for seismic analysis.

S.N.	Contents	Hours
1	**Dynamic systems with SDOF:** Analysis of single-degree-of-freedom (SDOF) systems, characterization of SDOF in relevant civil structural examples (water tanks, single storey frame etc.); Equation of motions; Free and forced vibration; Response to harmonic and general dynamic loading.	5
2	**Dynamic system with MDOF:** Analysis of multi-degrees-of-freedom system, relevant civil structural examples; Modal damping and classical damping, damping in relevant civil structural system; Systems with distributed mass and elasticity, relevant floor system example in multistorey building.	5
3	**Introduction to Seismology** Causes of earthquakes; seismic waves; focus, magnitude, and intensity; terms used in seismology; role of a seismologist and an earthquake engineer; characteristics of strong ground motions; translational and rotational components of ground motions; introduction to earthquake measuring instruments. Earthquake as source of dynamic force in structural systems, lessons from past earthquakes, Importance of dynamic analysis in structural systems and inclusion in relevant codes.	6
4	**Response Spectrum and analysis** Concepts of spectral quantities and response spectrum; Response history and response spectrum analysis, IS 1893: PART 1 (2016) code provisions, Calculations of lateral forces due to earthquake on simple framed-buildings/structures	6

5	**Introduction to earthquake resistant design practices** Earthquake design philosophy; Earthquake Resistant Construction: Commons seismic failure of masonry and reinforced concrete structures, Provisions for earthquake resistant construction of buildings, IS codes; IS-4326, IS-13827, IS-13828, IS-13920, IS-13935.	6
	Total	**28**

SUGGESTED READINGS

1. Chopra, A.K. (2012). Dynamics of Structures: Theory and Applications to Earthquake Engineering, 4th Edition, Prentice Hall, Englewood Cliffs, New Jersey.
2. P. Agarwal and M. Shrikhande (2010). Earthquake Resistant Design of Structures, PHI Learning Private Limited, New Delhi.
3. A. K. Chopra (2005) .Earthquake Dynamics of Structures: A Primer, Second Edition, Monograph published by Earthquake Engineering Research Institute, Oakland, Calif., 2005.
4. Dutta, T.K. (2010). Seismic Analysis of Structures, John Wiley & Sons (Asia) Pte Ltd, Clements Loop, Singapore.
5. Clough R.W. and J. Penzien – Dynamics of Structures, McGraw-Hill.

6CE5-14: Analysis and Design of Bituminous Pavements

Credit: 2Max **Marks: 100 (IA=30, ETE=70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To familiarize with the fundamentals of pavement design
2. To introduce the analysis of stress and strain in pavement layers
3. To understand the basic concept of traffic characteristics
4. To evaluate the influence of climate variation on material properties
5. To introduce the various methods of pavement design
6. To demonstrate the use of Kenlayer software for stress and strain analysis in pavement design

Course Outcomes: Upon completion of this course the students will be able to:

1. To analyze and interpret different combinations of pavement cross-sections and design
2. To conduct structural analysis of two-layered and multi-layered pavement structures
3. To develop an understanding of traffic characteristics
4. To gain knowledge of material characteristics with climate variation
5. To learn aspects associated with pavement design.
6. To gain hands-on experience in utilizing Kenlayer software for stress and strain analysis in pavement design

S.N.	Contents	Hours
1	Overview of pavement design/distress – Pavement cross-sections with different combinations of layers and their functions. Pavement distress considered for design – Rutting/Fatigue damage/Temperature cracking/Moisture damage/IRI	4
2	Single-layer stress-strain analysis – Introducing three-dimensional stress functions, Layered structure analysis - Boussinesq equation and numerical to determine stresses and strain at different locations of the layers Two-layered and multi-layered structural analysis and determination of stresses and strain for a different combination of layers with numerical examples	8
3	Traffic characteristics – Traffic volume, growth rate, lane distribution factor, modal distribution, Axle configuration, Equivalent single wheel load for different criteria and Equivalent wheel load factor, Axle load survey, distribution, Truck factors, ESAL and computation of the number of repetitions with numerical examples	6
4	Material and climate – Soil characteristics, granular material characteristics, and bituminous material characteristics, Climate variation, estimation and prediction model, Influence of climate in material characteristic functions.	5

5	AASHTO method of pavement design - 1993 and Reliability of pavement design, Distress transfer functions and damage accumulation, IRC37 guidelines for flexible pavement design and IITPAVE software, Design examples based on the IRC37 method of pavement design, Kenlayer software for the stress, strain analysis	5
	Total	**28**

SUGGESTED READINGS

1. Yang Huang,(2004). Pavement Analysis and Design, Pearson..
2. IRC37-2018, Guidelines for the design of flexible pavements, Indian Roads Congress, 2018.

6CE5-15: Water Resources Management

Credit: 2Max **Marks: 100 (IA=30, ETE=70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To learn how to manage water resources management.
2. Demonstrate and understanding the sustainable approaches in water resources development.
3. To launch the skillful techniques on application for water resource management.
4. To understanding the water economics, conflicts and policy.

Course Outcomes: Upon completion of this course the students will be able to:

1. Enable to explain basic principle of water resources management.
2. Understand the basic concept of rain water harvesting scheme and methods.
3. Have knowledge of watershed development and management.
4. Have knowledge of water economics, conflicts and policy.

S.N.	Contents	Hours
1	**Water Resources and Sustainable Development:** Importance of Natural Resources – Different Types Resources, Significance of Water Resources and their uses. Brief account of concept of water stress, scarcity, water footprint and virtual water trade, Concept and overview of National Water Mission.	6
2	**Water Harvesting and Watershed:** Necessity of Rain water harvesting, Importance of Rain water harvesting, Rain water harvesting methods (Chekdam, Trenches, Roof harvesting, Vegetation and plantation etc.), Conservation of water and recycling of the water, Storing the rain water in tanks and recharging ground water. Watershed Development - Concept of 'watershed', Characteristic of watershed, Watershed management & people's participation.	8
3	**Water Economics:** Valuing of water: The use and non-use values of water, Introduction to water valuation methods: Non-revenue waters (NRW) and unaccounted for water (UFW); Metering water uses; Water management through economic instruments. Water Pricing - Approach and Models: Significance of water pricing Water pricing models - flat rate and uniform rate, Brief account of water pricing practices in India and abroad.	7
4	**Water Governance, Conflicts and Policy:** Water Governance: Elements and dimensions of water governance; Effective water governance schemes; Indicators of good governance. Water Governance in India: Salient features of National water policy (Regulation and Management Acts), Conflicts in Water	7

	Pricing: Conflicts on subsidy verses sustainability, overview of global water conflicts and interstate water conflicts in India.	
	Total	**28**

SUGGESTED READINGS

1. Satyanarayan Murthy C. (2020). Water Resources Engineering: Principles & Practice, New Age International Ltd., New Delhi.
2. Colin H. Green (2003). Handbook of Water Economics: Principles and Practice, Publisher – Willy.
3. Ariel Dinar and Kurt Schwabe (2015). Handbook of Water Economics, Publisher - Edward Elgar.
4. Ramaswamy R. Iyer (2009). Water and the Laws in India, Publisher - SAGE Publications
5. Chandrakanth M.G. (2015). Water Resource Economics: Towards a Sustainable Use of Water for Irrigation in India Publisher - Springer.
6. A. Gunawansa and L. Bhullar (editors) (2013). Water Governance: An Evaluation of Alternative Architectures, Publisher - Edward Elgar.
7. Vedula S. and Mujumdar, P.P. (2005). Water Resources Systems, Tata McGraw.

6CE4-20: Structural Design and Detailing

Credit: 1.5Max **Marks: 100 (IA=60, ETE=40)**

0L+0T+3P

Course Objectives

1. Introduce structural modeling of reinforced concrete (RC) and steel structures.
2. Teach member and joint detailing required for RC and steel elements.
3. Introduce the ductile detailing requirement, IS code recommendations and practical intricacies involved in casting or fabrication of members.

Course Outcomes: Upon completion of this course the students will be able to:

1. Perform structural analysis,
2. Do design and detailing of simple RC and steel structures.

S.N.	Contents	Hours
1.	Detailing of various RC members and Connection detailing	2
2.	RC members detailing for ductility and drawings.	2
3.	Bar bending schedule.	2
4.	Develop a computer model of reinforced concrete (RC) real-life structure; Loads, Load combinations. Analyze the modeled RC structure under load combinations.	4
5.	Steel member and connection detailing	2
6.	Welding and bolting details, finishing.	2
7.	Steel members detailing for ductility and drawings.	2
8.	Gusset plate design and sizing.	2
9.	Develop a computer model of real-life steel structure; Loads, Load combinations. Analyze the model steel structure under multiple load combinations	4

SUGGESTED READINGS

1. IS 875: Code of practice for design loads (other than earthquake) for buildings and structures, All Parts Concrete: Year - Latest Edition
2. IS 456: General Construction in Concrete - Code of Practice
3. SP 16: Design Aids for Reinforced Concrete to IS 456
4. SP 24: Explanatory Handbook on Indian Standard Code of Practice for Plain and Reinforced Concrete
5. SP 34: Handbook on Concrete Reinforcement and Detailing
6. SP 43: 1987 Handbook on Structures with Reinforced Concrete Portal Frames (Without Cranes)

7. IS 2502: Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
8. IS 5525: Recommendations for Detailing of Reinforcement in Reinforced Concrete Works
9. IS 13920: Ductile detailing of reinforced concrete structures subjected to seismic forces.
10. IS 800: General Construction in Steel - Code of Practice SP 6: Handbook for structural engineers, All Parts
11. SP 38: Handbook of Typified Designs for Structures with Steel Roof Trusses (with and without Cranes)
12. SP 40: Handbook on Structures with Steel Portal Frames
13. SP 47: Handbook on Structures with Steel Lattice Portal Frames (Without Cranes)
14. N. Krishna Raju, "Structural Design and Drawing – Reinforced Concrete and Steel", Universities Press, 2005.
15. M. L. Gambhir, "Design of Reinforced Concrete Structures", PHI Learning, 2009.
16. Subramanian, N (2016). "Design of Steel Structures – LIMIT STATE METHOD", Oxford Higher Education, ISBN10 - 9780199460915.

RESOURCES REQUIRED FOR THE COURSE

1. Software for drawings – AutoCAD, Revit etc.
2. Software for analysis/design, STAAD Pro, SAP2000, ETABS etc.
3. Hardware – Computers

6CE4-21: Design of Hydraulic Structures Lab

Credit: 1.5Max **Marks: 100 (IA=60, ETE=40)**

0L+0T+2P

Course Objectives

1. Understanding nature of various dams and actions forces acting on dams
2. Stability analysis and design of Gravity and Embankment dams under various hydraulic conditions
3. Understanding various types of spillways, their functions and designs.
4. Knowledge and design of cross drainage works.

Course Outcomes: Upon completion of this course the students will be able to:

1. Calculate forces and stresses on gravity dam and check various factor of safety.
2. Check the stability analysis and design Gravity & Earth dams.
3. Design spillways, falls, canal head regulators and canal outlets.
4. Design various types of cross drainage structures.

S.N.	Contents	Hours
1.	Computation of Forces acting on a Gravity Dam under different Combinations	
2.	Stability Analysis and Design of a Gravity Dam.	
3.	Computation of Forces, slope stability analysis and Design of an Earth Dam.	
4.	Design of Ogee Spillway, Profile of Ogee Spillway.	
5.	Design of Chute spillway.	
6.	Hydraulics design of Canan falls.	
7.	Design of Canal Head Regulators, Cross regulators, Canal outlets.	
8.	Design of various types of cross drainage structure- aqueducts, syphon aqueduct, super-passage syphon	
	Total	

SUGGESTED READINGS

1. Arora, K.R., (2010). Irrigation Water Power and Water Resources Engineering, Standard Publishers Distributors, Delhi.
2. Garg, S.K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers, Delhi.
3. Asawa G L (2005). Irrigation and Water Resources Engineering, New Age Int. Ltd. Delhi.
4. Modi, P.N.(2020). Introduction to Water Resources and Waterpower Engineering, Standard Publication, Delhi.
5. Sharma S K (2017). Irrigation Engineering and Hydraulic Structures, S Chand, New Delhi.
6. Willi H. Hager, Robert M. Boes, Michael Pfister, Anton J. Schleiss (2020). Hydraulic Engineering of Dams, CRC Press, London.

7. Rajnikant M Khatsuria (2005). Hydraulics of Spillways and Energy Dissipators, CRC Press, London
8. Varshney, R.S., Gupta S.C. & Gupta R.L. (2009). Theory and Design of Hydraulic Structures Vol. 1 and 2, Nemi Chand and Bro. New Delhi.