15MCE11 APPLIED MATHEMATICS L T P C

4 0 0 4

ASSESSMENT: THEORY

Category: Foundation Course

COURSE OBJECTIVE:

To familiarize the students in the field of differential and elliptic equations to solve boundary value problems associated with engineering applications.

To expose the students to variational formulation and numerical integration techniques and their applications to obtain solutions for buckling, dynamic response, heat and flow problems of one and two dimensional conditions.

COURSE OUTCOMES:

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

*CO1 –**Apprehend the knowledge of Laplace and Fourier transformations***

*CO2-**UseEigen value problems and Calculus of variations in structural engineering problems***

*CO3-**Apply Numerical Integration techniques for complicated integrals***

ONE DIMENSIONAL WAVE AND HEAT EQUATIONS

Laplace transform methods for one-dimensional wave equation – Displacements in a long string – longitudinal vibration of an elastic bar – Fourier transform methods for one-dimensional heat conduction problems in infinite and semi-infinite rods.**(13)**

ELLIPTIC EQUATION

Laplace equation – Properties of harmonic functions – Solution of Laplace's equation by means of Fourier transforms in a half plane, in an infinite strip and in a semi-infinite strip – Solution of Poisson equation by Fourier transforms method.**(12)**

CALCULUS OF VARIATIONS

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functional dependant on functions of several independent variables – Variational problems with moving boundaries –Direct methods – Ritz and Kantorovich methods.**(12)**

EIGEN VALUE PROBLEMS

Methods of solutions: Faddeev – Leverrier Method, Power Method with deflation – Approximate Methods: Rayleigh – Ritz Method. **(12)**

NUMERICAL INTEGRATION

Gaussian Quadrature – One and Two Dimensions – Gauss Hermite Quadrature – Monte Carlo Method – Multiple Integration by using mapping function. **(11)**

Total: 60 Hrs

TEXT BOOKS

1. Sankara Rao.K, "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 2011.

2. Rajasekaran.S, "Numerical Methods in Science and Engineering A Practical Approach", S.Chand & CompanyLtd.,2003.

REFERENCES

1. Gupta.A.S, "Calculus of Variations with Applications", Prentice Hall of India Pvt. Ltd., New Delhi, 2008.
2. Andrews.L.C and Shivamoggi.B.K, "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1	x			x							
2	x			x	x						
3	x			x	x						

	L	T	P	C
15MCE12 APPLIED ELASTICITY AND PLASTICITY **ASSESSMENT: THEORY**	**3**	**0**	**0**	**3**

Category: Professional Core

COURSE OBJECTIVE

To understand the concept of 3D stress, strain analysis and its applications to simple problems.

COURSE OUTCOMES

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

*CO1-**Apprehend the principles of elasticity, plasticity and fracture mechanics***

*CO2-**Solve engineering problems related to thick cylinders, shafts and curved bars***

*CO3- **Use computer programming in solving problems related to plasticity and elasticity***

ANALYSIS OF STRESS AND STRAIN (8)

Elasticity approach - Definition and notation of stress – components of stress and strain – generalized Hooke's Law - Principal stresses and strains for three dimensional element Equations of equilibrium and compatibility conditions for 3-D problems in Cartesian and cylindrical co-ordinates - Transformation of stresses and strains - Boundary conditions. Use of Programming Languages/ Software Packages for Stress/ Strain Analysis

TWO DIMENSIONAL PROBLEMS IN CARTESIAN COORDINATES (8)

Plane stress and plane strain problems with practical examples. Equations of equilibrium and compatibility conditions in Cartesian coordinates - Airy's stress function, bending of a cantilever of narrow rectangular cross-section under the action of couples, knife edge and varying distributed loads, bending of simply supported beams by uniform and uniformly varying loads. Use of Computer Programming/ Software Packages.

TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATES (8)

Equations of equilibrium and compatibility conditions in polar coordinates - axisymmetrical problems; thick cylinder under uniform pressure, shrink and force fits, circular arc beams subjected to pure bending – bending of curved bar - Stress concentrations due to circular hole in plate - effect of concentrated and uniformly distributed load on straight boundary of semi-infinite plates, stresses in circular disc subjected to diametrically opposite concentrated loads. Use of Computer Programming/ Software Packages

TORSION (8)

Torsion of various shaped bars, pure torsion of prismatic bars, prandtle's membrane analogy, strain energy and finite difference method, torsion of rolled profiles, stress concentrations at re-entrant corners, torsion of thin walled tubes and hollow shafts. Plastic torsion - Elastic - plastic torsion analysis - circular section - sand heap analogy. Numerical Methods Using Software Packages

THEORY OF PLASTICITY **(8)**

Stress - strain diagram - Ideal plastic body - Illustration of plastic Analysis - Yield criteria - Rankine's theory - St.Venant's theory - Tresca Criterion - Beltramis theory - Von Mises criterion - Mohr's theory of yielding - Yield surface - Flow rule (stress - strain relation for perfectly plastic flow)- Prandtl Reuss equality - plastic work - stress - strain relation based on Tresca - plastic potential - uniqueness of a stress distribution - strain hardening – sand heap analogy.

INTRODUCTION TO FRACTURE MECHANICS **(5)**

Failure criteria and fracture toughness – stress intensity factor.

Total: 45 Hrs

TEXT BOOKS

1. Ernest E.Sechler, "Elasticity in Engineering", Dover Publications, New York, 1968.
2. Sadhu Singh, "Theory of Plasticity", Khanna Publications, New Delhi, 2000.

REFERENCES

1. Timoshenko and Goodier.J.N, "Theory of Elasticity", Mc Graw Hill book co, New York, 1988.
2. Chen.W.F. and Henry.D.J, "Plasticity for Structural Engineers", Cengage Learning India Pvt. Ltd., , New Delhi, 2008.
3. A.C.Ugural and S.K.Fenster, "Advanced Strength and Applied Elasticity", Edward Arnold Publishers Ltd., UK, 2003.

Mapping of course outcome with program outcome:

CO's	**Mapping of CO'S and PO'S**										
	PO's										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	**x**				**x**						
2					**x**						
3				**x**							

15MCE13 - COMPUTER ANALYSIS OF STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Core

COURSE OBJECTIVE

To study the energy concepts, analysis of structures by stiffness and flexibility approaches.

COURSE OUTCOMES

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

*CO1-**Apprehend the knowledge of behavior of structures***

*CO2-**Analyze structural systems using matrix methods***

*CO3- **Develop computer programs for matrix methods***

BASIC CONCEPTS (5)

Indeterminacy - Static, Kinematic – Generalized measurements – Degrees of Freedom – Constrained measurements – Behavior of Structures – Principle of Superposition – Equilibrium, Compatibility and Force displacement relations .

STIFFNESS AND FLEXIBILITY (6)

Stiffness and Flexibility matrices in Single, two and n-coordinates; Structures with Constrained measurements; Stiffness and flexibility coefficients – Basic Stiffness and basic Flexibility method applied to spring models.

ENERGY CONCEPTS AND TRANSFORMATION OF INFORMATION (9)

Strain energy; Stiffness and flexibility matrices for strain energy – Betti's law and its applications – Properties of stiffness and flexibility matrices – Contra gradient law- Co-ordinate transformations – Transformation of element matrices to structure matrices – orthogonal transformations.

STIFFNESS METHOD (9)

Development of the method - Structure stiffness matrix for beams, frames and trusses using displacement transformation matrix and coordinate transformation matrix – Internal forces due to thermal expansion and lack of fit – Direct stiffness methods- Static condensation – transfer matrix method – symmetry and anti-symmetry of structures – reanalysis technique -Analysis by substructures using the stiffness method.

FLEXIBILITY METHOD (9)

Flexibility Method applied to statically determinate and indeterminate structures; Choice of redundant; Primary structure- General formulation- Structures flexibility matrix using force transformation matrix – Internal forces due to thermal expansion and lack of fit.

COMPUTER PROGRAMS **(9)**

Development of Computer programs for simple problems (beams, frames and trusses). Computer application and use of computer packages.

Total: 45 Hrs

TEXT BOOKS

1. Devdas Menon, "Advanced Structural Analysis", Narosa Publishing House, Daryagang, New Delhi,2009.
2. Moshe.F.Rubinstein, "Matrix Computer Analysis of Structures", Prentice Hall, 1986

REFERENCES

1. Rajasekaran.S and Sankarasubramanian.G, "Computational Structural Mechanics", Prentice Hall of India, New Delhi, 2001.
2. Pandit.G.S and Gupta.S.P, "Structural Analysis – a Matrix Approach", Tata Mc Graw Hill Publishing Company, 2004.
3. Weaver.J.R and Gere.J.M, "Matrix Analysis of Framed Structures", CBS Publishers, New Delhi, 1986.
4. Fleming.J.F, "Computer analysis of Structural Systems", Mcgraw Hill Book Co., 1989.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1		x		x	x						
2	x		X	x		x					
3					x	x					

15MCE14 COMPUTER AIDED DESIGN OF REINFORCED CONCRETE STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Core

COURSE OBJECTIVE

To study the behavior, analysis and design of RC Structures.

COURSE OUTCOMES

On completion of the course the students will be able to

*CO1-**Gainknowledge in the behaviorof reinforced concrete elements.***

*CO2-**Design special Reinforced Concrete elements such as deep beams, corbels, shear wall and grid floors.***

*CO3-**Analyze and design the RC structures using software packages.***

DESIGN OF RC ELEMENTS AND SERVICEABILITY CRITERIA (9)

Review of limit state design of slabs, beams and columns according to IS codes. Calculation of Deflection and crack width for beams and slabs as per IS codes.

DESIGN OF SPECIAL RC ELEMENTS (10)

Design of RC walls – Ordinary and shear walls – Design of corbels – Design of deep beams - Detailing.

FLAT SLABS AND GRID FLOOR (10)

Design of flat slabs and flat plates – Limitations - Design of voided slabs - Analysis and design of Grid floors - Detailing.

INELASTIC BEHAVIOUR OF CONCRETE BEAMS (9)

Moment – Curvature (M - ϕ) relation of Reinforced Concrete Sections - Moment redistribution – Baker's method of plastic design – Advantages and Disadvantages of Moment Redistribution – Application of software packages and computer programming.

DESIGN LOADS OTHER THAN EARTHQUAKE LOADS **(8)**

Dead Loads – Imposed Loads (IS 875 Part 2) – Loads due to Imposed Deformations – General Theory of Wind Effects on Structures. Application of software packages and computer programming.

Total: 45 Hrs

TEXT BOOKS

1. P.C.Vargheese, "Advanced Reinforced Concrete Design",2nd Edition, Prentice hall of India,New Delhi, 2009.
2. Park.R and Paulay.T, "Reinforced Concrete Structures", John Wiley and Sons, New Delhi, 1988.
3. Unnikrishnan Pillai and Devdos Menon, "Reinforced Concrete design", Tata McGraw Hill Publishers Company Ltd., NewDelhi, 2009.

REFERENCES

1. Sinha.N.C and Roy.S.K, "Fundamentals of Reinforced Concrete", S.Chand and Company, New Delhi, 2003.
2. Dayaratnam.P, "Design of Reinforced Concrete Structures", Oxford & OBH Publishing Co. Pvt. Ltd., Calcutta, 2005.
3. P.Purushothaman, "Reinforced Concrete Structural Elements – Behaviour Analysis and Design", Tata McGraw Hill Publishing Company Limited, New Delhi, 1986.
4. Gambhir, "Design of Reinforced Concrete Structures", PHI Learning Ltd., New Delhi, 2008.
5. IS 456-2000 : Plain and Reinforced Concrete – Code of Practice.
6. IS 875 : Part 1 : Part 1 Dead loads - Unit weights of building material and stored materials (Incorporating IS:1911-1967).

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1		x			x						
2		x				x					
3		x				x					

15MCE15 ADVANCED STEEL STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Core

COURSE OBJECTIVE

To study the concept of limit state design and analysis and design of Industrial buildings, steel towers, Trusses and Chimneys.

COURSE OUTCOMES

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

*CO1-**Gainknowledge in the structural steel analysis and design***

*CO2- **Familiarize in the design of various steel structures and their connections***

*CO3-**Use software packages in the design of steel structures***

LIMIT STATE DESIGN (9)

Introduction to Limit state design –Ultimate and serviceability limit states - Design of tension, compression members – Design of beams.

BEHAVIOUR AND DESIGN OF CONNECTIONS (9)

Behavior of connections – Design requirements of bolted and welded connections –unstiffened and stiffened seated connections – framed connection – moment resistant connection – Tee stub and end plate connections

ANALYSIS AND DESIGN OF INDUSTRIAL BUILDING (9)

Types on loads on structures – Analysis and design of Industrial buildings and bents – sway and non sway frames – Analysis and design of gable frames -Design of Purlins , louver rails, gable column and wind girder.

ANALYSIS AND DESIGN OF STEEL TOWERS (9)

Transmission line towers - Micro Wave Towers - Loads on towers - Shape, Sag and Tension in Uniformly loaded conductors - Analysis of towers - Design of member in towers - Design of tower foundations. Design and Analysis of Steel Towers using Software packages.

ANALYSIS AND DESIGN OF SPECIAL STRUCTURES (9)

Analysis and design of trusses – forces in members – Design of self supporting chimney and guyed steel chimney- Stress due to wind and earthquake forces – Gust factor method - Design of foundation.

Total: 45 Hrs

TEXT BOOKS

1. Subramanian.N, "Design of Steel Structures", Oxford University press, 2014.
2. Duggal, "Limit state design of Steel structures", Tata McGraw Hill, New Delhi, 2014.
3. Ramachandra, "Design of Steel Structures" Vol.2, Standard Publishing House, New Delhi. 2010.

REFERENCES

1. Dayaratnam, 'Design of steel structure', S.Chand & Co., New Delhi, 2010.
2. IS 800 -2007,Indian Standard Code of practice for General Construction in Steel.
3. IS: 6533 Code of Practice for Design and Construction of steel chimney.
4. SP 6 : Part 1 : 1964 Handbook for structural engineers - Structural steel sections.
5. IS 802 : Part 1 : Sec 1 : 1995 Code of practice for use of structural steel in overhead transmission line towers, Part 1 Materials and Loads and permissible stresses Section 1 Materials and Loads
6. IS 6533: Part 2 : 1989 Code of practice for design and construction of steel chimneys Part 2 Structural aspects.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1		x		x							
2		x			x						
3		x			x		x				

15MCE16 COMPUTER APPLICATIONS LABORATORY
ASSESSMENT: PRACTICAL

L	T	P	C
0	0	2	1

Category: Professional Core

COURSE OBJECTIVE

On line training for application to advanced problems in analysis, design and planning tools in civil engineering which aims the student to understand structural engineering softwares and also develop to address the demand industry ready professionals.

COURSE OUTCOMES

On completion of the lab the student will be able to:

*CO1-**Perceive knowledge of various software packages and their difference among them to solve various structural engineering problems***

*CO2-**PerceiveLimitations of various software in practical aspect***

*CO3-**Apprehend algorithm for analysis and design of reinforced concrete and steel structures***

ANALYSIS - DISCRETISATION
Matrix methods of Structural Analysis - programs for semi automatic techniques for flexibility and stiffness approaches -- Direct Stiffness approach by MATLAB and EXCEL.

STRUCTURAL ANALYSIS
Modelling – loads and load combinations – calculation of deflections – stress resultants

USE OF GENERAL PURPOSE PACKAGES
Analysis and design of R.C and Steel structures using softwares like STAAD.Pro, ETABS, SAP 2000 and ANSYS.

Total: 30 Hrs

REFERENCE BOOKS

1. STAAD.Pro – manual volume 1 and 2, Bentley Systems India, Private Limited, New Delhi.
2. ETABS - Integrated Building Design Software, CSI, Berkeley, California.
3. SAP 2000 - Linear and Nonlinear Static and Dynamic Analysis and Design, CSI, Berkeley, California.
4. ANSYS Structural Analysis Guide, ANSYS, Inc.,Canonsburg, PA, USA.
5. MATLAB - Beginners Guide to MATLAB,MathWorks, Inc.,Clarkson University,New York.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1			x								x
2			x			x					
3		x	x								

15MCE21 STRUCTURAL DYNAMICS

ASSESSMENT: THEORY

Category: Professional Core

L	T	P	C
3	0	0	3

COURSE OBJECTIVE

To expose the students the principles and methods of dynamic analysis of structures and to prepare them for designing the structures for wind, earthquake and other dynamic loads

COURSE OUTCOMES

On completion of the course the students will be able to

CO1 – Model and formulate dynamic equilibrium equations for SDOF and MDOF systems.

CO2-Analyze SDOF and MDOF systems using classical and numerical methods.

CO3- Apprehendthe behavior of structures subjected to dynamic loads

INTRODUCTION AND PRINCIPLES OF STRUCTURAL DYNAMICS (9)

Dynamic analysis and their importance to structural engineering problems - Elements of vibratory systems and simple Harmonic Motion - Vibration with and without damping - D'Alembert's principle - Lagrange's equation.

Single degree of freedom

Mathematical models of SDOF systems - Principle of Virtual displacements - Assumed modes method - Free vibration - Damped and undamped - Critical damping - Logarithmic decrement - Response to support motion - Transmissibility - Evaluation of damping resonance - Band width method to evaluate damping - Vibration isolation.

RESPONSE TO GENERAL DYNAMIC LOADING (9)

Fourier series expression for loading - response to general dynamic loading - (blast or earthquake) - Duhamel's integral - Numerical evaluation - Finite difference method. Computer Methods

GENERALIZED DISTRIBUTED FLEXIBILITY

Expression for generalised system properties - Vibration analysis with Rayleigh's variational method - Rayleigh – Ritz method.

CONTINUOUS SYSTEMS (9)

Differential equation of motion - Transverse vibration of linearly elastic beams - Hamilton's Principle - Beam flexure including shear deformation and rotatory inertia - Analysis of undamped free vibration of simply supported and cantilever beams - Numerical evaluation of modes - Frequencies and response system - Vibration analysis using finite element method for beams and frames - Component mode synthesis. Software Applications.

MULTIDEGREE OF FREEDOM SYSTEM(9)

Evaluation of structural property matrices - Natural vibration - Solution of the eigen value problem - Iteration due to Holzer and Stodola - Transfer matrix method - Orthogonality of natural modes - Rayleigh's method - Rayleigh - Ritz method, Computer Programming using C / C++.

DESIGN OF STRUCTURES SUBJECTED TO DYNAMIC LOADS (9)

Idealization of multi-storied frames for dynamic analysis - Machine foundations - analysis to blast loading - Earthquake response - Elastic rebound theory - Deterministic analysis of earthquake response - lumped SDOF system - Design of earthquake resistant structures – Wind induced vibrations - IS code provisions - Computer Applications.

Total: 45 Hrs

TEXT BOOKS

1. Craig.R.R, "Structural Dynamics – An Introduction to Computer Methods", John Wiley & Sons, 1995.
2. Clough.R.W and Penzien, "Dynamics of Structures", McGraw Hill Book Company, 2015.
3. Anil K Chopra, "Dynamics of Structures – Theory and Applications to Earth Quake Engineering", Prentice Hall, New Delhi, 2007.

REFERENCES

1. Mario Paz, "Structural Dynamics – Theory of Computation", Kluwer Acadamic Publication, 2004.
2. Smith.J.W, "Vibration of Structures", Chapman and Hall, 1988.
3. Max Irvine, "Structural Dynamics", Allen & Unwin, London, 1986.
4. Fertis.D.G, "Dynamics and Vibrations of Structures", John Wiley & Sons, 1973.
5. Singiresu S. Rao, "Mechanical Vibrations", Pearson Education Inc., New Delhi, 2004.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1	x				x	x					
2	x			x							
3	x					x					

15MCE22 FINITE ELEMENT METHOD

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Core

COURSE OBJECTIVE

To study the energy principles, finite element concept, stress-strain analysis and applications

COURSE OUTCOMES

On completion of the course the students will be able to

CO1 - Apprehend the knowledge of Finite Element Method

CO2 - Formulate mathematical equation for structural engineering problems

CO3 – Apply Finite Element Method for common engineering problems

INTRODUCTION AND BASICS (9)

General description – Basic element shapes – Discretization process – Node numbering – Mesh generation – Energy principles – Variational methods **-** Raleigh Ritz method – Galerkin Method – Least squares approach.

ANALYSIS OF TRUSSES, BEAMS AND FRAMES (9)

Stiffness matrix for an axial element – transformation of vectors – plane truss analysis – beam stiffness – solution for beam problems – Two Dimensional beam element – rigid plane frames – inclined or skewed supports – analysis of grids.

PLANE STRESS AND PLANE STRAIN PROBLEMS (9)

Basic concepts of plane stress and plane strain – derivation of stiffness matrix for constant – strain, linear strain triangular elements – rectangular elements – iso parametric elements – Lagrange and Serendipity elements – static condensation – axisymmetric elements.

PLATE BENDING PROBLEMS (9)

Basic concepts – derivation of element stiffness matrix – four noded, eight noded rectangular and isoparametric elements – shear deformation in plates – computer applications.

OTHER APPLICATIONS(9)

Three dimensional stress analysis – Torsion problems – Free vibration analysis – Buckling problems – Heat transfer – Fluid flow problems – Thermal analysis – Finite element packages.

Total: 45 Hrs

TEXT BOOKS

1. Daryl L.Logan, "Finite Element Method", Thomson Canada Ltd., India Edition, 2016.

REFERENCES

1. Singiresu.S.Rao, "The Finite Element Method in Engineering", Butterworth-Heinemann, India Edition, 2001.
2. 2. Krishnamoorthy.C.S, "Finite Element Analysis", Tata Mc Graw Hill Publishing Co., New Delhi, 2008.
3. 3. Rajasekaran.S, "Finite Element Analysis in Engineering Design", S.Chand and Company Ltd., 2003.
4. 4. Larry.J.Segerlind, "Applied Finite Element Analysis", John Wiley and Sons, New York, 2010.
5. 5. Robert.D.Cook, David.S.Malkus, "Concepts and Applications of Finite Element Analysis", John Wiley and Sons, India Edition, 2007.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1	x				x						
2				x			x				
3			x								x

15MCE23 DESIGN OF FOUNDATION STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Core

COURSE OBJECTIVE

To study, analyse and design different types of foundations and retaining structures

COURSE OUTCOMES

On completion of the course the students will be able to

*CO1-**Apprehend the concepts of design of foundation structures***

*CO2-**Acquire knowledge about various Indian Standards for shallow and deep foundations***

*CO3-**Solve practical geotechnical problems***

SHALLOW FOUNDATIONS (9)

Bearing capacity and settlement - Spread footings - contact pressure - Structural design of individual footings, pedestals, combined footings (Rectangular and trapezoidal), Strap footings - Eccentrically loaded footings - Mat foundations.

PILE FOUNDATIONS (9)

Types of piles - Static and dynamic pile formula - Pile load tests - Negative skin friction - Pile groups - Efficiency of pile group - Settlement of piles - Batter piles - Analysis of pile groups - Structural design of piles and pile caps.

RETAINING STRUCTURES (9)

Stability of walls - Design of cantilever and counter fort walls - design of gravity walls - Cantilever sheet pile walls - Anchored bulkhead - Cofferdams - Braced cofferdams - Stability of bottom excavation - Anchorages - Walls and Tie rods.

WELL FOUNDATIONS (9)

Types of wells or caissons - components - Shapes of wells - Forces acting - Construction and sinking - Design of drilled caissons.

MACHINE FOUNDATIONS AND FOUNDATIONS ON EXPANSIVE SOILS (9)

Introduction to vibrations - Design criteria for satisfactory action of a machine foundation - Soil spring constants - Determination - Types of foundations - Design of Block foundation. Identification of swelling - Field conditions - consequences of swelling - Design.

Total: 45 Hrs

TEXT BOOKS

1. Bowles, "Foundations Analysis and Design", McGraw Hill Co., 1997.

REFERENCES

2. Gopal Ranjan and Rao ASR, "Basic and Applied soil Mechanics", New Age International Publishers, 2004.
3. Gulhati & Datta, " Geotechnical Engineering" Tata McGraw Hill, New Delhi,2005
4. Sam & Das, "Theory and Practice of Foundation Design", Prentice hall of India, New Delhi, 2006
5. Cuduto, "Geotechnical Engineering", Prentice hall of India, 2002
6. IRC-78: Standard Specifications and code of practice for Road Bridges.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1		x									x
2						x					x
3										x	x

15MCE27 ADVANCED STRUCTURAL ENGINEERING LABORATORY

L	T	P	C
0	0	2	1

ASSESSMENT: PRACTICAL

Category: Professional Core

COURSE OUTCOMES

On completion of the course the students will be able to

*CO1-**Acquire knowledge about mix design as per Indian and International standards***

*CO2-**Conduct experiments as per Indian and International Codes of practice***

*CO3-**Solve real time problems related to structural engineering***

Experiments:

1. Design of concrete mix as per IS 10262-2009.
2. Design of concrete mix as per ACI: 211 - 91Method.
3. Study of Instruments used for measuring Forces, Deflections, strains and vibrations.
4. Testing of Simply Supported Reinforced Concrete beams for flexure and shear
5. Testing of Simply Supported Steel beams for flexure and shear
6. Testing of Reinforced Concrete columns
7. Half-cell Potential Test (Durability Tests on Concrete)
8. Rapid Chloride Penetration Test (Durability Tests on Concrete)
9. Rebound hammer Test (Non Destructive Test)
10. Ultrasonic Pulse Velocity Tester (Non Destructive Test)
11. Winsor Pin System Test (Non Destructive Test)
12. Rebar locator
13. Concrete Core Cutting and its limitations

Total: 30 Hrs

REFERENCES:

1. T P Ganesan, "Model Analysis of Structures", University Press India Private Limited, Hyderabad , 2013
2. Shetty.M.S, "Concrete Technology", S.Chand and Company, New Delhi, 2010
3. IS 10262 : 2009 Recommended guidelines for concrete mix design.
4. ACI: 211 – 91 Standard Practice for selecting Proportions for Normal, Heavy weight andMass concrete.
5. "Guidebook on Non-Destructive Testing of Concrete Structures", International Atomic Energy Agency, Vienna, 2002
6. Santhakumar A R "Concrete Technology", Oxford Higher Education, New Delhi, 2011

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1		x				x					
2					x		x				
3						x	x				

15MCE34PRACTICAL TRAINING

L	T	P	C
0	0	0	2

ASSESSMENT: PRACTICAL

Category: Professional Core

COURSE OBJECTIVE

To train the students in the field work so as to have first-hand knowledge of practical problems related to Structural Engineering in carrying out engineering tasks.

COURSE OUTCOMES

On completion of the project work students will be in a position to

*CO1-**Apprehend the field/industrial oriented problems in structural engineering***

*CO2-**Apprehend the inter-disciplinary advances and provide solutions***

*CO3- **Solve real time problems and communicate effectively***

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1				x			x				
2					x						x
3								x	x		

15MCE41PROJECT WORK

L	T	P	C
0	0	36	18

ASSESSMENT: PRACTICAL

Category: Professional Core

COURSE OBJECTIVE

To inculcate and apply Structural Engineering knowledge, in solving the identified problem based on the formulated methodology, and to develop skills to analyze, discuss the test results, and make conclusions.

COURSE OUTCOMES

On completion of the project work students will be in a position to

CO1- ***Carry out analytical research on a real time projects and bring out sustainable solutions***

CO2-***Prepare detailed report for Structural Engineering problems and its solutions***

CO3-***Carry out case studies and provide suggestions satisfying global standards***

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1						x	x				
2		x		x							
3						x	x				

E1 STABILITY OF STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the concept of buckling and analysis of structural elements

COURSE OUTCOMES

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

*CO1-**Apprehend the concepts of stability of various structural elements***

*CO2-**Perceive knowledge about buckling behavior of diverse elements***

*CO3-**Apply current knowledge in structural stability***

INTRODUCTION (4)

Static equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem.
Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy - Timoshenko's Imperfect and kinetic methods.

SOLUTION PROCEDURES FOR COLUMN BUCKLING (7)

Approximate methods - Rayleigh Ritz, Galerkins approach - Numerical Techniques - Finite difference method – NewMark"s method -finite element method - Effect of shear on buckling - Design of columns. Buckling of Columns using Computer Programming/ Software Packages.

BEAM COLUMNS (5)

Theory of beam column - Stability analysis of beam column with single & several concentrated loads, distributed load and end couples - column on elastic foundation - Continuous column - Failure of beam columns - Design criteria. Buckling of Beam-Columns using Computer Programming/ Software Packages.

FRAMES (4)

Analysis of rigid jointed frames with and without sway - Moment distribution - Slope deflection & stiffness method. Buckling of Frames using Computer Programming/ Software Packages.

THIN WALLED OPEN SECTIONS (9)

Pure torsion - torsional buckling - Torsional and flexural buckling - Local buckling. Buckling of Open Sections using Computer Programming/ Software Packages
Lateral buckling of beams - Narrow rectangular beams - Symmetrical sections - Design simplifications for lateral buckling.

PLATES **(7)**

Governing differential equation - Analysis by equilibrium & energy approach - Approximate and Numerical techniques - Composite plates. Inelastic buckling of plates – Post buckling behavior of plates.. Application of Software Packages

NON LINEAR THEORY OF BUCKLING **(9)**

Perfect systems – imperfect systems – imperfection in-sensitive and sensitive systems – symmetric and asymmetric Bifurcation – simple examples

Double modulus theory - Tangent modulus theory - Shanley's model - Eccentrically loaded inelastic column. Application of Software Packages

Total: 45 Hrs

TEXT BOOKS

1. Chajes.A, "Principles of Structural Stability Theory", Prentice Hall, Inc., New Jersey, 1974.
2. H.G.Allen & P.S.Bulson, "Background to Buckling", Mc Graw Hill Co., 1980.
3. Timoshenko.S.P and Gere.J.M, "Theory of Elastic Stability", McGraw Hill Company, 1963.

REFERENCES

1. Zdeneic P Basanth & Luigi Cedolin, "Stability of Structures", World Scientific Co., Singapore, 2010
2. Iyenger,N.G.R., "Structural stability of columns and plates", Affiliated East West Press Pvt. Ltd., New Delhi, 1988.
3. Ashwini kumar, "Stability of structures", Allied Publishers Ltd, New Delhi, 1998.
4. Gambhir, "Stability Analysis and design of structures", springer, New York, 2004.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1	x				x						
2	x				x						
3	x				x						

E2 ADVANCED CONCRETE TECHNOLOGY

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY
Category: Professional Elective

COURSE OBJECTIVE

To study the properties of concrete and to know the state of the art developments in concrete

COURSE OUTCOMES

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

*CO1- **Apprehend the knowledge of cement chemistry, admixtures and special concretes***

*CO2- **Apply knowledge in mix design as perIndian and International standards***

*CO3-**Assess the fresh and hardened properties of concrete as per code of practices***

CONCRETE INGREDIENTS (15)
Composition of OPC – Manufacture – Modified Portland Cements – Hydration Process of Portland Cements – Structure of Hydrated Cement Paste
Mineral Admixtures – Hydration of Admixtures - Slags – Pozzolanas and Fillers – Chemical Admixtures – Solutes – Retarders – Air Entraining Agents – Water Proofing Compounds – Plasticizers and Superplasticizers – Compatibility issues with Chemical Admixtures.
Aggregates – Properties and testing of fine and coarse aggregates – combining of aggregates – Substitute material for aggregates – recent advancements.

SPECIAL CONCRETES (8)
Fibre Reinforced Concrete – High performance concrete – Ultra high strength concrete - Self Compacting Concrete – Polymer Concrete - Sulphur concrete – Geo polymer concrete

CONCRETING UNDER SPECIAL CIRCUMSTANCES (7)
Underground construction – concreting in marine environment – underwater construction – extreme weather concreting

MECHANICAL PROPERTIES OF CONCRETE (7)
Interfacial Transition Zone – Fracture Strength – Compressive strength – Tensile strength - Impact strength - Bond strength - Creep – Shrinkage

DURABILITY OF CONCRETE (8)
Factors affecting durability – Tests on chemical Attack – permeability – chloride penetration – water absorption – fire – frost action

Total: 45 Hrs

TEXT BOOKS

1. Santhakumar.A.R, "Concrete Technology", Oxford University press, New Delhi 2015
2. Gambhir.M.L, "Concrete Technology", Tata McGraw Hill Book Co. Ltd., Delhi, 2004.
3. Neville.A.M, "Properties of Concrete", Pearson Education Ltd., New Delhi, 2013.

REFERENCES

1. Metha.P.K and Montreio.P.J.M, “Concrete Microstructure, Properties, and Materials”, Prentice Hall, 2005.
2. Gupta.B.L and Amit Gupta, “Concrete Technology”, Standard Publishers and Distributers, New Delhi, 2004.
3. Shetty.M.S, “Concrete Technology”, S.Chand and Company, New Delhi, 2010
4. IS 456-2000 : Plain and Reinforced Concrete – Code of Practice.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
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	1	2	3	4	5	6	7	8	9	10	11
1					x	x					
2		x			x	x					
3						x				x	

E3 EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION ASSESSMENT: THEORY

L	T	P	C
3	0	0	3

Category: Professional Elective

COURSE OBJECTIVE

To learn the principles of measurements of static and dynamic response of structures and carryout the analysis of results

COURSE OUTCOMES

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

*CO1-**Carry out experiments related to civil engineering problems***

*CO2- **Use Non Destructive Testing to evaluate structural adequacy***

*CO3-**Gain inspiration for carrying out research works***

FORCE AND STRAIN MEASUREMENTS (9)

Strain gauges, principles, types, performance and uses - Photo elasticity, principle and applications - - Hydraulics jacks and pressure gauges - Electronic load cells - Proving Rings - Calibration of Testing Machines – Long term Monitoring – Vibrating wire sensors – fibre optic sensors

VIBRATION MEASUREMENTS (9)

Characteristics of structural vibrations - Linear - Linear variable differential transformer (LVDT) - Transducers for velocity and acceleration measurements - vibration meter - Seismographs - vibration analyzer - Display and recording of signals - Cathode Ray Oscilloscope - XY Plotter - Chart plotters - Digital data Acquisition systems.

ACOUSTICS AND WIND MEASUREMENTS (9)

Principles of pressure and flow measurements - pressure transducer - sound level meter - venturimeter and flow meters - wind tunnel and its use in structural analysis- structural modelling - direct and indirect model analysis.

DISTRESS MEASUREMENTS (9)

Diagnosis of distress in structures - crack observation and measurement - Corrosion of reinforcement in concrete - Half cell, construction and use - Damage assessment – controlled blasting for demolition – structural health monitoring

NON DESTRUCTIVE TESTING METHODS (9)

Load testing of structures, Buildings, bridges and towers - Rebound Hammer - acoustic emission - holography - use of laser for structural testing - Brittle coatings, Ultrasonic testing principles and applications.

Advanced NDT methods – Ultrasonic pulse echo, impact echo, impulse radar techniques, GECOR, Ground Penetrating Radar (GPR)

Total: 45 Hrs

TEXT BOOKS

1. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 2014.
2. J.W.Dalley and W.F.Riley, "Experimental Stress Analysis", McGraw Hill Book Company, New York, 1991.
3. L.S.Srinath et.al, "Experimental Stress Analysis", Tata McGraw Hill Co, New Delhi, 1984.

REFERENCES

1. R.S.Sironi, H.C.Radha Krishna, "Mechanical Measurements", New Age International (P) Ltd, 1997.
2. F.K.Garas, J.L.Clarke and G.S.T Armer, "Structural Assessment", Butterworths London, 1987.
3. D.E.Bray and R.K.Stanley, "Non-Destructive Evaluation", McGraw Hill Publishing Co., New York, 1989.

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	PO's										
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1				x		x	x				
2						x	x				
3				x							x

E3 EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION 3 0 0 3
ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

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

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FORCE AND STRAIN MEASUREMENTS (9)

Strain gauges, principles, types, performance and uses - Photo elasticity, principle and applications - - Hydraulics jacks and pressure gauges - Electronic load cells - Proving Rings - Calibration of Testing Machines – Long term Monitoring – Vibrating wire sensors – fibre optic sensors

VIBRATION MEASUREMENTS (9)

Characteristics of structural vibrations - Linear - Linear variable differential transformer (LVDT) - Transducers for velocity and acceleration measurements - vibration meter - Seismographs - vibration analyzer - Display and recording of signals - Cathode Ray Oscilloscope - XY Plotter - Chart plotters - Digital data Acquisition systems.

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Principles of pressure and flow measurements - pressure transducer - sound level meter - venturimeter and flow meters - wind tunnel and its use in structural analysis- structural modelling - direct and indirect model analysis.

DISTRESS MEASUREMENTS (9)

Diagnosis of distress in structures - crack observation and measurement - Corrosion of reinforcement in concrete - Half cell, construction and use - Damage assessment – controlled blasting for demolition – structural health monitoring

NON DESTRUCTIVE TESTING METHODS (9)

Load testing of structures, Buildings, bridges and towers - Rebound Hammer - acoustic emission - holography - use of laser for structural testing - Brittle coatings, Ultrasonic testing principles and applications.
Advanced NDT methods – Ultrasonic pulse echo, impact echo, impulse radar techniques, GECOR, Ground Penetrating Radar (GPR)

Total: 45 Hrs

TEXT BOOKS

4. Sadhu Singh, “Experimental Stress Analysis”, Khanna Publishers, New Delhi, 2014.
5. J.W.Dalley and W.F.Riley, “Experimental Stress Analysis”, McGraw Hill Book Company, New York, 1991.
6. L.S.Srinath et.al, “Experimental Stress Analysis”, Tata McGraw Hill Co, New Delhi, 1984.

REFERENCES

4. R.S.Sironi, H.C.Radha Krishna, “Mechanical Measurements”, New Age International (P) Ltd, 1997.
5. F.K.Garas, J.L.Clarke and G.S.T Armer, “Structural Assessment”, Butterworths London, 1987.
6. D.E.Bray and R.K.Stanley, “Non-Destructive Evaluation”, McGraw Hill Publishing Co., New York, 1989.

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1				**x**		**x**	**x**				
2						**x**	**x**				
3				**x**							**x**

E4 EARTHQUAKE RESISTANT DESIGN OF STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the effect of earthquakes, analysis and design of earthquake resistant Structures

COURSE OUTCOMES

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

*CO1- **Evaluate seismic forces for various structures as per relevant Indian standards.***

*CO2-**Design the structures for seismic resistance as per Indian Standards***

*CO3- **Apply concepts of repair and rehabilitation to earthquake affected structures***

INTRODUCTION (9)

Basic Seismology – General features of Tectonics of Seismic Regions- Earthquake Terminology - Definitions -Earthquake History – Behaviour of Buildings, Dams and Bridges in Past Earthquakes – Seismographs – Accelerographs – Theory of Vibrations – Damped and undamped system – free and forced vibrations – SDOF and MDOF systems – Analytical and Numerical methods.

EARTHQUAKE RESPONSE (9)

Earthquake Response to Elastic and Inelastic Buildings – Application to Response Spectrum Theory – base exited motion - ground motion parameters – Modal response contribution – modal participation factor – response history – spectral analysis – multiple support excitation – earthquake response to continuous systems on rigid base – approximate methods for lateral load analysis – Pushover Analysis.

IS CODE PROVISIONS (9)

Design Criteria Strength, Deflection, Ductility and Energy Absorption – Cyclic Behaviour of Structures- Design of Buildings as per IS 1893 and IS 4326 - Ductile Detailing of Structures as per IS 13920. Behaviour and Design of Masonry Structures as per IS 13827 and IS13828

EARTHQUAKE RESISTANT DESIGN OF RC AND MASNORY STRUCTURES (9)

Analysis and Design of Frames for Lateral Loads – Capacity Design – Shear Wall Frame System – Coupled Shear Wall – Design of Rectangular and Flanged Shear Walls – Ductile Detailing of Frames for Earthquake Forces - Strengthening of Existing Buildings – Retrofitting and Rehabilitation –earthquake resistant masonry buildings – guide line as per IS codes.

SPECIAL TOPICS (9)

Modern Concepts – Base Isolation, Passive Control and Active Control Systems – Computer Analysis and Design of Buildings for Earthquake Loads using Software Packages.

Total: 45 Hrs

TEXT BOOKS

1. Pankaj Agarwal and Manish Shrikhande, “Earthquake Resistant Design Structures”, Prentice Hall of India Private Ltd., New Delhi-110001, 2006.
2. Paulay.T and Priestley.M.J.N, “Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley and Sons Inc., New York, 1992.
3. S.K.Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press, 2008.

REFERENCES

1. Anil K.Chopra, “Dynamics of Structures – Theory and applications to Earthquake Engineering”, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
2. Miha Tomazevic, “EarthQuake Resistant Design of Masonry Buildings”, Imperial College Press, 1999.
3. IS 1893 : 1984 Criteria for earthquake resistant design of structures.
4. IS 4326 : 1993 Code of practice for earthquake resistant design and construction of buildings.
5. IS 13827 : 1993 Improving earthquake resistance of earthen buildings – Guidelines.
6. IS 13828 : 1993 Improving earthquake resistance of low strength masonary buildings – Guidelines.
7. IS 13920 : 1993 Ductile detailing of reinforced concrete structures subjected to seismic forces - Code of practice.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1					x	x					
2		x		x	x		x				
3							x			x	

E5 STRUCTURAL OPTIMIZATION

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the optimization methodologies applied to structural engineering

COURSE OUTCOMES

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

*CO1- **Apprehend the concepts of optimization***

*CO2-**Apprehend the different methods and algorithms developed for solving various types of optimization problems***

*CO3-**Apply the optimization techniques in the real time situations***

BASIC PRINCIPLES (9)

Definition - Objective Function; Constraints - Equality and inequality - Linear and non-linear, Side, Non-negativity, Behavior and other constraints - Design space - Feasible and infeasible - Convex and Concave - Active constraint - Local and global optima.

CLASSICAL OPTIMIZATION TECHNIQUES

Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization with no constraints - (Lagrange Multiplier method) - with inequality constraints (Khun - Tucker Criteria).

LINEAR PROGRAMMING (10)

Formulation of problems - Graphical solution - Analytical methods - Standard form - Slack, surplus and artificial variables - Canonical form - Basic feasible solution - SIMPLEX METHOD - Two phase method - Penalty method - Duality theory - Primal - Dual algorithm. Computer Algorithm for Linear Programming

NON-LINEAR PROGRAMMING

One Dimensional minimization methods: Unidimensional - Unimodal function - Exhaustive and unrestricted search - Dichotomous search - Fibonacci Method - Golden section method - Interpolation methods. Unconstrained optimization Techniques
(Multivariables): Unconstrained multivariable functions - Univariate method - Cauchy's steepest descent method - Conjugate gradient method (Fletcher Reeves) - Variable metric methods - (Davidon - Fletcher Powell).
Constrained optimization techniques: Direct and indirect methods - Cutting plane method - Methods of feasible direction - Interior penalty function - Exterior penalty function method. Computer Algorithm for Non-Linear Programming.

GEOMETRIC PROGRAMMING (8)

Posynomial - degree of difficulty - reducing G.P.P to a set of simultaneous equations - Unconstrained and constrained problems with zero difficulty - Concept of solving problems with one degree of difficulty. Computer Algorithm for Geometric Programming.

DYNAMIC PROGRAMMING (9)

Bellman's principle of optimality - Representation of a multistage decision problem - concept of sub-optimization problems using classical and tabular methods. Computer Algorithm for Dynamic Programming

STRUCTURAL APPLICATIONS **(9)**

Methods for optimal design of structural elements, continuous beams and single storied frames using plastic theory - Minimum weight design for truss members - Fully stressed design - Optimization principles to design of R.C. Structures such as multistorey buildings, water tanks, bridges, shell roofs. Use of Software packages for optimization

Total: 45 Hrs

TEXT BOOKS

1. Rao.S.S, "Optimization theory and applications", Wiley eastern (P) Ltd., 1995.
2. Uri Krish, "Optimum Structural Design", Mc Graw Hill Book Company, 1981.

REFERENCES

1. Verma, A.P., "Operations Research", S.K.Kataria & Sons, New Delhi 2001.
2. Kalyanmoy Deb, ""Optimization for Engineering Deisgn", Prentice Hall of India, New Delhi.2002
3. Ravindran, Ragsdell and Reklatis, " Engineering Optimization", Wily IndiaEdition, New Delhi, 2006
4. Majid. K.I., "Optimum Design of Structures", John Wiley & Sons, New York, 1974.
5. SPUNT, "Optimization in Structural Design", Prentice Hall, New Jersey, 1971.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
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	1	2	3	4	5	6	7	8	9	10	11
1			x		x						
2						x					x
3	x					x					

E6 HEALTH MONITORING OF STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the damages, repair and rehabilitation of structures

COURSE OUTCOMES

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

*CO1-**Apprehend the assessment procedure for evaluating a damaged structures***

*CO2-**Apprehend and reduce the design and construction errors in concrete construction***

*CO3-**Perceive the materials and techniques for repair distressed structures***

DIAGNOSTICS (9)

Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance, various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration.

SERVICEABILITY AND DURABILITY OF CONCRETE (9)

Quality assurance for concrete construction, concrete properties - Strength, permeability, thermal properties and cracking - Effects due to climate, temperature, chemicals, corrosion - Design and construction errors - Effects of cover thickness and cracking

MATERIALS AND TECHNIQUES FOR REPAIR (9)

Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement and polymers, coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection.

REPAIRS TO STRUCTURES (9)

Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels and cathodic protection.

Repair of structures distressed due to earthquake – Strengthening using FRP- Strengthening and stabilization techniques for repair.

SAFETY AND PRECAUTIONS (9)

Safety measures – Dismantling of structures – Safety in finishing works – NDT testing procedures - Engineered demolition techniques for structures.

Total: 45 Hrs

TEXT BOOKS

1. Denison Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", Longman Scientific and Technical UK, 1991.
2. Allen R.T and Edwards S.C, "Repair of Concrete Structures", Blakie and Sons, UK, 1987.
3. SP: 25 – 1984, "Handbook on Causes and Prevention of Cracks in Buildings, Bureau of Indian Standards", New Delhi, 1999.

REFERENCES

1. Guha.P.K, "Maintenance and Repairs of Buildings", New Central Book Agency (P) Ltd, Kolkata, 1998.
2. Raikar, R.N., "Learning from failures - Deficiencies in Design, Construction and Service" - R&D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.
3. Santhakumar A.R., "Concrete Technology" Oxford University Press, Printed in India by Radha Press, New Delhi, 2007.
4. Peter H.Emmons, "Concrete Repair and Maintenance Illustrated", Galgotia Publications pvt. Ltd., 2001.

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CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1					x	x	x				
2					x	x	x			x	
3					x	x	x		x	x	

E7 PRESTRESSED CONCRETE STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the principle of prestressing, analysis and design of prestressed concrete structures.

COURSE OUTCOMES

*CO1-**Apprehend the knowledge of Prestressed Concrete Structures***

*C02- **Use Indian standard for the design of prestressed concrete members***

*CO3-**Use Computer programs to design Prestressed Concrete Structures***

PRINCIPLES OF PRE-STRESSING (10)

Difference between reinforced and prestressed concrete. Principles of prestressing - Methods and systems of prestressing - Principles of Electrothermal prestressing & chemical prestressing - Classification of prestressed concrete structures - Materials - High strength concrete and High strength steel - stress - strain diagrams. Losses in Prestress: Loss due to elastic shortening in pretensioned and post tensioned beams. Loss due to creep, shrinkage, relaxation, friction - Approximate percentage of various losses in pretensioned and post tensioned beams.

DESIGN OF FLEXURAL MEMBERS (8)

Design of prismatic prestressed concrete members for bending at working loads - Magnel's graphical method - check for ultimate load stage (Limit State Design) - Non prismatic members (Design principles only) - Simple cable profiles - calculation of deflections - Design Using Computer Programming.

DESIGN FOR SHEAR TORSION AND END BLOCK (10)

Design of beams for shear and Torsion at working and ultimate loads. Design of Anchorage Zone by Guyon's method - Concept of Mangel's method - IS 1343 recommendations. Design of end blocks - Design Using Computer Programming.

DESIGN OF TENSION, COMPRESSION AND COMPOSITE MEMBER (7)

Design of tension members - Design of columns subjected to bending moment and axial compression for working and ultimate loads. Composite prestressed concrete beams - Design procedure - calculation of stresses at important stages both for propped and unpropped constructions - Design of shear connectors - Shrinkage Stresses.

DESIGN OF CONTINUOUS BEAMS (10)

Statically indeterminate structures - concept of concordant cable and linear transformations - sketching of pressure lines for continuous beams and single span single storey rigid frame. Design principles of partially prestressed concrete structures - circular prestressing - Design of a circular tank for circular and vertical prestressing. Determination of Concordant Cable profile Using Computer Programming.

Total: 45 Hrs

TEXT BOOKS

1. Krishna Raju.N, "Prestressed Concrete", Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2000.
2. Rajagopalan.N, "Prestressed Concrete", Alpha Science International Ltd., UK, 2005.

REFERENCES

1. Dayaratnam.P, "Prestressed Concrete Structures", Oxford and India Book House Ltd., Chennai, 1982.
2. Lin.T.Y and Ned H Burns, "Design of Prestressed Concrete Structures", John Willey and Sons, NewYork, 1982.
3. Sinha.N.C and Roy.S.K, "Fundamentals of Prestressed Concrete", S.Chand and Company, New Delhi, 1998.
4. Kachaturian and Gurfinkel, "Prestressed Concrete", McGraw Hill, New York, 1961.
5. IS 1343-2012: Code of Practice for Prestressed Concrete.

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1		x				x					
2		x			x						
3				x						x	

E8 CORROSION AND ITS PREVENTION

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the environmental effects on structures, corrosion, tests and prevention of corrosion

COURSE OUTCOMES

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

*CO1- **Perceive about phenomenon of corrosion and its propagation***

*CO2-**Monitor corrosion using various techniques***

*CO3-**Apprehend the different types of protective measures***

INTRODUCTION (10)

Corrosion of steel reinforcement in concrete, definition of corrosion, forms of corrosion, phenomenon of corrosion, corrosion initiation-environment-cover thickness-quality of cover concrete –type of steel and critical chloride-presence of cracks, corrosion propagation - electrochemical process – physical process, theory of reinforcement corrosion-basic corrosion cell-anode and cathode-electrolyte- corrosion potential and rate of corrosion.

IDENTIFICATION AND APPRAISAL OF CORROSION (10)

Corrosion process and mechanism – approach to investigation-visual observation and documentation, insitu testing of concrete-rebound hammer test, cover meter survey-ultrasonic pulse velocity (UPV) test – core sampling and testing, insitu testing of steel rebar –carbonation test and pH value, chloride content-half cell potential survey-resistivity mapping –measurement of corrosion rate.

MONITORING OF CORROSION (9)

Methods used for monitoring corrosion – open circuit potential measurement, resistivity measurement, corrosion cell ratio, electrical resistance probe method, polarization resistance technique, impedance technique, guard ring technique, electrochemical noise analysis.

PROTECTIVE MEASURES (8)

Coating to reinforcement-metallic coatings-epoxy coatings-cement based coatings –coating to prestressing steel, galvanized reinforcement, stainless steel, non-ferrous reinforcement and coating to concrete surface, improving the concrete, corrosion resistant steel.

INHIBITORS FOR CONCRETE (8)

Definition of inhibitor-anodic and cathodic inhibitors-rice husk ash, fly ash, electrochemical removal of chloride from concrete, non-metallic materials, carbon FRP, Glass FRP, parafil tendons.

Total: 45 Hrs

TEXT BOOK

1. Fontanna, G.Mars, “Corrosion Engineering”, Third Edition, McGraw – Hill Book Company,1986.

REFERENCES

1. Kumar Mehta, P., “Concrete-Structure, Properties and Materials”, Prentice – Hall, INC, Englewood Cliffs, New Jersey 07632.

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3				x	x		x				

E9 THEORY OF PLATES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the behaviour and analysis of thin plates and the behaviour of thick plates and its computer application

COURSE OUTCOMES

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

*CO1- **Apprehend the behavior of various types of plates.***

*CO2- **Develop the governing differential equation for thin and thick plates***

*CO3-**Analyze plates with different loading and boundary conditions***

INTRODUCTION (10)

Thin and thick plates - Plate behaviour - Material behaviour - Isotropic and orthotropic Materials.

SMALL DEFLECTION THEORY AND CLASSICAL METHODS

Differential equation of plates in Cartesian co-ordinate system - boundary conditions - Rigorous solution - Navier's Method - Levy's Method.

SYMMETRICAL BENDING OF CIRCULAR PLATES (10)

Differential equation for symmetrical bending of laterally loaded circular plates - Simply supported edges - Clamped edges - Circular plate with a circular hole at the center - Circular plate concentrically loaded.

APPROXIMATE METHODS (9)

Energy methods - Galerkin's Method - Ritz Method, Method of Images - Plate strip - Influence surfaces - Membrane and Various Analogies - Simultaneous Bending and Stretching.

NUMERICAL METHODS (8)

Finite difference method - Improvements for solution, matrix displacement analysis of Grids - introduction to Finite Element Method. Computer Applications.

PLATES OF OTHER SHAPES

Triangular plates - Elliptic plates - Sector plates - Skew plates - Plates on elastic foundation - Continuous plates. Computer Applications

ADVANCED TOPICS (8)

Large Deflection theory - Thermal stresses - Multilayered plates. - Mindlin's theory of plates - Flat slabs - Engineering approach to design of Rectangular floor slabs. Computer Applications.

Total: 45 Hrs

TEXT BOOKS

1. Rudolph Szilard, "Theory and Analysis of Plates – Classical and Numerical Methods", Prentice Hall, 1995.
2. Timoshenko.S and Krieger.S.W, "Theory of Plates and Shells", Mc-Graw Hill Book Company, New York, 1990.

REFERENCES

1. Donnel.L.H, "Beams, Plates and Shells", McGraw Hill Inc., 1976.
2. Chandrashekhara, K., "Theory of plates" , University Press(India) limited, Hyderabad, 2001
3. Bairagi.N.K, "A Text Book of Plate Analysis", Khanna Publishers, New Delhi, 1996.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1					x	x					
2					x	x	x				
3						x	x				

L T P C

E10 DESIGN OF CONCRETE BRIDGES **3 0 0 3**

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the loads, forces on bridges and design of several types of bridges.

COURSE OUTCOMES

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

CO1- Apprehend the planning and investigation of bridges.

CO2-Design the superstructure of bridge using different methods.

CO3- Design the substructure of bridges.

1. Introduction - Classification, Investigations and planning, choice of type, I.R.C Specifications for road bridges, standard live loads, other forces acting on bridges, general design considerations. **(5)**

2. Short Span Bridges - Load distribution theories, analysis and design of slab culverts, tee beam and slab bridges. **(6)**

3. Design principles of Long span Girder Bridges and continuous bridges **(5)**

4. Design Principles of box girder bridges, and balanced cantilever bridges. **(5)**

5. Design of prestressed Concrete Bridges **(6)**

6. Bearings and expansion joints. **(6)**

7. Substructures and footings for bridges. **(6)**

8. Analysis and Design of bridges using Software packages **(6)**

Total: 45 Hrs

TEXT BOOKS

1. Raina.V.K, “Concrete Bridge Practice”, Tata McGraw Hill Publishing Co, New Delhi, 2007.
2. Krishnaraju.N, “Design of Bridge”, Oxford Publishing Co, 2015.

REFERENCES

1. Ponnuswamy.S, “Bridge Engineering”, Tata McGraw Hill, New Delhi, 2008.
2. IRC 5:1998 Standard Specifications and code of practice for Road Bridges. Section I-General Features and Design
4. IRC 6:2014 Standard Specifications and code of practice for Road Bridges. Section I-Loads and stresses.
5. IRC 78:2014 Standard Specifications and code of practice for Road Bridges. Section VII-Foundation and substructures.
6. IRC 83:2015 Standard Specifications and code of practice for Road Bridges. Section IX-Metallic Bearings
7. IRC 112:2011.Code of practice for concrete road bridges.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1		x			x						
2		x					x				
3		x				x					

E11 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES

ASSESSMENT: THEORY

L	T	P	C
3	0	0	3

Category: Professional Elective

COURSE OBJECTIVE

To develop an understanding of the behavior, analysis and design of Steel concrete composite elements and structures.

COURSE OUTCOMES

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

*CO1- **Analyze steel concrete composite structures***

*CO2- **Design composite structures and its connections***

*CO3- **Conduct case studies related to steel concrete composite constructions of buildings***

INTRODUCTION **(9)**

Introduction to steel - concrete composite construction - theory of composite structures - Introduction to steel - concrete - steel sandwich construction.

DESIGN OF COMPOSITE MEMBERS **(9)**

Behavior of composite beams, columns, design of composite beams, steel, concrete composite columns - design of composite trusses.

DESIGN OF CONNECTIONS **(9)**

Types of connections, Design of connections in the composite structures - shear connection, Design of connections in composite trusses.

COMPOSITE BOX GIRDER BRIDGES **(9)**

Introduction - behaviour of box girder bridges - design concepts

GENERAL CASE STUDIES on steel - concrete composite construction in buildings - seismic behaviour of Composite structures

USE OF SOFTWARE PACKAGES **(9)**

Analysis and design of Composite structures using Software Packages

Total: 45 Hrs

TEXT BOOKS

1. Johnson.R.P, "Composite structures of steel and concrete", Blackwell Scientific Publications (Third Edition), UK, 2013.

REFERENCES

1. Owens.G.W and Knowels.P, "Steel Designers manual", (Fifth edition), Steel Concrete Institute (UK), Oxford Blackwell Scientific Publications, 1992.
2. Proceedings of workshop on "Steel Concrete Composite Structures", conducted at Anna University,2007.
3. IRC 24:2010 Standard Specifications and code of practice for Road Bridges. Section V- Steel Road Bridges.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1		x			x	x					
2		x		x	x	x					
3		x				x	x				

E12 OFFSHORE STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the concept of wave theories, forces, analysis and design of jacket towers and cables.

COURSE OUTCOMES

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

*CO1-**Apprehend the static and dynamic effect of wind on structures***

*CO2-**Possess the knowledge on wave hydrodynamics***

*CO3-**Analyze and design of offshore structures***

WIND EFFECTS **(9)**

Wind on Structures - Rigid Structures - Flexible Structures -Static and dynamic effects.

WAVE HYDRODYNAMICS **(9)**

Wave generation and propagation small and finite amplititudes wave theories - wave energy and pressure distribution.

WAVE LOADING **(9)**

Wave forces on structures - Environmental loadings - use of Morrison equation.

OFFSHORE STRUCTURE MODELLING **(9)**

Different types of structures, Foundation modelling, static methods of analysis, Dynamics of Offshore structures. Software applications.

DESIGN OF OFFSHORE STRUCTURES **(9)**

Loads, design of platforms, Derricks, Helipads, Design principles and examples of Jacket towers, Mooring cables.

Total: 45 Hrs

TEXT BOOKS

1. Chakrabarti.S.K, "Hydrodynamics of Offshore Structures", Computational Mechanics Publications, 1987.
2. Thomas M.Dawson, "Offshore Structural engineering", Prentice Hall Inc Englewood Cliffs, N.J., 1983.

REFERENCES

1. API, Recommended Practice for Planning, Designing and Construction, Fixed Offshore Platforms, American Petroleum Institute Publication, RP2A, Dalls, Tex, 2000.
2. PeterSachs, “Wind forces in Engineering”, Pergomon press, New York, 1972.
3. Ippen.J, “Esterany and Coast line hydrodynamics”, McGraw Hill Book, Co., 1966.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1	x			x	x						
2	x			x	x	x					
3	x	x	x	x	x	x	x	x	x	x	

E13 SHELL STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

Study the behaviour and design of shells, folded plates and application of software.

COURSE OUTCOMES

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

*CO1- **Analyze and design various shells and spatial structures***

*CO2-**Apprehend the behaviour of folded plates***

*CO3-**Design double curvature shells using membrane theory***

INTRODUCTION

Structural behavior of shells and folded plates - Theory of surfaces - Generation of surfaces - Classification - IS code provisions.

ANALYSIS OF CYLINDRICAL SHELLS (10)

Membrane theory; Bending theory; Beam - Arch approximation; Continuous Cylindrical shells – Long and Short shells. Shells with and without edge members - Multibarrel shells.

DESIGN OF CYLINDRICAL SHELLS (10)

Design by ASCE Manual No.31 tables - Shells of various boundary conditions - North light shells - proportioning shells - Reinforcement in shell and edge members - Prestressing of edge members - Review of recommendations of codes - Constructional aspects - Design of Traverses. Analysis/ Design of Cylindrical Shells using Software Packages.

FOLDED PLATES (6)

Various steps in the analysis - Analysis by ASCE Task committee method - Analysis by Finite Strip approach - Design of reinforcement - Transverses. Analysis/Design of Folded plates using Software Packages

SHELLS OF DOUBLE CURVATURE (9)

Membrane theory for shells of revolution - Membrane theory for general shells of double curvature - Synclastic and anticlastic shells - Approximate bending theory of shallow shells - Design of H.P cooling tower shells. Analysis/Design of Shells of Double Curvature using Software Packages.

DESIGN OF DOUBLY CURVED SHELLS **(10)**

Hyperbolic paraboloid roofs - Determination of forces in shells and edge members - Design of umbrella and inverted umbrella roof - Design of conoidal shells - Skew Hypars - H.P shells on parabolic directrix boundary - New Shell forms - Funicular shells. Analysis/ Design of Doubly Curved Shells using Software Packages.

Total: 45 Hrs

TEXT BOOKS

1. G.S.Ramaswamy, "Design and Construction of concrete shell roofs", CBS publishers and distributors, New Delhi, 2005.
2. Vasanth.S.Kelkar & Robert T.Sewell, "Fundamentals of the Analysis and Design of shell structures", Prentice hall,inc,New Jersy,1987

REFERENCES

1. Billington.D.F, "Thin shell concrete roofs", Mc Graw Hill Book Company, New York, 1982.
2. Chatterjee.B.K, "Theory and design of concrete shells", Champman and Hall Ltd., London, 1988.
3. K.Chandrashekara, "Analysis of thin concrete shells, Tata McGraw Hill Book Co., 1986.
4. N.K.Bairagai, "Shell Analysis", Khanna Publishers, New Delhi, 1990.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1	x	x		x	x	x	x	x	x	x	
2	x		x	x	x						
3	x	x		x	x	x	x	x	x	x	x

E14 COMPUTER AIDED ANALYSIS AND DESIGN OF TALL BUILDINGS **L T P C**

ASSESSMENT: THEORY **3 0 0 3**

Category: Professional Elective

COURSE OBJECTIVE

To study the behaviour, analysis and design RC frames and steel frame

COURSE OUTCOMES

At the end of this course the students will be able to:

*CO1-**Apprehend the design concepts and the different types of loading***

*CO2-**Analyze the components of tall structures for various effects***

*CO3-**Design the various structural systems used in the construction of tall structures***

STRUCTURAL SYSTEMS AND CONCEPTS (8)

History – structural systems and concepts – criteria and loading – materials and construction – Strcutural steel system – reinforced concrete – pre-stressed concrete – composite system – gravity and lateral systems – loads – gravity – wind – earthquake – temperature load – creep – shrinkage – fire loading – blast loading.

GRAVITY SYSTEMS – DESIGN AND BEHAVIOUR (8)

Floor systems in concrete and steel – one way and two way slabs – flat slabs with capitals – prestressed concrete floor – shell systems- bearing walls – composite steel concrete floors – columns – open web truss system in steel – stub girder system.

LATERAL SYSTEMS – DESIGN AND BEHAVIOUR (8)

Static and dynamic approach, analytical method, Wind Tunnel , Earthquake loading – Equivalent lateral load analysis- Response spectrum method, Combination of loads.

SHEAR WALL

Moment resisting frame – braced – shear trsses –shear wall- frame system – framed tube – outrigger – bundled tube system – diagonal trussed tube – mega tube system – approximate methods of analysis – design of frames for lateral load – p- Δ effects – detailing of shear walls for ductility.

FRAMED TUBE SYSTEM (4)

Behaviour – approximate methods – preliminary design – design of frame work – design of transfer girders.

OUTRIGGER (3)

Behaviour – approximate methods – belt trusses – columns – dynamics of outrigger systems.

BUNDLED TUBE – DIAGONAL TRUSS – MEGA TUBES (4)

Behaviour – approximate methods – preliminary design – damping in mega tubes – design of modular tubes.

DESIGN OF CONNECTIONS (5)

Behaviour of connections – design of moment connections- simple and semi-rigid – beam – column connections- braced frame connection – connections in outriggers – connections for plastic design – design of connection for ductility.

EXPLOSION AND FIRE ON BUILDINGS (5)

Review of bombed buildings – explosions – case studies – threats – wave scaling law – fire loading – restraints – codal provisions – limit state and plastic analysis – nonlinear behaviour- Nonlinear finite element – inelastic finite element analysis- design for ductility – plastic design and behaviour – limit analysis – Translational and torsional instability – out of plumb effects – Computer software for tall buildings.

Total: 45 Hrs

TEXT BOOKS

1. Taranath.B.S, "Analysis and Design of Tall Buildings", McGraw-Hill co, 2011.
2. Ramaswamy.S.D and Yam.C.T, "Proceedings of the International Conference on Tall Buildings", Singapore , 1984.
3. Smith.B.S and Coull.A, "Tall Building Structures Analysis and Design", John Wiley and Sons, Inc, 2011.

REFERENCES

1. Fintel, M., "Hand Book of Concrete Engineering", Van Nostrand Reinhold co 1974.
2. Mehta, J.B., "High Rise Buildings"., M/S Skyline, 1978.
3. Coull,A., and Smith,S.B. "Tall Buildings", Pergamon Press, London, 1997.
4. Beedle, L.S.,"Advances in Tall Buildings CBS publishers and Distributors, Delhi, 1996.
5. Bangash, M.Y.H. "Prototype Building Structures – Analysis and Design", Thomas Telford, 1999.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1	x			x							
2	x			x	x				x	x	
3	x	x		x	x		x		x	x	

E15 WIND AND CYCLONE EFFECTS ON STRUCTURES

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the concept of wind and cyclone effects, analysis and design of structures.

COURSE OUTCOMES

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

*CO1-**Apprehend the knowledge of wind force measurement.***

*CO2-**Carry out wind tunnel studies and its applications.***

*CO3-**Analyse the effect of wind on different high rise structures.***

1. Introduction, Spectral studies, Gust factor, wind velocity, Return Period, Method of measurement, variation of speed with height, shape factor, aspect ratio, drag effects. (10)

2. Wind Tunnel Studies, Types of tunnels, Modeling requirements, Interpretation of results, Aero - elastic models. Computer applications (5)

3. Wind on structures, Rigid structures, Flexible structures, Static and dynamic effects, Tall buildings, Chimneys. Computer applications. (12)

4. Application to design, Buildings, Chimneys, Roofs and Shelters. (12)

5. Cyclone effect on structures, cladding design, window glass design. (6)

Total: 45 Hrs

TEXT BOOKS

1. Cook.N.J, "The Designer's Guide to Wind Loading of Building Structures", Butterworths, 1990.
2. Kolousek. et.al, "Wind Effects on Civil Engineering Structures", Elsevier Publications, 1984.

REFERENCES

1. Peter Sachs, "Wind Forces in Engineering", Pergamon Press, New York, 1972.
2. Lawson.T.V, "Wind Effects on Building", Vol.I and II, Applied Science Publishers, London, 1980.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1		x		x	x						
2	x		x						x	x	
3	x	x	x	x	x				x	x	

E16 SOIL STRUCTURE INTERACTION

L	T	P	C
3	0	0	3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study and analyse soil foundation interaction.

COURSE OUTCOMES

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

*CO1-**Apprehend the soil-foundation behavior***

*CO2-**Analyse the beams on elastic foundation***

*CO3-**Analyze the plates and laterally loaded piles***

SOIL-FOUNDATION INTERACTION (9)

Introduction to soil-foundation interaction problems – Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, Soil response models, Winkler, Elastic continuum, two parameter models, Elastic plastic behaviour, Time dependent behaviour **.**

BEAM ON ELASTIC FOUNDATION-SOIL MODELS (9)

Infinite beams, two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams based on their stiffness.

PLATE ON ELASTIC MEDIUM (9)

Infinite plate, Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates, Analysis of finite plates, rectangular and circular plates, Numerical analysis of finite plates – Simple solutions.

ELASTIC ANALYSIS OF PILE (9)

Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

LATERALLY LOADED PILE (9)

Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Pile raft system, Solutions by influence charts.

Total: 45 Hrs

TEXT BOOKS

1. Selvadurai.A.P.S, "Elastic Analysis of Soil Foundation Interaction", Elsevier, 2011.
2. Poulos.H.G and Davis.E.H, "Pile Foundation Analysis and Design", John Wiley, 1990.

REFERENCES

1. Scott.R.F, "Foundation Analysis", Prentice Hall of India, 1981.
2. ACI 336, "Suggested Analysis and Design Procedure for combined footings and mats", American Concrete Institute, Delhi, 1988.

Mapping of course outcome with program outcome:

CO's	**Mapping of CO'S and PO'S**										
	PO's										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1				**x**	**x**		**x**				**x**
2	**X**			**x**		**x**	**x**		**x**	**x**	**x**
3	**X**	**x**		**x**	**x**	**x**	**x**		**x**	**x**	

E17 MECHANICS OF COMPOSITE MATERIALS **L T P C**

3 0 0 3

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the behaviour of composite materials and to investigate the failure and fracture characteristics

COURSE OUTCOMES

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

*CO1-**Apprehend the stress strain relationship of orthotropic and anisotropic materials***

*CO2-**Analyze laminated composites***

*CO3- **Assess the failure criterion and fracture mechanics of composites***

INTRODUCTION (9)

Introduction to Composites, Classifying composite materials, commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites, Short Fiber Composites,

STRESS STRAIN RELATIONS (9)

Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains, Residual Stresses.

ANALYSIS OF LAMINATED COMPOSITES (9)

Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates. Static, dynamic and stability analysis for simpler cases of composite plates. Inter laminar stresses.

FAILURE AND FRACTURE OF COMPOSITES (9)

Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction.

APPLICATIONS AND DESIGN (9)

Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues.

Total: 45 Hrs

TEXT BOOKS

1. Daniel and Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2013.
2. Jones.R.M, "Mechanics of composite materials", McGraw-Hill, Koghkusha, International Students Edition, Tokyo, 2015.

REFERENCES

1. Agarwal.B.D and Broutman.L.J, “Analysis and Performance of fiber composites”, John-Wiley and Sons, 1980.
2. Michael W.Hyer, “Stress Analysis of Fiber-Reinforced Composite Materials”, McGraw Hill, 1999.
3. Mukhopadhyay.M, “Mechanics of Composite Materials and Structures”, University Press, India, 2004.

Mapping of course outcome with program outcome:

CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1	x				x		x				
2	x			x	x	x	x		x	x	
3	x			x	x	x	x		x	x	

E17 MECHANICS OF COMPOSITE MATERIALS

ASSESSMENT: THEORY

Category: Professional Elective

COURSE OBJECTIVE

To study the behaviour of composite materials and to investigate the failure and fracture characteristics

COURSE OUTCOMES

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

*CO1-**Apprehend the stress strain relationship of orthotropic and anisotropic materials***

*CO2-**Analyze laminated composites***

*CO3- **Assess the failure criterion and fracture mechanics of composites***

INTRODUCTION (9)

Introduction to Composites, Classifying composite materials, commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites, Short Fiber Composites,

STRESS STRAIN RELATIONS (9)

Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains, Residual Stresses.

ANALYSIS OF LAMINATED COMPOSITES (9)

Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates. Static, dynamic and stability analysis for simpler cases of composite plates. Inter laminar stresses.

FAILURE AND FRACTURE OF COMPOSITES (9)

Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction.

APPLICATIONS AND DESIGN (9)

Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues.

Total: 45 Hrs

TEXT BOOKS

3. Daniel and Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press, 2013.
4. Jones.R.M, "Mechanics of composite materials", McGraw-Hill, Koghkusha, International Students Edition, Tokyo, 2015.

REFERENCES

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5. Michael W.Hyer, “Stress Analysis of Fiber-Reinforced Composite Materials”, McGraw Hill, 1999.
6. Mukhopadhyay.M, “Mechanics of Composite Materials and Structures”, University Press, India, 2004.

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CO's	Mapping of CO'S and PO'S										
	PO's										
	1	2	3	4	5	6	7	8	9	10	11
1	x				x		x				
2	x			x	x	x	x		x	x	
3	x			x	x	x	x		x	x	