SEVENTH SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
PC	20CV701	Design and Detailing of Steel and RC Structures	2-0-2	4	6
PC	20CV702	Design of Bridges and Flyovers	3-0-0	3	3
PC	20CV703	Specifications and Quantity Surveying	3-0-0	3	3
PC	20CV704	Prestressed Concrete Structures	4-0-0	4	4
PC	**20CV75X**	**Professional Elective-3**	**3-0-0**	**3**	**3**
PC	**20CV76X**	**Professional Elective-4**	**3-0-0**	**3**	**3**
PC	**20CV708**	**Environmental Engineering Laboratory**	**0-0-2**	**1**	**2**
PC	**20CV709**	**Mini Project-2**	**0-0-4**	**2**	**8**
OEC	**20SWCV8**	**SWAYAM-2**	**0-0-0**	**0**	**0**
OE	**20OECV7X**	**Open Elective**	**3-0-0**	**3**	**3**
			Total	**26**	**35**

AE: Ability Enhancement Course; OE: Open Elective

EIGHTH SEMESTER					
Course Category and Course Code		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
PC	20CV801	Seminar	**0-0-2**	**1**	**2**
PI	**20CV802**	**Project work**	**0-0-18**	**9**	**18**
PI	**20CV803**	**Internship**	**0-0-2**	**1**	**-**
PC	**20CV804**	**Construction Planning and Management**	**3-0-0**	**3**	**3**
PC	**20CV806**	**Building Information Modeling**	**0-0-2**	**1**	**2**
PC	**20CV85X**	**Professional Elective-5**	**3-0-0**	**3**	**3**
				18	**28**

Course Code- 20CV701 **L-T-P-C 2-0-4-4**
CIE -50marks **Hours/week-3**
SEE -50 marks **Exam duration = 4Hr**

DESIGN AND DETAILING OF STEEL AND RC STRUCTURES

COs	At the end of the course the student will be able to:	Mapping to POs
CO1	Analyze and design steel structural components	PO2, PO3, PO8
CO2	Analyze and design RC structural components	PO2, PO3, PO8
CO3	Know the importance of detailing of steel structural components especially in terms of connection details	PO1, PO2, PO5
CO4	Illustrate bar bending details and determine total quantity of concrete and steel for a given RC structural element	PO1, PO5, PO8

MODULE–1: Steel Structures

Design and Detailing of Plate girder, Roof Trusses, member forces should be given Grillage Foundation The connections in all the above structures shall be welded connections only. **20 Hrs**

Self-study component: Students shall visit different types of Steel structures within the campus and identify different types structural connections and submit a report.

MODULE–2: Reinforced Concrete Structures

Design and detailing of Circular and Rectangular water tanks resting on ground with fixed base and without top cover Cantilever retaining walls, Combined footing (rectangular) slab and beam type only. Water tanks shall be designed as per relevant IS guidelines. The design of cantilever retaining wall and combined footings shall be by the limit state method. **32 Hrs**

Self-study component: Students shall visit different types of RC structures within the campus and out-side the campus and identify detailing in terms of bar bending for water tanks, retaining walls and combined footings; prepare a report and submit.

Text Books:

1. Ramamrutham.S “Design of Reinforced Concrete Structures” Dhanpath Rai & Sons,2009
2. Punmia, B.C., “Reinforced Concrete Structures” Vol. 1 & 2 Laxmi Publication Pvt. Ltd.,2010

Reference Books:

1. Clyder T Morris “Designing and Detailing of Simple Steel Structures” Little field press USA 2008 (Part1)
2. Krishnamurthy – Structural Design and Drawing (Concrete Structures) CBS publishers, New Delhi 1985(Part-2)
3. Krishna Raj.N “Structural Design and Drawing Reinforced Concrete and Steel” Universities Press,Hyderabad2009
4. IS 3370 (part 4) 1967, IS 456 - 2000, IS 800 - 2007, SP 16, BIS New Delhi

Question Paper Pattern: Two questions from Module-I of 40 Marks (25 marks for Design and 15 marks for Detailing) each, two questions from Module-II of 60 Marks (35 marks for Design and 25 marks for Detailing) each shall be set. The student has to answer one question from each part.

SEE: Duration 04 hrs including use of Drafting software both RCC & Steel (Theory Examination).

Course Code- 20CV702 **L-T-P-C 3-0-0-3**
CIE -50marks **Hours/week-3**
SEE -50 marks **Exam duration = 3Hrs**

DESIGN OF BRIDGES AND FLYOVERS

COs	At the end of the course the student will be able to:	Mapping to POs
CO1	Gain fundamental knowledge about bridges-their components, Compute the design discharge for a given bridge site	PO1, PO2 PO3
CO2	Compare the types of abutments and piers - compute the forces acting on them	PO1, PO2 PO3
CO3	Comprehend the design of slab culvert and pipe culvert for given IRC loading	PO1, PO3, PO5
CO4	Comprehend the design of RC- T beam bridge and steel composite bridge for given IRC loading	PO1, PO2, PO3, PO5

Module -1

Introduction: Definition of a bridge - Components of a bridge and a flyover - Classification of bridges and flyovers - Requirements of an ideal bridge- Forces to be considered for the design of bridges and flyovers - IRC loading standards- Impact effect**. Hydraulic Design:** Design discharge- Afflux, Natural waterway- Linear waterway -Economic span. **10Hrs.**

Self-study component: Students shall visit different types of bridges and flyovers and identify the various components, types of bridges, water way and number of spans etc., prepare a report and submit.

Module -2

Substructures: Abutments, Piers - Wing walls- Forces on substructures- Stability Considerations - Empirical design. **Foundations:** Depth of foundation – Pile and well foundation - Depth of scour**.** **10 Hrs.**

Self-study component: Students shall visit a typical bridge construction site and identify the substructures and type of foundation, prepare a report and submit.

Module -3

RC Slab Culverts: Design of superstructure for IRC class AA loading. **Pipe Culverts:** Design for both shallow and deep embankment for IRC class AA wheel loading. **11Hrs.**

Self-study component: Students shall visit a typical slab culvert and pipe culvert construction sites and identify various components, prepare a report and submit. They shall also observe the type of vehicular loading on the Culverts.

Module -4

RC T Beam Bridge: Design of slab by using Pigeaud's curves- Design of longitudinal girders by Morice Little method for IRC class AA or 70R loading. **Composite Bridge:** Design of RC slab and steel girder for equivalent loading- Design of shear connectors. **Flyovers:** Introduction, Advantages and disadvantages, types of flyover bridges, simple flyover design. **11 Hrs.**
(Drawings of bridges providing all details shall be given asassignment)

Self-study component: Students shall visit a typical RC T Beam Bridge and composite bridge and identify the components and, prepare a report and submit. They shall also observe the type of vehicular loading on the above- mentioned bridges.

Text Books:

1. Jhonson Victor. “Essentials of Bridge Engineering” Oxford IBH Publication 2008 (Ch. 1, 4, 5 & 7).
2. Bindra S.P. “Principles and Practice of Bridge Engineering” Dhanapat Rai Publications 2008 (Ch. 2, 3, 6&8).

Reference Books:

1. Krishna Raju N. “Design of Bridges” Oxford IBHPublication2008
2. Jagadeesh, T. R. & Jayaram, M. A. “Design of Bridge Structure” II Edn. PHI Learning Pvt.Ltd., 2009
3. IRC 21- R2000

Relevant Design charts to be supplied in SEE

Course Code- 20CV703 **L-T-P-C 3-0-0-3**
CIE -50marks **Hours/week-3**
SEE -50 marks **Exam duration =3Hrs**

SPECIFICATIONS AND QUANTITY SURVEYING

COs	At the end of the course the student will be able to:	Mapping to POs
CO1	Comprehend theimportanceof estimationand specifications with different types of contracts and check measurement and bill preparations for a given project.	PO1, PO2, PO6, PO7
CO2	Determine the quantities of various items identified in a project for given specifications	PO2, PO6, PO7
CO3	Apply long wall and short wall method and centerline method for calculating quantities	PO1, PO2, PO6
CO4	Conduct rate analysis for standard items with given specifications	PO1, PO6, PO7

Module -1

Introduction - Different type of estimates — Study of various drawings attached with estimates- important terms, units of measurement — abstract — approximate methods of estimating cost of buildings. **Estimating** - Methods of taking out quantities and cost — center line method— long and short wall method or crossing method — Preparation of detailed and abstract estimates for the following Civil Engineering works: Buildings framed structures with flat or sloped RCC slabs and Masonry structures. **12Hrs**

Self-study component: Students shall visit a building under construction and observe how the center line is marked and find the total length of the centre line. They shall also identify the long walls, short walls and intersection points of the walls. They shall observe the progressive construction of masonry and RC components, prepare a report and submit.

Module -2

Estimating; Building components: Beams - Columns, Column Footings, stair cases and retaining walls**. Estimating** - Steel trusses, A.C. Sheet and G.I. Sheet roofs, RCC slab culverts, pipe culverts, metal led roads, C.C. track way, premix carpeting, stabilized soil roads, manholes and septic tanks **10Hrs**

Module -3

Rate Analysis - Definition and purpose — Working out quantities and rates as per CPWD standards for the following standard items of work: earthwork indifferent types of soils— cement concrete of different mixes, brick and stone masonry, flooring — plastering— RCC works, painting, white washing and distempering**. Computation of Earthwork in cuttings and embankments for Roads and canals** - Methods of computation of earthwork — cross-sections — mid section formula — trapezoidal or average end area or mean sectional area formula — prismoidal formula- for different terrains. **10Hrs**

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Module -4

Specifications: Definition of specifications — objective of writing specifications — essentials of specifications — general and detailed specifications of various items of work in buildings. **Contracts** - Types of contract — essentials of contract agreement-legal aspects- penal provisions on breach of contract — Definition of the terms — Tender — earnest money deposit— security deposit — tender

forms—documents and types— Comparative statements — acceptance of contract documents and issue of work orders- Duties and liabilities- termination of contract—completioncertificate-qualitycontrol—rightsofcontractor—refundofdeposit Administrative approval— Technical sanction—Nominal muster roll— measurement books — procedure for recording and checking measurements — preparation of bills. **10Hrs**

Self-study component: Students shall visit a building under construction. They will go through the estimates in detail by including the measurement of actuals at site along with working drawings, contract details, specifications, rate of various components like materials, Labor, machinery, prepare a report and submit. Ready software packages may be used to prepare for the estimates.

Text Books:

1. Datta, B. N. "Estimating and Costing in Civil Engineering" UBS Publications 7thReprint - twenty sixth revised ed.2009
2. Chakraborti, N. "Estimating, Costing, Specification and Valuation", published by the author, ninthedition.1987

Reference Books:

1. Bhasin, P. L. "Quantity Surveying" S. Chand & Co., New Delhi.2006
2. Kohli, D. D. and Kohli, R. C. A text book on "Estimating, Costing and Accounts" - S. Chand Co., New Delhi. 2008.
3. PWD SR (HassanCircle)
4. National Building Code (NBC), Bureau of IndianStandards.

Examination Question Pattern:

MODULE-1 [Compulsory] One Question for 40 marks shall be set from topic no. 1 and 2.

MODULE-2, 3 & 4 - Six Questions carrying 15 marks each shall be set from topics 3, 4, 5, 6, 7 and 8. Students shall be asked to answer any four questions from Module 2, 3 & 4.

Course Code- 20CV704 **L-T-P-C 4-0-0-4**

CIE -50marks **Hours/week-4**

SEE -50 marks **Exam duration = 3Hrs**

PRESTRESSED CONCRETE STRUCTURES

COs	At the end of the course the student will be able to:	Mapping to POs
CO1	Enumerate the concept of prestressing and analysis of PSC sections	PO2, PO3, PO4
CO2	Estimate the loss of prestress due to various reasons	PO2, PO4
CO3	Evaluate deflection, flexural strength & shear capacity of PSC members	PO1, PO4
CO4	Design PSC sections by limit state method & blocks as per IS codal provisions	PO3, PO4.PO8

Module-1

Introduction & fundamentals– Definition of pre stressing & pre stressed concrete, comparison & advantages over RCC, High Strength materials, necessity, properties, Difference between pre tensioning and post tensioning systems, analysis of prestress - resultant stress concept, pressure line concept, load balancing concept. **15hrs**

Self-study component: Students shall visit nearby factory producing pre tensioned electric poles and observe the method of pre tensioning materials used and testing of products, prepare a report and submit.

Module-2

Variation of stresses - Variation of stress in steel in bonded and unbonded beams, Cracking moment, **Losses of Pre stress** – Types of losses in pre tensioning and post tensioning. Determination of losses due to various causes. **13hrs**

Self-study component: Students shall visit nearby factory producing pre tensioned electric poles and observe the method of pre tensioning materials used and testing of products, prepare a report and submit.

Module-3

Deflection of Pre-stressed Members – Short term and long-term deflections, deflections at transfer & working load stage, codal provisions, **Flexural Strength and Shear Capacity** - IS recommendations, ultimate flexural strength, ultimate shear resistance, shear reinforcement as per IS codal provisions. **12hrs**

Self-study component: Students shall visit a construction site comprising post tensioning of beams and slabs and collect the details, prepare a report and submit.

Module-4

Design of PSC Beams - Permissible stresses, design of symmetrical and unsymmetrical sections, **Anchorage Zone and End Blocks** – Transmission of pre stress in pre tensioning systems, transmission length, anchorage stresses in post tensioning systems, end blocks, design of end blocks by IS Method **12hrs**

Self-study component: Students shall visit a construction site comprising post tentioning of beams and slabs and collect the details of Anchorage zone End blocks, prepare a report and submit.

Textbooks:

1. Sinha, N. C. & Roy, S. K. “Fundamentals of Pre stressed Concrete” ,S. Chand. Co New Delhi, 1997 [Ch.1,2]
2. Krishnaraju, N. “Prestressed Concrete” Tata McGraw Hill, New Delhi.2007 [Ch.1 to 14) Ninth reprint 2010.

Reference Books:

1. Dayaratnam.P, 1996, “Prestressed Concrete Structures” oxford – IBH publishers -, ISBN-13: 9788120400450.
2. LiN .T.Y, Margy Burns,1981, ‘Design of Prestressed Concrete Structures. John Willey & Sons-,ISBN 0-471-01898-8.
3. Rajagopalan.N,2005, “Design of Prestressed Concrete Structure”, BIS New Delhi, ISBN-13: 9781842652121.
4. Muthu K U., Ibrahim Azmi,Janardhana Maganti Vijayanand M (2016),Prestressed Concrete, ISBN-13: 9788120351691.
5. IS 1343-2000, “Prestressed concrete structure-Code of practice”, BIS New Delhi.

Course Code- 20CV751 **L-T-P-C 3-0-0-3**
CIE -50marks **Hours/week-3**
SEE -50 marks **Exam duration = 3Hrs**

RAILWAY, HARBOUR AND AIRPORT ENGINEERING

COs	At the end of the course the student will be able to:	Mapping to POs
CO1	Understand the history and development, role of railways & learn different types of structural components, engineering properties of the materials, to calculate the material quantities required for construction	PO1, PO3, PO4
CO2	Understand various aspects of geometric elements, construction techniques and significance of maintenance of tracks.	PO1, PO2, PO4,
CO3	Understand various components of harbour, wave action and design of harbour structures	PO2, PO4, PO5
CO4	Comprehend the concepts of airport planning, geometric design of runway and taxiway	PO3, PO4

MODULE - 1

Railway: Role of railways in transportation, Historical developments of railways in India, Selection of routes - preliminary and locations surveys. **Permanent way**: Rail – functions and types, sleeper – functions and requirements, ballast – functions, requirements and types. Guages, cross section of permanent way, coning of wheel, creep of rail, rail damage – defects, failures and wear of rail. Fixtures and fastenings, rail joints, calculation of quantity of materials needed for laying of tracks. Traction and tractive resistances – tractive power and Hauling capacity. **11 Hrs.**

Self-study component: Students shall visit nearby Railway and Metro stations and observe the components of railway track, rail joints, sleepers and other details, prepare a report and submit.

MODULE - 2

Construction and Maintenance: Construction – earth work – formation and consolidation, plate laying, laying of ballast. Maintenance – necessity, advantages, conventional method and modern method. **Station and Yards**: Railway station – site selection, requirements, classification. Types of yards. **Geometric Design of Track**: gradient – necessity, ruling gradient, pusher gradient, momentum gradient, gradients in station yards. superelevation– cant deficiency and negative cant. Curves – necessity, types, transition curve – objectives and requirement **11Hrs**

Self-study component: Students shall visit nearby Railway station and discuss with the railway staff regarding track maintenance, ruling gradient, speed of train, prepare a report and submit.

MODULE – 3

Harbour Engineering: Water transportation – inland and ocean. Harbour – components, classification, requirements and site selection. Wave – origin, wave action on coastal structure and coastal protection works. Harbour Structures and their design. **09Hrs**

Self-study component: Students shall collect the material from internet on typical details of an Harbour and Airport and identify various components and other relevant details, prepare a report and submit.

MODULE – 4

Airport Planning: air transportation – role, advantages and limitations. Airport – components, site selection, classification and regional planning. Aircraft characteristics. **Runway Design**: Analysis of wind data by wind rose diagram to find out the best direction of runway. Basic patterns of runway, basic runway length – correction to runway length by ICAO and FAA specifications. Runway geometric design. **Taxiway Design**: Factors affecting layout of taxiway, Geometric design of Taxiway, turning radius of taxiways as per ICAO. Design of exit taxiway. Instrumental landing system **11 Hrs**

Self-study component: Students shall collect the material from internet on typical details of Airport markings, prepare a report and submit.

Text Books:

1. Saxena and Arora "Railway Engineering" Dhanpath Rai and Sons, New Delhi - 2005 (Ch. 1,2,3,4)
2. Khanna, Arora and Jain "Airport Planning and Design" Nemchand and Bros, Roorkee, 2006 (Ch.5,6,7,8)
3. Venkatramaiah, C. "Transportation Engineering", Volume II: Railways, Airports, Docks and Harbours.

Reference Books:

1. Agarwal, M. M. "Indian Railway Track" Jaico publications, Bombay –2003
2. Kadiyali, L. R. and Chopra, "Highway and Airport Engineering" Nemchand and Bros. – Roorkee,2005.

Course Code- 20CV752 **L-T-P-C 3-0-0-3**
CIE -50marks **Hours/week-3**
SEE -50 marks **Exam duration = 3Hrs**

STRUCTURAL DYNAMICS

COs	At the end of the course the student will be able to:	Mapping to POs
CO1	Comprehend principles of vibration and elementary components of a vibratory system, analyze undamped and dampedfree vibration of a single degree of freedom system	PO1, PO2, PO3
CO2	Analyze undamped and damped forced vibration of a single degree of freedom system	PO2, PO3, PO4
CO3	Comprehend the response of SDOF to general system of loading	PO2, PO3, PO4, PO5
CO4	Analyze MDOF systems	PO2, PO3, PO4, PO5

MODULE-1

Introduction; Laws of motion, D' Alembert's Principle, Stiffness of springs in series and parallel, Mass moment of inertia, Simple harmonic motion, Definition of vibration – Parts of a vibrating system –Degrees of freedom – Types of vibration. **Free vibration;** Undamped and damped free vibration of a single degree of freedom system–Logarithmic decrement**.** **11Hrs**

Self-study component: Students shall collect material from the internet on fundamentals of dynamics and free vibration, prepare a report and submit.

MODULE-2

Forced Vibration; Undamped and damped forced vibration of a single degree of freedom system – Steady state response, Dynamic magnification factor, response to harmonic loading. **Forced vibration (cont'd)**; Rotational and reciprocating unbalance, Force transmissibility, Force transferred to the foundation. **11Hrs**

Self-study component: Students shall collect material from the internet on forced vibration and its effect on machine foundation. prepare a report and submit.

MODULE-3

SDOF subjected to base excitation; Harmonic base excitation, Vibration isolation, Vibration measuring instruments. **Response of SDOF for general System of loading (undamped);** Duhamel' Integral – dynamic load factor for step, rectangular, ramp and triangular input. **11Hrs**

Self-study component: Students shall collect material from the internet on fundamentals of vibration isolation, vibration measuring instruments and response of a SDOF system. prepare a report and submit.

MODULE-4

MDOF Systems: Free vibration – natural frequencies – Orthogonality principle. Eigen values and Eigen vectors, Shear buildings modeled as MDOF systems. **MDOF Systems (Cont'd);** Forced undamped and damped vibration of shear buildings – Modal superposition method – Response to harmonic excitation only. **11Hrs**

Self-study component: Students shall observe the demonstration of vibration of MDOF system, and collect material from the internet on fundamentals of MDOF systems subjected to both forced undamped and damped vibrations. prepare a report and submit.

Text Books:

1. Mukhopadhya, M. “Vibrations, Dynamics and Structural Systems” Oxford IBH Publications, 2000 (Ch. 1, 2, &8)
2. Mario Paz, “Structural Dynamics” CBS Publishers, 2004 (Ch. 3, 4, 5, 6 &7)

Reference Books:

1. Clough & Penzien. “Dynamics of Structures” McGraw Hill Publishers2004
2. Anil K. Chopra, “Dynamics of Structures” PHI Publishers2006

Course Code- 20CV753 **L-T-P-C 3-0-0-3**
CIE -50marks **Hours/week-3**
SEE -50 marks **Exam duration = 3Hrs**

ADVANCED FOUNDATION DESIGN

COs	At the end of the course the student will be able to:	Mapping to POs
CO1	Comprehend factors affecting bearing capacity and settlement of foundation. Design of various kinds of shallow footing.	PO1, PO3, PO4, PO5
CO2	Comprehend need for pile foundation, efficiency of piles, construction of drilled piles	PO2, PO4, PO5
CO3	Comprehend types of caissons and design aspects of caissons and well foundations	PO1, PO3, PO4, PO5
CO4	Identify expansive soils, foundation treatment, design of machine foundations	PO2, PO4, PO5, PO7

MODULE 1

Shallow Foundations- Presumptive bearing capacity according to BIS – Factors affecting bearing capacity and settlement – Factors influencing selection of depth of foundation – Problems on settlement-Principles of design of footings _ Design of Isolated footing – Combined footing – Strap footing – Strip footing and raft (proportioning only). Foundations on Expansive Soils-identification of expansive soils – foundation treatment for structures on expansive soils. **14 Hrs**

Self-study component: Students shall visit construction sites and observe the type of foundation adopted for a given design situations

MODULE 2

Deep Foundations - Pile groups – Number of piles and spacing – group capacity of piles – group efficiency of piles – settlement of piles – negative skin friction and under reamed piles. Drilled Piers: Introduction – Construction – Advantages and disadvantages of drilled piers

10 Hrs

Self-study component: Students shall visit construction sites and observe pile driving, pile testing and drilled piers.

MODULE 3

Caissons and well foundation- Caissons - Introduction – Types of Caissons – Design aspects of caissons – Construction of open, pneumatic and floating caissons – their advantages and disadvantages – Well Foundation: Shapes of wells – components of well foundation and their design aspects – forces acting on a well foundation – Sinking of wells– causes and remedies of tilts and shifts **10 Hrs**

Self-study component: Students shall visit a bridge construction site and observe the components of caissons and well foundation.

MODULE 4

Machine Foundations – Dynamic Soil Properties, Machine Foundations - Introduction – Types of machine foundations –Basic definitions – Degrees of Freedom of a block foundation – general criteria for design of machine Foundation - free and forced vibrations – vibration analysis of a machine Foundation – Determination of natural frequency - vibration isolation and control **10 Hrs**

Self-study component: Students shall visit a construction site and observe the behaviour of a typical expansive soil and the measures taken to treat the same - collect the material from the internet on behavior and performance of machine foundation.

Text Books:

1. Arora, K. R. "Soil Mechanics and Foundation Engineering" Standard Publishers Distributors, Delhi, Fifth edition 2001(Ch.1,2,3,4,5,6,8)
2. Gopal Ranjan & Rao. A. S. R "Basic and Applied Soil Mechanics" New Age International Publishers, 2nd edition 2006(Ch.1,2,3,6,7,8)

Reference Books:

1. Punmia, B. C., Ashok Kumar Jain, Arun Kumar Jain "Soil Mechanics and Foundations" Laxmi Publications (P) ltd, 16thedition Oct. 2008(Ch.1,2,3,6,8)
2. Venkataramaiah, C "Geotechnical Engineering" New Age International Publishers, 3rdedition 2006 (ch.1,2,3,5,6,8)
3. Srinivasulu, P and Vaidyanathan, C. V. (2017). Handbook on machine foundations. Tata McGrawHill.

Course Code- 20CV754 **L-T-P-C 3-0-0-3**
CIE -50marks **Hours/week-3**
SEE -50 marks **Exam duration = 3Hrs**

ADVANCED NUMERICAL METHODS

COs	At the end of the course the student will be able to:	Mapping to POs
CO1	Solve the system of linear equations by direct methods & iterative methods, formulate storage schemes & solution of large system of linear equations by skyline storage & band solver	PO2, PO3, PO4
CO2	Obtain solution techniques for eigen-value problems	PO3, PO4
CO3	Evacuate the integrals using methods based on different methods	PO2, PO4, PO5
CO4	Solve first order differential equations by numerical methods & apply finite difference methods for the solution of differential equations	PO1, PO3, PO4

Module -1

Linear System of Equations (Direct Methods): Introduction – Cramer's Rule – Gaussian Elimination – Gauss – Jordan Method – Factorization method – conditioned matrix – sealing of a matrix – How to solve ax= b on a computer – Summary – Exercises; **Iterative Methods for Solving Linear Equations**: Introduction – Basic Ingredients –Stationary Methods: Jacobi Iteration – Computer Time Requirement for Jacobi Iteration – Gauss – Seidel Method – Relaxation Method Condition of Convergence of Iterative Method – Summary–Exercises. **10 Hrs**

Module - 2

Storage Schemes and Solution of Large System of Linear Equations: Introduction – Solution of Large sets of Equations – Band Form – Skyline storage –Solution of Band Matrix in Core – Band Solver for large number of equations – Cholesky (L), (U) Decomposition in skyline storage – Bandwidth Reduction–Frontal Solvers – Substructure Concept – Submatrix Equation Solver- Summary; **Solution Techniques for Eigen-value Problems** : Introduction – Practical problems – Methods for solution of Eigen-value problems – Methods of characteristic polynomial – Vector Iteration Techniques – Transformation Method – Transformation of the Generalized Eigen-value Problem to a standard form – Approximate solution techniques – Polynomial iteration techniques. **12 Hrs**

Module - 3

Numerical Integration: Introduction – Newton – Cotes Closed quadrature – Trapezoidal rule – Romberg – integration – Newton – Cotes Open quadrature – Gaussian quadrature – Gauss – Laguerre quadrature – Gauss – Chebyshev quadrature – Gauss – Hermite quadrature – Numerical integration using spline Monte–Carlo method for numerical integration–How to choose a method for estimating a proper integral - Discontinuities and improper integrals - Multiple integration – integration by using mapping function – Summary. Exercises. **10Hrs**

Module - 4

Solution of Ordinary First Order Differential Equations: Introduction – Initial value Problem, Reduction of n^{th} order differential equation - Difference equations – Physical problem – Taylor series – Euler method – modified Euler method – Picard method of successive approximation – Runge-Kutta methods – solution of simultaneous ordinary differential equations by Runge Kutta Methods. Predictor - Corrector method – How to select numerical integration method –Summary- Exercise; **Boundary Value Problems (Finite Difference Approach):** Introduction – Classification – basic methods – Practical examples – Numerical solution – One dimension – two dimensions – Solution of Elliptic equation – Parabolic Equations (practical examples) Hyperbolic equations – Summary– Exercises. **10Hrs**

Self-study component: Students shall use any predictive analytics tool to solve problems numerically and arrive at solutions. Students shall also attempt to reduce the computation time for numerical analysis.

Text Books:

1. Gerald, G. F and Wheatley, P. O., “Applied Numerical Analysis” 6th Ed. Pearson Education 1999.

Reference Books:

1. Iyengar, S. R. K., Jain, M. K., Jain, R. K.(2019). Numerical Methods for Scientific and Engineering Computation. India: New Age International (P) Limited, Publishers.
2. Chapra, S. C., and Canale, R. P (2003). “Numerical Methods for Engineers with Programming and Software Applications” 3rd Ed. Tata McGrawHill.
3. Scaborough, J. B. “Numerical Mathematical Analysis" Oxford IBH Publishers, NewDelhi.
4. Salvadori, M., “Numerical Methods”, PHI, NewDelhi
5. Saxena, H. C. “Examples in Finite Difference & Numerical Analysis” S Chand & Co., New Delhi.

Course Code- 20CV755 **L-T-P-C 3-0-0-3**
CIE -50marks **Hours/week-3**
SEE -50 marks **Exam duration = 3Hrs**

WATER AND AIR QUALITY MODELING

Course Outcomes

At the end of this course, students will be able to-

COs	Course Outcomes	POs
CO1	Develop mass-balance equations for predicting water quality in different types of water bodies	PO2, PO3
CO2	Evaluate various mathematical models for microbial growth and its limitations	PO1, PO2
CO3	Predict the path and concentrations of air borne pollutants at different atmospheric stability conditions	PO2, PO5
CO4	Formulate governing equations for pollutant transport processes by performing model calibration, validation, and verification	PO1, PO5, PO9

MODULE 1

Introduction to Mathematical Models- Introduction to Environmental Systems, System Analysis, Design and Syntheses - Classification of models, Considerations in selection of models - Modeling environmental systems. Development of a model, Modelling approaches to water quality - Mathematical models for water quality - Concept of mass balance, Waste load allocation – Principal steps involved in Waste Load Allocation Process, Step Response functions **12 Hrs**

MODULE 2

Water Quality Models for Rivers and Streams- Pollution parameters, BIS Standards, Biochemical Oxygen Demand, Mathematical representation - Streeter Phelps Model, Thomas – Slope Method, The Concept of Self-purification in rivers and streams, Dissolved Oxygen (DO) Models for Streams – Sources and sinks of DO, Estimation of system parameters, Oxygen Sag Curve, Determination of deoxygenation and reaeration coefficient, Demonstration of use of water quality modeling software **10 Hrs**

MODULE 3

Water Quality Models for Lakes and Estuaries- Limnology, lake stratification, classification of lakes, Eutrophication, Leibig's law of minimum, Temperature models – Modeling Lake system for water quality, Estuaries – Physical aspects of estuaries, types, Flow in estuaries, Models for Estuary – DO Equation, Segmental Models, Modelling estuaries for water quality. Microbial Growth Population – Exponential, Logistic, and Monod's Model **10 Hrs**

Module 4

Air Quality Models - Air pollution, Air Act & Ambient Air Quality Standards, Air pollution Meteorology, pollutant transport, air quality models – Micrometeorological processes, Box model, Gaussian and dispersion models, stack height computation, regional air quality models, source inventories and significance, Demonstration of use of air quality modeling software **10 Hrs**

Self-study Component: **Evaluated through Activity-2 for 5 marks**

1. Visit a nearby water and air quality monitoring stations and list the parameters measured and recorded, interact with the personnel regarding the measurement of parameters
2. Collect water and air quality data from authentic government agencies and perform simple analyses of data
3. Collect data from assigned situation / project and evaluate the models studied during the course – discuss with faculty incharge

4. Perform real-time monitoring of air, water, and/or industrial effluent quality to acquire primary data and evaluate relevant models - discuss with faculty incharge

Activity 1 will be a quiz conducted by the end of the semester to assess the understanding of concepts introduced to the students during the course. Activity 2 focuses on the assessment of students as an individual as well as a team player for the assigned group activity.

Textbooks:

1. Chapra, S. C. (2011). Surface Water Quality Modeling, McGraw Hill International Edition, 2nd Edition.
2. Thomann, R. V., and Mueller, J. A. (1987). Principles of Surface Water Quality Modeling and Control, Manhattan College, Pearson.
3. Ragazzi, M. (Ed.). (2016). Air Quality: Monitoring, Measuring, and Modeling Environmental Hazards. CRC Press.

Reference Books:

1. Ji, Z. G. (2017). Hydrodynamics and water quality: modeling rivers, lakes, and estuaries. John Wiley & Sons.
2. Baklanov, A., Sue, G., Alexander, M., & Athanassiadou, M. (Eds.). (2009). Meteorological and air quality models for urban areas (Vol. 140). Berlin, Heidelberg: Springer.

Course Code - 20CV761 **L-T-P-C 3-0-0-3**
CIE - 50 marks **Hours/week-3**
SEE - 50 marks **Exam duration = 3 Hrs**

ADVANCED DESIGN OF RC STRUCTURES

COs	At the end of this course, students will be able to-	Mapping to POs
CO1	Comprehend the design of overhead RC tanks as per IS 3370. Analysis and design silos, bunkers	PO1, PO2, PO3, PO5
CO2	Comprehend the behavior of shells and folded plates	PO3, PO4, PO5
CO3	Conduct yield line analysis of slabs by equilibrium & virtual work methods	PO2, PO4, PO5
CO4	Comprehend the design of Grid floors by approximate methods & flat slab	PO2, PO3, PO5

MODULE-1

Design of RC overhead circular and rectangular water tanks with supporting towers. Design of silos and bunkers using Janssen's Theory
12Hrs.

Self-study component: Students shall visit construction sites of RC overhead tank and supporting towers and observe various components and their details.

MODULE-2

Introduction to shell and folded plate roofs – their forms and structural behavior **10Hrs.**

Self-study component: Students shall visit construction sites of Shell and folded plate roofs and observe various components and their details.

MODULE-3

Yield line analysis of slabs with equilibrium method and virtual work method. Strip Method of Design for RCC slabs **10Hrs.**

Self-study component: Students shall test in the laboratory a slab panel with different boundary condition and observe the yield line pattern at failure.

MODULE-4

Design of Grid Floors by approximate methods**.** Design of flat slabs by Direct Design Method (with and without drops) **10Hrs.**

Self-study component: Students shall visit a construction site with grid slab and flat slab structural systems. Observe various components and their details.

Text Books:

1. Devadas Menon and Unnikrishnan, P "Reinforced ConcreteStructures"
2. Varghese, P. C. "Limit State Design of Reinforced Concrete Vol. II" Prentice Hall of India (P) ltd, New Delhi

Reference Books:

1. Jai Krishna and Jain "Plain and Reinforced Concrete Vol. II" Nem Chand Bros.Roorkee
2. Varghese P.C "Advanced Reinforced Concrete Design" Prentice Hall of India-2007

Course Code - 20CV762 **L-T-P-C 3-0-0-3**
CIE - 50 marks **Hours/week-3**
SEE - 50 marks **Exam duration = 3 Hrs**

PAVEMENT ANALYSIS AND DESIGN

COs	At the end of this course, students will be able to-	Mapping to POs
CO1	Comprehend the desirable characteristics of different types of pavements & different types of distress in pavements	PO1
CO2	Analyze the stresses due to wheel loads	PO2, PO9
CO3	Design the flexible pavement	PO3, PO8, PO9, PO12
CO4	Analyze the stresses and design the rigid pavement by IRC 58 - 2005	PO3, PO8, PO9, PO12

MODULE-1

Introduction: Importance, Functions, Requirements, Types and Uses of Pavements - Factors affecting Design and Performance of Pavements – Functions and Significance of various layers – Factors affecting the choice and selection of pavement type. **Distress:** Distresses in Asphalt and Concrete pavements, Major distress mechanisms and material characterization – Performance prediction and applications. **Traffic:** Different types of highway traffic, Measurement of traffic load, Load distribution concept, Load equivalency factors – ESAL and ESWL of Multiple Wheels, Repeated Loads – Sustained Loads and Pavement behaviour under repeated traffic load applications. **12Hrs**

Self-study component: Students shall collect the information about types of pavements and types of distress and submit the report.

MODULE-2

Design of Flexible Pavements: Stresses, Strains and Deflections in Homogeneous Masses – Layered systems concept, Elastic Solutions, Visco-elastic Solutions. Structural Design – Approaches, Development, Mechanistic-Empirical design Principles, Design steps – IRC method of Flexible Pavement Design for High Volume Roads (IRC 37) and for Low Volume Roads (IRC SP72). **10 Hrs**

Self-study component - Students shall collect the information about difference between airfield pavement and highway pavements and different methods used in pavement designs and submit the report on same.

MODULE-3

Design of Rigid Pavements: General conditions in Rigid Pavement Analysis, Types of Stresses and Causes – Wheel Load Stresses, Warping Stresses, Frictional Stresses, Combined Stresses. Structural Design – Approaches, Development, Design Principles, Design steps – IRC method of Rigid Pavement Design for High Volume Roads (IRC 58) and for Low Volume Roads (IRC SP 62). Joints in Pavements and their Functions, Design of Joint Details, Concrete White topping – Thin and Ultra-thin (IRCSP76). **10 Hrs**

Self-study component: Students shall collect the information about design of rigid pavements and joints in rigid pavements and submit the report on same.

MODULE-4

Sustainable Pavements: Geosynthetics–Types, Propertie sand Functions, Applicability and Benefits of Geosynthetics in Roadways, Design Principles and Methodologies for flexible Pavements. Design steps – IRC method of design for Reinforcement of Asphalt layer, Unbound Pavement Layers and Subgrade stabilization (IRC 59); Concept of Life Cycle Cost – Approaches & Techniques, Cost-Saving Concepts – Perpetual Pavements, Recycling techniques; green highways. **10Hrs**

***Self-study component*:** Students shall submit a report on different types of geosynthetics used in highway pavement, their merits and demerits.

Textbooks:

1. Srinivasa Kumar, R, Pavement Design, Orient Blackswan Private Limited - NewDelhi
2. Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering – Principles and Practice, CRC Press, Taylor & FrancisGroup

Reference Books:

1. Khanna, S.K. and Justo, C.E.G., Highway Engineering Nem Chand and Bros,Roorkee.
2. Kadiyali, L. R. and Lal, N. B Principle and practice of Highway Engineering, Khanna Publishers, New Delhi.
3. Partha Chakraborty and Animesh Das, 'Principles of Transportation Engineering',Prentice-Hall.
4. Yoder and Witzack 'Principles of Pavement Design', - 2nd edition, John Wiley andSons.
5. Yang H Huang, 'Pavement Analysis and Design', PrenticeHall.
6. Papagiannakis A T and Masad E A, 'Pavement Design and Materials', John Wiley &Sons.
3. IRC: 37 – 2018, Design of FlexiblePavement
4. IRC: 58 – 2015, Design of RigidPavement

Course Code - 20CV763 **L-T-P-C 3-0-0-3**
CIE - 50 marks **Hours/week-3**
SEE - 50 marks **Exam duration = 3 Hrs**

COMPOSITES AND SMART MATERIALS

COs	At the end of this course, students will be able to-	Mapping to POs
CO1	Comprehend the basic properties and manufacturing process along with their application in various industries for different types of Composites	PO2, PO3
CO2	Perceive different classes of ceramic and polymeric smart materials; development of actuators and sensors and their integration into a smart structure	PO2, PO3
CO3	Apply the principles to various fields like automobile, space, medical, automotive, building construction, etc	PO2, PO3
CO4	Design of embedded & surface mounted, piezoelectric devices	PO1, PO2, PO3

MODULE - 1

Introduction to Composite materials : Classifications and applications of fibers, volume fraction and load distribution among constituents, minimum & critical volume fraction, compliance and stiffness matrices. **10Hrs**

Self-Study component: Student shall gain knowledge about the innovative composite materials and their applications in civil engineering domain.

MODULE - 2

Anisotropic elasticity: Unidirectional and anisotropic lamina, thermo-mechanical properties, micro-mechanical analysis, classical composite lamination theory, Cross and angle– ply laminates, symmetric, antisymmetric and general asymmetric laminates, mechanical coupling, laminate stacking. **10Hrs**

Self-Study component: Student shall explore appropriate websites to observe the behaviour of composite material subject to varying temperature

MODULE -3

Analysis of simple laminated structural elements :Ply-stress and strain, lamina failure theories - first fly failure, environmental effects, manufacturing of composites. Fiber Reinforced polymers, Carbon reinforced polymers properties and their applications. **10Hrs**

Self-Study component: Student shall learn different types of composite materials and their application in aircraft design

MODULE - 4

Smart materials: Introduction, Types of smart structures, actuators & sensors, embedded & surface mounted, piezoelectric coefficients, phase transition, piezoelectric constitutive relation. Beam modeling with strain actuator, bending extension relation. **12Hrs**

Self-Study component: Student shall learn about self-healing materials used in aircraft industry etc

Textbooks:

1. Robart M Jones, "Mechanic of Composite Materials", McGraw Hill Publishing Co, ISBN 10: 0891164901 ISBN, 13: 9780891164906, Wonder book seller , Frederick, USA.
2. Bhagwan D Aggarwal and Lawrence J Broutman, "Analysis and Performance of Fiber Composites", ISBN: 978-1-119-38997-2, John Willy and Sons, NewYork.

Reference Books:

1. Crawley, E and de Luis, J., "Use of piezoelectric actuators as elements of intelligent structures", AIAA Journal, Vol. 25 No 10, Oct 1987, PP 1373-1385.
2. Crawley, E and Anderson, E., "Detailed models of Piezoceramic actuation of beams", Proc. of the 30th AIAA /ASME/ASCE/AHS/ASC- Structural dynamics and material conference, AIAA Washington DC, April 1989
3. Lecture notes on "Smart Structures", by Inderjith Chopra, Department of Aerospace Engg., University of Maryland.

Course Code - 20CV764 **L-T-P-C 3-0-0-3**
CIE - 50 marks **Hours/week-3**
SEE - 50 marks **Exam duration = 3 Hrs**

REMOTE SENSING & GIS

COs	At the end of this course, students will be able to-	Mapping to POs
CO1	Students should understand the concept and different mode of remote sensing and ground data collection	PO1, PO2, PO3
CO2	Learn on types of data and its processing for its field applications	PO2, PO3, PO4
CO3	Fundamentals of GIS and its applications, Data processing & analysis in GIS	PO2, PO4, PO5
CO4	Organizations structure for GPS survey, Principles of application of GPS for field survey	PO3, PO4

MODULE-1

Introduction: Basics of Remote Sensing, Active and Passive Remote sensing (RS), Scope of remote sensing; Electromagnetic radiation and electromagnetic spectrum: Visible, Infra-Red (IR), Near IR, Middle IR, Thermal IR, and Microwave. Black body radiation and radiation laws; Interaction of EMR with atmosphere and Earth's surface features; **Types of Remote Sensing and Sensors Characteristics** Platform and Orbits: Ground Based, Air Borne, Space borne. Orbits: Geo-Stationary satellite, Polar Orbiting satellite. Types & characteristics of sensors, Sensor resolution, Concept of Swath and Nadir, Image referencing system, Remote sensing data products: IRS, LANDSAT, SPOT, IKONOS, Quick Bird. **10Hrs**

Self-study component: Students shall collect the information on space research organizational structure, Types of Indian satellites, and data products.

MODULE-2

Thermal Remote Sensing; Thermal properties of materials: emissivity of materials; thermal inertia of Earth surface features; Thermal data sets: LANDSAT and ASTER; Concept and Principles of microwave remote sensing; Microwave data sets SLAR. LIDAR and SAR; Application of Thermal and Microwave data; **Digital Image processing:** Introduction to Image, Digital image Types of Data Products, Types of image interpretation, Basic elements of image interpretation, Visual interpretation keys, Digital Image Processing, Preprocessing, image enhancement techniques, multispectral image classification, Supervised and unsupervised. **10Hrs**

Self-study component: Students shall collect the information on commercial and open-source Remote Sensing data for use in GIS. Download free DEM and LULC data.

MODULE-3

Introduction to GIS: Fundamentals of Geographic Information System: Basic Concepts: definition of GIS, Components of GIS, Variables - points, lines, polygon, Functionality of GIS, Recent trends and applications of GIS; GIS Softwares, Open-source GIS; **GIS Data base:** Geographic data: Spatial and non-spatial; Data models: Raster and vector; Database Management System (DBMS): Geo-database. Data Structures: Relational, hierarchical and network; Data input and scale: Nature and Source of data, Digitization of maps and imageries, Attribute data generation; Data Editing: Coordinate systems, Coordinate transformation .Re-projection. **10Hrs**

Self-study component: Students shall collect the information on different commercial and open- source GIS software.

MODULE-4

Spatial analysis: Spatial overlay operations, network analysis and proximity analysis; 3D models; TIN, Types of DEM. Application of DEM, Raster to Vector vice versa conversion. Water shed delineation using topographic sheets. Estimation of reservoir capacity; **Introduction to Global Positioning System (GPS):** GPS satellites constellations; GPS segments: Space, Control, User; GPS antennas, signals, and codes; GPS receivers; Modes of measurements and post processing of data; Accuracy of GPS measurements; Application of GPS. **10Hrs**

***Self-study component: Students shall collect the information on different GPS system in world and their working*.**

Textbooks:

1. Lillesand, Kiefer, Chipman, "Remote Sensing and Image Interpretation", Wiley2011.
2. Basudeb Bhatta "Remote sensing and GIS" Oxford university Press, New Delhi, India,2021

Reference Books:

1. Panda, B. C., 2008. Remote Sensing: Principles and Applications, Viva Books Private Limited,India
2. Kumar S "Basics of Remote Sensing and GIS" Laxmi Publications (p) Ltd, NewDelhi

Course Code- 20CV765 **L-T-P-C 1-0-4-3**
CIE -50marks **Hours/week-3**
SEE -50 marks **Exam duration = 3Hrs**

DESIGN AND DRAWING OF IRRIGATION STRUCTURES

COs	At the end of this course, students will be able to-	Mapping to POs
CO1	Gain fundamental knowledge of irrigation structures such as overflow gravity dams, different types of earthen dams & canal sections	PO1, PO2, PO3
CO2	Design head and cross regulators for given details	PO2, PO4, PO5
CO3	Design canals drop for given details	PO2, PO3, PO5
CO4	Design direct sluice for a canal and tank sluice for given details	PO3, PO4, PO6

MODULE – 1

Preparation of Drawings for given design details of: Overflow Section of Gravity Dams. Sections of earth dams of Homogeneous fill, zonal embankment, and Diaphragm types with drainage plans. Sections of Canals of different conditions, in cutting, in banking and partly in cutting & partlyinbanking. **22Hrs.**

Self-study component: Students shall visit nearby gravity dam, canals in cutting and embankment, submit a report.

MODULE – 2

Designs and Drawings for: Surplus Weir with stepped type of aprons, Tank Sluice, Direct Sluice, Head Regulator, Cross regulator, and Canal Drop(Notchtype). **20Hrs.**

Self-study component: Students shall visit nearby tank weir, sluice, canal sluice, canal drop and canal regulator, observe the components, submit a report.

Question Paper Pattern: In the examination two questions are to be set from **Module-1** for 20 marks and two questions from **Module-2** for 80 marks (20 marks for design and 60 marks for drawing) Student are expected to answer one question from each part. The duration of SEE is **04 Hrs.**

Textbooks:

1. Murthy, C. S. “Design of Minor Irrigation and Canal Structures” Wiley Eastern Ltd, New Delhi (Part A) 2000 Edition (Ch. Part A, PartB)
2. Leliavsky, S. “Design Textbook in Civil Engineering ‘Oxford and IBH Publishing co., Pvt.Ltd, New Delhi (Part B) 1996Edition

Reference Books:

1. Sehgal, P. P. “Design of Irrigation Structures” Khanna Publishers, NewDelhi.1998
2. Varshney, S.C. Gupta &. “Irrigation Engineering & Hydraulic Structures” R. L Nem Chand & BrosRoorkee,1999

Course Code- 20CV766 **L-T-P-C 1-0-0-1**
CIE -100marks **Hours/week-1**

DESIGN OF PRECAST AND COMPOSITE STRUCTURES

COs	At the end of this course, students will be able to-	Mapping to POs
CO1	Understand the concepts and techniques of precast construction and select or design precast elements suitable for project specific requirements	PO1, PO3, PO5
CO2	Design precast systems to ensure integrity and safety of the structure and to avoid progressive collapse and Design composite floors and beam elements	PO2, PO4, PO5

MODULE – 1

Introduction: Concepts, components, Structural Systems and Design of precast concrete floors, Need and types of precast construction, Modular coordination, Precast elements- Floor, Beams, Columns and walls. Structural Systems and connections. Precast concrete columns and walls- systems and Introduction to 3d volumetric precast. Types of precast structure- a) Column beam hollow core- design principles and connections. Design of Corbels, b) 2d-Precast -RC wall and Concrete half slab with topping- Principles of structural framing, 3) Introduction to 3d volumetric Precast; Design of precast reinforced and prestressed Concrete beams - Theoretical and Design Examples of ITB – Full section precast, Semi Precast, propped and unpropped conditions. Reference to IS1343:2012. Introduction to Beam bearing, Beam half Joint, Steel Inserts, Socket Connection, Structural integrity, Avoidance of progressive collapse, Design of Structural Ties. Progressive collapse – Code provisions In reference to IS15916:2010 **07Hrs**

MODULE – 2

Steel Concrete Composite Structures - Introduction to Steel Concrete Composite Floors and Beams Composite Floors: Profiled Sheeting with concrete topping, Design method, Bending and Shear Resistance of Composite Slabs, Serviceability Criteria. Composite Beams: Elastic Behaviour, Ultimate Load behavior of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams. **07Hrs**

Evaluation Pattern: Only CIE for 100 Marks will be conducted, No SEE. The course will be handled by industry personnel with an assigned faculty coordinator.

References:

1. Krishna Raju N., “Prestressed concrete”, 5th Edition, Tata McGraw Hill Company, New Delhi,2012
2. Pandit G.S. and Gupta S.P., “Prestressed Concrete”, CBS Publishers and Distributers Pvt. Ltd,2012.
3. Hass A.M. – Precast Concrete – Design and applications Applied Science,1983.
4. David Sheppard – “Plant cast, Precast and Prestressed concrete – McGraw Hill;1989
5. NBC – 2005 (Part I to Part VII) BIS Publications, New Delhi, IS 15916- 2011, IS 11447, IS6061
6. R.P.Johnson: Composite Structure of Steel and Concrete (Volume 1), Blackwell Scientific Publication (Second Edition), U.K.,1994.
7. IS:11384-1985, Code of Practice for Composite Construction in Structural Steel and Concrete.
8. INSDAG Teaching Resource Chapter 21 to 27:www.steel-insdag.org
9. Pandit.G.S. and Gupta.S.P., “Prestressed Concrete”, CBS Publishers and Distributers Pvt. Ltd,2012.
10. Rajagopalan.N, “Prestressed Concrete”, Narosa Publishing House,2002.
11. Dayaratnam.P., “Prestressed Concrete Structures”, Oxford and IBH,2013
12. Lin T.Y. and Ned.H.Burns, “Design of prestressed Concrete Structures”, Third Edition, Wiley India Pvt. Ltd., New Delhi,2013.
13. IS1343:2012, Code of Practice for Prestressed Concrete, Bureau of Indian Standards, New Delhi, 2012
14. IS IS: 11384 -1985, Code of practice for composite construction in structural steel and concrete, Bureau of Indian Standards, New Delhi,2003

Course Code - 20CV708 **L-T-P-C 0-0-2-1**
CIE -50marks **Hours/week-2**
SEE - 50 marks

ENVIRONMENTAL ENGINEERING LABORATORY

COs	At the end of this course, students will be able to-	Mapping to POs
CO1	Estimate the physical & general parameters concerning substances undesirable in excessive amounts for the suitability of water for drinking and construction purpose as per the specifications	PO1, PO4, PO8, PO9
CO2	Estimate the parameters of wastewaters for its suitability to discharge the environmental pollutants as per specifications	PO1, PO4, PO8, PO9

List of experiments

1. Determination of Solids in Sewage: Total Solids - Suspended Solids - Dissolved Solids - Volatile Solids - Fixed Solids – SettleableSolids.
2. Determination of Chlorides andSulphates
3. Determination of Alkalinity, Acidity andpH
4. Determination of Calcium, Magnesium and TotalHardness
5. Determination of Dissolved Oxygen, BOD andCOD
6. Determination of percentage of available chlorine in bleaching powder, residual Chlorine and ChlorineDemand
7. Jar Test for Optimum Dosage of Alum – Turbidity determination by Nephelometer & determination of Nitrates usingSpectrophotometer
8. Determination of Iron by Phenanthroline method and Fluorides by SPADNSMethod
9. Determination ofMPN
10. Determination of Sodium and Potassium by flamephotometer

Reference Books:

1. Manual of Water and Wastewater Analysis – NEERIPublication
2. American Public Health Association (2012). "Standard methods for the examination of water and wastewater". 22nd Edition edited by Rice, E.W., Baird, R.B., Eaton, A.D., and Clesceri, L.S. American Public Health Association (APHA), American Water Works Association (AWWA) and Water Environment Federation (WEF), Washington, D.C., USA.
3. IS Standards – 2490-1974, 3360-1974, 3307-1974, 10500:2012
4. Sawyer, C. N., McCarty P. L., and Parkin, G. F. (2009). "Chemistry for Environmental Engineering & Science", Tata McGrawHill
5. Schedule VI, The Environmental (Protection) Act1986.

Course Code- 20CV709 **L-T-P-C 0-0-4-2**
CIE - 100 marks

MINI PROJECT - 2

Mode of Evaluation

1. Student batches (minimum of 4 students) have to perform a project
2. A project guide along with two faculty members will be internally evaluating the mini project in 3 phases for 100 Marks without SEE Component. The Phase – 1 & 2 will be evaluated for 25 Marks, and Phase – 3 will be evaluated for 50Marks.
3. The phase-wise assessment of students will be followed as stated below:

   Phase-1: Literature survey & Problemstatement

   Phase-2: Progress, & schedule of pending work

   Phase-3: Presentation, report and quality of the work

Course Code–20SWCV8 **L-T-P-C-0-0-0-0**
CIE -100marks -

SWAYAM – 2 (AUDIT COURSE)

Mode of Evaluation

1. Students have to register for NPTEL course of minimum 8 weeks duration and obtain the relevant certificate
2. No CIE or SEE examination
3. The department SWAYAM course coordinator verifies the Certificates produced by Students in consultation with College-level SWAYAM Coordinator and uploads the data in the institute software platform –Contineo.

Course Code – 20OECV71 **L-T-P-C 3-0-0-3**
CIE - 50 marks **Hours/week-3**
SEE - 50 marks **Exam duration = 3 Hrs**

MECHANICS OF DEFORMABLE BODIES

COs	At the end of this course, students will be able to-	Mapping to POs
CO1	Comprehend the basic concepts of stress & strain at a point, compatibilityequationsfor2D&3Dplanestress&planestrain problems	PO1, PO2, PO3
CO2	Write stress functions for a given continuum problem using Airy's stress functions and stress polynomials, solving for stresses and displacement	PO1, PO3, PO4
CO3	Solve continuum problems in polar coordinates for stresses & displacement	PO1, PO3, PO4
CO4	Solve3Dproblemsincontinuumforprincipalstresses&principal strains	PO2, PO3, PO4

Module-1: Basic Concepts

Definition of stress & strain at a point, components of stress & strain at a point, strain displacement relations in Cartesian co-ordinates, constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases, plane stress, plane strain. **10 Hrs**

Module-2: Two-dimensional problems in Rectangular Coordinates

Airy's stress function approach to2-D problems of elasticity. Solution by Polynomials – End Effects, Saint – Venant's Principle – solution of some simple beam problems, including working out of displacement components. **10 Hrs**

Module-3: Two - dimensional problems in Polar coordinates

General equation in Polar coordinates –Strain & displacement relations, equilibrium equations - Stress distribution symmetrical about an axis – Pure bending of curved bars – Displacements for symmetrical stress distributions – The effect of a small circular hole on stress distribution in a large plate subjected to uni- axial tension and pure shear. **12Hrs**

Module-4: Analysis of Stress and Strain in Three Dimensions

Introduction. Stress at a point in any arbitrary direction– Principal stresses & corresponding directions – Determination of the principal stresses & principal planes – Stress invariants – Determination of the maximum shearing stress- Octahedral stress components. Strain at a point in any arbitrary section, Principal strains & corresponding directions – strain invariants. **10Hrs**

Text Books:

1. Timoshenko and Goodier (1983). Theory of elasticity. McGraw Hill Book Company, IIIEdition.
2. Valliappan. S (1981).Continuum Mechanics fundamentals, Balkema academic and technical publications.

Reference Books:

1. T G Sitharam & L Govindaraju, Elasticity for Engineers, IK International Publisher, New Delhi.Year2017
2. Sadhu Singh, Theory of Elasticity, Fourth Edition,KhannaPublishers,1979
3. P D S Verma, Theory of Elasticity, Sangam Books Limited,1997.

Course Code – 20OECV72 **L-T-P-C 3-0-0-3**
CIE - 50 marks **Hours/week-3**
SEE - 50 marks **Exam duration = 3 Hrs**

ENGINEERING OPTIMIZATION

Course Outcomes	At the end of the course the student will be able to:	Mapping to POs
CO1	Discuss the concept and need of optimization in engineering.	PO2, PO3, PO4
CO2	Use conventional methods of optimization under constraints and the concept of linear programming to typical Engineering problems	PO2, PO3
CO3	Apply the numerical methods for design optimization problems	PO1, PO3
CO4	Apply genetic algorithms for optimum design of structural elements	PO2, PO4

MODULE – 1

Classical Optimization Techniques: Engineering applications, Statement of optimization problem, Classification of optimization problems, Optimization techniques. Single variable optimization, Multivariable optimization with no constraints, with equality constraints - Lagrange multiplier - method, constrained variation method. **12 Hrs**

MODULE – 2

Linear Programming: Standard form of Linear programming problem, simplex method, two phase simplex method - application problems. **10 Hrs**

MODULE – 3

Design optimization of structural elements. Application Problems: Optimum design of steel structural elements. Algorithms for optimum designs **10 Hrs**

MODULE - 4

Genetic Algorithms: Introduction – fitness function, crossover and mutation - Application problems. **10 Hrs**

Self-study component:

Text Books:

1. Rao, S.S. - Optimization Theory and Applications, Wiley Eastern Limited,1978.
2. Fox, R.L. - Optimization Methods for Engineering Design, Addison Wesley, 1971

Reference Books:

1. Stark. R.M. Nicholls.R.L., Mathematical Foundations for Design, McGraw Hill Book Company.
2. NarsingkDeo – System simulation with digital computer, Prentice – Hall of India Pvt, Ltd. New Delhi – 1989.

Course Code – 20OECV73 **L-T-P-C 3-0-0-3**
CIE - 50 marks **Hours/week-3**
SEE - 50 marks **Exam duration = 3 Hrs**

COMPOSITES AND SMART MATERIALS

Course Outcomes	At the end of the course the student will be able to:	Mapping to POs
CO1	Comprehend the basic properties and manufacturing process along with their application in various industries for different types of Composites	PO2, PO3
CO2	Perceive different classes of ceramic and polymeric smart materials; development of actuators and sensors and their integration into a smart structure	PO2, PO3
CO3	Apply the principles to various fields like automobile, space, medical, automotive, building construction, etc	PO2, PO3
CO4	Design of embedded & surface mounted, piezoelectric devices	PO1,PO2,PO3

MODULE – 1

Introduction to Composite materials: Classifications and applications of fibers, volume fraction and load distribution among constituents, minimum & critical volume fraction, compliance & stiffness matrices.
Anisotropic elasticity - Unidirectional and anisotropic lamina, thermo- mechanical properties, micromechanical analysis, classical composite lamination theory. **13Hrs.**

Self-Study component: Student shall gain knowledge about the innovative composite materials and their applications in civil engineering domain.

MODULE – 2

Anisotropic elasticity (Cont'd) - Cross and angle–ply laminates, symmetric, antisymmetric and general asymmetric laminates, mechanical coupling and laminate stacking. **09 Hrs**
Self-Study component: Student shall explore appropriate websites to observe the behaviour of composite material subject to varying temperature

MODULE – 3

Analysis of simple laminated structural elements - Ply-stress and strain, lamina failure theories - first fly failure, environmental effects and manufacturing of composites. **10 Hrs**
Self-Study component: Student shall learn different types of composite materials and their application in aircraft design

MODULE – 4

Smart materials - Introduction, Types of smart structures, actuators & sensors, embedded & surface mounted, piezoelectric coefficients, phase transition, piezoelectric constitutive relation. **10 Hrs**

Self-Study component: Student shall learn about self-healing materials used in aircraft industry etc

Textbooks:

1. Robart M Jones, "Mechanic of Composite Materials", McGraw Hill Publishing Co, ISBN 10: 0891164901 ISBN, 13: 9780891164906, Wonder book seller , Frederick, USA.
2. Bhagwan D Aggarwal and Lawrence J Broutman, "Analysis and Performance of Fiber Composites", ISBN: 978-1-119-38997-2, John Willy and Sons, NewYork.

References:

1. Crawley, E and de Luis, J., "Use of piezoelectric actuators as elements of intelligent structures", AIAA Journal, Vol. 25 No 10, Oct 1987, PP 1373-1385.
2. Crawley, E and Anderson, E., "Detailed models of Piezoceramic actuation of beams", Proc. of the 30th AIAA /ASME/ASCE/AHS/ASC- Structural dynamics and material conference, AIAA Washington DC, April 1989
3. Lecture notes on "Smart Structures", by Inderjith Chopra, Department of Aerospace Engg., University of Maryland.

Course Code– 20OECV74 **L-T-P-C 3-0-0-3**
CIE -50marks **Hours/week-3**
SEE -50 marks **Exam duration = 3Hrs**

URBAN DESIGN AND REGENERATION

COs	At the end of this course, students will be able to-	Mapping to POs
CO1	Discuss the strategies involved in Urban regeneration.	PO6, PO7
CO2	Interpret the various planning tools regarding the urban assets	PO6, PO8
CO3	Review the public and private sector roles and relationships and project phasing in the implementation of the urban regeneration projects	PO7, PO8
CO4	Report on the translation of the concepts of urban regeneration in a case study project.	PO9, PO10, PO12

MODULE 1

Definition, the three orientations, the interrelated groups of spaces in the domain of urban design, the eight elements of urban design. The process of urban regeneration projects. The fundamental first phase – Scoping: The key components, macro and microlevel scoping. The Planning Process: defining the planning framework, masterplanning, developing design standards, Setting the scene, defining the implementation process and Institutional arrangements, partnering arrangements with the private sector, defining early wins. The Financial tools: Municipal finance tools, land specific financial and regulatory tools for public land. Financial tools for private lands (non capital markets and capital markets), Regulatory tools for private lands (policy and fiscal). **12hrs**

Self-study component: Study of the Review of the Book "The Urban Design Process" by Hamid Shirvani.

MODULE 2

Urban assets – First asset land: ownership regimes, tools for land assembly (voluntary and involuntary), land tools for public asset management, land regulatory frameworks. Second asset community: Tools for community participation, charrettes, using technology for public participation.. Third asset: Environment: Site assessment, site investigation, EIA and site remediation plan. **10 hrs**

Self-study component: Examine the tools for public participation in case studies from the world Bank report Regenerating Urban Land: A Practitioner's Guide to Leveraging Private Investment.

MODULE 3

Social equity aspects of regeneration. Interventions for a more socially equitable regeneration project. The potential undesirable impacts of urban regeneration: Gentrification and Loss of social capital. Tools to mitigate the undesirable social impacts: resettlement, principle of minimizing displacement, compensation, Inclusionary zoning and housing vouchers. **10 hrs**

Self-study component: Reading of the book "Uses of Disorder" by Richard Senett and short review writing on any one chapter of the book.

MODULE 4

Implementation Phase. Political leadership, Public and private sectors roles and responsibilities, phases of implementation, Framework for assessing and mitigating risks : political, financial, technical environmental, Land ownership and regulation, stakeholders, fiduciary and commercial risks.
The parameters that influence the urban regeneration strategy: Landuse and zoning, historical preservation, environmental features, open spaces, building form, people participation, economic base, infrastructure and transportation networks, urban planning policies and political leadership. case study for each parameter. **10 hrs**

Self-study component: Collect information and read about Government of India strategies like Swachh Bharat Mission - Urban (SBM-U), Pradhan Mantri Awas Yojana - Urban (PMAY-U), Smart Cities Mission (SCM), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Deendayal Antyodaya Yojana - National Urban Livelihoods Mission (DAY-NULM) and Heritage City Development and Augmentation Yojana(HRIDAY)

Text Books:

1. Hamid Shirvani, “The Urban Design Process” Van Nostrand Reinhold,1985
2. Amirtahmasebi, Rana, Mariana Orloff, Sameh Wahba, and Andrew Altman. Regenerating Urban Land: A Practitioner’s Guide to Leveraging Private Investment. 2016. Urban Development Series. Washington, DC: World Bank. doi: 10.1596/978-1-4648-0473-1. License: Creative Commons Attribution CC BY 3.0IGO

Reference Books:

1. Urban Regeneration, A Handbook, edited by Peter Roberts and Hugh Skyes. Sage Publications Limited2008.
2. Ministry of Housing and Urban Affairs, Government of India, “Transforming Urban Landscape”2014-19

Course Code– 20OECV75 **L-T-P-C 3-0-0-3**
CIE -50marks **Hours/week-3**
SEE -50 marks **Exam duration = 3Hrs**

HAZARDOUS WASTE MANAGEMENT

COs	At the end of this course, students will be able to-	Mapping to POs
CO1	Summarize the fundamentals of hazardous waste, relevant regulations, and the magnitude of the problem because of its improper management	PO1, PO2, PO7, PO8
CO2	Explain various physical, chemical & biological methods of treating hazardous wastes and remediation of polluted sites	PO1, PO2, PO3
CO3	Assess risks for toxic substances and their adverse effects on living organisms, environment and human health	PO1, PO2, PO6
CO4	Estimate the concentrations of hazardous pollutants in different phases & engineering design of treatment units and disposalfacilities	PO1, PO2, PO3, PO9

MODULE 1

Fundamentals of Hazardous Waste Management- Definition of hazardous waste, properties and characteristics of hazardous wastes, past waste management practices, Partitioning coefficients, Conceptual Site Model, Source – Pathway – Receptor Analyses. Environmental legislations for hazardous waste disposalandtransport **12 Hrs**

MODULE 2

Risk Assessment and Waste Handling- Concept of risk and hazard, exposure pathway, calculation of risk, hazard identification, toxicity assessment, carcinogenic effects and non- carcinogenic effects, exposure assessment, applications of risk assessment, and Uncertainties. Waste minimization – factors & case studies, Solutions to major problems associated with hazardouswastes **10 Hrs**

MODULE 3

Treatment of Hazardous Wastes- Physico – chemical treatment - Stabilization, Sorption, Volatilization – Air stripping, Soil Vapor Extraction, Advanced Oxidation Process, Permeable Reactive Barrier Biological treatment - Difference between biological treatment of solid waste with hazardous waste, Composting, Bioremediation – growth kinetics, inhibition, *in situ* and *ex situ* bioremediation - Reductive dehalogenation, Bioreactors, and Constructed Wetlands **10 Hrs**

MODULE 4

Storage & Disposal of Hazardous Wastes- Treatment, Storage and Disposal Facilities (TSDFs) - Facility Design & Operation - Hazardous waste landfills – landfill design parameters, Landfill gases and leachate generation, Air strippers – operating requirements and their design aspects, Incinerators - types of devices, operating & regulatory requirements and their design aspects

10 Hrs

Self-study Component: **Evaluated through Activity 2 for 5 marks**

1. Identify Critically Polluted Areas (CPAs) identified by Central Pollution Control Board (CPCB), New Delhi. Find out the pollutant involved in at least 5CPAs.

2. Assess the risk associated with the pollutant by finding the current levels of pollution (in air, water or soil environment) in the closest vicinity of the respectiveCPA
3. Propose an appropriate *in situ* / *ex situ* treatment or remediation techniques that can be implemented in the respectiveCPA.

Activity 1 will be a quiz conducted by the end of the semester to assess the understanding of concepts introduced to the students during the course. Activity 2 focuses on the assessment of students as an individual as well as a team player for the assigned group activity.

Text books:

1. Pichtel, J. (2014). Waste Management Practices: Municipal, Hazardous, and Industrial. CRC Press.
2. La Grega, M. D., Buckingham, P. L., & Evans, J. C. (2010). Hazardous Waste Management. WavelandPress.

Reference Materials:

1. Bhat, S. (2019). Handbook on Chemicals and Hazardous Waste Management and Handling in India. Ministry of Environment, Forests & Climate Change, New Delhi & National Law School of India University,Bengaluru.
2. Hazardous and Other Wastes (Management & Transboundary Movement) Rules. (2016). Ministry of Environment, Forests & Climate Change, New Delhi.

Course Code- 20CV801 **L-T-P-C-0-0-2-0**
Exam Hours-3 **CIE - 100marks**

SEMINAR

Course Objectives: To upgrade technical presentation and communication skills through literature survey, review and documentation.

Course Outcomes (COs) {with mapping shown against the Program Outcomes (POs)}

Upon successful completion of this course, the student shall be able to:

COs	Statement	POs
1	Carry out the required literature survey on any topic of research and developments in Civil Engineering	PO2, PO4
2	Prepare a technical report based on the literature survey on given topic of the domain of Civil Engineering	PO2, PO10
3	Acquire presentation skill on the chosen technical topic	PO9, PO10

COURSE CONTENTS:

Seminar shall be either on topics in any stream of specialization in Civil Engineering including Structural Engineering, Construction Technology and Management, Transportation Engineering, Geotechnical Engineering, Environmental & Water Resources Engineering, and Utility & Development (not covered under the syllabus) or industrial visit /internship.

SCHEME FOR SEMINAR EVALUATION:

Sl. No.	Criteria	Maximum Marks
1	Organization and style	15
2	Content and knowledge	20
3	Understanding and relevance	20
4	Presentation	10
5	Format and flow of communication	15
6	Report organization and presentation	20
	TOTAL	**100**

Course Code- 20CV802 **L-T-P-C-0-0-18-9**
CIE -50marks **Hours/week-18**
SEE - 50 marks

PROJECT WORK

Course Objectives: To involve in team work to demonstrate the acquired skill & knowledge gained to identify, formulate, analyze, evaluate and to provide meaningful engineering solutions to industrial/ societal needs

Course Outcomes (COs) {with mapping shown against the Program Outcomes (POs)}

Upon successful completion of this course, the student shall be able to:

COs	Statement	Mapping toPOs	PSO
CO1	Identify a problem from the available literature and societal needs	PO2, PO4	--
CO2	Apply principles of Civil Engineering in designing and conducting experiments, data acquisition and interpretation towards meaningful analysis of identified problem	PO2, PO4, PO5	PSO1
CO3	Use analytical, teamwork and leadership skills in designing and development of products or find solution to the identified problem	PO4, PO5, PO6, PO7, PO8, PO9	PSO2
CO4	Prepare a detailed project report and present the work using appropriate presentation tools	PO9, PO10, PO12	PSO2

SCHEME OF EVALUATION

The project will be evaluated in three phases.

Project Phase – I □ Duration of two weeks between VII and VIII semesters. Candidates in consultation with the guides shall carry out literature survey / visit premier institutions/laboratory/ industry to finalize the topic of the project. Evaluation of the project and its feasibility is evaluated in the concerned department in the beginning of the VIII semester. Total credits shall be 02 (10 Marks)

Project Phase – II □ Eight weeks duration during the VIII semester students are expected to finalized the project work and indicate intermediate results, design carried out/ algorithms developed must be validated. Total credits shall be 03 (15Marks)

Project Phase – III □ Project evaluation shall be taken up during this phase. At the end of the semester project work evaluation and Viva – Voce examination shall be conducted. Total credits shall be 04 (25Marks)

The working condition of the project work carried out must be shown to the committee. The continuous evaluation of the project phase – I, II, and III shall be carried out by the committee consisting of Head of the department, guide and the evaluator.

The evaluation follows the below-mentioned scheme:

Sl. No.	Criteria	CIE	SEE
1	Organization	10	10
2	Content	10	10
3	Subject knowledge	10	10
4	Presentation	10	10
5	Communication and Time Management	10	10
	TOTAL	**50**	**50**

Final project report should have the following contents:

1. Introduction – Showing the relevance of the subject in the present context /motivation
2. LiteratureReview
3. Objectives and scope of theProject
4. Materials andMethodology
5. Results and Discussion
6. Conclusions and scope for futurework
7. References
8. Appendices (Ifany)

Course Code- 20CV803 **L-T-P-C-0-0-2-1**
CIE - 100 marks

INTERNSHIP

Course Objectives: To upgrade technical knowledge through undergoing industry or institution level job training

Course Outcomes (COs) {with mapping shown against the Program Outcomes (POs)}

Upon successful completion of this course, the student shall be able to:

COs	Statement	Mapping to POs
1	Carry out the industry-level training by completing specific tasks assigned by the reporting officer	PO8, PO11, PO12
2	Acquire report writing skills on specific tasks undertaken at the industry / institute in any specialization streams of Civil Engineering	PO2, PO10
3	Acquire presentation skill on the chosen technical topic	PO9, PO10

- Students has to undergo internship for a minimum period of 4 weeks in the Department / Division related to Civil Engineering stream of any industry / organization during the semester break of VII and VIII Semester
- Report submission and presentation (No SEE)
- CIE will be conducted for 100 Marks

SCHEME OF EVALUATION

Sl. No.	Criteria	Maximum Marks
1	Knowledge acquired	25
2	Quality & nature of tasks performed at the industry / institute	25
3	Report on Internship	25
4	Presentation	25
	TOTAL	**100**

Course Code- 20CV804 **L-T-P-C3-0-0-3**
CIE -50marks **Hours/week-3**
SEE - 50 marks

CONSTRUCTION PLANNING AND MANAGEMENT

COs	At the end of the course the student will be able to:	Mapping to POs
CO1	Comprehend the basic concepts of engineering economic analysis for deciding project feasibility by comparisonof alternative project proposals	PO2, PO6, PO11
CO2	Apply linear programming as a tool for optimization by both graphical method and simplex method	PO1, PO6, PO11
CO3	Distinguish the concept of value engineering, time management, labor and material management, and employ construction planning methods to achieve optimum cost by CPMand PERT-gain knowledge on construction equipment	PO1, PO6, PO11
CO4	Explain a study on construction, project management and transportation problems for optimum results	PO2, PO6, PO11

MODULE-1

Introduction to Engineering Economics – Basic concepts of engineering Economic analysis – Micro and Macro analysis – project feasibility –economic and financial feasibility**. Engineering Planning Methods**: Time value of money - interest formulae – present worth – future worth - annual equivalent – rate of return and benefit cost ratio methods for comparison of alternative project proposals – breakevenanalysis. **11Hrs**

Self-study component: Students shall visit a construction site and discuss the points pertaining to project planning, financing and time schedule, prepare a report and submit.

MODULE-2

Linear Programming: Standard form of a linear programming– problem Formulation – graphical solution – simplex method – maximization and Minimization-application problems. **Construction Industry and Management:** Introduction – value engineering Time management – labor and material management – contract and contractor-organization and administration **11Hrs**

Self-study component: Students shall visit a construction site and discuss the points pertaining to project management in terms of time, labor and material management, prepare a report and submit.

MODULE-3

Construction Planning: Introduction – time estimates – Bar and Milestone Charts – CPM and PERT network analysis – cost analysis – direct cost indirect cost – total cost – optimum cost – optimum duration of project. **Construction Equipment:** Introduction – factors for selecting equipment – economic life of equipment - various earth moving equipment – hoisting equipment – trenching machines. **11Hrs**

Self-study component: Students shall visit a construction site and observe bar charts exhibited at

the site, various construction equipments, prepare a report and submit.

MODULE-4

Work Study in Construction, Project control during construction – Project supervision -safety measures. **Transportation Problems:** Introduction – Mathematical formulation Optimal solution of transportation problems – methods for initial basic feasible solution – summary of methods of initial BFS – North west corner method – Lowest cost entry method – Vogel's approximation method –optimality test – Degeneracy in Transportation Problems **09Hrs**

Self-study component: Students shall use any typical construction management software and prepare critical path for the execution of the project.

Text Books:

1. Subramaniam.K"ConstructionManagement",AnuradhaPublishers,Madras,1989(Ch.1–5)
2. Peurifoy, R L "Construction Planning equipments and methods" McGraw Hill Publications 3rd edition, 1985

Reference Books:

1. Mahesh Varma "Construction Planning and Management" Metropolitan Book Co.Delhi1982
2. Sharma.S.D. "Operation Research" Khanna Publishers, NewDelhi

Course Code- 20CV806 **L-T-P-C0-0-2-1**
CIE -50marks **Hours/week-2**
SEE - 50 marks

BUILDING INFORMATION MODELING

Course Outcomes

At the end of this course, students will be able to-

COs	At the end of the course the student will be able to:	Mapping to POs
CO1	Know the creating & editing of building model	**PO3, PO5**
CO2	Develop a 3D model of a residential building with all the building elements	**PO1, PO5, PO9, PO10**

List of Exercises:

1. Introduction to BIM. Using 3D tools creation of Levels and Grids. Application of various techniques used in the modeling of walls.
2. Using 3D tools creation of doors and windows, and various types of roofs.
3. The different types of floors, floor finishes, key steps involved in creation of ceilings.
4. The modeling of staircases and railings.
5. 3D Modeling of a single storied two-bedroom house.
6. 3DModelingofaframedstructurelikeofficebuilding
7. Generation of Topo surface and contours using site tool for a given project. Rendering concepts and generation of walkthrough.
8. Placing room tags and room legend options. Creation of door schedule, window schedule and room schedule of a project.
9. Create new sheet and place views such as floor plans and plot the sheet.

Self-study component: Each student shall on the internet observe and understand spatial characteristics of architecturally designed Buildings, download and document the same. Relate and create similar features in the lab exercises. The students shall visit- ongoing project sites and study for real time experience ofBIM.

Note: Examination pattern:

1. TheCIE-1,CIE-2andSEEshallbeconductedintheCADlab.CivilEngineeringDepartment.
2. All drawings shall be prepared using REVIT ARCHITECTUREonly.

Text Books:

1. LinkanSagar,SristryRawalREVIT2019Architecturestepbystep.BPBPublications.2019
2. S.PArora,S.P.BindraTheTextbookofBuildingConstruction,DhanpatRaiPublications.

Reference Books:

1. Shah.M.H.andKale.C.M.“BuildingDrawing”TataMcGrawHillPublishingCo,NewDelhi.
2. Linkan Sagar, Sristry Rawal REVIT 2019 Architecture Training Guide, BPB Publications. 2019.
3. REVIT ARCHITECTUREmanual.

Course Code- 20CV851 **L-T-P-C3-0-0-3**
CIE -50marks **Hours/week-3**
SEE - 50 marks

FINITE ELEMENT ANALYSIS

COs	At the end of the course the student will be able to:	Mapping to POs
CO1	Comprehend the importance & scope of finite element method of structural analysis	PO1, PO3, PO5
CO2	Comprehend finite element modeling, displacement functions, Element coordinates & global coordinates for one dimensional element	PO2, PO3, PO4
CO3	Learn two-dimensional truss element & solution of 2D truss problems & Comprehend beam element & analysis of continuous beams	PO2, PO3, PO5
CO4	Learn the application of 2D frame elements & the analysis of 2D plane stress & plane strain problems	PO3, PO4

MODULE-1

Introduction: Basic concepts and background review – stress-strain relations and strain displacement relations – matrix displacement formulation – energy concepts – equilibrium and energy methods for analyzing the structures – Rayleigh-Ritz and Galerkin's methods – simple applications in structural analysis; **Fundamentals of Finite Element Method:** Introduction, Finite Element modeling -Displacement functions–element coordinates- Global co- ordinates. Displacement functions for 1-D element and simple element. **12Hrs**

Self study component: Students shall recapture the concept of stress strain displacement relations from theory of elasticity and learn energy methods of structural analysis.

MODULE -2

Analysis of Pin Jointed Frames: 2-D truss element and its application to simple truss problems; **Continuous Beams and Stiff Jointed Frames:** Euler – Bernouli's beam element – Hermitian interpolation function – generation of stiffness matrix and nodal load vector – Analysis of Continuous beams. **10Hrs**

Self-study component: Students shall recapture the matrix methods of analysis of pin jointed trusses, continuous beams and frames.

MODULE - 3

2 D Frame Element: 2 D Frame Elements - Solution of simple stiff jointed Frames (maximum of three kinematic degrees of freedom); **Analysis of 2-Dimensional Plane stress / Plane Strain Problems:** Introduction – finite element modeling – different types of triangular and quadrilateral elements, characteristics and suitability for applications – polynomial shape functions – Lagrange's interpolation - compatibility and convergence requirements of shape functions – element strain and stresses – element stiffness matrices, nodal load vector - application of CST, LST and quadrilateral elements. Simple Problems **10Hrs**

Self-study component: Students shall attempt to run a FEM package for the analysis of 2D frames andtrusses.

MODULE - 4

Isoparametric Elements, Numerical Integration and Higher Order Elements: Isoparametric, superparametric and subparametric elements – necessity – description of solution processusing Isoparametric elements – characteristics of Isoparametric quadrilateral elements – computation ofstiffness matrix – numerical integration – convergence criteria for Isoparametricelements. **10Hrs**

Self-study component: Students shall attempt to run a FEM package for the analysis of Axi - symmetric structural problems.

Text Books:

1. Krishnamoorthy C. S "Finite Element Analysis", Theory and Programming II Edition,1994.
2. Rajashekaran"Finite Element Analysis in Engineering Design", Wheeler publisher-2008.

Reference Books:

1. ChandruptalaT.R.,Belegundu.A.D.,"IntroductiontoFEM",3rdedition,PrenticeHall-2009.
2. Mukhopadyaya. M "Matrix, Finite Element, Structural Analysis", Oxford &IBH Publishers.
3. Robert D. Cook "Concept and Applications of Finite Element Analysis" John Wiley & Sonsinc.

Course Code: 20CV852 **L-T-P-C (3-0-0)3**
CIE -50marks **Hours/week-3**
SEE - 50 marks

SOLID WASTE MANAGEMENT

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

CO1	Comprehend the sources, classification, characteristics and system of collection and transportation of solidwaste	PO1, PO2,PO4,
CO2	Learn different methods of solid waste processing and treatment techniques	PO2,PO3,PO5
CO3	Comprehend the various methods of biological treatment and landfilling	PO3,PO4
CO4	Learn different disposal methods of solid waste, biomedical waste and electronic waste and their regulations	PO2,PO4, PO5

MODULE - 1

Introduction: Scope and importance of solid waste management – Classification, source and characteristics. Estimation of energy content and derivation of approximate chemical formula. Material flow and Functional elements of solid wastemanagement.
Collection and transportation: Types of collection service. Systems of collection – hauled container and stationary container system. Estimation of solid waste quantities. Transport methods, Transfer station and route optimization techniques. **11 Hrs**

Self- study component: Students shall visit various parts of the city and study the functional elements of solid waste management-systems of collection, submit a report

MODULE - 2

Solid waste Processing: Mechanical volume reduction, Chemical volume reduction, Mechanical size reduction, Component separation, Drying and dewatering. Life Cycle Assessment and Integrated Waste management using 3Rs and 4Rs concepts.
Thermal Treatment: Incineration (Process, advantages and disadvantages, 3T's of incineration process) and plasma arc
Incineration Emission Control Technologies: Gravitational settling chambers, Cyclone separator, Fabric filters, Electrostatic precipitators and Scrubbers **10 Hrs**

Self- study component: Students shall visit various parts of the city and study the transportation, treatment and incineration process, submit a report

MODULE - 3

Biological Treatment: Objectives, Aerobic and anaerobic composting – process and design consideration. Bangalore process of composting and Indore process of composting. Factors affecting composting. Vermicomposting

Engineered Land Filling: Different types – Trench, area and Ramp Method. Advantages and disadvantages, Site selection. Landfill gases and Leachate generation, Bioreactor Landfilling **11 Hrs**

Self- study component:Students shall visit town municipality office and collect information on composting processes, land filling methods, submit a report

MODULE - 4

Disposal Methods: Open dumping, Ocean disposal and feedingtohogs
Biomedical wastes and disposal: classification, potential implication and steps in waste management.
Electronic waste management: categories, composition, environmental and health hazard, e-waste management. **Waste management handling and rules, regulations and legislation**. **10 Hr**

Self- study component: Students shall visit town municipality office and collect information ondisposal methods, biomedical waste-environmental significance of reuse and recycling, submit areport

Text Books:

1. Integrated Solid Waste Management : Tchobanoglous : Mc. Graw Hill, 1970, I Edition
2. Sasi Kumar.K, Sanoop Gopikrishna "Solid Waste Management" PHI Learning Pvt.ltd, 2009

Reference Books:

1. Pavoni J.L "Hand book on Solid Waste Disposal" -1973
2. Peavy and Tchobanoglous "Environmental Engineering"1985
3. Biomedical waste handling rules –1998

Course Code- 20CV853 **L-T-P-C3-0-0-3**
CIE -50marks **Hours/week-3**
SEE - 50 marks

WATER RESOURCES ENGINEERING

Course Outcomes (COs)

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

CO1	Comprehend scope of water resources engineering, economics in water resource planning, need for conserving waterresources	PO1, PO2, PO3
CO2	Learn the concept of water law in terms of riparian rights, permit system and water codes	PO2, PO3, PO4
CO3	Estimate design floods and probable maximum floods for multipurpose projects	PO2, PO4, PO5
CO4	Learn the aspects of engineering economy in water resources projects, principle of optimization in planning	PO3, PO4

MODULE-1

Introduction: Fields of water resources engineering, Economics in Water resource planning, social aspects, planning of water resources surveys, Water resources of the world, Water resources in India, Water demand for various purposes, Need for conserving water resources. **Water Law:** Riparian right, Appropriative rights, Permit system, Water codes. Groundwater laws, Interstate problems,internationalproblems **12Hrs**

Self-study component: Students shall collect the information from internet on water resource Planning, interstate river disputes, international problems. submit a report.

MODULE-2

Floods: Importance of flood studies, Definition of flood, causes of floods Factors affecting flood flow. Estimating the magnitude and frequency of floods, Empirical formulae, Rational method, Envelope curve, Unit hydrograph method and probability methods, Design floods, Standard project flood & probable maximum flood. **Engineering Economy in Water Resources Projects:** Introduction, Steps involved in economy study, Economics of combined flood projects and multipurpose projects. Principle of Optimization in planning, Capitalbudgeting. **10Hrs**

Self-study component: Students shall collect information from the internet on causes of flood- estimation of design flood-economics of multipurpose projects-capital budgeting, submit a report.

MODULE-3

Planning for Water Resources Development: Definition of Planning, Levels of planning, Phases of planning, Objectives of Planning Project. Formulation Project evaluation Environmental aspects in planning, System analysis, Pit falls in Planning; **Multi-purpose Projects:** Functional requirements, Compatibility of multipurpose uses, Cost Allocation to various uses in multipurpose projects planning, Component parts of a multipurpose river basin development, Operation of multipurpose reservoirs, Watershed management, small dam's v/s big dams, Economic height of a dam. **10Hrs**

Self-study component: Students shall collect the information from the internet on objectives of planning-cost allocation in multipurpose projects-watershed management-visit small dams, submit a report.

MODULE-4

Integrated Water Resource Development: Main Objectives, Secondary objectives like reclamation of waterlogged areas. Control of overdraft of groundwater, Salt-water intrusion etc. Aspects of integrated and conjunctive use of water & their constraints. A brief description of perspective water. resources development of Himalayan and Peninsular rivers of India. **Organization of Water Resources Development**: Present administrative structures, problems involved therein, Organizational setup for execution of water resources development and river basin development**. Applications of GIS in WaterResourceEngineering. 10Hrs**

Self-study component: Students shall collect the information from the internet on integrated and conjunctive use of water –water resource development of peninsular and Himalayan rivers-visit water resource department and collect details on the organizationalsetup.

Textbooks:

1. Subramanya. K "Engineering Hydrology" Tata McGraw-Hill Publishing Company Ltd., New York,2008
2. Linsley.K& Frozini.J.B"Water Resources Engineering International Students Edition, McGraw-Hill Kogakusha Ltd.

Reference Books:

1. Garg. S.K "Hydrology and Water Resources Engineering"Khanna Publishers, New Delhi,India
2. Gupta.B.L& Amith Gupta "Water Resources Systems and Management" Standard Publishers & Distributors,Delhi

Course Code- 20CV854 **L-T-P-C 3-0-0-3**
CIE -50marks **Hours/week-3**
SEE - 50 marks

URBAN AND RURAL PLANNING

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

CO1	Comprehend the basic objects and principles of town planning and types of planning.	PO1, PO4, PO9
CO2	Apply land use analysis, zoning regulations to development plan	PO1, PO7, PO9
CO3	Describe the concepts, principles, philosophies ofgreat pioneers like Hebenezer Howard, Patrick Geddes, Le Corbusier, C.A. Doxiadies, etc. during and post-industrial revolution,transportation problems in the developing countries.	PO1, PO7, PO9
CO4	Demonstrate the problems in rural areas, legislation in planning; Comprehend the knowledge on norms, procedures, etc., in planning	PO1, PO6, PO9

MODULE-1
Definition of Urban unit or town, Standard Urban areas, classification of towns and cities, Urban Infrastructure Management, Components of Urban Infrastructure, definition of planning by various planners, objects of town planning, aims of planning, main goals of Modern town planning, characteristics of successful planning, principles of town planning, necessity of town planning, physical, social and economic resources, origin of towns: Natural growth: Concentric spread, Ribbon Development, Satellite Growth, Scattered Growth, Planned Growth: Horizontal and Vertical Growth, types of planning, relationship between planning, policy and implementation, types of surveys, techniques of surveys, scale for structuring questionnaire. Selection of samples, type of selection of samples, errors in surveying. Population growth, density of population, occupational categories, evolution of towns in India: Ancient, medieval and modern, urbanization in India, Functional classificationoftowns. **12Hrs**

Self-study component: Students shall collect the information from Census, the Hassan Development Authority, Municipality Office regarding population growth, occupational pattern of Hassan city and submit a report.

MODULE-2
Definition of zoning, zoning regulations, principles of zoning, advantages of zoning, maps for zoning, Aspects of Zoning: Density, Height and Use Zoning, building byelaws, developed and undeveloped area, developed and undeveloped land, land use and land use pattern in urban areas, the character of a town, categories of a town, densities of town, planning process, detailed classification of land uses, classification of urban road and rural roads, Perspective plan, Development plan, Annual plan and Plans of Projects/Schemes, Surveys to be conducted before Development Plan, objectives of a Master Plan, necessity, data to be collected, drawing to be prepared, features of a Master plan, planning standards, report, stages of preparation, method of execution, Outline and Comprehensive DevelopmentPlan. **10Hrs**

Self-study component: Students shall collect the information from the internet on evolution of cities- visit the Hassan Development Authority and collect details on concept of zoning, Comprehensive Development plan for Hassan city submit areport.

MODULE-3
The Industrial Revolution and Urban Planning: The Garden city concept, Satellite Towns, Philosophy of Patrick Geddes, Le Carbusier – C.A. Doxiades – Evolution of cities, Planning Theory: Land use theories – Descriptive – Exploratory and Speculative theories,Transportation

Planning: interdependence of the land use and traffic, Transportation problems in developing countries, Traffic flow characteristics, Transport Surveys andParkingSurveys. **10Hrs**

Self-study component: Students shall collect the information from the Hassan Development Authority, Municipality Office and collect details on land uses-transport and parking survey, submit a report.

MODULE-4

RuralPlanning**:**Definition–Surveys–Developmentplanforavillage–Problemsofruralhousing – Areas of development – Socio Economic aspects of housing, Legislation in Planning: Objectives of Development Controls – Technical considerations for formation of Building Bye-laws – Urban local bodies – Public health and sanitation – Public works and public utilities – Education and Social Welfare Development – Administrative and General Functions–Obligatory and Discretionary functions. **10Hrs**

Self-study component: Students shall collect the information from the local village panchayath office and collect details on development plan of the village-socio economic aspects of housing, submit areport.

Text Books:

1. Abir Bandyapadhyay "Text Book of Town Planning" Books and Allied (P) ltd, Calcutta, India 2000(Ch.1,2,3,4,5,6,8)
2. RameGowda. K.S "Urban and Regional Planning", Prasaranga, University of Mysore, Mysore, 1986(Ch.7)

Reference Books:

1. Arthur.B.Gallion Simon Eisner " The Urban Pattern" CBS Publishers and Distributors, New Delhi,1998.
2. Rangawala.S.C., Rangawala P.S &Rangawala.K.S " Town Planning" Charotar Publishing House, Anand, India,1987.
3. Lewis Keeble, "Principles and Practices of Town & Country Planning", The Estates Gazette Limited, London,1969.
4. Kadiyali L. R., "Traffic Engineering & Transport Planning" Khanna Publishers, Delhi,2005.
5. C A O' Flahertly, "Transport Planning and Traffic Engineering", Butterworth-Heinemann, An Imprint of Elsevier, 2006.(Edited)
6. Partha Chakroborty & Animesh Das, "Principles of Transportation Engineering", Prentice Hall of India Private Limited, New Delhi,2003.
7. Kulshrestha S. K., "Dictionary of Urban and Regional Planning", Kalpaz Publications, Delhi, 2006.
8. Urban Development Plans Formulation & Implementation (UDPFI) Guidelines, Ministry of Urban Affairs & Employment, Government of India, NewDelhi.

Course Code- 20CV855 **L-T-P-C 3-0-0-3**
CIE -50marks **Hours/week-3**
SEE - 50 marks

EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

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

CO1	Understand earthquake phenomenon, engineering seismology and estimation ground motion parameters.	PO1, PO2, PO3
CO2	Comprehend meaning and need of seismic hazard assessment & response of structures to ground motion and construction of response spectrum	PO2, PO3, PO4
CO3	Learn response spectrum analysis by different methods, concepts of earthquake resistant design	PO2, PO3, PO5
CO4	Estimate the lateral forces in RC framed buildings and lateral stiffness of masonry walls	PO3, PO4

MODULE-1
Introduction - Development of Earthquake engineering, Global & Indian scenario, Earthquake phenomenon, Seismo/plate tectonics, Engineering seismology, basic terms and definitions, Intensity, Magnitude, Seismic zoning of India, Liquefaction–Causes and remedial measures. **Earthquake/Ground motion Parameters**: Ground motion measuring instruments, Strong ground motion, Parameters of strong ground motion, Characteristics, estimation of strong ground motion parameters. **14Hrs**

Self-study component: Students shall collect the information from the internet on earthquake phenomenon - ground motion measuring instruments.

MODULE-2
Seismic Hazard Assessment: Meaning and need of seismic hazard assessment, Deterministic approach, Gutenberg-Richter recurrence law, Poisson's probabilistic model, **Response of structures to ground motion;** Response to ground displacement/acceleration, Response Spectrum-Definition, construction and application. **10Hrs**

Self-study component: Students shall collect the information from the internet on seismic hazard assessment-response of structures to ground motion, submit a report

MODULE-3
Response spectrum analysis: Analysis by modal superposition method, absolute sum method, square root of sum of squares (SRSS) method Response spectrum analysis **Concepts of Earthquake Resistant Design;** Causes of damage, planning and architectural consideration, Philosophy & and principles of earthquake resistantdesign. **10Hrs**

Self-study component: Students shall collect the information from the internet on response spectrum analysis causes of damage due to earthquake-philosophy of earthquake resistant design, submit areport

MODULE-4
Seismic Analysis of RC Buildings; Lateral load resisting elements in RC structure, Lateral load

analysis as per IS 1893, Centre of mass, Centre of rigidity, base shear **Seismic Analysis of Masonry Buildings;** Lateral load resisting elements in masonry structures, Behavior of unreinforcedandreinforcedmasonrywalls,Lateralstiffnessofwallwithandwithoutopenings. **10Hrs**

Self-study component: Students shall collect the information from the internet on seismic analysis of RC buildings, masonry buildings, and Earthquake resistant systems. Simple building - seismic assessment shall be attempted by thestudents

Textbooks:

1. Chopra A.K, "Dynamics of Structures", Prentice Hall,India.
2. S.K. Duggal "Earthquake Resistant Design of Concrete Structures", Oxford university press, NewDelhi.
3. Kramer "Geotechnical Earthquake Engineering" Pearson education,India

Reference Books:

1. Pankaj Agarwal & Manish Shrikhande, "Earthquake Resistant Design of Concrete Structures", Prentice Hall of India. NewDelhi.
2. Ghosh S.K, "Earthquake Resistant Design of Concrete Structures", SDCPL-R&D center, New Delhi.
3. IS: 1893-2016, IS: 4326-1993, IS: 13920-1993
4. IITK-GSDMA guidelines for seismic design. National Information Center of Earthquake Engineering.
5. Murty, C. V. R. (2005). IITK-BMTPC Earthquake Tips Learning Earthquake Design and Construction. Indian Institute of Technology Kanpur,India.

Course Code- 20CV856 **L-T-P-C3-0-0-3**
CIE -50marks **Hours/week-3**
SEE - 50 marks

REINFORCED EARTH STRUCTURES

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

CO1	Identify, formulate reinforced earth techniques that are suitable for different soils and in different structures	PO1, PO2, PO12
CO2	Design RE retaining structures	PO1, PO2, PO3, PO6, PO7, PO8, PO12
CO3	Apply soil nailing concepts to the field problems	PO1, PO2, PO3, PO6, PO7, PO12
CO4	Asses the use of Geo synthetics in drainage requirements and landfill designs	PO1, PO2, PO6, PO7, PO12

MODULE - 1: Basics of Reinforced Earth Construction
Definition, Historical Background, Components, Mechanism and Concept, Advantages and Disadvantage of reinforced earth Construction, Sandwitch technique for clayey soil. **Geosynthetics and Their Functions** Classification based on materials type – Metallic and Non- metallic, Natural and Man-made. Geosynthetics – Geotextiles, Geogrids, Geomembranes, Geocomposites, Geonets, Geofoam, Geomats, Geomeshes, Geowebsetc **10Hrs**

MODULE - 2: Design of Reinforced Earth Retaining Walls
Concept of Reinforced earth retaining wall, Assumption made in designing, Internal stability: Check against Tie-break, check against pillout, External stability: Check against Sliding, Overturning, Tilting and Bearing Capacity Failure, Selection of materials, typical design problems **10Hrs**

MODULE - 3: Soil Nailing Techniques
Concept, Advantages & limitations of soil nailing techniques, comparison of soil nailing with reinforced soil, methods of soil nailing, Construction sequence, Components of system, Design aspects: Initial design considerations include wall layout (wall height and length), soil nail vertical & horizontal spacing, soil nail pattern on wall face, soil nail inclination, soil nail length & distribution, soil nail material & relevant ground properties & precautions to be taken. Applications in Embankment & Slopes **10Hrs**

MODULE - 4: Geosynthetics - Filter, Drain and Landfills
Filter & Drain – Conventional granular filter design criteria, Geosynthetic filter design requirements, Drain and filter properties, Design criteria – soil retention, Geosynthetic permeability, anticlogging, survivability and durability. Landfills – Typical design of Landfills – Landfill liner & cover. **10 Hrs**

Self-study component: Students shall visit the sites where RES techniques applied and study them. Also, they shall apply the knowledge to adopting different techniques for different types of soil

Text Books:

1. Design with geosynthetics- Koerner. R.M. -Prince Hall Publication,2005.
2. Construction and Geotechnical Engineering using synthetic fabrics- Koerner. R.M. & Wesh, J.P.- Wiley Inter Science, New York,1980.
3. An introduction to Soil Reinforcement and Geosynthetics – Sivakumar Babu G.L.,

Universities Press, Hyderabad, 2006
4. Reinforced Soil and its Engineering Applications, Swami Saran, I. K. International Pvt. Ltd, New Delhi,2006

Reference Materials:

1. Earth reinforcement and Soil structure- Jones CJEPButterworths, London,1996.
2. Geotextile Hand Book- Ingold, T.S. & Millar, K.S. - Thomas, Telford,London.
3. EarthReinforcementPractices-HidetoshiOctial,Shigenori
4. Hayshi&JenOtani-Vol.I,A.A.Balkema,Rotterdam,1992.
5. Ground Engineer's reference Book- Bell F.G. - Butterworths, London,1987.