KUMARAGURU COLLEGE OF TECHNOLOGY,

An autonomous Institution affiliated to Anna University, Chennai

COIMBATORE – 641 049.

M.E., STRUCTURAL ENGINEERING

REGULATIONS 2018

CURRICULUM AND SYLLABI

I to IV Semesters

Department of Civil Engineering

VISION

Department of Civil Engineering is striving to become as a world class Academic Centre for quality education and research in diverse areas of Civil Engineering, with a strong social commitment.

MISSION

- Producing highly competent and technologically capable professionals and motivated young academicians
- Providing quality education in undergraduate and post graduate levels, with strong emphasis on professional ethics and social commitment.
- Developing a scholastic environment for the state – of –art research, resulting in practical applications.
- Undertaking professional consultancy services in diverse areas of Civil Engineering.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives of Structural Engineering Postgraduate Program are to prepare the students:

I. To produce students with excellent academic qualities and inculcate the required skills to contribute for the academic and research requirements.

II. To develop the students as experts in laboratory and experimental work as per recommended standards.

III. To prepare the students to meet the industrial needs by encouraging them to involve in real time projects.

PROGRAM OUTCOMES (POs)

Graduates of the Structural Engineering Postgraduate Program should have the ability to:

PO 1: Independently carry out research /investigation and work to solve practical problems.

PO 2: Write and present a substantial technical report/document.

PO 3: Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO 4: Analyze and solve complex structural engineering problems using the knowledge of mathematics and engineering.

PO 5: Use modern/advanced techniques, tools and skills for structural engineering problems and practices.

PO6: Engage in lifelong learning for updating oneself on structural engineering contemporary advancements.

KUMARAGURU COLLEGE OF TECHNOLOGY

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REGULATIONS 2018

M.E. STRUCTURAL ENGINEERING

CURRICULUM

Semester I									Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**	
1	P18MAI1201	Applied Numerical Methods for Structural Engineering	Embedded	3	0	2	0	4	-------
2	P18SET1001	Advanced Solid Mechanics	Theory	3	0	0	0	3	-------
3	P18SEI1202	Design of Advanced Concrete Structures	Embedded	3	0	2	0	4	-------
4	P18SEI1203	Advanced Concrete Technology	Embedded	3	0	2	0	4	-------
5	P18_______	Professional Elective I	Theory	3	0	0	0	3	-------
Total Credits								**18**	
Total Contact Hours/week								**21**	

Semester II									Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**	
1	P18SET2001	Finite Element Method	Theory	3	0	0	0	3	-------
2	P18SEI2202	Structural Dynamics	Embedded	3	0	2	0	4	-------
3	P18SET2003	Advanced Design of Steel Structures	Theory	3	0	0	0	3	-------
4	P18_______	Professional Elective II	Theory	3	0	0	0	3	-------
5	P18SEP2504	Design Studio	Laboratory	0	0	4	0	2	-------
Total Credits								**15**	
Total Contact Hours/week								**18**	

Semester III	Pre-requisite

Signature of BOS chairman, CE

S.No	Course code	Course Title	Course Mode	L	T	P	J	C	
1	P18________	Professional Elective III	Theory	3	0	0	0	3	-------
2	P18________	Professional Elective IV	Theory	3	0	0	0	3	-------
3	P18SEP3701	In-plant Training*	Project	0	0	0	0	1	-------
4	P18SEP3702	Project Phase I / Industry Project	Project	0	0	0	24	12	-------
* At the end of second semester for 2 weeks									-------
Total Credits								**19**	
Total Contact Hours/week								**30**	

Semester IV									**Pre-requisite**
S.No	**Course code**	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**	
1	P18SEP4701	Project Phase II / Industry Project	Project	0	0	0	36	18	-------
Total Credits								**18**	
Total Contact Hours/week								**36**	

List of Mandatory Audit Courses									**Semester Offered**
S.No	**Course code**	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**	
1	P18SEA0001	Disaster Management	Audit	3	0	0	0	0	2

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List of Electives									Pre-requisite
S.No	**Course code**	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**	
1	P18INT0001	Statistics & Research Methodology	Theory	3	0	0	0	3	-------
2	P18SEE0001	Design of Bridges	Theory	3	0	0	0	3	-------
3	P18SEE0002	Design of Pre-Stressed Concrete Elements	Theory	3	0	0	0	3	P18SEI1202
4	P18SEE0003	Earthquake Resistant Design of Structures	Theory	3	0	0	0	3	P18SEI2202
5	P18SEE0004	Smart Materials for Construction	Theory	3	0	0	0	3	-------
6	P18SEE0005	Structural Health Monitoring	Theory	3	0	0	0	3	-------
7	P18SEE0006	Experimental Methods and Model Analysis	Theory	3	0	0	0	3	-------
8	P18SEE0007	Design of Plates, Shells and Spatial Structures	Theory	3	0	0	0	3	-------
9	P18SEE0008	Design of Structures for Dynamic Loads	Theory	3	0	0	0	3	P18SEI2202

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SEMESTER I

Signature of BOS chairman, CE

P18MAI1201	APPLIED NUMERICAL METHODS FOR STRUCTURAL ENGINEERING	L	T	P	J	C
		3	0	2	0	4

Course Outcome

After successful completion of this course, the students should be able to

CO1: Solve a set of algebraic equations representing steady state models formed in engineering problems
CO2: Fit smooth curves for the discrete data connected to each other or to use interpolation methods over these data tables
CO3: Find the trend information from discrete data set through numerical differentiation.
CO4: Estimate integrals from discrete data through numerical methods.
CO5: Predict the system dynamic behaviour through solution of ODEs modeling the system
CO6: Solve PDE models representing spatial and temporal variations in physical systems through numerical methods.

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1				S		
CO2				M		
CO3				M		
CO4				W		
CO5				M		
CO6				M		

NUMERICAL SOLUTION OF ALGEBRAIC EQUATIONS **10 Hours**

Solution of nonlinear equations– Newton's method, Secant method and Muller method for a single equation. Numerical evaluation of multiple roots: Brent's algorithm. Solution of non - linear system of equations by Newton's method.

INTERPOLATION AND CURVE FITTING **9 Hours**

Divided differences – Newton's divided difference formula - Curve fitting – Method of least squares. Spline curves - Bezier curves and B–spline curves - Bezier surfaces and B-spline surfaces - Cubic spline interpolation

NUMERICAL DIFFERENTIATION AND INTEGRATION **6 Hours**

Numerical differentiation by using Newton's divided difference formula – Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules–Numerical double integration

NUMERICAL SOLUTION OF BOUNDARY VALUE PROBLEMS **9 Hours**

Boundary value problems (ODE) – Finite difference methods–Shooting Methods–Collocation Methods

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS **11 Hours**

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions–Two dimensional parabolic equations–ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods.

PRACTICAL (Computing Lab Component) 30 Hours

1. Solving a nonlinear equation using Newton's method, Secant method
2. Solving a system nonlinear equation using Newton's Method
3. Fitting of curves by Method of least squares. Spline curves-Bezier curves
4. Interpolation using Newton divided difference.
5. Numerical differentiation– Newton divided difference.
6. Numerical Integration using Trapezoidal rule, Simpson's rule.
7. Solution of ODE using Shooting Methods.
8. Solution of ODE using Collocation Methods.
9. Solution of PDE using weighted average approximation
10. Solution of PDE using explicit and implicit methods.

Theory: 45	Tutorial: 0	Practical: 30	Project: 0	Total: 75 Hours

REFERENCES

1. Kendall E.Atkinson, An Introduction to numerical analysis, John Weley & Sons, second edition, 1990.
2. Conte S.D and Carl de Boor, Elementary Numerical Analysis-An Algorithmic Approach, McGraw-Hill.
3. Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers with Programming and Software Applications", McGraw-Hill, 2004.
4. John H. Mathews and Kurtis D. Fink, "Numerical Methods using Matlab", Prentice Hall of India, 2004.
5. Gerald C.F. and Wheatley P.O, "Applied Numerical Analysis", Pearson Education Asia, New Delhi, 2002.
6. Sastry S.S, "Introductory Methods of Numerical Analysis", Prentice Hall of India Pvt. Ltd, New Delhi, 2003.

L	T	P	J	C
3	0	0	0	3

P18SET1001 ADVANCED SOLID MECHANICS

Course Outcome

After successful completion of this course, the students should be able to

CO1: Formulate equilibrium and compatibility equations for 3D problems
CO2: Formulation of boundary value problems in linearized elasticity and solution of 2D problems using Airy's stress functions.
CO3: Solution to boundary value problems corresponding to end torsion of prismatic beams
CO4: Analyze using plastic theories
CO5: Analyze using fracture mechanics

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	W					
CO2	W					
CO3				M		
CO4				S		
CO5				S		

INTRODUCTION TO ELASTICITY 12 Hours

Elasticity approach-Definition and notation of stress - components of stress and strain - generalized Hooke’s Law - Transformation of stresses and strains - Stress invariants - Principal stresses and strains for three-dimensional element - Equilibrium equations and compatibility conditions in Cartesian and cylindrical coordinates.

BOUNDARY VALUE PROBLEMS: FORMULATION 12 Hours

Airy's stress functions for plane stress and strain problems-Bending of a cantilever and simply supported narrow rectangular cross-section under different loads –Asymmetric problems like thick and thin cylinders subjected to internal pressure-Stress concentrations due to circular hole in plate –Non-axisymmetric problems like Flemant approach

END TORSION OF PRISMATIC BEAMS 8 Hours

Formulation of the BVP for torsion of beams with solid cross section - warping function and Prandtl stress function approach-Torsion of circular, elliptic, rectangular and triangular cross sections-Membrane analogy-Torsion of thin walled tubes-thin rectangular sections, rolled sections and multiply connected section

PLASTIC DEFORMATION 9 Hours

Strain Hardening, Idealized Stress- Strain curve, Yield Criteria, von Mises Yield Criterion, Tresca Yield Criterion, Plastic Stress-Strain Relations, Principle of Normality and Plastic Potential, Isotropic Hardening.

Signature of BOS chairman, CE

INTRODUCTION TO FRACTURE MECHANICS **4 Hours**

Failure criteria and fracture toughness– stress intensity factor.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

1. Richard. G. Budynas, Advanced Strength and Applied Stress Analysis, McGraw-Hill, New Delhi, Second Edition, 2011
2. Chakrabarty, Theory of Plasticity, Tata McGraw Hill Book Co., New Delhi, 2012.
3. L.S. Srinath, Advanced Mechanics of Solids, Tata McGraw Hill, 2007.
4. Chwo P.C. and Pagano N.J., Elasticity Tensor, Dyadic and Engineering Applications, D.Van Nastrand and Co., Inco. 2013
5. M.H. Sadd, Elasticity: Theory, Applications and Numeric, Academic Press, 2006.
6. Timoshenko S. and Goodier J.N., Theory of Elasticity, Hill Education., India, Third Edition, 2010.
7. Sadhusingh, Theory of Elasticity, Khanna Publishers, New Delhi, Fourth Edition, 2012.
8. A.R. Ragab and S.E. Bayoumi, Engineering Solid Mechanics: Fundamentals and Applications, CRC Press, 1999.

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P18SEI1202 **DESIGN OF ADVANCED CONCRETE STRUCTURES**

L	T	P	J	C
3	0	2	0	4

Course Outcome

After successful completion of this course, the students should be able to

CO1: Calculate short term and long-term deflections for structural elements
CO2: Analyze the structure after redistribution of moments
CO3: Design and detail deep beams, grid floor and flat slabs in accordance with relevant IS code and standards
CO4: Design bunkers and silos.

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			M	S		
CO2		M	S	S		
CO3		M	S	S		
CO4		M	S	S		

SERVICEABILITY CRITERIA FOR RC BEAMS AND SLABS **9 Hours**

Deflection: Introduction– Short Term and Long-Term Deflection of Beams Slabs, Continuous slabs as per IS456–Deflection due to Imposed Loads. Crack Width: Introduction - Factors affecting Crack width in Beams–Mechanism of Flexural Cracking–Estimation of Crack width in Beams by IS456 and BS8110 – Shrinkage, Creep and Thermal Cracking.

REDISTRIBUTION OF MOMENTS TO REINFORCED CONCRETE BEAMS **9 Hours**

Introduction – Redistribution of Moments in a Fixed Beam– Plate Theory Concepts - Advantages and Disadvantages of Moment Redistribution - Moment Redistribution for a Two–Span Continuous Beam – Modification of Clear Distance between Bars in Beams (for Limiting Crack width) with redistribution – Moment – Curvature (M -Φ) Relation of Reinforced Concrete Sections.

DESIGN OF REINFORCED CONCRETE DEEP BEAMS **9 Hours**

Introduction – Design by IS456– Checking for Local failures– Detailing of Deep Beams

DESIGN OF RIBBED (Voided) SLABS **9 Hours**

Introduction – Specification regarding the slabs – Analysis of the Slabs for Moment and Shears – Ultimate Moment of Resistance – Design of Shear – Deflection– Arrangement of Reinforcements

DESIGN OF GRID FLOORS AND FLAT SLABS **9 Hours**

Introduction – Analysis and design of Flat Grid Floors – Detailing of Steel in Flat Grids – Analysis and design of Flat slabs.

Signature of BOS chairman, CE

DESIGN OF SPECIAL STRUCTURES 9 Hours

Introduction - Difference between bunker and silo - Design of Bunkers – Design of Silo – Design of RC walls.

PRACTICAL 9 Hours

1. Design of Ribbed Slab.
2. Design of Flat Slab.
3. Design of Grid Floor.
4. Design of Deep Beam.
5. Design of Bunkers.
6. Design of Silo.

Theory: 45	Tutorial: 0	Practical: 30	Project: 0	Total: 75 Hours

REFERENCES

1. P.C. Vargheese, ‘Advanced Concrete Design’, Prentice Hall of India Pvt. Ltd., 2009
2. Krishnaraju, N. ‘Advanced Reinforced Concrete Design’, CBS Publishers and Distributors, Delhi,2013
3. Jain, A.K. ‘Reinforced Concrete-Limit State Design’, Nem Chand and Bros., Roorkee, 2012
4. Park. R. and Paulay T., ‘Reinforced Concrete Structures’, John Wiley and Sons, New Delhi, 2009.
5. Sinha, N.C. and Roy S.K., ‘Fundamentals of Reinforced Concrete’, S. Chand and Company, New Delhi, 2007.
6. B.C. Punmia, A.K.Jain , ‘Limit State Design of Reinforced concrete’, Firewall media, 2007.

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P18SEI1203 **ADVANCED CONCRETE TECHNOLOGY**

L	T	P	J	C
3	**0**	**2**	**0**	**4**

Course Outcome

After successful completion of this course, the students should be able to

CO1: Understand the constituent materials of structural concrete.
CO2: Acquire the knowledge of cement and concrete properties.
CO3: Understand the quality control and testing methods of concrete.
CO4: Acquire knowledge on production process and applications of concrete.
CO5: Understand about the Eco-friendly Concrete.

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	W					
CO2						M
CO3					S	
CO4						W
CO5						M

CONSTITUENT MATERIALS OF CONCRETE **10 Hours**

Constituent materials of structural concrete, including: material types and production- Physical and chemical characteristics; coverage in codes and standards-Impact on fresh and hardened concrete properties; and contributions to carbon foot print and sustainability.

CEMENT AND CONCRETE PROPERTIES **10 Hours**

Early-age and the long-term performance of concrete, including issues such as its ability to be placed and compacted - Properties and performance characteristics, structural movements, strength development- Fire resistance and durability performance

TESTING, QUALITY ASSURANCE, REPAIR AND MAINTENANCE OF CONCRETE **10 Hours**

Quality concepts and quality control of concretes-Test methods used both in laboratories and on site for measuring physical and chemical properties of concrete in fresh and hardened state, Non-destructive tests on structural elements-Different repair and maintenance methods that can be used to ensure durable concrete structures

CONCRETE PRODUCTION, PROCESSES, APPLICATIONS AND CONSTRUCTIONS **8 Hours**

Key construction methodologies associated with concrete buildings and infrastructure - Range of types of concretes that can be used for different applications

ECO-FRIENDLY CONCRETE **7 Hours**

Recycled materials in concrete–Partial and Full replacement of materials in concrete – M-sand, Eco-sand, Fly-ash, Silica Fume, GGBFS

PRACTICAL **30 Hours**

1. Casting and Testing of Simply Supported Reinforced Concrete beams for flexure.
2. Casting and Testing of Simply Supported Reinforced Concrete beams for shear.
3. Testing of Simply Supported Steel beams for flexure.
4. Casting and Testing of Reinforced Concrete columns.
5. Accelerated Corrosion Test on concrete.
6. Rapid Chloride Penetration Test.
7. Rebound hammer Test.
8. Ultrasonic Pulse Velocity Test.
9. Rebar locator Test..

Theory: 45	Tutorial: 0	Practical: 30	Project: 0	Total: 75 Hours

REFERENCES

1. Shetty M.S., Concrete Technology (Theory and Practice), S. Chand & Co. Ltd, 2008
2. Krishnaraju, N., Advanced Concrete Technology, CBS Publishers, 2010
3. Nevile, A. M., Concrete Technology, Prentice Hall, 2010.
4. Santhakumar A.R., Concrete Technology, Oxford University Press India, 2006
5. A.M. Neville, Properties of Concrete, Pearson Education India, 2012
6. Zongjin Li, Advanced Concrete Technology, John Wiley & Sons, 2011
7. Pierre-Claude Aitcin, High Performance Concrete, CRC Press, 2011.

SEMESTER II

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L	T	P	J	C
3	0	0	0	3

P18SET2001 FINITE ELEMENT METHOD

Course Outcome

After successful completion of this course, the students should be able to

CO1: understand the energy principles and finite element concepts.
CO2: formulate shape functions for various elements
CO3: determine the stresses and strains for 2D and 3D problems
CO4: apply finite element method for the analysis of framed structures
CO5: analyze plates and shells using Finite Element Method

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	W					
CO2	W					
CO3				M		
CO4				S		
CO5				S		

INTRODUCTION 9 Hours

Introduction - Basic Concepts of Finite Element Analysis - Introduction to Elasticity - Steps in Finite Element Analysis

Finite Element Formulation Techniques - Virtual Work and Variational Principle - Galerkin Method - Finite Element Method: Displacement Approach - Stiffness Matrix and Boundary Conditions

ELEMENT PROPERTIES 9 Hours

Natural Coordinates - Triangular Elements-Rectangular Elements - Lagrange and Serendipity Elements - Solid Elements - Isoparametric Formulation - Stiffness Matrix of Isoparametric Elements

ANALYSIS OF FRAME STRUCTURES 9 Hours

Stiffness of Truss Members-Analysis of Truss-Stiffness of Beam Members-Finite Element Analysis of Continuous Beam-Plane Frame Analysis-Analysis of Grid and Space Frame

FEM FOR TWO AND THREE-DIMENSIONAL SOLIDS 9 Hours

Constant Strain Triangle - Linear Strain Triangle - Rectangular Elements- Numerical Evaluation of Element Stiffness - Computation of Stresses, Geometric Nonlinearity and Static Condensation - Axisymmetric Element - Finite Element Formulation of Axisymmetric Element - Finite Element Formulation for 3 Dimensional Elements- Problems

FEM FOR PLATES AND SHELLS & ADDITIONAL APPLICATIONS OF FEM 9 Hours

Introduction to Plate Bending Problems - Finite Element Analysis of Thin Plate - Finite Element Analysis of Thick Plate - Finite Element Analysis of Skew Plate -Introduction to Finite Strip Method - Finite Element Analysis of Shell

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

1. Chandrupatla, R.T. and Belegundu, A.D., “Introduction to Finite Elements in Engineering”, Prentice Hall of India, 2012.
2. Desai, Y.M., Eldho, T.L. and Shah, A.H., “Finite Element Method”, Pearson Education Asia, New Delhi, 2011.
3. Chandrakant S. Desai and John F. Abel ‘Introduction to the Finite Element Method’ CBS Publishers and Distributors Pvt. Lts., 2005.
4. SS. Bhavikkatti, “Introduction to Finite Element Analysis”, New Age International Pvt. Ltd., New Delhi, 2005.
5. Wail N. AL-Rifaie and Ashok. K. Govil, “Finite Element Method for Structural Engineers”, New Age International Pvt. Ltd., New Delhi, 2010.
6. Singiresu. S. Rao, “The Finite Element Method in Engineering”, Butterworth-Heinemann, India Edition, 2010.
7. Bathe K.J, Finite Elements Procedures in Engineering analysis, Prentice Hall Inc., 2014.
8. Zienkiewicz O.C., Finite Element Method, & Taylor R.L. Vol. I, II & III, Elsevier, 2000.

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P18SEI2202 STRUCTURAL DYNAMICS

L	T	P	J	C
3	0	2	0	4

Course Outcome

After successful completion of this course, the students should be able to

CO1: Understand the importance of mathematical modelling and vibration analysis.
CO2: Solve response of the structures to dynamic loads using numerical methods
CO3: Study the dynamics response of single degree freedom system using fundamental theory and equation of motion.
CO4: Study the dynamics response of Multi degree freedom system using fundamental theory and equation of motion.
CO5: Understand the special loads like wind loads, Vibrations due to traffic etc. and the concept of base isolation.

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	W					
CO2				S	M	
CO3	W			S		
CO4	W			S		
CO5	W					

INTRODUCTION **5 Hours**

Objectives, Importance of Vibration Analysis, Nature of Exciting Forces, Mathematical Modelling of Dynamic Systems.

SINGLE DEGREE OF FREEDOM SYSTEM **9 Hours**

Single Degree of Freedom System: Free and Forced Vibration with and without Damping, Response to Harmonic Loading, Response to General Dynamic Loading using Duhamel's Integral, Fourier Analysis for Periodic Loading, State Space Solution for Response.

NUMERICAL METHODS **9 Hours**

Numerical Solution to Response using Newmark Method and Wilson Method, Numerical Solution for State Space Response using Direct Integration

MULTIPLE DEGREE OF FREEDOM SYSTEM (LUMPED PARAMETER) **13 Hours**

Multiple Degree of Freedom System, Inverse Iteration Method for Determination of Natural Frequencies and Mode Shapes, Dynamic Response by Modal Superposition Method, Direct Integration of Equation of Motion. Multiple Degree of Freedom System (Distributed Mass and Load): Single Span Beams, Free and Forced Vibration, Generalized Single Degree of Freedom System

SPECIAL TOPICS IN STRUCTURAL DYNAMICS **9 Hours**

Dynamic Effects of Wind Loading, Moving Loads, Vibrations caused by Traffic, Blasting and Pile Driving, Foundations for Industrial Machinery, Base Isolation. (Concepts only)

PRACTICAL **30 Hours**

1. Response of structures and its elements against extreme loading events.
    a. Impact test on slab specimen b. Cyclic load test on RC beam
    b. Demonstration on Horizontal and Vertical Shake table.
2. Model Testing:
    a. Dynamic Response of cantilever steel beam
    b. Lateral Load testing of G+1 storied steel frame
3. Evaluation of dynamic modulus of concrete.
4. Testing of Shear wall model for lateral load – Stiffness, Energy absorption
5. Vibration Characteristics of RC Beam using FFT analyzer.
6. Study on Vibration isolation.

Theory: 45	**Tutorial: 0**	**Practical: 30**	**Project: 0**	**Total: 75 Hours**

REFERENCES

1. Clough R. W. and Penzien J., Dynamics of Structures, McGraw Hill.,2007
2. A.K. Chopra, Dynamics of Structures – Theory and Applications of Earthquake Engineering, Pearson Education., 2014.
3. Paz Mario., Structural Dynamics – Theory and Computation, CBS Publication., 5th edition,2006.
4. Shashikant K. Duggal., Earthquake Resistant Design of Structures, Oxford University Press, 2013.
5. Ashok K. Jain., Dynamics of Structures with MATLAB Applications, Pearson Education., 2017.

P18SEI2003	ADVANCED DESIGN OF STEEL STRUCTURES	L	T	P	J	C
		3	0	0	0	3

Course Outcome

After successful completion of this course, the students should be able to

CO1: design various types of connections for steel structural elements.
CO2: analyze and design cold-formed steel structural components.
CO3: analyze and design steel towers.
CO4: design special structures like steel chimney and bunkers and silos and analyse the structures for wind and earthquake forces for design loads.
CO5: Design composite beams, slabs and columns.

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		M	S	S		
CO2		M		S		
CO3		M		S		
CO4		M		S		
CO5		M		S		

BEHAVIOUR AND DESIGN OF CONNECTIONS **9 Hours**

Connection behavior – Design requirements of bolted and welded connections-unstiffened and stiffened seat connections – framed connections – Connections for force and moment transmission - tee stub and end plate connections - Column stiffeners and other reinforcement – principles of semi-rigid connections.

ANALYSIS AND DESIGN OF COLD-FORMED STEEL STRUCTURES **9 Hours**

Types of cross sections - concepts of local buckling, and effective width - Design of compression and tension members - concepts of lateral buckling – Design of Beams, deflections of beams and design of beam webs - Combined stresses and connections- Empirical design of Z-purlins with lips and wall studs

ANALYSIS AND DESIGN OF STEEL TOWERS **9 Hours**

Micro Wave Towers – Transmission line towers – Loads on towers - Shape, Sag and Tension in Uniformly loaded conductors -Analysis of towers – Design of member in towers.

ANALYSIS AND DESIGN OF SPECIAL STRUCTURES **9 Hours**

Design of self-supporting chimney and guyed steel chimney – Stress due to wind and earthquake forces – Gust factor method – Design concept of bunkers and silos

COMPOSITE STRUCTURES **9 Hours**

Composite beams – composite slabs – infilled encased columns – uniaxial eccentrical composite columns

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

Signature of BOS chairman, CE

REFERENCES

1. L.S.Jayagopal, D.Tensing, Design of Steel Structures, Vikas Publishing, 2015
2. Dayaratnam, Design of Steel Structures, S. Chand & Company Ltd.,2012
3. S.Ramchandra and Virendra Gehlot,‘Design of Steel Structures’, Vol.-II, Scientific Publication, New Delhi,2010.
4. INSDAG, ‘Teaching Resource for Structural Steel Design’, Kolkotta, Version-II
5. Wei Wen Yu, Roger A. LaBoube, Cold Formed Steel Desgin, Wiley Publishers, 2010.
6. Subramanian.N, “Design of Steel Structures”, Oxford University press, 2011.

Signature of BOS chairman, CE

P18SEP2504	DESIGN STUDIO	L	T	P	J	C
		0	0	4	0	2

Course Outcome

After successful completion of this course, the students should be able to

CO1: design RC structural elements using spread sheets
CO2: analyse and design multi-storeyed RC building and trussed steel roof structures for wind and seismic forces
CO3: analyse and design various RC and steel structures
CO4: develop FEM model for RC elements

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		W		M	S	
CO2		W			S	
CO3		W			S	
CO4		W	M	M	S	

LIST OF EXPERIMENTS **60 Hours**

1. Design of simple structural elements of RC structures using Excel spread sheets- Design of slab, beam.
2. Analysis and design of multi-storey RC frame using computer software.
3. Design of steel foot-over bridge
4. Design of Industrial Shed
5. Design of T beam bride for moving load
6. Design of water tanks
7. Design of retaining walls
8. FEA of flat slab

Theory: 0	**Tutorial: 0**	**Practical: 60**	**Project: 0**	**Total: 60 Hours**

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ELECTIVES

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P18INT0001 **STATISTICS AND RESEARCH METHODOLOGY**

L	T	P	J	C
3	0	0	0	3

Course Outcome

After successful completion of this course, the students should be able to

CO1: Understand and apply the concepts of research
CO2: Apply statistical and other research tools to analyze and interpret data
CO3: Demonstrate skills in writing research topics

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S					S
CO2				S	S	
CO3		S				M

INTRODUCTION TO RESEARCH METHODS **9 Hours**

Definition and Objectives of Research, Scientific Methods, Various Steps in Scientific Research, Research planning, Selection of a Problem for Research, Formulation of the Selected Problems, Purpose of the Research, Formulation of research objectives, Formulation of research questions, Hypotheses Generation and Evaluation, Literature search, and review, Research abstract.

INTRODUCTION TO STATISTICS **9 Hours**

Population and Sample, Sampling and sample size, Population Proportion and Population Mean, Sample Proportion and Sample Mean, Estimation of Standard Error and confidence Interval, Identifying the dependent and independent variables, Introduction to data, Types of data and their importance, Descriptive Statistics and Inferential Statistics, Summarizing and describing data, Measures of Central Tendency and Measures of Dispersion, Mean, Median, Mode, Range, Variance, Standard Deviation

STATISTICAL MODELING AND ANALYSIS **12 Hours**

Probability Distributions, Normal, Binomial, Poisson, Fundamentals of Statistical Analysis and Inference, Hypothesis Testing, Confidence interval, Test of Significance, Comparison of Means (T test, Z test), Analysis of variance (ANOVA), Measures of association/Relationship, Chi-square test, Simple Regression Analysis, Multiple Regression analysis, Correlation, Data visualization techniques

RESEARCH DESIGN/PLAN **6 Hours**

Types and Methods of Research, Classification of Research, Research Ethics, Sampling Techniques, Methods of Collecting Primary Data, Use of Secondary Data, Experimentation, Design of Experiments, Survey Research and Construction of Questionnaires, Pilot Studies and Pre-tests, Data Collection methods, Processing of Data, Editing, Classification and Coding, Transcription, Tabulation, Validity and Reliability

RESEARCH REPORTS **9 Hours**

Structure and Components of Research Report/thesis, Types of Report, Planning of Report/thesis Writing, Research Report Format, Layout of Research Report, Presentation of data and Data Analysis Reporting, Mechanism of writing a research report, Principles of Writing, Writing of Report

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. C.R. Kothari, Research Methodology Methods and Techniques, 3/e, New Age International Publishers, 2014.
2. Ranjit Kumar, Research Methodology A Step-by-Step Guide for Beginners, 4th Edition, Sage Publishing, 2014
3. R. Pannerselvam, Research Methodology, 2nd edition, Prentice Hall India, 2014
4. Devore, J.L., Probability and statistics for Engineering and the Sciences, Cengage Learning, ebook, 8th edition, 2010.

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P18SEE0001 DESIGN OF BRIDGES

L	T	P	J	C
3	0	0	0	3

Course Outcome

After successful completion of this course, the students should be able to

CO1: Calculate loads for different types of Bridges.
CO2: Design short span and long span bridges.
CO3: Design bearings and substructure for bridges.

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		M	M	S		
CO2		M	M	S		
CO3		M	M	S		

INTRODUCTION **9 Hours**

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.

SHORT SPAN BRIDGES **9 Hours**

Load distribution theories, analysis and design of slab bridge, box culverts and tee beam bridges.

LONG SPAN GIRDER BRIDGES **9 Hours**

Design principles of balanced cantilever bridges – Design of articulation - continuous bridges - box girder bridges.

DESIGN OF PRESTRESSED CONCRETE BRIDGES **9 Hours**

Design of prestressed concrete bridges – Preliminary dimensions – Design of girder section - Maximum and minimum prestressing forces-Eccentricity-Live load and dead load shear forces – cable zone in girder - Short term and long-term deflections.

BEARINGS, SUB-STRUCTURES AND FOOTINGS FOR BRIDGES **9 Hours**

Design of bearings – Foundation for bridges – Well and caisson foundation – Design of pier cap - Design of pier.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

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1. Krishnaraju, N., ‘Design of Bridges’, Oxford and IBH Publishing, 2010.
2. Ponnuswamy, S., ‘Bridge Engineering’, Tata McGraw-Hill,2007.
3. N. Rajagopalan, ‘Bridge Superstructure’, Alpha Science Intl. Ltd, 2006.
4. Raina V.K. ‘Concrete Bridge Practice’, Tata McGraw-Hill Publishing Company, New Delhi,1994.
5. Bakht, B. and Jaegar, L.G., ‘Bridge Analysis Simplified’, McGraw-Hill,1985.
6. Derrick Beckett, ‘An introduction to Structural Design of Concrete Bridges’, Surrey University Press, Henley Thomes, Oxford Shire, 1973.
7. Taylor, F.W., Thomson, S.E., and Smulski E., ‘Reinforced Concrete Bridges’, John Wiley and Sons, New York, 1955.
8. Edwin H. Gaylord Jr., Charles N. Gaylord, James, E., Stallmeyer ‘Design of Steel Structures’ McGraw-Hill International Editions, 1992.
9. D. Johnson Victor, ‘Essentials of Bridge Engineering’, Oxford and IBH Publishing, 2010.

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P18SEE0002	DESIGN OF PRE-STRESSED CONCRETE ELEMENTS	L	T	P	J	C
		3	0	0	0	3

Course Outcome

After successful completion of this course, the students should be able to

CO1: Understand different methods of pre-stressing techniques
CO2: Design pre-stressed concrete structures for flexure and shear
CO3: Analyze and design the anchorage zone.
CO4: Design pre-stressed concrete pipes and tanks
CO5: Analyze composite and indeterminate pre-stressed concrete structures

Pre-requisites: Design of Advanced Concrete Structures

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S					
CO2		S	M	S		
CO3				S		
CO4		S	M	S		
CO5				S		

PRINCIPLES AND ANALYSIS FOR FLEXURE **9 Hours**

Principles of Pre-stressing – Types of pre-stressing systems– Materials – Systems and devices– Analysis and design for flexure – Behaviour of pre-stressed concrete elements – General concept of pre-stress – Force transmitted by pre-tensioned and post-tensioned systems - losses in prestress – analysis for Ultimate strength – Comparison of codal provisions

DESIGN FOR FLEXURE **8 Hours**

Concept of Limit State design – Limit state of Collapse and serviceability – Design using allowable stresses – Stress range approach-Lin's approach – Magnel's approach – Analysis of Ultimate Strength

DESIGN FOR SHEAR, TORSION AND ANCHORAGE ZONE **8 Hours**

Principal stresses – Shear resistance in beams – Design for shear in rectangular and flanged beams – Behaviour under torsion – Modes of failure - Design for torsion, shear and bending Anchorage Zone – analysis and design of pre-tensioned and post tensioned end blocks

STATICALLY INDETERMINATE STRUCTURES **7 Hours**

Analysis of indeterminate structures – Continuous beams – linear transformations - Concept of concordance – Choice of cable profiles – deflection of pre-stressed members.

SPECIAL STRUCTURES **7 Hours**

Concept of circular prestressing – Design of pre-stressed concrete pipes and cylindrical water tanks - Composite construction- types, behaviour, flexural stresses, longitudinal shear transfer, transverse shear– Compression members–Design of poles, piles and sleepers - Partial pre-stressing – Principles, analysis and design concepts

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DESIGN FOR TENSION **6 Hours**

Design of tension members

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

1. N. Krishnaraju, ‘Prestressed Concrete’, Tata McGraw-Hill Publishing Company,4th Ed 2012
2. N. Rajagobalan, ‘Prestressed Concrete’, Norosa Publishing House, 2014
3. T.Y. Lin & Ned Bhurns, ‘Design of Prestressed Concrete Structures’, 3rd edition, John Wiley & Sons, 1982
4. N.C. Sinha & S.K. Roy, ‘Fundamentals of Prestressed Concrete’ S. Chand & Co, New Delhi, 2011.

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P18SEE0003	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES	L	T	P	J	C
		3	0	0	0	3

Course Outcome

After successful completion of this course, the students should be able to

CO1: Acquire knowledge on earthquake and theory of vibration.
CO2: Understand response of the structures to dynamic loads and capacity design.
CO3: Understand the code provisions for seismic analysis of structures.
CO4: Design RC elements of frame system as per code provision.
CO5: Understand Retro-fitting of existing damaged buildings and vibration control measures

Pre-requisites: Structural Dynamics

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	W					
CO2	W					
CO3	S		S			
CO4		M	M	S		
CO5	S					S

INTRODUCTION **9 Hours**

Elements of Seismology – Definitions of magnitude – Intensity – Epicenter etc.- General features of tectonics of seismic regions– Seismographs and Accelerographs. Theory of Vibrations - Free vibrations of single degree – Two degree and multiple degree freedom systems.

EARTHQUAKE RESPONSE **9 Hours**

Cyclic Behaviour of PCC, RCC, Steel and PSC Elements, Earthquake Response to Elastic and Inelastic Buildings – Response Spectrum Theory – Design spectrum – Design principles, Capacity based design, Strong column – weak beam concept, Ductility – Definition, Types, Importance and Requirements

BIS SPECIFICATIONS & SEISMIC ANALYSIS **9 Hours**

Code Provisions of Design of Buildings as per IS1893 and IS4326 – Behaviour and Design of Masonry Structures as Per IS 13827 and IS13828. Methods of Seismic Analysis: Equivalent static analysis – Response Spectrum method – Time history method – Pushover Analysis

DUCTILE & DESIGN DETAILING **9 Hours**

Code Provisions of Ductile Detailing of Structures as per IS13920 – Design of RC beams, columns, Beam-column joints and shear walls.

SPECIAL TOPICS **9 Hours**

Base isolation technique, Active and passive control devices, Seismic retro-fitting strategies for RC and masonry buildings. Soil Liquefaction.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

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REFERENCES

1. Pankaj Agarwal, Earthquake Resistant Design of Structures, Prentice – Hall of India Pvt. Ltd., New Delhi, 2006.
2. Chopra A.K., Dynamics of Structures - Theory and Applications of Earthquake Engineering, N J Pearson Education inc., 2017.
3. Duggal S.K., Earthquake Resistant Design of Structures, Prentice Hall of India, New Delhi, 2013.
4. Bungale S. Taranath, Wind and Earthquake Resistant Buildings: Structural Analysis and Design, CRC Press, 2004.

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L	T	P	J	C
3	**0**	**0**	**0**	**3**

P18SEE0004 **SMART MATERIALS FOR CONSTRUCTION**

Course Outcome

After successful completion of this course, the students should be able to

CO1: choose a suitable concrete admixture
CO2: design steel-concrete composite elements
CO3: design fiber reinforced concrete mix as per ACI standards
CO4: suggest composition of geopolymer and ferrocement

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M		S			
CO2		M		S		
CO3		M		S		
CO4	M	M	S			

CONCRETE ADMIXTURES **9 Hours**

Mineral (pozzolanic materials and fillers) – Chemical (accelerators, retarders, plasticizers, super plasticizers, air entraining agent, viscosity modifier, corrosion inhibitors and water repellent) – Dosage – Compatibility

STEEL CONCRETE COMPOSITE **9 Hours**

Introduction to steel-concrete composite structures, Anatomy of a composite building, Construction of composite structures, Design of composite beam and column, Shear connectors, Design strength of shear connectors, Load resisting systems, connections, Analysis procedures of buildings for gravity and lateral loads

FIBER REINFORCED CONCRETE **9 Hours**

Fibre materials, mix proportioning, distribution and orientation, interfacial bond, properties in fresh state, strength and behaviour in tension, compression and flexure of steel fibre reinforced concrete, mechanical properties, crack arrest and toughening mechanism – Applications of FRC – Design as per ACI 544.4R-18 – Case study

GEO-POLYMER CONCRETE **9 Hours**

Characterisation – activating solution – structure of geopolymers – accelerated curing – durability – design – Engineering properties – applications – case study

FERROCEMENT **9 Hours**

Ferro cement: Ferrocement materials, mechanical properties, cracking of ferrocement, strength and behaviour in tension, compression and flexure, Design of ferrocement in tension, ferrocement constructions, durability, and applications.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. A.M Paillere, “Applications of Admixtures in Concrete”, Taylor & Francis, 2007.
2. D. J. Oehlers and M. A. Bradford, “Composite Steel and Concrete Structural Members: Fundamental Behaviour”, Pergamon, 1995.
3. Harvinder Singh, “Steel Fiber Reinforced Concrete”, Springer, 2017
4. J. L. Provis and J. S. J. van Deventer, “Geopolymers: Structures, Processing, Properties and Industrial Applications”, CRC Press, 2009
5. Stanley Abercrombie, “Ferrocement: Building with cement, sand, and wire mesh”, Hill Family Books, 2008

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P18SEE0005	STRUCTURAL HEALTH MONITORING	L	T	P	J	C
		3	0	0	0	3

Course Outcome

After successful completion of this course, the students should be able to

CO1: Diagnose for serviceability and durability aspects of concrete.
CO2: Suggest the materials and techniques used for repair of structures.
CO3: Decide the appropriate repair, strengthening, rehabilitation and retrofitting technique required for a case study building
CO4: Recommend an appropriate health monitoring technique and demolition technique

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	S					M
CO2	S	S				S
CO3	S	S				S
CO4	S	S				M

INTRODUCTION TO STRUCTURAL HEALTH MONITORING 9 Hours

Definition of structural health monitoring (SHM), Motivation for SHM, SHM as a way of making materials and structures smart, SHM and biomimetics, Process and pre-usage monitoring as a part of SHM, SHM as a part of system management, Passive and active SHM, NDE, SHM and NDECS, Variety and multi-disciplinary: the most remarkable characters of SHM, Birth of the SHM Community.

VIBRATION-BASED TECHNIQUES FOR SHM 9 Hours

Basic vibration concepts for SHM, Local and global methods, Damage diagnosis as an inverse problem, Model-based damage assessment, Mathematical description of structural systems with damage, General dynamic behavior, State-space description of mechanical systems, Modelling of damaged structural elements, Linking experimental and analytical data, Modal Assurance Criterion (MAC) for mode pairing, Modal Scaling Factor (MSF), Co-ordinate Modal Assurance Criterion (COMAC), MECE error localization technique.

FIBER-OPTIC SENSORS 9 Hours

Classification of fiber-optic sensors, Intensity-based sensors, Phasemodulated optical fiber sensors, or interferometers, Wavelength based sensors, Photoelasticity in a plane stress state, Orientation of the optical fiber optic with respect to the reinforcement fibers, Ingress/egress from the laminate, Measurement of strain and stress variations, Measurement of spectral perturbations associated with internal stress release resulting from damage spread, Examples of applications in civil engineering, Stiffened panels with embedded fiber Bragg gratings, Concrete beam repair

SHM WITH PIEZOELECTRIC SENSORS 9 Hours

The use of embedded sensors as acoustic emission (AE) detectors, Algorithms for damage localization, Algorithms for damage characterization, Available industrial AE systems, New concepts in acoustic emission, Sensor technology, Acousto-ultrasonic signal and data reduction methods, Available industrial acousto-ultrasonic systems with piezoelectric sensors, Electromechanical impedance, E/M impedance for defect detection in metallic and composite parts, The piezoelectric implant method applied to the evaluation and monitoring of viscoelastic properties.

SHM USING ELECTRICAL RESISTANCE 9 Hours

Composite damage, Electrical resistance of unloaded composite, Percolation concept, Anisotropic conduction properties in continuous fiber reinforced polymer, Influence of temperature, Composite strain and damage monitoring by electrical resistance, 0° uni-directional laminates, Multidirectional laminates, Randomly distributed fiber reinforced polymers, Damage localization.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, Wiley ISTE, 2006.
2. Douglas E Adams, Health Monitoring of Structural Materials and Components-Methods with Applications, John Wiley and Sons, 2007.
3. J.P. Ou, H.Li and Z.D. Duan, Structural Health Monitoring and Intelligent Infrastructure, Vol-1, Taylor and Francis Group, London, U.K, 2006.
4. Victor Giurglutiu, Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc, 2007.

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P18SEE0006	EXPERIMENTAL METHODS AND MODEL ANALYSIS	L	T	P	J	C
		3	0	0	0	3

After successful completion of this course, the students should be able to
CO1: demonstrate the various force and strain measuring equipment.
CO2: choose various data indicating and recording instruments.
CO3: perform model analysis.

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1					S	
CO2	S					
CO3				S	S	

FORCE AND STRAIN MEASUREMENTS **9 Hours**
Basic Concept in Measurements – Types of strain gauges – Hydraulic jacks – pressure gauges – proving rings – electronic load cells – Calibration of Testing Machines

DATA RECORDING **9 Hours**
Strain gauge circuits – Potentiometer and Wheatstone bridge – use of lead wires switches etc., - Use of electrical resistance strain gauges in transducer applications – LVDT - Indicating and recording devices - Static and dynamic data recording –Data (Digital and Analogue) acquisition and processing systems.

VIBRATION MEASUREMENT **9 Hours**
Strain analysis methods – Rosette analysis. Static and dynamic testing techniques. - Equipment for loading - Moire's techniques - Transducers for velocity and acceleration measurements - vibration meter - Seismographs - vibration analyzer - Cathode Ray Oscilloscope

NON-DESTRUCTIVE TESTING TECHNIQUES (NDT) **9 Hours**
Non-destructive testing techniques - Load testing of structures, Buildings, bridges and towers -Acoustic emission - holography - use of laser for structural testing.

MODEL ANALYSIS **9 Hours**
Laws of similitude - model materials – model testing – testing large scale structures – holographic techniques – Photoelasticity – optics of photoelasticity – Polariscope – Isoclinics and Isochromatics - methods of stress separation – wind tunnel and its use in structural analysis

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

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1. Dally J W and Riley W.F, ‘Experimental stress Analysis’, McGraw-Hill Inc. New York, 1991.
2. Sadhu Singh, ‘Experimental Stress Analysis’, Khanna Publishers, New Delhi, 2009.
3. Rangan C S et al., ‘Instrumentation – Devices and Systems’, Tata McGraw-Hill Publishing Co., Ltd., New Delhi, 2017.
4. Srinath L S et al, ‘Experimental Stress Analysis’, Tata McGraw-Hill Publishing Co., Ltd., New Delhi,1984.
5. D.E.Bray and R.K.Stanley, “Non-Destructive Evaluation”, McGraw Hill Publishing Co., New York, 1997.

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P18SEE0007 **DESIGN OF PLATES, SHELLS AND SPATIAL STRUCTURES**

L	T	P	J	C
3	0	0	0	3

Course Outcome

After successful completion of this course, the students should be able to

CO1: analyze various shapes of plates using various methods
CO2: analyze and design circular and cylindrical shells
CO3: analyze and design space frame

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1				S		
CO2				S		
CO3				S		

SYMMETRICAL BENDING OF PLATES **11 Hours**

Equation of equilibrium and deformation of plates – Bending of rectangular plates and circular plates – Post buckling behaviour.

NUMERICAL METHODS **9 Hours**

Energy method, finite difference and finite element methods for solution of plate bending problems. Principles of design of folded plates

SHELLS **9 Hours**

Geometry of shells – Classification of Shells – membrane theory of circular and cylindrical shells – Detailed Analysis and design of cylindrical shells – Detailing of Reinforcement in shells, edge beams and transfer beam

INTRODUCTION TO SPACE FRAMES **8 Hours**

Space frames – configuration – types of nodes – general principles of design Philosophy – Behaviour.

ANALYSIS OF SPACE FRAMES **8 Hours**

Analysis of space frames – Formex Algebra, FORMIAN – detailed design of space frames.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES

1. Ramasamy, G.S. ‘Design and Construction of Concrete shells roofs’, CBS Publishers, 2005.
2. Timoshenko, S. ‘Theory of plates and Shells’, McGraw-Hill, 2017
3. Principles of space structures by Dr.N. Subramanian – 1999, Wheeler Publishing Co.
4. Proceedings of International Conference on Space structures, Anna University, November 1997.
5. Szllard, R. Theory of Analysis of Plates, Prentice Hall Inc, 1973.

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P18SEE0008 **DESIGN OF STRUCTURES FOR DYNAMIC LOADS**

L	T	P	J	C
3	0	0	0	3

Course Outcome

After successful completion of this course, the students should be able to

CO1: explain the behavior of structures under dynamic loads
CO2: design structures for earthquake, blast and impact loads
CO3: perform ductile detailing

Pre-requisites: Structural Dynamics

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			S			
CO2				S		
CO3			S			

INTRODUCTION **9 Hours**

Factors affecting design against dynamic loads - Behaviour of concrete, steel, masonry and soil under impact and cyclic loads - Recap of Structural dynamics with reference to SDOF, MDOF and continuum systems - Ductility and its importance

DESIGN AGAINST EARTHQUAKES **9 Hours**

Earthquake characterisation - Response spectra - seismic coefficient and response spectra methods of estimating loads - Response of framed, braced frames and shear wall buildings - Design as per BIS codes of practice - Ductility based design.

DESIGN AGAINST BLAST AND IMPACT **9 Hours**

Characteristics of internal and external blast - Impact and impulse loads - Pressure distribution on buildings above ground due to external blast - underground explosion - Design of buildings for blast and impact as per BIS codes of practice.

DESIGN AGAINST WIND **9 Hours**

Characteristics of wind - Basic and Design wind speeds - Effect of permeability of the structure – pressure coefficient - Aeroelastic and Aerodynamic effects - Design as per BIS code of practice including Gust Factor approach - tall buildings, stacks and chimneys.

SPECIAL CONSIDERATIONS **9 Hours**

Energy absorption capacity – Ductility of the material and the structure – Detailing for ductility – Passive and active control of vibrations – New and favourable materials.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

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1. Bela Goschy, 'Design of Building to withstand abnormal loading', Butterworths, 1990.
2. Paulay, T. and Priestly, M.N.J., 'A seismic Design of Reinforced Concrete and Masonry building', John Wiley and Sons, 2013.
3. Dowling, C.H., 'Blast vibration - Monitoring and Control', Prentice Hall Inc., Englewood Cliffs, 1985.
4. Kolousek, .V. et al., 'Wind effects on Civil Engineering Structures', Elsevier, 1984.
5. Synthesis Report CEB, 'Concrete Structures under Impact and Impulsive Loading', Lousanne, Germany, 1988.

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AUDIT COURSES

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L	T	P	J	C
3	0	0	0	0

P18SEA0001 DISASTER MANAGEMENT

Course Outcome

After successful completion of this course, the students should be able to

CO1: prepare disaster mapping using GIS.
CO2: assess disaster vulnerability of a location.
CO3: prepare disaster management plan

Pre-requisites: Nil

CO/PO Mapping (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak						
COs	Programme Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		M				
CO2	M					
CO3		M				

NATURAL DISASTERS **9 Hours**

Cyclones, Floods, Drought and Desertification - Earthquake, Tsunami, Landslides and Avalanche.

MAN MADE DISASTERS **9 Hours**

Chemical industrial hazards, major power breakdowns, traffic accidents, Fire, War, Atom bombs, Nuclear disaster- Forest Fire-Oil fire –accident in Mines.

GEOSPATIAL TECHNOLOGY **9 Hours**

Remote sensing, GIS and GPS applications in real time disaster monitoring, prevention and rehabilitation-disaster mapping.

RISK ASSESSMENT AND MITIGATION **9 Hours**

Hazards, Risks and Vulnerabilities. -Disasters in India,Assessment of Disaster Vulnerability of a location and vulnerable groups- Preparedness and Mitigation measures for various Disasters Mitigation through capacity building -Preparation of Disaster Management Plans

DISASTER MANAGEMENT **9 Hours**

Legislative responsibilities of disaster management- Disaster management act 2005- post disaster recovery & rehabilitation, Relief & Logistics Management; disaster related infrastructure development- Post Disaster, Emergency Support Functions and their coordination mechanism.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES

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1. Khanna B K, "All You Wanted to Know About Disasters", New India Publishing Agency, New Delhi, 2005.
2. Ramana Murthy, "Disaster Management", Dominant, New Delhi, 2004.
3. Rajdeep Dasgupta, Disaster Management and Rehabilitation, Mittal Publishers, New Delhi, 2007.
4. Disaster Management in India- A Status Report- Published by the National Disaster Management Institute, Ministry of Home Affairs, Govt. of India.2004.
5. Murthy D B N, "Disaster Management: Text and Case Studies", Deep and Deep Publications (P) Ltd., New Delhi, 2007.
6. Sundar I and Sezhiyan T, "Disaster Management", Sarup and Sons, New Delhi, 2007.

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