WASTEWATER TREATMENT & SOLID WASTE DISPOSAL

Course Code	**: 19CV7DCWWT**	**Credits**	**: 4**
L:P:T:S	**: 4:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**
Hours/Week	**: 04**	**Total hours**	**: 50**

Course Objectives

1. Estimate The Quantity Of sewage from different sources and characterisation of sewage.
2. Acquires capability to design sewer and Sewerage treatment plant.
3. Evaluate degree of treatment and type of treatment for disposal, reuse and recycle.
4. Estimate The Quantity Of Solidwaste from different sources and their characterisation.
5. Suggest suitable scientific methods for solid waste management elements.

	Course Outcome
CO1	Choose sanitation methods and methods of domestic wastewater disposal
CO2	Identify the factors affecting dry weather flow, flow variations and their effects on design of sewerage system
CO3	Determine the velocity of wastewater flow by using hydraulic formulae and diameter of sewer
CO4	Design of municipal waste water treatment plant.
CO5	Characterization of solid waste from different sources
CO6	Identifying suitable method of disposal of solid waste.

Mapping of Course outcomes to Program outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	1				2	2	2	2					2	
CO2	3	2	2	1		2	2	2	2					2	
CO3	3	2	2			2	2	2	2					2	
CO4	3	3	1			2	2	2	2					2	
CO5	3	2				2	2	2	2					2	
CO6	3	3	3	2		2	2	2	2				3	2	

Module	Content	Hours	Co's
1	**Introduction:** Need for sanitation, methods of sewage disposal, types of sewerage systems, dry weather flow, wet weather flow, factors effecting dry and wet weather flow on design of sewerage system, estimation of storm water flow, time of concentration flow, numericals. **Design of sewers:** Hydraulic formula to determine velocity and discharge. Self cleansing and non scouring velocity. Design of hydraulic elements for circular sewers for full flow and half flow conditions. **Sewer appurtenances:** Manholes, catch basins, oil and grease traps. P, Q and S traps. Material of sewers, shape of sewers, laying and testing of sewers, ventilation of sewers basic principles of house drainage	10	**CO1 CO2 CO3**
2	**Waste water characteristics:** sampling, significance and techniques, physical, chemical and biological characteristics, flow diagram for municipal waste water Treatment unit operations and process. Estimation of BOD. Reaction kinetics (zero order, 1st order and 2nd order). **Treatment of municipal waste water:** Screens: types, disposal. Grit chamber, oil and grease removal. primary and secondary settling tanks.	10	**CO2 CO3**
3	**Disposal of effluents:** Dilution, self-purification phenomenon, oxygen sag curve, zones of purification, sewage farming, sewage sickness, numerical problems on disposal of effluents. Streeter-Phelps equation. **Biological Treatment Process:** Suspended growth system - conventional activated sludge process and its modifications. Attached growth system – trickling filter, bio-towers and rotating biological contactors. Principle of stabilization ponds, oxidation ditch, Sludge digesters (aerobic and anaerobic), Equalization. Sludge thickeners and drying beds	10	**CO3**
4	**Sources:** Sources of Solid waste, Types of solid waste, Physical and Chemical composition of municipal solid waste. Generation rate, Numerical Problems. Collection: Collection of solid waste- services and systems, equipment, Transportation: Need of transfer operation, transfer station, transport means and methods, route optimization. Solid waste management 2000 rules with, 2016 amendments. Processing techniques: Purpose of processing, Chemical volume reduction (incineration) – Process description, 3T's, principal components in the design of municipal incinerators, Air pollution control	10	**CO4**
5	Composting Aerobic and anaerobic method – process description, process microbiology, design consideration, Mechanical composting, Vermicomposting, Numerical Problems. Sanitary landfilling: Definition, advantages and disadvantages, site selection, methods, reaction occurring in landfill- Gas and Leachate movement, Control of gas and leachate movement, Design of sanitary landfill. Numerical Problems	10	**CO5**

NOTE: 1. Questions for CIE and SEE not to be set from self-study component.

2. Assignment Questions should be from self-study component only.

Self Study Component		
Module	**Contents**	**CO's**
1	Principles of house drainage	CO1
2	Reaction kinetics (zero order, 1st order and 2nd order).	CO2
3	Sludge thickeners and drying beds	CO3
4	Solid waste management 2000 rules with, 2016 amendments.	CO4
5	Vermicomposting,	CO5

Text Books:

1. Howard S. Peavy, Donald R. Rowe, George T, "Environmental Engineering" - Tata McGraw Hill, New York, Indian Edition, 2013
2. B C Punmia, "Environmental Engineering vol-II", Laxmi Publications 2nd, 2016
3. Karia G.L., and Christian R.A, "Wastewater Treatment Concepts and Design Approach", Prentice Hall of India Pvt. Ltd., New Delhi. 3rd, Edition, 2017
4. S.K.Garg, "Environmental Engineering vol-II, Water supply Engineering", Khanna Publishers, – New Delhi, 28th edition and 2017
5. George Tchobanoglous, Hilary Theisen , Samuel A Vigil, Integrated Solid Waste Management: Engineering principles and management issues, M/c Graw hill Education . Indian edition.
6. Howard S Peavy, Donald R Rowe and George Tchobanoglous, Environmental Engineering, Tata Mcgraw Hill Publishing Co ltd.,

Reference Books:

1. CPHEEO manual on sewage treatment, Ministry of Urban Development, Government of India, New Delhi,1999
2. Mark.J Hammer, "Water & Waste Water Technology" John Wiley & Sons Inc., New York, 2008
3. Benefield R.D., and Randal C.W, "Biological Process Design for Wastewater Treatment", Prentice Hall, Englewood Chiffs, New Jersey 2012
4. Metcalf and Eddy Inc, "Wastewater Engineering - Treatment and Reuse", Publishing Co. Ltd., New Delhi, 4th Edition, 2009.
5. Municipal Solid Wastes (Management and Handling) Rules, 2000.Ministry of Environment and Forests Notification, New Delhi, 25th September, 2000. Amendment – 1357(E) – 08-04-2016
6. Municipal Solid waste management manual, Part II published under Swachh Bharat Mission, Central Public Health And Environmental Engineering Organization (CPHEEO), 2016, Ministry of Urban Development, Government of India.
7. Handbook of Solidwaste management, second edition, George Tchobanoglous, Frank Kreith, published by M/c Graw hill Education, 2002, ISBN-13 9780071356237 ISBN -10 0071356231

HYDRAULIC STRUCTURES AND IRRIGATION DESIGN

Course Code : 19CV7DEHSD **Credits : 3**

L:P:T:S	**: 3:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**
Hours/Week	**: 03**	**Total hours**	**: 40**

Course Objectives

To know importance, locations, components & types of irrigation structures

To design various irrigation structures

	Course Outcome
CO1	Classify the Reservoirs and Storage zones of a reservoir
CO2	Study the types of earthen dam and practical profiles
CO3	Determine the elementary and practical profiles of a gravity dam,
CO4	Study the stability analysis (without earthquake forces)
CO5	Exposure to the design & drawing Tank Plug sluice with & without tower head
CO6	Exposure to the design & drawing of Surplus weir with stepped apron

Mapping of Course outcomes to Program outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	1				2	2	2	2					2	
CO2	3	2	2	1		2	2	2	2					2	
CO3	3	2	2			2	2	2	2					2	
CO4	3	3	1			2	2	2	2					2	
CO5	3	2				2	2	2	2					2	
CO6	3	3	3	2		2	2	2	2				3	2	

Module	**Content**	**Hours**	**Co's**

1	Introduction, classification of Reservoirs, Area elevation capacity curve, toposheets, storage zones of a reservoir, mass curve, fixing capacity of a reservoir, safe yield - problems, density currents, Trap efficiency, Reservoir sedimentation, life of a reservoir, economic height of a dam, problems. Environmental effects of reservoirs, spillway	8	**CO1**
2	Earthen Dams: Types of earth dams, construction methods, design criteria for earth dams, causes of failure of earth dams, section of dam, preliminary design criteria, problems. Safety measures for earthen dams	8	**CO2**
3	Introduction, forces on a gravity dam, stress analysis in gravity dam, Problems, combination of forces for design. Elementary & practical profiles of a gravity dam, stability analysis (without earthquake forces), problems, galleries in gravity dams	8	**CO3 CO4**
4	Introduction to **surplus weir**, design concepts, practical applications, designs of wing wall, abutments, side walls, apron, number of weir calculation	8	**CO5**
5	Introduction to **tank plug sluice**, design concepts, practical applications, designs of wing wall, abutments, side-walls, apron. Tower head applications.	8	**CO6**

NOTE: 1. Questions for CIE and SEE not to be set from self-study component.
2. Assignment Questions should be from self-study component only.

Self Study Component		
Module	**Contents**	**CO's**
1	Types of hydraulic structures in practical field	CO1
2	Profile of KRS dam	CO2
3	Control of seepage through earth dams.	CO4
4	Irrigation Design- Drawing, Canal regulator	CO4,CO5
5	Notch type Canal Drop, Aqueduct	CO6

Text Books:

1. Text book of irrigation engineering & Hydraulic Structures R.K.Sharma, Oxford &IBH publishing Co., New Delhi (2002)
2. Irrigation & Water resources engineering- G.L.Asawa, New Age International Publishers, New Delhi (2005)

Reference Books:

1. Irrigation engineering & Hydraulic structures- Garg.S.K, Khanna publishers, New Delhi
2. Hydraulic Structures & Irrigation Design Drawing Dr. N. Balasubramanya, Tata Mcgraw-Hill Education Pvt.Ltd.,New Delhi
3. Irrigation and Water Power Engineering- Madan Mohan Das &Mimi Das Saikia, PHI Learning Pvt. Ltd., New Delhi (2009)

EARTHQUAKE RESISTANT STRUCTURES

Course Code : 19CV7DEERS | **Credits : 3**
L:P:T:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 03 | **SEE Marks : 50**
Hours/Week : 03 | **Total hours : 40**

Course Objectives:

1. To introduce principles of Engineering seismology and fundamentals of structural dynamics relevant to earthquake resistant design
2. Evaluate seismic response of structures and Design the reinforced concrete buildings for earthquake resistance

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

	Course Outcome
CO 1	Develop knowledge on principles of engineering seismology
CO 2	Discuss the performance of structures with Structural irregularities
CO 3	Analyze and Design structures for Earthquake resistance
CO 4	Evaluate the structure response to ground motion
CO 5	Comprehend the requirement for Earthquake Resistance of Structures
CO 6	Recommend for retrofitting of structure

Mapping of Course outcomes to Program outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2							2			1	3		
CO2	3	2							2	2		1	3		1
CO3	3	2	1	1					2	2	1	1	3		2
CO4	3	3	2	3					2	2		1	3		2
CO5	3	2	1	2						2		1	3		2
CO6	3	1	1	2						2		1	3		2

Module	Content	Hours	Co's
1	Engineering Seismology, Causes for earthquakes, terminologies, theory of plate tectonics, seismic waves, Magnitude and intensity of earthquakes,. classification of Earthquakes, Seismic zoning map of India, Tsunami earthquake ground motion characteristics, , local site effects, Seismograph.	8	CO1 CO3
2	Basic concept of dynamics: Amplitude, Frequency, free vibration. Forced vibration, Resonance, Single degree freedom system, Multidegree freedom system,mathematical modelling. Damping and its types, building characteristics, Earthquake response spectrum and design spectrum,	8	CO1 CO4
3	Effect of Structural Irregularities on seismic performance of RC buildings. Vertical irregularity and plan configuration problems, Seismo resistant building architecture – lateral load resistant systems, Base isolation load combinations, Structural modelling, Seismic design philosophy , Code based seismic design methods .	8	CO2 CO4 CO5
4	Equivalent lateral force and dynamic analysis procedure. Step by step procedure for seismic analysis of RC buildings (maximum of 4 storeys , without infills) - Equivalent static lateral force method, response spectrum methods	8	CO3 CO4 CO5
5	Ductile detailing of Reinforced concrete beams and columns. Retrofitting methods Earthquake resistant design of masonry buildings - elastic properties of structural masonry, failure patterns, lateral load analysis concepts for earthquake resistant masonry buildings – codal provisions, infill walls, slenderness concept	8	CO2 CO5 CO6

NOTE: 1. Questions for CIE and SEE not to be set from self-study component.
2. Assignment Questions should be from self-study component only.

Self-Study Component		
Module	**Contents of the unit**	**CO's**
1	Continental drift theory, types of faults, past earthquakes of india	CO1
2	Seismic education	CO5
3	Case Study	CO2,CO4,CO5, CO6

REFERENCE BOOKS:

1. Earthquake Resistant Design of Building Structures, Vinod Hosur, WILEY (India)
2. Earthquake Resistant Design of Structures, Duggal, Oxford University Press
3. Earthquake resistant design of structures - Pankaj Agarwal, Manish Shrikande – PHI India
4. IS 1893(Part1): 2016
5. IS 13920:2016

FINITE ELEMENT ANALYSIS

Course Code	**: 19CV7DEFEA**	**Credits**	**: 3**
L:P:T:S	**: 3:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**
Hours/Week	**: 03**	**Total hours**	**: 40**

Course Objectives

To introduce the concepts of Mathematical Modeling of Engineering Problems.

To appreciate the use of FEM to a range of Engineering Problems

	Course Outcome
CO1	Summarize the basics of finite element formulation.
CO2	Apply finite element formulations to solve one dimensional Problems.
CO3	Evaluate two dimensional scalar Problems.
CO4	Evaluate two dimensional Vector problems.
CO5	Apply finite element method to solve problems on iso parametric element
CO6	Execute FEM analysis using SOFTWARES

Mapping of Course outcomes to Program outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	2					2	1			3		2
CO2	3	3	2	2					2	1			2		–
CO3	3	3	2	2					2	1			3		–
CO4	3	3	2	2					2	1			2		–
CO5	3	3	2	2					2	1			3		–
CO6	3	3	2	2	3				2	1			3		–

Module	Content	Hours	Co's
1	Kinematic and Static variables for various types of structural problems –Rayleigh – Ritz method – Finite difference method – Finite element method-Principles of finite element method – advantages & disadvantages – Finite element procedure. Finite elements used for one-, two- & three-dimensional problems – Element aspect ratio – mesh refinement vs. higher order elements –Numbering of nodes to minimize band widt.	8	CO1
2	Nodal displacements – Convergence criterion – Compatibility requirements – Geometric invariance – Shape function – Polynomial form of displacement function. Generalized, Natural and area coordinates –Lagrangian interpolation function – shape functions for one-, two- & three-dimensional elements.	8	CO2
3	Isoparametric elements - Internal nodes and higher order elements – Serendipity and Lagrangian family of Finite Elements – Sub parametric and Super parametric elements – Condensation of internal nodes –Jacobian transformation Matrix. Development of strain – displacement matrix and stiffness matrix. Numerical integration.	8	CO3 CO4
4	Application of Finite Element Method for the analysis of one- & two-dimensional problems –Coordinate systems – Natural, Area, Geometric coordinates, Concepts of Pascal triangle. Analysis of simple beams and plane trusses – Application to plane stress / strain /axisymmetric problems using CST & Quadrilateral Elements.	8	CO5
5	Commercially available Standard packages, Desirable features, Structure of Finite element analysis program, Pre and Post Processors	8	CO6

NOTE: 1. Questions for CIE and SEE not to be set from self-study component.

2. Assignment Questions should be from self-study component only.

Self Study Component		
Module	**Contents**	**CO's**
1	Application to Field Problems – Thermal problems	CO2
2	Torsion of Non circular shafts	CO3,4
3	Body forces and temperature effects	CO3,4
4	Stress calculations	CO4
5	Plate and shell elements.	CO4

Text Books:

1. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005

2. Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007

3.Krishnamoorthy C S, "Finite Element Analysis"- Tata McGraw Hill ,1994

REFERENCE BOOKS

1. Shames I H and Dym C J, “Energy and Finite Element Methods in Structural Mechanics”- McGraw Hill, New York, 1985
2. Bathe K J, “Finite Element Procedures in Engineering Analysis”- Prentice Hall,1982
3. Cook R D, Malkan D S &Plesta M.E, “Concepts and Application of Finite Element Analysis” - 3rd Edition, John Wiley and Sons Inc., 1989.
4. Desai C and Abel J F, “Introduction to the Finite Element Method”- East West Press Pvt. Ltd., 1972.
5. Peter Kattan “MATLAB Guide to Finite Elements” – Springer International Edition, 2002

PAVEMENT DESIGN

Course Code : 19CV7DEPDE | **Credits : 3**
L:P:T:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 03 | **SEE Marks : 50**
Hours/Week : 03 | **Total hours : 40**

Course Objectives:

1. To understand the deferment parameters in pavement design
2. To learn the method of stress analysis in pavement layers and design the thickness of both flexible and rigid pavements

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

	Course Outcome
CO 1	Analyse the basic different between flexible and rigid pavements. Highway and Airfield pavements and their design parameters
CO 2	Design of Layered analysis of both types of pavements for stresses calculation for different conditions
CO 3	Analyse methodology of both flexible and rigid pavements with full detailing
CO 4	Design the different types of pavement failures and investigate the causes and evaluation of pavements for their structural and functional adequacy
CO 5	Analyse the different ways the Rigid pavements fail and analyze root cause in technical way
CO 6	Analyse the overview of the entire pavement analysis, design, failure and reasons for failure and remedies

Mapping of Course outcomes to Program outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1			1		1					3	2	1
CO2	3	2	1			1		1					3	2	1
CO3	3	3	1			1		1					3	2	1
CO4	3	2	1			1		1					3	2	1
CO5	3	1	1			1		1					3	2	1
CO6	3	1	1			1		1					3	2	1

Module	Content	Hours	Co's
1	INTRODUCTION: Desirable characteristics of pavement, types and Components, Difference between Highway pavement and Air field pavement- Design strategies of variables – Functions of subgrade, sub base – Base course – surface course and their compositions – comparison between Rigid and flexible pavement.	6	CO3
2	FUNDAMENTALS OF DESIGN OF PAVEMENTS: Design life – Traffic factors – climatic factors – Road geometry – Subgrade strength and drainage, Stresses and deflections, Boussinesq's theory – principle, Assumptions –Limitations and problems on above – Busmister theory – Two layered analysis – Assumptions – problems on above STRESSES IN RIGID PAVEMENT: Principle – Factors – wheel load and its repetition – properties of sub grade. External conditions – joints – Reinforcement – Analysis of stresses –Assumptions – Westergaard's Analysis – Modified Westergaard's equations –Critical stresses – Wheel load stresses, Warping stress – Frictional stress –combined stresses (using chart / equations) – problems on above	12	CO3 CO2
3	DESIGN FACTORS: Design wheel load – contact pressure – ESWL concept – Determination of ESWL by equivalent deflection criteria – Stress criteria – EWL concept DESIGN OF RIGID PAVEMENT: Design of C.C. Pavement by IRC: 38 –2002 for dual and Tandem axle load – Reinforcement in slabs – Requirements of joints – Types of joints – Expansion joint – contraction joint– warping joint – construction joint – longitudinal joint, Design of joints, Design of Dowel and Tie bars – problems of the above	8	CO4
4	FLEXIBLE PAVEMENT FAILURES, MAINTENANCE AND EVALUATION: Types of failures, causes, remedial/maintenance measures in flexible pavements – Functional Evaluation by visual inspection and unevenness measurement by using different techniques – Structural E-valuation by Benkelman Beam Deflection Method, Falling weight deflectometer, GPR Method. Design factors for Runway Pavements – Design methods for Airfield pavements and problems on above.	10	CO5
5	RIGID PAVEMENT FAILURES, MAINTENANCE AND EVALUATION: Types of failures, causes, remedial/maintenance measures in rigid pavements – Functional Evaluation by visual inspection and unevenness measurements. Design factors for Runway Pavements – Design methods for Airfield pavements.	4	CO6

NOTE: 1. Questions for CIE and SEE not to be set from self-study component.
2. Assignment Questions should be from self-study component only.

Self Study Component		
Module	**Contents**	**CO's**
1	Studying Cross section details of flexible and rigid pavements	CO2
2	Analysis of Three layered analysis of flexible pavements	CO4
3	Determination of Stress distribution in CC pavement at joints if dowel bar is present	CO3
4	Working and application of Bump Integrator Equipment-concept, methodology and result analysis	CO1

Text Books:

1. Yoder and Witczak, "Principles of Pavement Design"- John Wiley and sons Inc(second edition) 1975
2. IRC 37-2001, IRC 81-1997, IRC 58 – 2002, IRC 59 – 1976, IRC 101-1988,
3. Khanna and Justo "Highway Engineering"- Nemchand & Bros, Roorkee
4. Principles of Highway Engineering, L. R. Kadiyali and Lal

References

1. Yang, "Design of functional pavements"- Mc Graw Hill Book Co.
2. Huang, "Pavement Analysis"- Elsevier Publications
3. David Croney, Paul Croney, "Design & Performance of Road Pavements"- Mc Graw hill Book Co.
4. W.Ronald Hudson, Ralph Haas and Zeniswki "Modern Pavement Management"- Mc Graw Hill and Co

DESIGN OF BRIDGE ENGINEERING

Course Code : 19CV7DEDBE
L:P:T:S : 3:0:0:0
Exam Hours : 03
Hours/Week : 03

Credits : 3
CIE Marks : 50
SEE Marks : 50
Total hours : 40

Course Objectives:

1. To introduce the theory and application of analysis and design of reinforced concrete bridges. 2. To understand the structural behavior of reinforced concrete highway bridges subjected to static loads.

Course Outcome:

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

CO1	Understand different types of bridges and their behavior
CO2	Analyse the effect of various types of IRC load cases and their effects
CO3	Design & Detail concrete bridges
CO4	Analyse & Design Prestressed Concrete bridges
CO5	Comprehend the concepts involved in the design of substructures
CO6	Understand the importance of maintenance in bridges

Mapping of Course outcomes to Program outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1			1		1					3	2	1
CO2	3	2	1			1		1					3	2	1
CO3	3	3	1			1		1					3	2	1
CO4	3	2	1			1		1					3	2	1
CO5	3	1	1			1		1					3	2	1
CO6	3	1	1			1		1					3	2	1

Module	Content	Hours	CO's
1	INTRODUCTION Historical Developments, Hydraulic particulars related to bridges, Site Selection for Bridges, Classification of Bridges, Loads and stresses on bridges, IRC Codes, Components of Bridge. Introduction to sub structures, stability aspects of piers, abutments, bridge bearings, hinges and expansion joints.	8	**CO1 CO2 CO5**
2	Slab Bridge: Proportioning of Components Analysis of interior Slab & Cantilever Slab Using IRC Class AA Tracked, Wheeled and Class A Loading, Structural Design of Slab.	8	**CO2 CO3**
3	T Beam Bridge (Up to three girders): Proportioning of Components, different methods available for the design of Longitudinal girder of a T beam bridge, Analysis and design of Slab and cross girder for IRC Class AA Tracked, Wheeled and Class A Loading, Analysis of Main Girder for Dead Load & Live Load Using IRC Class AA Tracked, Wheeled Class A Loading Structural Design of Main Girder.	8	**CO2 CO3**
4	Box Culvert: Different Loading Cases IRC Class AA Tracked, Wheeled and Class A Loading, Calculation of BM & SF by Moment distribution method, Structural Design of Box Culvert (Single vent only).	8	**CO2 CO3**
5	PSC Bridges: Introduction to Pre and Post Tensioning, Design of post tensioned bridges - Proportioning of Components, Analysis and Structural Design of Slab, IRC Class AA tracked vehicle, Calculation of pre-stressing force, cable profile and calculation of stresses. Detailing of main girder. Introduction to maintenance of bridges Introduction to joints and bearings	8	**CO4 CO6**

NOTE: 1. Questions for CIE and SEE not to be set from self-study component.

1. Assignment Questions should be from self-study component only.

Self Study Component		
Module	**Contents**	**CO's**
1	Materials for modern bridges	**CO1 CO2**
2	Serviceability criteria – deflection and fatigue	**CO2,CO3**
3	Scour depth, Traffic projection	**CO2,CO3 CO4**
4	Design of culvert	**CO5**
5	Evaluation of sub structures	**CO6**

Text books:

1. Ponnuswamy, S. "Bridge engineering", Tata McGraw-Hill, 2008.
2. Essentials of Bridge Engineering- D Johnson Victor, Oxford & IBH Publishing Co New Delhi

3. Design of Bridges - N Krishna Raju, Oxford & IBH Publishing Co New Delhi
4. Raina V.K., “Concrete Bridge Practice”- Tata McGraw Hill

Reference:

1. Bangash, M. Y. H. “Prototype bridge structures: analysis and design”, Thomas Telford, 1999.
2. Bennett, David, “The architecture of bridge design”, Thomas Telford, 1997.
3. Xanthakos, Petros P, “Bridge substructure and foundation design”, Prentice Hall, 1995
4. Fryba, L. “Dynamics of Railway Bridges”, Thomas Telford
5. IRC 6 – 1966 “Standard Specifications and Code of Practice for Road Bridges”- Section II Loads and Stresses, the Indian Road Congress New Delhi
6. IRC 21 – 1966 “Standard Specifications and Code of Practice for Road Bridges”- Section III Cement Concrete (Plain and reinforced) The Indian Road Congress New Delhi
7. IS 456 – 2000 “Indian Standard Plain and Reinforced Concrete Code of Practice”- (Fourth Revision) BIS New Delhi
8. IS 1343 – “Indian Standard Prestressed Concrete Code of Practice”- BIS New Delhi

STRUCTURAL DYNAMICS

Course Code : 19CV7DESTD | **Credits : 3**
L:P:T:S : 3:0:0 | **CIE Marks : 50**
Exam Hours : 03 | **SEE Marks : 50**
Hours/Week : 03 | **Total hours : 40**

Course Objectives To know importance of vibration of earthquake and interpret the data

	Course Outcome
CO1	Develop the equations of motion for structures
CO2	Characterize the dynamic properties of a structure
CO3	Evaluate the behavior of structure subjected to dynamic loading
CO4	Interpret the dynamic analysis results
CO5	Analyse vibration control measures for structures
CO6	Apply structural dynamics theory to earthquake analysis, response, and design of structures

Mapping of Course outcomes to Program outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2										2		
CO2	3	3	2	2									2		
CO3	3	2	2	2	2				2				2		
CO4	3	2	2	2	1				2				2		
CO5	3	2	2										2		
CO6	3	2	3	2					2				2		

Module	Content	Hours	Co's
1	**Introduction:** Introduction to structural dynamics, brief history of vibration, Basic definitions, vibration of SDOF (Single Degree of Freedom) systems, undamped, Damped, Free vibrations, equivalent viscous damping, Logarithmic decrement	8	**CO1**
2	Forced vibrations of SDOF system, Response of undamped and damped system subjected to harmonic loading, response to SDOF subject to harmonic base excitation, Duhamel's integral, response to general system of loading, dynamic load factor, response spectrum.	8	**CO2**
3	Free vibration of MDOF (Multi Degree Freedom System), Natural frequencies, Normal modes, Orthogonality of normal modes, Eigen Values Shear buildings modeled as MDOF systems. Free vibrations, Natural frequencies,	8	**CO3** **CO4**
4	Forced vibrations, Motion of shear buildings, Model Superposition Method, Response to shear buildings, Base motion, Harmonic fixed excitation. Damped motion of shear buildings, Equations for damped shear buildings, uncoupled damped equations, Conditions for damping uncoupled.	8	**CO5**
5	Dynamic analysis of base stuffiness matrices, Lumped mass and consistent mass formulation, Equations of motion.	8	**CO6**

NOTE: 1. Questions for CIE and SEE not to be set from self-study component.
2. Assignment Questions should be from self-study component only.

Self Study Component		
Module	**Contents**	**CO's**
1		CO1
2		CO2
3		CO4
4		CO4,CO5
5		CO6

Text Books:

1. Anil K Chopra, "Structural Dynamics", PHI Publications
2. Mukobadhyay, "Vibrations, Structural Dynamics", Oxford IBH Publications
3. Vinod Husur, "Earth Quake resistant design of building structures", WILE EASTERN India Publications

Reference Books:

1. V K Mac Subramanian, "Elementary structural dynamics", Danpatra Publications
2. Mario Poz, "Structural Dynamics", CBS publications.
3. Manik A Selvam, "Structural Dynamics", Danpatra publications

ADVANCED FOUNDATION DESIGN

Course Code : 19CV7DEAFD | **Credits : 3**
L:P:T:S : 3:0:0:0 | **CIE Marks : 50**
Exam Hours : 03 | **SEE Marks : 50**
Hours/Week : 03 | **Total hours : 40**

Course Objectives:

1. Design of reinforced earth foundations and Embankments
2. Design of geosynthetics - filter, drain and landfills

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

	Course Outcome
CO 1	Define the basics of Foundation design
CO 2	Design of various kinds of footings
CO 3	Analyse using different methods Pile load test and Penetration tests.
CO 4	Design the open, pneumatic and floating caissons
CO 5	Analyse the type of Machine foundations including degree of freedom of a block foundation
CO 6	Explain the necessity of pile foundation

Mapping of Course outcomes to Program outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3					2	1	2			3		
CO2	3	3	3	3				2	1	2			3		
CO3	3	3	3	3				2	1	2			3		
CO4	3	3	3	3				2	1	2			3		
CO5	3	3	3	3				2	1	2			3		
CO6	3	3	3	3				2	1	2			3		

Module	Content	Hours	Co's
1	Presumptive bearing capacity according to BIS, Factors affecting bearing capacity Factors influencing selection of depth of foundation, types of shallow foundations Settlement of Shallow Foundations: Immediate, consolidation, & differential settlements.	8	CO1
2	Principles of Design of footing, Proportioning of footings for equal settlement. Design of isolated footing, combined footing, Strap footing, Strip footing and Raft (Proportioning only)	8	CO2
3	Pile Foundation: Introduction Necessity of pile foundations, Classification, Load bearing capacity of single pile by Static formula, Dynamic formula, Pile load test and Penetration tests.	8	CO6
4	Introduction, Definition, Identification, Mineral Structure, Index properties of expansive soils, Swell potential and Swell pressure, Free swell, CNS layer, foundation treatment for structures in expansive soil. Machine Foundation: Introduction, Types of Machine foundations, basic definitions, degree of freedom of a block foundation, general criteria for design of machine foundation, free and forced vibrations,	8	CO6
5	Foundations on expansive soils: Introduction, Pile groups, group action of piles in sand and clay, group efficiency of piles, settlement of piles, negative skin friction & under reamed piles. Introduction, construction, advantages and disadvantages of drilled piers. Design of open, pneumatic and floating caissons. Advantages and disadvantages of floating caissons.	8	CO4

NOTE: 1. Questions for CIE and SEE not to be set from self-study component.
2. Assignment Questions should be from self-study component only.

Self Study Component		
Module	**Content**	**CO's**
1	Sand witch technique for clayey soil	CO1
2	Geosynthetics – Geotextiles, Geogrids, Geomembranes, Geocomposites, Geonets, Geofoam, Geomats, Geomeshes, Geowebs etc.	CO2
3	Selection of materials, typical design problems	CO3
4	Drainage requirements, Construction technique.	CO4
5	Landfills – Typical design of Landfills – Landfill liner & cover, EPA Guidelines, Barrier walls for existing landfills and abandoned dumps	CO6

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

5. Engineering with Geosynthetics- Venkattappa Rao, G., & Suryanarayana Raju., G. V.S. - Tata Mc Graw Hill publishing Company Limited., New Delhi.

REFERENCE BOOKS:

1. Earth reinforcement and Soil structure- Jones CJEP Butterworths, London, 1996.
2. Geotextile Hand Book- Ingold, T.S. & Millar, K.S. - Thomas, Telford, London.
3. Earth Reinforcement Practices - Hidetoshi Octial, Shigenori Hayshi & Jen Otani -Vol. I, A.A. Balkema, Rotterdam, 1992.
4. Ground Engineer's reference Book- Bell F.G. - Butterworths, London, 1987.
5. Reinforced Earth- Ingold, T.S. - Thomas, Telford, London.
6. Geosynthetics in Civil Engineering, Editor

ECOLOGY & EIA

Course Code	**: 19CV7DEEEI**	**Credits**	**: 3**
L:P:T:S	**: 3:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**
Hours/Week	**: 04**	**Total hours**	**: 40**

Course Objectives

Compare and contrast the ecosystem structures from the ecosystem function

Understand phenomena of impacts in the environment

Know the impact quantification of various projects on the environment

	Course Outcome
CO1	Know the different principles and concepts of ecology and sustainable development.
CO2	Acquiring a better understanding of theoretical ideas in a broad and general way the ecology of human societies and the social impact of development on communities and regions.
CO3	Prepare portions of environmental documents through administrative and legal requirements and standards of professional practice.
CO4	Utilize EIA documents for policy development, project planning or for legal or political action planning.
CO5	Fully participate in interdisciplinary environmental report preparation teams.
CO6	Analyze proposed development project plans for possible environmental effects and prepare appropriate initial studies.

Mapping of Course outcomes to Program outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2			3	3									
CO2	3	3			3	3									
CO3	3	3	3	3	3	3									
CO4	3	3	3	3	3	3									
CO5	3				3	3									
CO6	3			2	3	3									

Module	Content	Hours	Co's
1	Structure and function of the ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundar ban). Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur]. Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity.	8	
2	Environmental Impact Assessment: Definition and scope, preliminary screening requiring EIA of projects. Objectives and Scope, Contents of EIA, Types of EIA, rapid and comprehensive, EIS, FONSI.	8	
3	Step-by-step procedures for conducting EIA, Limitations of EIA, Frame work of Impact Assessment. Methods of environment impact assessment; ad-hoc method, maps and overlays, check lists, matrix, cause condition impacts.	8	
4	Assessment and Prediction of Impacts on Attributes Air, Water, Noise, Land Ecology, Soil, Cultural and Socio-economic Environment. EIA guidelines for Development Projects. Procedure For EIA Clearance: EIA review and screening; state level screening, clearance from DOE and MOEF.	8	
5	Public Participation in Environmental decision making. EIA for Water resource developmental projects, Highway projects: Nuclear Power plant projects, Mining project (Coal, Iron ore), Thermal Power Plant. EIA on Forest	8	

NOTE: 1. Questions for CIE and SEE not to be set from self-study component.
2. Assignment Questions should be from self-study component only.

Self Study Component		
Module	**Contents**	**CO's**
1	Endemic species, Biodiversity Hot-spot.	
2	preliminary screening requiring EIA of projects.	
3	cause condition impacts.	
4	state level screening, clearance from DOE and MOEF.	
5	EIA for Water resource developmental projects,	

Text Books:

1. Environmental Studies Benny Joseph Tata Mc Graw-Hill. 2ndEdition, 2012
2. Jain, R.K., Urban, L.V. and Stacey, G.S., Environment Impact Analysis, Von Nostrand Reinhold Company.
3. Lawrence, David P., Environmental Impact Assessment (Practical Solutions to Recurrent Problems), Wiley International, New Jersey.

Reference Books:

1. Masters, G. M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt. Ltd.,1991.

2. MoEF, GoI, Environment Impact Assessment, Impact Assessment Division, January 2001 (Manual).
3. Water (Prevention and Control of Pollution) Act 1974. Air (Prevention and Control of Pollution) Act 1981.
4. Trivedi, P.R., Natural Resources Conservation, APH Publishing Corporation, New Delhi.
5. Westman, Walter E., “Ecology, Impact Assessment and Environment Planning” John Wiley and Sons, Canada, 1985.

CONCRETE AND HIGHWAY MATERIALS LABORATORY

Course Code	**: 19CV7DLCHL**	**Credits**	**: 2**
L:P:T:S	**: 3:0:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**
Hours/Week	**: 03**	**Total hours**	**: 40**

Course Objectives:

1. Perform tests on hardened and fresh concrete

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

	Course Outcome
CO 1	Analyze Normal Consistency, Setting time, Soundness by Autoclave method, Compression strength test
CO 2	Determine Workability by performing slump, Compaction factor and Vee Bee Consistometer tests.
CO 3	Analyse aggregates for Crushing, abrasion, impact and Shape tests: Combined Index test (Flaky and Elongation test),
CO 4	Determine the Specific Gravity, Penetration, Ductility, Softening point, Flash and fire point of bitumen
CO 5	Perform Specific gravity and water absorption on aggregates
CO 6	Analyse Viscosity of bitumen

Mapping of Course outcomes to Program outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	1					2	2	1		1	2		1
CO2	3	3	1					2	2	1		1	2		1
CO3	3	3	3					2	2	1		1	2		1
CO4	3	1	1					2	2	1		1	2		1
CO5	3	1	2					2	2	1		1	2		1
CO6	3	1	1					2	2	1		1	2		1

Experiment	Content	Hours	Co's
1	**CEMENT:** Normal Consistency, Setting time, Soundness by Autoclave method, Compression strength test and Air permeability test for fineness, Specific gravity of cement.	**10**	
2	**FRESH CONCRETE:** Workability : slump, Compaction factor and Vee Bee Consist meter tests. Flow table test. **HARDENED CONCRETE:** Compression strength on cubes and Split tensile test cylinder, Flexural strength of PCC beams	**10**	
3	**AGGREGATES:** Crushing, abrasion, impact and Shape tests: Combined Index test (Flaky and Elongation test), Specific gravity and water absorption.	**10**	
4	**BITUMINOUS MATERIALS:** Specific Gravity, Penetration, Ductility, Softening point, Flash and fire point, Viscosity test on Bituminous materials	**9**	
5	Tests on hardened concrete using NDT – only demo	**3**	

NOTE: 1. Questions for CIE and SEE not to be set from self-study component.
2. Assignment Questions should be from self-study component only.

Self-Study Component		
Unit	**Contents of the unit**	**CO's**
1	NIL	
2	NIL	
3	NIL	
4	NIL	

Text books:

1. Khanna and Justo "**Highway Materials Testing** "- Nemchand & Bros, Roorkee
2. M.L Gambhir, Concrete Manual, Dhanpat Rai and Sons, New-Delhi
3. BIS and IRC- Relevant standards code books

URBAN WASTE HANDLING AND DISPOSAL

Course Code	**: 19CV7IEUHD**	**Credits**	**: 3**
L:P:T:S	**: 3:0:0:0**	**CIE Marks**	**: 50**
Exam Hours	**: 03**	**SEE Marks**	**: 50**
Hours/Week	**: 03**	**Total hours**	**: 40**

Course Objectives:

1. To study the effects of the various types of waste on human being, animals and environment.
2. To study the water &wastewater management and solid waste of urban area.
3. To study the various techniques and options for handling industrial wastewater, hazardous waste and air pollution of urban area.

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

	Course Outcome
CO 1	To evaluate the effects of various wastes on human beings, animals and on Environment.
CO 2	To solve the water and wastewater treat by using conventional and advanced treatment methods.
CO 3	To estimate quantity of solidwaste, E-waste and biomedical wastes and to suggest their disposal methods.
CO 4	To suggest reuse and recycles techniques of solid waste, E-waste and biomedical wastes and to suggest their disposal methods.
CO 5	To characteristics and to select treatment options for selected industrial wastewater.
CO 6	To discuss the impacts of hazardous waste and air pollution.

Mapping of Course outcomes to Program outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	1												
CO2	3	3	1												
CO3	3	1	1												
CO4	3	3	1												
CO5	3	1	2												
CO6	3	1	2												

Module	Content	Hours	COs
1	**Introduction** Definition of waste, types and sources of waste, properties of water, wastewater and air, effects on Human beings and animals and on their environment, introduction to various acts and rules for waste in India	6	CO1
2	**Domestic Water and Wastewater Management:** Importance of water and wastewater treatment, water quality standards, effluent standards, Flow diagram of water and wastewater treatment, Advanced wastewater treatments-RO, Nitrification and De-nitrification process, SBR techniques	8	CO2
3	**Solid Waste Management:** **Municipal waste-** Types, sources, collection, transportation and disposal methods **Biomedical waste-** Types, sources, collection and disposal methods **E-waste** –Composition, segregation, Reuse and recycle and disposal techniques **Construction and Demolition Waste-** Problems of collection, Segregation, transportation & limitations, Reuse and disposal of waste	10	CO3 CO4
4	**Industrial wastewater management:** Volume and strength reduction, equalization, neutralization, Propagation techniques Flow diagram and treatment methods for pulp and paper, dairy, sugar & textile industries	8	CO5
5	**Hazardous waste and Air pollution management:** Definition of hazardous waste, classification of waste, processing techniques, rules and regulation of disposal of waste Sources of air pollution, formation of acid rain, Causes of acid rain for environment and its control, green houses gasses and global warming, air pollution in Indian Scenario	8	CO6

NOTE: 1. Questions for CIE and SEE not to be set from self-study component.
2. Assignment Questions should be from self-study component only.

Self Study Component		
Module	**Contents of the unit**	**CO's**
1	Acts and rules for water, wastewater and air pollution in India	CO1
2	Acts and rules for Biomedical waste- and E-waste disposal	CO3
3	Rules and regulation of disposal of hazardous waste	CO6
4	Air pollution in Indian Scenario	CO6

Text Books:

1. Environmental Engineering: Howard S. Peavy, Donald R. Rowe, George Tchnobanoglous McGraw Hill International Edition.
2. Industrial Waste Water Treatment.-Rao MN, and Dutta A.K.

3. Hazardous Waste Management-Charles A. Wentz - 1998
4. Air Pollution M N Rao, H V N Rao Air Pollution Tata McGraw-hills Publishers, New Delhi,

Reference Books:

5. Integrated solid waste management-Engineering principles and management issues George Tchobanoglous, Hilary Theisen, S. A. VigilMc Graw-Hill,
6. E-waste: Implications, regulations, and management in India and current global best practices By Rakesh Johri