NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

RULES AND REGULATIONS
SCHEME OF INSTRUCTION AND SYLLABI
FOR M.TECH PROGRAM IN ENGINEERING STRUCTURES

Effective from 2016-17

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.

- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.

- Fostering product oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

DEPARTMENT OF CIVIL ENGINEERING

VISION

To be a knowledge nerve centre in civil engineering education, research, entrepreneurship and industry outreach services for creating sustainable infrastructure and enhancing quality of life.

MISSION

- Generating a specialized cadre of civil engineers by imparting quality education and training.

- Attain international standards in teaching, research and consultancy with global linkages.

GRADUATE ATTRIBUTES OF M.TECH PROGRAM

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

1. **Scholarship of Knowledge**: Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
2. **Critical Thinking**: Analyze complex engineering problems critically; apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
3. **Problem Solving**: Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
4. **Research Skill**: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
5. **Usage of modern tools**: Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.
6. **Collaborative and Multidisciplinary work**: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
7. **Project Management and Finance**: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one's own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.
8. **Communication**: Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
9. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
10. **Ethical Practices and Social Responsibility**: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11. **Independent and Reflective Learning**: Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

DEPARTMENT OF CIVIL ENGINEERING

M.TECH. ENGINEERING STRUCTURES

PROGRAM EDUCATIONAL OBJECTIVES

PEO1	Identify and analyze contemporary issues in structural engineering systems.
PEO2	Analyze and design structural components and systems complying with relevant standards and codes.
PEO3	Identify and apply sustainable, alternative and cost effective construction materials adopting quality control practices.
PEO4	Communicate effectively, demonstrate leadership qualities and exhibit professional ethics.
PEO5	Engage in lifelong learning for career enhancement and adapt to changing societal needs.

Mapping of Mission statements with program educational objectives

Mission Statement	PEO1	PEO2	PEO3	PEO4	PEO5
MS1	2	3	2	2	2
MS2	3	3	3	3	3

Mapping of program educational objectives with graduate attributes

PEO	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11
PEO1	3	3	3	2	2	2	1	1	1	1	1
PEO2	3	3	3	2	2	2	1	1	1	2	1
PEO3	3	3	2	2	1	1	1	1	1	1	1
PEO4	1	1	1	1	1	3	2	3	1	3	1
PEO5	1	1	1	2	2	2	1	1	3	2	2

PROGRAM OUTCOMES: At the end of the program the student will be able to:

PO1	Apply knowledge of mathematics, science and engineering to solve problems related to contemporary issues in structural engineering.
PO2	Analyse, design and conduct experiments, interpret and report results of complex structural engineering problems.
PO3	Design civil engineering structures complying with standards and specifications.
PO4	Apply engineering tools, instrumentation and software for solving structural engineering problems.
PO5	Apply sustainable technologies and practices to protect environment and ecosystems.
PO6	Work in inter-disciplinary engineering teams with social responsibility and ethical values.
PO7	Communicate effectively and demonstrate leadership skills.
PO8	Engage in lifelong learning and demonstrate awareness of contemporary issues.

Mapping of program outcomes with graduate attributes

PO	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11
PO1	3	3	3	3	2	2	1	2	2	2	3
PO2	3	3	3	3	2	2	1	2	2	2	3
PO3	3	3	3	3	1	1	1	1	2	2	3
PO4	2	2	2	2	3	2	1	1	1	1	2
PO5	1	1	2	2	1	2	1	1	1	3	2
PO6	3	2	2	1	1	3	1	1	2	3	1
PO7	1	1	1	1	1	2	1	3	2	2	1
PO8	2	2	2	3	1	3	1	1	3	2	2

Mapping of program outcomes with program educational objectives

Program Outcomes	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	-	-	1
PO2	3	3	-	-	1
PO3	2	3	2	-	-
PO4	1	2	1	-	-
PO5	1	1	3	1	2
PO6	1	1	1	2	2
PO7	1	1	1	3	1
PO8	1	1	2	2	2

SCHEME OF INSTRUCTION

M.Tech. (Engineering Structures) Course Structure

M.Tech. I - Year I – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	CE5201	Theory of Elasticity	4	0	0	4	PCC
2	CE5202	Behavior of Concrete Structures	4	0	0	4	PCC
3	CE5203	Seismic Resistant Design	4	0	0	4	PCC
4		Elective – I	3	0	0	3	DEC
5		Elective – II	3	0	0	3	DEC
6		Elective – III	3	0	0	3	DEC
7	CE5204	Concrete Lab	0	0	3	2	PCC
8	CE5205	CAD Lab	0	0	3	2	PCC
9	CE5241	Seminar – I	0	0	2	1	PCC
		TOTAL	**21**	**0**	**8**	**26**	

M.Tech. I - Year II – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	CE5251	Structural Stability	4	0	0	4	PCC
2	CE5252	Finite Element Analysis of Structures	4	0	0	4	PCC
3	CE5253	Theory of Plates and Shells	4	0	0	4	PCC
4		Elective – IV	3	0	0	3	DEC
5		Elective – V	3	0	0	3	DEC
6		Elective – VI	3	0	0	3	DEC
7	CE5254	Structural Design Lab	0	0	3	2	PCC
8	CE5255	Structural Testing Laboratory	0	0	3	2	PCC
9	CE5291	Seminar – II	0	0	2	1	PCC
		TOTAL	**21**	**0**	**8**	**26**	

M.Tech. II - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1		Industrial Training (8-10 weeks; Optional)	-	-	-		
2	CE6242	Comprehensive Viva voce	-	-	-	2	PCC
3	CE6249	Dissertation Part – A	-	-	-	6	PCC
		TOTAL	**-**	**-**	**-**	**8**	

M.Tech. II - Year II – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	CE6299	Dissertation Part – B	-	-	-	12	PCC
		TOTAL				**12**	

List of Electives

I Semester			II Semester	
Course Code	**Course Title**		**Course Code**	**Course Title**
CE5151	Neo Construction Materials		CE5162	Timber and Formwork Design
CE5153	Building Services		CE5261	Fracture Mechanics of Concrete Structures
CE5211	Analysis and Design of Bridges		CE5262	Vulnerability and Risk Analysis
CE5212	Reliability Analysis of Structures		CE5263	Rehabilitation of Structures
CE5213	Structural Masonry		CE5264	Tall Structures
CE5214	Theory and Applications of Cement Composites		CE5265	Structural Health Monitoring
CE5215	Design of Industrial Structures		CE5266	Advanced Prestressed Concrete
CE5216	Plasticity and Limit design of Steel structures		CE5267	Blast Resistant Design
CE5217	Experimental Methods in Structural Engineering		CE5268	Durability of Concrete Structures
			CE5161	Underwater Construction

DETAILED SYLLABUS

CE 5201	Theory of Elasticity	PCC	4 – 0 – 0	4 Credits

Pre-requisites: Mathematics, Strength of Materials and Mechanics of Solids.

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

CO1	Apply principles of elastic theory to estimate stresses and strains of structural engineering problems.
CO2	Solve engineering problems such as thick cylinders, rotating discs, shafts and complex loading on structural members.
CO3	Model and analyze homogenous and isotropic elastic plane problems.
CO4	Apply strain energy principles to solve engineering problems.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	-	-	-	1	1
CO2	3	3	2	-	-	-	1	2
CO3	3	2	2	-	-	-	-	2
CO4	3	3	1	-	-	-	1	1

Detailed Syllabus:

Introduction to Theory of Elasticity, Assumptions made in strength of materials and theory of Elasticity, Necessary and sufficient conditions for analyzing a structure, State of stress at a point, Specification of stress at a point-Determination of Normal thrust and Shear stress, Problems on Specification of stress at a point, Concept of Orthogonal Transformation of axes and Problems, Determination of Stress invariants, Determination of Principal Stresses and Planes. Concept of Cauchy's Concoid, Lames Expression and problems on calculation of principal stresses and planes, Determination of Maximum Shear Stresses and their corresponding planes and problems, Tresca's criteria, Derivation of Octahedral stresses and planes, deviatoric stresses, Von-Mises criteria, Concept of Strain at a point, Determination of Normal and Shear Strain, Generalized Hooke's Law and problems on interrelationship between stress and Strain in three dimensions, Derivation of Equilibrium conditions in three dimensions, Derivation of Compatibility conditions in three dimensions, Derivation of stress tensor, strain tensor, principal stress and strain, maximum shear stress and strain tensor for Plane Stress and Plane Strain cases, Equations of equilibrium and Compatibility of strain in two dimensions, Boundary Conditions, Governing Differential equation in Cartesian coordinates, Formulation of a stress analysis problem using the necessary and sufficient conditions in three dimensions and modifying the same to identify the unknowns in plane cases, Derivation of Airy's Stress function using the boundary conditions, equilibrium equations, compatibility conditions, Solution to stress analysis problem using method of polynomials, Solution to stress analysis problem using method of polynomials, Solution to stress analysis problem using Indirect method, Solution to stress analysis problem using semi-inverse method, Application to two dimensional problems in rectangular coordinates, Solution to two dimensional problems in Polar Coordinates, Stress distribution in radially symmetric problems-Thick cylinder problem, Castigliano's theorem-Principle of rupture as explained from the concept of theory of elasticity, Torsion-Saint Venant's theory.

Reading:

1. Timoshenko and Goodier, "Theory of Elasticity", 3rd Edition, McGraw Hill, 2010.
2. C.T. Wang, "Applied Elasticity", McGraw Hill, 1953.
3. L.S. Srinadh, "Advanced Mechanics of Solids", TMH Publishing Company Limited, 1992.
4. Sadhu Singh, "Theory of Elasticity", Khanna Publishers, 1997.

CE 5202	Behaviour of Concrete Structures	PCC	4 – 0 – 0	4 Credits

Pre-requisites: Concrete Technology, Design of Concrete Structures and Prestressed Concrete.

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

CO1	Understand the background of structural concrete and behaviour of beams in flexure.
CO2	Understand the behavior of beams in shear and torsion.
CO3	Design columns in uniaxial and biaxial compression and combined loading.
CO4	Design RC and PSC members as per Indian Standards and specifications.
CO5	Detail reinforcement in RC and PSC members as per Codes of Practice.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	1	-	-	-	-	1
CO2	2	2	3	-	-	-	-	1
CO3	3	2	3	-	-	-	-	1
CO4	1	2	3	-	-	-	-	-
CO5	1	2	3	-	-	-	-	-

Detailed Syllabus:

Introduction - A brief review of Limit State Design Philosophy - Application to beams.

Behaviour of Columns - Rectangular and circular columns - Interaction diagrams - Biaxial bending - Interaction surfaces - Design for bi-axial bending - Limit states of deflection and crack width.

Behaviour of RC Members in Shear and Torsion - Kani's theory for shear - Skew bending theory for torsion - Different modes of failure in torsion and bending - Design of beams in combined Shear, Bending, and Torque as per I.S. code.

Design of Statically Indeterminate RC Structures - Development of moment curvature diagrams - moment redistribution in R.C. structures - Baker's method of design - ductility of R.C. members - Confined concrete - Cambridge method of design - Generation of load-deflection diagrams.

Yield line theory of Slabs - Yield line theory of slabs- Analysis and design of slabs at Limit state of failure.

Behaviour of Statically Indeterminate Pre-stressed Concrete Structures - Moment - Curvature diagrams of Class I, II, III structures - Moment redistribution in Pre-stressed concrete beam - Principle of design of Portal frames - Design of continuous beams - Cable profile - Concordant cable and Linear Transformation - Limit state of crack width for class - III beams.

PSC under combined Loading - Behaviour of Pre-stressed Concrete Structures in combined shear, Bending Moment and Torque-I.S. code method.

Serviceability design of RC Structures - Serviceability - Deflection- Significance of Span to depth ratio- Short term-Long term deflection due to Shrinkage, Creep- Cracking-Crack width calculation- Vibration control-limits.

Detailing of RC Structures - Basic Principles of detailing- Truss analogy – directional changes – general layout of reinforcement.

Concept of Strut and Tie models - Strut and Tie models application to B and D regions of Structures – detailing beam column joints – corbels.

Reading:

1. R. Park and T. Paulay, “Reinforced Cement Concrete Structures”, MISL-WILEY Series, Wiley India Pvt. Ltd, 2009.
2. F.K. Kong and R.H. Evans, “Reinforced and Prestressed Concrete Structures”, 3rd Edition, Spon Press, 1990.
3. Yves Guyon, “Limit State Design of Prestressed Concrete Members”, Halsted Press Division, Wiley, 1974.
4. Lin. T.Y., “Design of Prestressed Concrete Structures”, 3rd Edition, Wiley India Pvt. Ltd, 2010.

CE 5203	Seismic Resistant Design	PCC	4 – 0 – 0	4 Credits

Pre-requisites: Mathematics and Engineering Mechanics.

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

CO1	Model and Formulate dynamic equilibrium equations for SDOF and MDOF systems.
CO2	Analyse SDOF and MDOF systems using classical and numerical methods.
CO3	Perform modal analysis and Compute seismic response of Structural systems.
CO4	Understand the effects of system/model parameters on dynamic response.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	1	-	-	-	-
CO2	3	3	1	2	-	-	-	-
CO3	3	2	1	2	-	-	-	-
CO4	2	3	1	2	-	-	-	-

Detailed Syllabus:

Single Degree of Freedom Systems - Response under time dependent Transient and Steady state forcing functions - Damping Vibrations system - response under general type of excitation – numerical methods- response spectrum.

Multidegree of Freedom Systems - Free vibration - Determination of Natural frequencies and mode shapes - Vanello Stodola and Matrix iteration methods

Continuous Systems - Free and forced vibrations of beams - Approximate solutions - Rayleigh and Rayleigh - Ritz Methods

Concepts of seismic design - Seismic design and seismic performance - Seismic design limit states – serviceability – damage – survival limit states - Structural properties – strength stiffness and ductility - Definition of design quantities – philosophy of capacity design.

Essentials of structural systems for seismic resistance - Structural systems – frames, walls, dual systems - Response in elevation – plan - Influence of building configuration – structural classification.

Earthquake analysis of linear systems - Response history analysis - Modal analysis – modal response - Response spectrum analysis.

Codal Provisions - Structural modelling – assumptions - Regularity in framing systems – moment redistribution - Principles of design of beams, columns – beam column joints - Ductility demand – soft story concept.

Reading:

1. Mario Paz, “Structural Dynamics - Theory & Computations”, 2nd Edition, CBS Publishers, 2010.

2. Clough and Penzien, “Dynamics of Structures”, 5th Edition, McGraw Hill Book Co., 1975.
3. A.K. Chopra, “Dynamics of Structures”, 3rd Edition, Pearson, 2007.
4. T. Paulay and MJN Priestley, “Seismic Design of RC and Masonry Buildings”, John Wiley Inter Science, 1992.
5. D.J. Dowrick, “Earthquake Resistant Design and Risk Reduction”, 2nd Edition, Wiley India, 2011.
6. IS: 1893 (Part - I) – 2002, “Criteria for Earthquake Resistance Design of Structures”, Bureau of Indian Standards, New Delhi, 2002.
7. IS: 4326 - 1993, “Earthquake Resistant Design and Construction of Buildings – Code of Practice”, 2003.

CE 5204	Concrete Lab	PCC	0 – 0 – 3	2 Credits

Pre-requisites: Concrete Technology.

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

CO1	Understand the influence of constituents on the properties of concrete.
CO2	Design the Concrete Mix based on IS and ACI methods for various grades.
CO3	Understand the behaviour of beams under flexural loading.
CO4	Assess the properties of concrete using Rebound Hammer and Ultrasonic Pulse Velocity instruments.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	3	-	1	-	2	3
CO2	2	3	3	-	1	-	2	3
CO3	1	3	2	1	-	-	1	2
CO4	1	2	2	2	-	-	1	2

Detailed Syllabus:

Study of the effect of water/cement ratio on workability and strength of concrete, Effect of aggregate/cement ratio on strength of concrete , Effect of fine aggregate/coarse aggregate ratio on strength and permeability of concrete, Study of Mix design methods, Study of stress-strain curve of concrete, Correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture, Effect of cyclic loading on steel, Non-Destructive testing of concrete,

Reading:

1. A.M. Neville,” Properties of Concrete”, 5th Edition, Prentice Hall, 2012.
2. M.S. Shetty, “Concrete Technology”, S. Chand and Co., 2006.

CE 5205	CAD Lab	PCC	0 – 0 – 3	2 Credits

Pre-requisites: Structural Design.

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

CO1	Development of design charts for structural components using spread sheets
CO2	Modeling and analysis of structural components using STAAD pro
CO3	Perform seismic analysis of High rise structures
CO4	Understand push over analysis concepts using SAP2000

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	-	2	3	-	-	-	-
CO2	2	1	2	3	-	-	-	-
CO3	1	-	2	3	-	-	-	-
CO4	2	2	3	3	-	-	-	-

Detailed Syllabus:

Developing design charts for RCC beams using Spread sheets

Developing design charts for RCC slabs using Spread sheets

Design of a multistoried RCC building using STAAD Pro.

Seismic Analysis of high rise buildings

Pushover Analysis of structures

Reading:

1. STAAD Pro Manuel
2. SAP2000 Manuel

CE 5241	Seminar – I	PCC	0 – 0 – 2	1 Credit

Pre-requisites: None.

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

CO1	Identify and chose appropriate topic of relevance.
CO2	Assimilate literature on technical articles of specified topic and develop comprehension.
CO3	Write technical report.
CO4	Design, develop and presentation on a given technical topic.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	2	3	-	2	2
CO2	2	1	1	1	-	-	3	3
CO3	1	1	-	-	-	-	3	3
CO4	2	1	1	1	-	-	3	3

Detailed Syllabus:

There is no specific syllabus for this course. However, student can choose any topic, of his choice, pertaining to Engineering Structures. Topic should be a relevant and currently researched one. Students are advised to refer articles published in current journals in the area of Structural Engineering for choosing their seminar topics. Student should review minimum of 5 to 6 research papers relevant to the topic chosen, in addition to standard textbooks, codebooks, etc. Students are required to prepare a seminar report, in the standard format and give presentation to the Seminar Assessment Committee (SAC) in the presence of their classmates. It is mandatory for all the students to attend the presentations of their classmates.

Reading:

1. Structural Engineering Journals.
2. Research Articles / Reports available on Internet.
3. Structural Engineering Textbooks, Handbooks and Codebooks.

CE 5251	Structural Stability	PCC	4 – 0 – 0	4 Credits

Pre-requisites: Strength of Materials.

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

CO1	Determine critical loads for straight columns for different loading and end conditions.
CO2	Determine the critical loads for discrete and continuous systems.
CO3	Assess the buckling of thin walled bars and lateral buckling of beams.
CO4	Assess the buckling of rectangular plates.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	1	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-

Detailed Syllabus:

Buckling of Columns - Introduction - Methods of finding critical loads, critical loads for straight columns with different end conditions and loading - Inelastic buckling of axially loaded columns - Energy methods - Prismatic and non-prismatic columns under discrete and distributed loadings - General Principles of elastic stability of framed structures.

Mathematical Treatment of Stability Problems - Critical loads for discrete systems - Discrete Eigen value problem - Buckling of continuous systems - Continuous Eigen value problem - Orthogonality relation - Methods of converting continuous Eigen value problem to a discrete problem.

Buckling of Thin Walled Members of Open Cross Section - Torsion of thin-walled bars - Warping - Non-uniform torsion - Torsional buckling under axial loading - Combined bending and torsion buckling.

Lateral Buckling of Beams - Beams under pure bending - Cantilever and simply supported beams of rectangular and I sections - I Beams under transverse loading - Energy methods - Solution of simple problems.

Buckling of Rectangular Plates - Plates simply supported on all edges and subjected to constant compression in one or two directions - Plates simply supported compression in one or two directions - Plates simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides.

Buckling of shells - Introduction to buckling of axially compressed cylindrical shells.

Reading:

1. Timoshenko and Gere, “Theory of Elastic Stability”, 2nd Edition, Tata McGraw Hill, 2010.
2. Stephen H. Crandall, “Engineering Analysis - A Survey of Numerical Procedures”, Krieger Publishing Co.,1986.
3. Bleich,” Buckling of Metal Structures”, McGraw Hill Book Co., New York, 1952.
4. Alexander Chajes, “Principles of Structural Stability Theory”, Prentice Hall Inc., 1974.
5. N.G.R Iyengar, “Structural Stability of Columns and Plates”, Ellis Horwood Ltd, 1988.
6. A.H. Chilver, “Thin Walled Structures”, Chatto and Windus Ltd., 1967.
7. Coxhl, “The Buckling of Plates and Shells”, H.L. Pergaman press, 1963.

CE 5252	Finite Element Analysis of Structures	PCC	4 – 0 – 0	4 Credits

Pre-requisites: Mathematics and Theory of structures – II.

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

CO1	Apply numerical methods to solve partial differential equations with application to structural engineering problems.
CO2	Derive constitutive relations and solve structural engineering problems with appropriate mathematical models.
CO3	Apply FE Models to solve trusses, beams, plates, shells and structural dynamics.
CO4	Develop the shape functions for different elements.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	1	2	-	-	-	1
CO2	3	2	1	2	-	-	-	-
CO3	2	3	1	2	-	-	-	-
CO4	3	3	1	2	-	-	-	-

Detailed Syllabus:

Introduction - Background and general description of the method – Applications.

Methods of Structural Analysis - Review of various classical methods of Structural analysis-Matrix methods- Stiffness and Flexibility methods.

Numerical methods of Structural analysis - Variational method- Weighted residual method- Sub domain and Impulse methods- Galerkins method – Least squares method- Application to bending problems- Strong and Weak formulation.

Theory of Finite Element method - Discretisation concept- Concept of element – various elements shapes – displacement models – Convergence- shape functions – condensation of internal degrees of freedom-Summary of analysis procedure.

Finite Element Analysis - Development of shape functions for different elements-Spring-Truss-Beam-Plane elements- Plane stress and plane strain-Assemblage of elements construction of stiffness matrix and loads – boundary conditions –patch test-solution of overall problem.

Isoparametric Formulation -Concept of Isoparametric element – One and Two dimensional elements-Natural coordinates- Numerical integration-Gaussian Quadrature-Development of Higher order elements- Lagrange –Serendipity –Interpolation-formulation of element stiffness and loads.

Application to Solid Mechanics problems - Analysis of Trusses – Beams – Frames-Plates-Axisymmetric elements-Shells- Structural dynamics.

Reading:

1. O.C. Zeinkiewicz, “Finite Element Method: Its Basic and Fundamentals”, 6th Edition, Butterworth Heinemann, 2007.
2. R D Cook, “Concepts and Applications of Finite Element Analysis”, Willey Publication, 1995.
3. SS Rao, “The Finite Element Method in Engineering”, Elsevier Publication, 2009.
4. Chandrupatla Belegundu, “Finite Element Method”, McGraw-Hill, 1997.
5. P Seshu, “Textbook of Finite Element Analysis”, 1st Edition, PHI, 2009.
6. C.S. Krishna Murthy, “Finite Element Analysis – Theory and Programming, 2nd Edition, Tata McGraw Hill, 2005.

CE 5253	Theory of Plates and Shells	PCC	4 – 0 – 0	4 Credits

Pre-requisites: Mechanics of Solids and Theory of Elasticity.

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

CO1	Understand behaviour of plates and shells for UDL, hydrostatic, concentrated load cases.
CO2	Perform cylindrical bending of long rectangular plates, pure bending of rectangular and circular plates, and small deflection theories for various boundary conditions.
CO3	Understand membrane theory for shells and structural behaviour of plates.
CO4	Implement Whitney's method to analyse folded plates.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	3	-	-	2	-	-
CO2	3	2	3	-	-	2	-	-
CO3	3	3	2	-	-	1	-	-
CO4	3	3	2	-	-	2	-	-

Detailed Syllabus:

Theory of Plates - Introduction to thin plates under small deflection theory - Kirchoff's assumptions - Lame's parameters - Development of strain - displacement relationships - stress-strain relationships - Force-displacement equations and equilibrium equations in curvilinear co-ordinates - Lame's parameters u, v, w equations - Variational principles and its applications to plate problems - Study of various boundary conditions - Rectangular plates - Differential equation - Solution of simply supported plates under various loading conditions - Uniformly distributed load - Hydrostatic pressure and a concentrated load - Navier and Levy types of solutions - Symmetrical bending of circular plates - Differential equations - Uniformly loaded and concentrically loaded plates with various boundary conditions.

Theory of Shells - Introduction - Definition and assumptions - Development of strain displacement relationships - Stress-strain relationships - Force displacement equations and equilibrium equation in curvilinear co-ordinates - Kirchoff's assumptions in thin shallow shell theory - Classification of shell systems - Principal curvatures - Lame's parameters - Gauss-Godazzi relations - Love's first approximation - Membrane theory - Application to does of various shapes - Shells of double curvature - Circular cylindrical shells - Membranes deformation of symmetrically loaded cylindrical and spherical shells - North light shells - Folded plates - Structural Behaviour of folded plates - Equation of three shears - Application of Simpson's and Whitney's methods and comparison of cylindrical shells with folded plates - General theory of circular cylindrical shells loaded symmetrically - Beam method of analysis - Approximate solution by Schorer's method.

Reading:

1. G.S. Ramaswamy, "Design and Construction of Concrete Shell Roofs", 1^{st} Edition, CBS Publishers, 2005.
2. R. Szilard, "Theory and Analysis of Plates - Classical and Numerical Methods", Prentice Hall, 1974.
3. Timoshenko and Krierger, "Theory of Plates and Shells", 2^{nd} Edition, Tata McGraw Hill, 2010.

CE 5254	Structural Design Lab	PCC	0 – 0 – 3	2 Credits

Pre-requisites: Design of Concrete Structures and Steel Structures.

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

CO1	Analyse, Design and detail industrial structures.
CO2	Analyse, Design and detail bridge structures.
CO3	Analyse, Design and detail multi-storey frame buildings.
CO4	Analyse, Design and detail R.C.C., bunkers and silos.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	-	1	1	1
CO2	3	3	3	3	-	1	1	1
CO3	3	3	3	3	-	1	1	1
CO4	3	3	3	3	-	1	1	1

Detailed Syllabus:

Study of the effect of water/cement ratio on workability and strength of concrete, Effect of aggregate/cement ratio on strength of concrete , Effect of fine aggregate/coarse aggregate ratio on strength and permeability of concrete, Study of Mix design methods, Study of stress-strain curve of concrete, Correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture, Effect of cyclic loading on steel, Non-Destructive testing of concrete, Study of behavior of Beams under flexure, Shear and Torsion.

Reading:

1. A.M. Neville,” Properties of Concrete”, 5th Edition, Prentice Hall, 2012.
2. M.S. Shetty, “Concrete Technology”, S. Chand and Co., 2006.

CE 5255	Structural Testing Lab	PCC	0 – 0 – 3	2 Credits

Pre-requisites: Design of Concrete Structures and Steel Structures.

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

CO1	Understand the various testing methods and equipments used for testing.
CO2	Perform various tests to understand the properties of concrete and steel.
CO3	Carry out Non destructive testing of concrete structures.
CO4	Understand the behavior of beams for various loading conditions Viz.,Bending, flexure, shear and torsion.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	3	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-
CO4	2	3	-	-	-	-	-	-

Detailed Syllabus:

Understanding the different structural testing methods- loading conditions-Related instrumentation such as deflection gauges, load cells, proving rings, strain gauges, accelerometers, impact hammers, data acquisition systems- Study of behavior of under reinforced, over reinforced RC Beams under flexure – Study of effect of shear span to depth ratio on the behavior of RC beams- Study of RC beams under torsion.

Reading:

1. Robert T Reese, Wendell A Kawahara, ‘Handbook on structural Testing’, Fairmont press, 1993.
2. M.S. Shetty, “Concrete Technology”, S. Chand and Co., 2006.

CE 5291	Seminar – II	PCC	0 – 0 – 2	1 Credit

Pre-requisites: None.

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

CO1	Identify and chose appropriate topic of relevance.
CO2	Assimilate literature on technical articles of specified topic and develop comprehension.
CO3	Write technical report.
CO4	Design, develop and deliver presentation on a given technical topic.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	2	3	-	2	2
CO2	2	1	1	1	-	-	3	3
CO3	1	1	-	-	-	-	3	3
CO4	2	1	1	1	-	-	3	3

Detailed Syllabus:

There is no specific syllabus for this course. However, student can choose any topic, of his choice, pertaining to Engineering Structures. Topic should be a relevant and currently researched one. Students are advised to refer articles published in current journals in the area of Structural Engineering for choosing their seminar topics. Student should review minimum of 5 to 6 research papers relevant to the topic chosen, in addition to standard textbooks, codebooks, etc. Students are required to prepare a seminar report, in the standard format and give presentation to the Seminar Assessment Committee (SAC) in the presence of their classmates. It is mandatory for all the students to attend the presentations of their classmates.

Reading:

1. Structural Engineering Journals.
2. Research Articles / Reports available on Internet.
3. Structural Engineering Textbooks, Handbooks and Codebooks.

CE 5151	Neo Construction Materials	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Concrete Technology.

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

CO1	Understand structural, physical and long-term performance of building materials.
CO2	Understand the mechanical and non-mechanical behaviour of materials as FRC, Ferrocement, SCC, RAC, and LWAC.
CO3	Apply advanced materials used in construction as SCC, Light weight aggregate concrete, recycled aggregate concrete, fiber based concretes.
CO4	Identify crucial problem areas in manufacture and applications of building materials.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	-	1	-	3	1	2	1
CO2	1	-	1	-	2	1	2	1
CO3	2	-	2	-	1	1	1	1
CO4	1	-	1	-	1	1	1	1

Detailed Syllabus:

Introduction, Historical back ground of Light weight aggregate concrete - Artificial aggregates, Physical properties of aggregates, Light weight aggregate concrete - Applications of light weight aggregate concrete - Properties of green light weight aggregate concrete - Effect of size aggregate on the strength properties of LWAC made with palm oil shells - Recycled aggregate - High performance concrete –applications - Pre placed aggregate concrete - Fiber reinforced concrete - Behaviour of steel fibers in concrete - Glass fiber reinforced concrete - GFRC in construction - Natural fiber reinforced concrete - High strength concrete - Effect of RHA on the properties of HSC - Self-Compacting Concrete, Concrete made with waste rubber, Changes in concrete with respect to time - Corrosion in concrete and its protection, Corrosion of rebars in concrete - Influence of fly ash on the corrosion steel bar in concrete, Industrial waste materials in concrete - Special Concretes, Sulfur Concrete, Ferro cement, Geo synthetics - Adhesives in construction industry, Acrylics - Bridge bearings - Rapid wall panels - Nano Concrete - Moisture Barriers.

Reading:

1. A.M. Neville, “Properties of Concrete”, 5th Edition, PHI, 2012.

2. Kumar Mehta. P and Paulo J M Monteiro, “Concrete Microstructure, Properties and Materials”, McGraw Hill, 2006.

CE 5153	Building Services	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Building Planning and Construction.

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

CO1	Design buildings for grouping and circulation, lighting, ventilation and fire protection.
CO2	Design vertical transportation in buildings-stair cases and lifts.
CO3	Analyse and Design prefabrication systems in buildings.
CO4	Plan and Design various building services as electrical installation, air conditioning, plumbing services and acoustics.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	2	-	-	3	-	-	-
CO2	-	2	-	-	3	-	-	-
CO3	-	3	-	-	3	2	-	-
CO4	-	2	-	-	-	2	-	-

Detailed Syllabus:

Orientation and Planning - Selection of site - Orientation of building - Design of residential buildings with particular reference to grouping and circulation.

General building requirements - Open spaces in and around buildings for lighting and ventilation - Minimum sizes and height of roofs - Rat and Termite proofing of buildings - Lightning protection of buildings.

Fire protection of buildings - Important considerations in fire protection - Fire resisting - Properties of common building materials - Fire safety and exit requirements.

Vertical transportation in buildings - Essential requirements and details of construction of stairs, lifts escalators and ramps.

Prefabrication systems in residential buildings - Planning and modules and sizes of components in prefabrication - Testing of components - Manufacturing and erection guide lines.

Miscellaneous structures - Shell structures – Domes - Folded plate structures - Skeletal and space frame structures - Grain storage structures - Earthquake resistant structures.

Building services - Lighting and Ventilation - Electrical installation - Air-conditioning and heating - Acoustics and Sound insulation - Plumbing services.

Reading:

1. “National Building Code of India”, published by Bureau of Indian Standards, 2005.
2. Arora and Bindra, “Building Construction”, 3rd Edition, Dhanpat Rai and Sons, 1984.
3. N.B.O, “Hand Book for Building Engineers”.

CE 5211	Analysis and Design of Bridges	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Design of RC Structures and Theory of Structures.

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

CO1	Understand the codal provisions for loading and design standards of bridges.
CO2	Design the substructure including pier and pier cap and well elements.
CO3	Design the superstructure of bridge using different methods.
CO4	Design girder bridges and cable stayed bridges.
CO5	Understand, design and select materials suitable for bearings.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	1	3	-	-	2	2	3
CO2	3	2	3	2	-	-	-	-
CO3	3	2	3	3	1	2	1	3
CO4	3	3	3	2	-	2	1	2
CO5	3	3	3	-	-	-	-	-

Detailed Syllabus:

Introduction - Classification – Investigation for bridges - Loading standards – IRC and Railway loads – Impact.

Bridge substructure - Determination of maximum flood discharge - Determination of linear water way - Determination of maximum depth of scour - Loads acting on substructure - Design of pier and pier cap - Design well elements - Sinking of wells.

Bridge Superstructure - Pigeaud's curves method for design of slab - Analysis of beams– Courbon's Method – Hendry Jaeger Method – Guyon and Massonet Method - Box Girder Bridges - Grillage analogy.

Cable Bridges - Advantages - Arrangement of stay cables - types of towers - Linear analysis of cables and towers

Bridge Bearings and expansion joints - Functions, types and selection of bearings - Bearing materials - Design of elastomeric bearings for different conditions - Expansion joints – types of expansion joints.

Reading:

1. Swami Saran, "Analysis and Design of Substructures", Oxford & IBH Publishing Co., 1996.

2. J.E. Long, “Bearings in Structural Engineering”, Newnes Butterworth & Co., 1974.

3. R.E. Rowe, “Concrete Bridge Design”, 1st Edition, Elsevier Science and Technology, 1962.

4. L.G. Hendry and A.W. Jaeger, “The Analysis of Grid Frameworks and Related Structures”, Chatto & Windus, 1958.

5. Jaeger & Bakht, “Bridge Analysis by Microcomputer”, Mc Graw Hill, 1989.

6. C.S Surana & R. Agarwal, “Grillage Analogy in Bridge Deck Analysis”, Narosa Publication, 1998.

7. Maisel and Roll, “Method of Analysis and Design of Concrete Box Beams with Side Cantilever”, Cement and Concrete Associations, 1974.

8. M.S. Troitsky, “Cable Stayed Bridges: An approach to Modern Bridge Design”, 2nd edition, Van Nostrand Reinhold Company, 1988.

9. T.R. Jagdeesh and M.A. Jayaram, “Design of Bridge Structures”, 2nd Edition, Prentice Hall of India Pvt. Ltd., 2003.

CE 5212	Reliability Analysis of Structures	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Mechanics of Solids and Theory of Elasticity.

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

CO1	Estimate Probabilistic analysis for various loads as wind loads and gravity loads.
CO2	Compute reliability indices for simple structural engineering problems as beams, trusses.
CO3	Check the Safety of structures as per NBC, CEB formats.
CO4	Apply reliability based design to structural problems as trusses and frames.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	-	-	-	3	-	-
CO2	3	2	3	-	-	2	-	-
CO3	3	3	3	-	-	3	-	-
CO4	3	2	2	-	-	-	-	-

Detailed Syllabus:

Introduction to structural safety- Evolution of design codes.

Uncertainty Modeling – Fundamentals of probability theory , random variables, moments, utility and descriptive statistics.

Bayesian decision theory – Apriori and postereriori probability, Bayes strategy and computation Reliability theory and methods – specification of limit state functions-classification (level1-level2-level3)- first order second moment method (FORM), SORM, computation of reliability index.

System reliability – characteristic values, Multiple safety factor formats, series system, parallel system, structure functions- modelling of truss/Frame system.

Stochastic models for loads – gust wind loads, wave loads, earthquake loads and live load modelling; stochastic theory of load combinations.

Reading:

1. Ang,A.H.,S. and Tang, W.H., "Probability Concepts in Engineering Planning and Design", Vol I & II ., John wiley & sons,1975.
2. Augusti, G., Barratta, A. and casciati F., " Probabilistic methods in Structural engineering", Chapman & Hall,1984.
3. Ditlevson, o., and Madsen H.O., " structural Reliability methods", Wiley; 1 edition ",1996.

4. Ranganathan R.,"structural Reliability Analysis and Design", 1st edition, Jaico Publishing House,1999.
5. Madsen, H.O., Krenk, S. and N.C. Lind, " Methods of structural safety", Dover Publications,2006.

CE 5213	Structural Masonry	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Mechanics of Solids and Theory of Elasticity.

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

CO1	Understand the behaviour of masonry structures under gravity and lateral loads.
CO2	Design masonry structures for gravity, wind and seismic loads.
CO3	Design masonry infill as shear walls for lateral action.
CO4	Apply strengthening techniques for repair and rehabilitation of masonry structures.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	-	-	-	-	1
CO2	1	2	3	-	-	-	-	-
CO3	1	2	3	-	-	-	-	-
CO4	1	2	2	-	-	-	-	2

Detailed Syllabus:

Introduction - Masonry construction - National and International perspective - Historical development, Modern masonry, Principles of masonry design, Masonry standards: IS 1905 and others.

Material Properties - Masonry units: clay and concrete blocks, Mortar, grout and reinforcement, Bonding patterns, Shrinkage and differential movements.

Masonry in Compression - Prism strength, Eccentric loading, Kern distance.

Masonry under Lateral loads - In-plane and out-of-plane loads, Analysis of perforated shear walls, Lateral force distribution -flexible and rigid diaphragms.

Behaviour of Masonry - Shear and flexure - Combined bending and axial loads - Reinforced and unreinforced masonry - Cyclic loading and ductility of shear walls for seismic design - Infill masonry.

Structural design of Masonry - Working and Ultimate strength design - In-plane and out-of-plane design criteria for load-bearing and infills, connecting elements and ties - Consideration of seismic loads - Code provisions.

Seismic evaluation and Retrofit of Masonry - In-situ and non-destructive tests for masonry - properties - Repair and strengthening of existing masonry - structures for seismic loads.

Reading:

1. Dayaratnam, P, “Brick and Reinforced Brick Structures”, Oxford & IBH Publishing Co, 1987.

2. Drysdale, R. G. Hamid, A. H. and Baker, L. R, “Masonry Structures: Behaviour & Design”, Prentice Hall Hendry,1994.

3. A.W. Hendry, B.P. Sinha and Davis, S. R, “Design of Masonry Structures”, E & FN Spon, UK, 1997.

4. Sahlin, S, “Structural Masonry”, Prentice Hall, Englewood Cliffs, NJ, 1971.

5. R.S. Schneider and W.L. Dickey, “Reinforced Masonry Design”, Prentice Hall, 3rd edition, 1994.

6. Paulay, T. and Priestley, M. J. N., “Seismic Design of Reinforced Concrete and Masonry Buildings”, John Wiley, 1992.

7. A.W. Hendry, “Structural Masonry”, 2nd Edition, Palgrave McMillan Press, 1998.

CE 5214	Theory and Applications of Cement Composites	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Strength of Materials and Neo Construction Materials.

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

CO1	Understand stress-strain behaviour and formulate constitutive behaviour of composite materials.
CO2	Understand the classification of materials based on orthotropic and anisotropic behaviour.
CO3	Estimate elastic constants using theories applicable to composite materials.
CO4	Analyse and Design structural elements made of cement composites as ferrocement, SIFCON and fibre reinforced concrete.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	1	3	-	-	3	-
CO2	2	3	1	3	-	-	3	-
CO3	3	3	1	3	-	-	3	-
CO4	3	3	1	3	-	-	3	-

Detailed Syllabus:

Introduction - Classification and characteristics of composite materials - Basic terminology – advantages.

Stress-strain relations - Orthotropic and anisotropic materials - Engineering constants for orthotropic materials – restrictions on elastic constants – plane stress problem - Biaxial strength – theories for an orthotropic lamina.

Mechanical behaviour - Mechanics of materials approach to stiffness – determination of relations between elastic constants - Elasticity approach to stiffness – bounding techniques of elasticity – exact solutions - Elasticity solutions with contiguity – Halpin – Tsai equations – comparison of approaches to stiffness.

Cement composites - Types of cement composites – terminology - Constituent materials and their properties - Construction techniques for fibre reinforced concrete, Ferrocement, SIFCON, Polymer concretes - Preparation of reinforcement – casting and curing.

Mechanical properties of cement composites - Behaviour of ferrocement, fiber reinforced concrete in tension, compression, flexure, shear, fatigue and impact, durability and corrosion.

Application of cement composites - FRC and Ferrocement - housing – Water storage – Boats and miscellaneous structures.

Reading:

1. Robert M Jones, "Mechanics of Composite Materials", 2nd Edition, Taylor and Francis/BSP Books, 1998.

2. R.P. Pama, "Ferrocement – Theory and Applications", IFIC, 1980.

3. R.N. Swamy, "New Concrete Materials", 1st Edition, Blackie, Academic and Professional, Chapman & Hall, 1983.

CE 5215	Design of Industrial Structures	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Design of Concrete Structures and Design of Steel Structures.

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

CO1	Design steel structures as Industrial structures, Gantry girders.
CO2	Design of Steel Structure Frames.
CO3	Design RCC structures as Bunkers and Silos.
CO4	Design elevated structures as Chimneys and Water tanks.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	-	1	1	1
CO2	3	3	3	3	-	1	1	1
CO3	3	3	3	3	-	1	1	1
CO4	3	3	3	3	-	1	1	1

Detailed Syllabus:

Steel Gantry Girders – Introduction, loads acting on gantry girder, permissible stress, types of gantry girders and crane rails, crane data, maximum moments and shears, construction detail, design procedure.

Portal Frames – Design of portal frame with hinge base, design of portal frame with fixed base - Gable Structures – Lightweight Structures.

Steel Bunkers and Silos – Design of square bunker – Jansen's and Airy's theories – IS Codal provisions – Design of side plates – Stiffeners – Hooper – Longitudinal beams – Design of cylindrical silo – Side plates – Ring girder – stiffeners.

Chimneys – Introduction, dimensions of steel stacks, chimney lining, breech openings and access ladder, loading and load combinations, design considerations, stability consideration, design of base plate, design of foundation bolts, design of foundation.

Water Tanks – Design of rectangular riveted steel water tank – Tee covers – Plates – Stays – Longitudinal and transverse beams –Design of staging – Base plates – Foundation and anchor bolts – Design of pressed steel water tank – Design of stays – Joints – Design of hemispherical bottom water tank – side plates – Bottom plates – joints – Ring girder –Design of staging and foundation.

RC Intz Tanks – IS method of calculating shear forces and moments – Hoop tension – Design of intze tank – Dome – Ring girders – Conical dome – Staging – Bracings – Raft foundation.

RC Bunkers and Silos – Design of square bunker – Side Walls – Hopper bottom – Top and bottom edge beams – Design of cylindrical silo – Wall portion – Design of conical hopper – Ring beam at junction.

Reading:

1. B. C. Punmia, Ashok Kr. Jain, Arun Kr. Jain, “Design of Steel Structure”, 2nd Edition, Lakshmi Publishers, 1998.
2. Punmia B.C, Ashok Kr. Jain, Arun Kr. Jain, “RCC Designs (Reinforced Concrete Design)”, 10th Edition, Lakshmi Publishers, 2006.
3. Ram Chandra, “Design of Steel Structures”, 12th Edition, Standard Publishers, 2009.

CE 5216	Plasticity and Limit Design of Steel Structures	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Design of Steel Structures.

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

CO1	Perform Limit analysis and design of steel structures.
CO2	Perform Limit state design of trusses and frames.
CO3	Perform Minimum weight design of steel structures.
CO4	Prepare detailed structural drawings of steel structures.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	2	-	1	1	1
CO2	3	3	3	2	-	2	1	1
CO3	3	3	3	1	-	1	1	1
CO4	3	3	3	2	-	1	1	1

Detailed Syllabus:

Introduction - Nature of plasticity- Assumptions - Stress-strain curve - Bauschinger effect.

Plastic Stress- Strain relations - Necessary Elasticity-Plane stress and plane strain - Yield criteria and flow rules - Tresca Theory-Vonmises Theory-Geometrical representation - St. Venant's theory of plastic flow - PrnadtlReuss theory - Concept of slip line field theory.

Semi rigid design of steel structures - Connection flexibility in steel frames - Analysis of continuous beams with flexible connections - Semi rigid design of steel frames.

Limit analysis of steel structures - Development of Moment –Curvature relations for steel sections - Moment redistribution – Plastic hinge - Principle of Virtual work - Mechanism condition – Statical and Mechanism methods of analysis.

Limit state design – Trusses - Portal frames - Gable frames.

Factors affecting plastic moments - Secondary design aspects - Influence of axial force, shear on plastic moment – Buckling - Column stability - Brittle fracture – repeated loading.

Minimum weight design – Assumptions - Minimum weight theorems – Heyman and Prager method.

Design guides - Use of SP – 6 - Single span, two span frames flat roof – gable roofs.

Reading:

1. L.S. Beedle, "Plastic Design of Steel Frames", John Wiley & Sons, 1958.
2. G.C.Spencer, "An Introduction to Plasticity", Chapman and Hall, 1968.

3. Hill Rodney, “Mathematical Theory of Plasticity”, Ox.U.Press, 1950.

4. B.G. Neal, “Plastic Methods of Structural Analysis”, 3rd Edition, Chapman and Hall, 1977.

5. R. Narayanan et al, “Teaching Resource for Structural steel design” Institute for Steel Development and Growth, 2003.

6. SP: 6(6) - 1972, “ISI Handbook for Structural Engineers – Application of Plastic Theory in Design of Steel Structures”, Indian Standards Institution, 1972.

7. J.F. Baker, “Steel Skeleton”, University Press, 1953.

8. W.F. Chen, D.J. Han, “Plasticity for Structural Engineer”, J Ross Publishing, 2007.

CE 5217	Experimental Methods in structural Engineering	DEC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Understand different measuring techniques
CO2	Analyse suitable Mounting methods and performance characteristics
CO3	Plan, calibrate and test different structural systems
CO4	Demonstrate advanced numerical ,graphical data processing systems

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	-	-	-	-	-	-
CO2	2	3	-	2	1	-	-	-
CO3	2	3	2	1	-	-	-	-
CO4	1	2	-	2	-	-	-	-

Detailed Syllabus:

Hydraulic loading systems, strain gauges, strain and force measuring devices, etc. used in the experiments planned in the laboratory. Utilisation of Mechanical, acoustical, electrical resistance and other types of strain gauges to study the behaviour of structural materials (concrete, steel, etc.) and also of structural members (reinforced concrete beams and columns, steel beams, etc.)

Dimensional analysis, Buckingham's Pi theorem, scale factors and dynamic similitude; Uses and applications of models: types of model investigation, indirect and direct models, elastic and inelastic models (steel, concrete and masonry), size effects; Analysis of experimental data: error and uncertainty in experiment, measurement systems, accuracy in models and reliability of results.

Test planning, design and implementation: testing sequence and experimental plan, loading systems, devices, actuators and their control, Instrumentation: mechanical, electrical, electronic system and their calibration, various types of sensors for displacement, velocity, acceleration, pressure, loads, strains, full-field measurements.

Static and dynamic data acquisition system and data processing: analog systems, digital systems using personal computers, dynamic measurement, numerical and graphical data processing and archiving.

Reading:

1. V Dalley .J.W and Riley.W.F, “Experimental Stress Analysis”, McGraw Hill Book Company, N.Y.1991.
2. Harris and Sabnis., “ Structural Modelling and Experimental Techniques”,CRC Press, 1999.
3. Reese and Kawahara., “Hand book of structural testing”, Prentice Hall,1993.
4. Ganesan.T.P, “Model Analysis of Structures”, University Press, India, 2000.
5. Sirohi.R.S., Radhakrishna.H.C, “Mechanical Measurements”, New Age International (P) Ltd. 1997.

CE 5162	Timber and Formwork Design	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Engineering Mechanics and Building Materials.

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

CO1	Design decking, Form work and False work with steel and Timber.
CO2	Understand the sequence of construction of civil engineering structures.
CO3	Understand the safety steps involved in the design of form work and false work.
CO4	Select a right material for manufacturing false work and form work for specific requirements.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	1	1	-	-	-
CO2	2	3	3	-	1	-	-	-
CO3	1	2	3	-	2	2	1	-
CO4	2	3	3	1	2	2	1	-

Detailed Syllabus:

Formwork and false work - Temporary work systems - Construction planning and site constraints – Materials and construction of the common formwork and false work systems - Special and proprietary forms .

Concrete pressure on forms - Design of timber and steel forms - Loading and moment of formwork - Types of beam, decking and column formwork .

Design of decking - False work design - Effects of wind load - Foundation and soil on false work design - The use and applications of special forms - Sequence of construction - Safety use of formwork and false work.

Reading:

1. Austin, C.K., “Formwork for Concrete”, Cleaver - Hume Press Ltd., 1996.
2. Michael P. Hurst, “Construction”, Press London and New York, 2003.
3. Robert L. Peurifoy and Garold D. Oberiender, “Formwork for Concrete Structures”, McGraw-Hill, 1996.
4. Tudor Dinescu and Constantin Radulescu, “Slip Form Techniques”, Abacus Press, Turn Bridge Wells, Kent, 2004.

CE 5261	Fracture Mechanics of Concrete Structures	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Mathematics and Theory of Elasticity.

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

CO1	Identify and classify cracking in concrete structures based on fracture mechanics principles.
CO2	Understand stress intensity factor and implement to notched members.
CO3	Apply fracture mechanics models to high strength concrete and FRC structures.
CO4	Understand the concepts of LEFM and compute J-Integral for various sections.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	-	-	2	-	-
CO2	3	3	2	-	-	3	-	-
CO3	3	3	3	-	-	3	-	-
CO4	3	2	3	-	-	2	-	-

Detailed Syllabus:

Introduction - Basic Fracture Mechanics – Crack in a structure - Mechanisms of fracture and crack growth - Cleavage fracture – ductile fracture - Fatigue cracking – Environment assisted cracking - Service failure analysis.

Stress at crack tip - Stress at crack tip – linear elastic fracture mechanics - Griffith's criteria – stress intensity factors - Crack tip plastic zone – Erwin's plastic zone correction - R curves – compliance - J Integral - Concept of CTOD and CMD.

Material models - General concepts – crack models – band models - Models based on continuum damage mechanics– applications to high strength concrete – fibre reinforced concrete - crack concepts and numerical modelling.

Reading:

1. C.T Suri and Jin Z.H, "Fracture Mechanics", 1st Edition, Elsevier Academic Press, 2012.
2. David Broek, "Elementary Engineering Fracture Mechanics", 3rd Revised Edition, Springer, June 1982.
3. L. Elfgreen, "Fracture Mechanics of Concrete Structures – Theory and Applications", Rilem Report, Chapman and Hall, 1989.
4. Victor, C. Li, Z.P. Bazant, "Fracture Mechanics – Applications to Concrete", ACI SP 118, ACI Detroit, 1989.

CE5262	Vulnerability and Risk Analysis	DEC	3-0-0	3 credits

Pre-requisites: None

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

CO1	Understand the framework under which damage assessment models are developed.
CO2	Model various components of a structure using a FEM software.
CO3	Assess seismic vulnerability characteristics of structures .
CO4	Understand necessity of risk evaluation and communication.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	-	2	-	-	-	1
CO2	2	1	-	3	-	-	-	-
CO3	2	2	-	3	-	-	-	-
CO4	1	-	-	2	1	2	3	2

Detailed Syllabus

Concepts and Components of Risk : Introduction to Hazard, vulnerability, exposure and risk; Estimation of risk from components for an earthquake hazard.

Overview of Modeling of structures: Application of finite element modelling of structural components Viz., various components of buildings, Bridges etc. (SAP 2000 Software can be used)

Vulnerability assessment of Buildings: Empirical and analytical approaches, building topology, use of intensity scales for estimating seismic vulnerability, Hazus methodology, displacement based approach (Capacity design method).

Risk estimation: Convolution of hazard, vulnerability and exposure to quantify risk, loss ratios, indoor and outdoor casualty rates; Case studies of different projects- Viz., HAZUS, EU-RISK.

Post Earthquake Damage Studies: Earthquake damage surveys, data to be collected, handling and processing of data, classification of damage, and Estimation of fragility from damage data.

Risk Communication: Role of planners, architects, engineers, banks and insurers; Rating of damage assessment, disaster impact analysis.

Reading:

1. Krammer, S. L., “Geotechnical Earthquake Engineering”, Pearson Education, 1996.
2. Reiter, L. “Earthquake Hazard Analysis, Issues and Insights”, Columbia University Press, 2001.
3. Coburn, A. and Spence R., “Earthquake Protection”, John Wiley and Sons, Ltd. 2002.
4. McGuire, Robin K., “Seismic Hazard and Risk Analysis”, Earthquake Engineering Research Institute, 2004.
5. “HAZUS-MH, MR1 & MR2 Technical Manual”, FEMA, Federal Emergency Management Agency, Washington, D.C, 2006.

CE 5263	Rehabilitation of Structures	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Concrete Technology and Neo Construction Materials.

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

CO1	Estimate the causes for distress and deterioration of structures.
CO2	Understand NDT for condition assessment of structures, identify damages in RC structures.
CO3	Select repair material and retrofitting strategy suitable for distress.
CO4	Formulate guidelines for repair management of deteriorated structures.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	3	2	2	2	2	2
CO2	1	2	3	2	-	2	1	2
CO3	-	1	2	2	2	2	2	2
CO4	1	2	2	2	-	2	1	2

Detailed Syllabus:

Introduction - An overview of present repair practices, distress identification and repair management - Causes of distress in concrete structures-Holistic Models for deterioration of concrete, Permeability of concrete, aggressive chemical agents, durability aspects - Condition Survey- Definition, objectives, different stages-Preliminary inspection, planning stage, visual inspection, field laboratory testing stage, consideration for repair strategy - Non-Destructive evaluation tests-Concrete strength assessment- Rebound hammer test-Ultrasonic pulse velocity tests, penetration resistance, pull out tests, core sampling and testing - Chemical tests-Carbonation tests and chloride content, Corrosion potential assessment- cover meter survey, half-cell potentiometer test, resistivity measurement - Discussion of case studies of RCC buildings subjected to distress-Identification and estimation of damage - Fire damage assessment, structural integrity and soundness assessment, interpretation and evaluation of results - Evaluation of reserve strength of existing structures, analysis necessary to identify critical sections, active and passive repairs, modeling of repaired composite structures - Selection of repair materials for concrete-Essential parameters for repair materials-Strength and durability aspects, cost and suitability aspects - Materials for repair-Premixed cement concrete and mortars, polymer modified mortars and concrete, epoxy and epoxy systems including epoxy mortars and concrete, polyester resins, coatings - Rehabilitation and retrofitting methods-repair options, performance requirements of repair systems, important factors to be considered for selection of repair methods - Discussion of case studies-RCC buildings, water tanks, industrial structures- Identifying a suitable repair option for certain damage in a structure - Repair stages, Repair methods-guniting, shortcreting, polymer concrete system, reinforcement replacement, strengthening concrete by surface impregnation, polymer and epoxy overlays - Repair methods-

Resin/polymer modified slurry injection, plate bonding technique, ferrocement jacketing, RCC jacketing, propping and supporting - Repair methods- fiber wrap technique, foundation rehabilitation methods, chemical and electrochemical method of repair - Repair/Rehabilitation strategies- Stress reduction technique, repair and strengthening of columns and beams - Rehabilitation strategies-Compressive strength of concrete, cracks/joints, masonry, foundation, base isolation - Guidelines for framing terms and conditions for repair and rehabilitation works contracts- engagement of consultants, contractors, execution of work, post repair inspection.

Reading:

1. R.N. Raika, "Learning from failures - Deficiencies in Design, Construction and Service" Rand Centre (SDCPL), Raikar Bhavan, Bombay, 1987.
2. Santhakumar A.R., "Concrete Technology" Oxford University Press, New Delhi, 2007.
3. "CPWD Handbook on Repair and Rehabilitation of RCC buildings", Govt of India Press, New Delhi, 2002.

CE 5264	Tall Structures	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Building Construction.

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

CO1	Develop a thorough understanding of structural systems of Tall buildings.
CO2	Implement the latest construction practices and processes for various structural systems.
CO3	Analyse and design high rise structures using structural engineering software.
CO4	Develop a thorough understanding of fire protection in tall buildings.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	-	-	-	3	-
CO2	-	-	-	-	-	3	2	-
CO3	2	3	3	3	-	1	-	-
CO4	-	3	-	-	2	-	2	-

Detailed Syllabus:

Evolution of Tall buildings – Introduction - Design criteria for structural design of Tall building - Concept of premium for height - Development of high rise architecture.

Assembly of Building and site investigation - Building performance –cost, quality and time

Environmental requirements - Industrialization& Robotics in Construction - Introduction to safety and Health Management System - Stages of site Investigation - Site Reconnaissance & Ground investigation-Field tests & Laboratory tests.

Foundation systems

Material handling and Mechanization - Material handling considerations - Earthmoving equipment's - Horizontal and vertical movements - Selection & Utility of Cranes (Tower Cranes & Climbing Cranes).

Wind & seismic effects on behavior of Tall Structures - Outlook of Design considerations and Characteristics of wind - Codal wind loads and cladding pressures on behavior of tall buildings - Introduction to Tall building behavior during earthquakes and seismic design philosophy.

Structural Forms & Flooring Systems - Introduction of Various structural forms and their importance to high rise architecture - Introduction to various Flooring Systems in concrete & steel.

Modeling for analysis - Approaches for analysis - Assumptions involved in modeling - Reduction techniques - Application using Structural engineering Software.

Reading:

1. Taranath B, Steel, “Concrete and Composite Design of Tall Buildings”, 2nd Edition, McGraw Hill, 1998.
2. White and Salmon, “Building Structural Design Handbook”, John Wiley & Sons, 1987.
3. Wolfgang Schueller, “The Design of Building Structures”, Prentice Hall, 1996.

CE 5265	Structural Health Monitoring	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Seismic Resistant Design.

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

CO1	Understand types of static field testing and loading methods
CO2	Perform Dynamic field testing
CO3	Perform Continuous and periodic monitoring
CO4	Identify Hardware required for remote data acquisition system for health monitoring

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	-	3	-	2	-	-
CO2	2	3	-	3	-	3	-	-
CO3	1	2	-	3	-	-	1	1
CO4	1	2	-	2	-	3	-	1

Detailed Syllabus:

Introduction - Definition of SHM - Motivation for structural health monitoring - Assessment by NDT equipment's.

Static Testing - Static field testing- types of static tests- loading methods - Behavioural / Diagnostic tests - Proof tests - Static response measurement – strain gauges, LVDTs, dial gauges - case study.

Dynamic field testing - Types of dynamic tests - Stress history data - Dynamic load allowance tests - Ambient vibration tests - Forced Vibration Method - Dynamic response methods - Impact hammer testing - Shaker testing - Periodic and continuous monitoring.

Data Acquisition - Static data acquisition systems - Dynamic data acquisition systems - Components of Data acquisition system - Hardware for Remote data acquisition systems.

Remote Structural health monitoring - Remote Structural Health Monitoring - Importance and Advantages – Methodology - RF/PSTN/GSM/Satellite Communications - Networking of sensor - Data compression technique - Case Studies

Reading:

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, "Structural Health Monitoring", John Wiley and Sons, 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.

CE 5266	Advanced Prestressed Concrete	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Concrete Technology, Design of Concrete Structures

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

CO1	Understand the effect of prestressing force on the behavior of beams in flexure.
CO2	Understand the behavior of beams in shear.
CO3	Design indeterminate structures.
CO4	Design slabs, compression and tension members as per Codes of Practice.
CO5	Detail reinforcement in PSC members as per Codes of Practice.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	2	2	-	-	-	-
CO2	1	3	2	-	-	-	-	-
CO3	2	2	1	2	-	-	-	-
CO4	2	2	1	2	-	-	-	-
CO5	-	-	3	2	-	-	-	-

Detailed Syllabus:

Review of Fundamentals of prestressing - Analysis by Stress method, Force method and Load balancing method- Losses of prestress by different standard codes

Design of flexure members - Ultimate moment of resistance - Design for Shear and Bond – Deflections.

Partially prestressed concrete - End block design - Design of indeterminate structures - Design of slabs - Compression members and tension members - Circular prestressing – Applications.

Reading:

1. Krishna Raju,N ‘ Prestressed Concrete’, Tata Mc Graw Hill
2. Lin.T.Y, ‘ Presteressed concrete’, Mc Graw Hill Pub. Co.
3. Rajagopalan, ‘Prestressed concrete’, Narosa Publishing House
4. E.G. Nawy, 'Fundamentals of presressed concrete', Prentice Hall.

CE 5267	Blast Resistant Design	DEC	3 – 0 – 0	3 Credits

Pre-Requisites: None

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

CO1	Determine blast loads on structures
CO2	Determine response of structures to blast loads using SDOF analysis
CO3	Design new structures to resist blast loading
CO4	Design retrofit strategies for upgrading existing structures

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	2	-	-	-	-
CO2	2	2	-	3	-	-	-	-
CO3	-	2	3	-	-	-	-	-
CO4	1	3	2	-	-	-	-	-

SYLLABUS

Introduction to explosion effects:
Air-blast, Fragmentation, Stand-off distance vs. Explosive charge mass
Chemical explosives Classification, initiation, TNT-equivalence, explosion effects, blast load categories, incident and reflected blast, blast wave parameters calculation Types of industrial explosions Flammability, combustion, gas-phase explosion (vapour-cloud explosions, loading from industrial explosions: TNO method, Baker-Strehlow-Tang method, equivalent TNT method.

Blastload-structure interaction Contact / Near contact, close-in and far-field loading, Front face loading, blast clearing, stagnation pressure, Side wall and roof loading, Back face loading, Net loading on structure, Ground Shock Material Response to High strain Rate loading.

Dynamic behaviour of materials, Stress wave propagation, Reflection and Transmission of Stress waves, X-T Diagrams, Plastic Stress waves, Charpy Impact Test, Instrumented Drop Test, Split-Hopkinson Bar Test, Taylor Impact Test, Flyer Plate Test, Johnson Cook Material Constitutive Model.

Single-degree-of-freedom analysis of structures: D'Alambert's principle, dynamic equation of motion, free and forced vibration, harmonic forced vibration, forced vibration to generalized loading, Duhamel integral, response to triangular loading (blast load)
Equivalent SDOF analysis of structural elements SDOF analysis of nonlinear systems, pressure-impulse diagrams for elastic system and elasto-plastic systems, P-I Diagrams.

Design/analysis of reinforced concrete elements subjected to blast loading: Concrete and steel reinforcement behaviour under high strain rates (DIF), Reinforced concrete section properties, Resistance function, Response limits.
Design and analysis of structural steel elements subjected to blast loading: Structural steel behaviour under high strain rates (DIF), Structural steel section properties, Resistance function, Response limits.

Design for Progressive Collapse: Code provisions for structural stability, Alternate path method, Redundancy requirements.
Blast Resistant Window Design:Introduction to glass design standards for blast (DoD, GSA, VA), Introduction to window design, construction and testing, Design and analysis procedures, Design and analysis of windows, frames and Mullions.

Anti-terrorism design:Design Philosophy, Master Planning, Threat and Vulnerability assessment, Design Strategies Design Codes, Construction of Blast Resistant Structures, Evaluation and Retrofitting of existing structures.

READING:

1. J.M.Biggs, Introduction to Structural Dynamics, McGrawHill, 1964
2. G.F. Kinney & K.J.Graham, Explosive Shocks In Air, 2nd Ed., Springer Science+Business Media New York, 1985
3. P.D.Smith, J.G.Hetherington, Blast and Ballistic Loading of Structures,Butterwoth & Heinemann, Elsevier,2003, ISBN 0-7506-2024-2
4. Design of Blast Resistant Buildings in Petrochemical Facilities, 2nd Ed. , ASCE Publication, 2010.
5. IS 4991 (1968): Criteria for blast resistant design of structures for explosions above ground.
6. UFC 3-340-02: Structures To Resist The Effects Of Accidental Explosions , December 2008 Change 2, 1 September 2014
7. NAVFAC, Blast Resistant Structures, DESIGN MANUAL 2.08, DECEMBER 1986
8. General Services Administration (GSA), Alternate Path Analysis & Design Guidelines For Progressive Collapse Resistance, 2013.
9. UFC 4-010-01: Dod Minimum Anti-Terrorism Standards For Buildings.

CE 5268	Durability of Concrete Structures	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Concrete Technology

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

CO1	Understand and Identify typical deterioration mechanisms of concrete
CO2	Analyse controlling parameters and apply techniques to quantify deterioration
CO3	Select different Performance-based specifications for durability improvement.
CO4	Implement advanced practices to assess the service life prediction of RCC structures.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	3	-	1	-	-	-	-
CO2	1	3	-	2	-	-	-	-
CO3	-	2	-	3	-	-	-	-
CO4	-	2	2	1	-	-	-	-

Detailed Syllabus:

Fresh and hardened properties of concrete, Durability problems in concrete, Overview of concrete deterioration: Alkali-aggregate reaction, reactive minerals, mechanism of deterioration, identification and tests.

Corrosion, Carbonation; Permeability of concrete and its measurement, penetration of carbon dioxide and chlorides into concrete, corrosion of steel in concrete, Identification of deterioration mechanisms, Electrochemistry of corrosion, micro and macro cell corrosion, corrosion cells and currents, role of concrete, prevention of corrosion.

Performance-based specifications for durability improvements in the concrete infrastructure, High durability concrete using new materials, Diffusion and permeation in concrete as porous media, Studies on various concrete:-durability point of view, Waste material:-durability point of view, FRC concrete:- durability point of view, Durability aspects of Geo-polymer concrete, Durability aspects of Bacterial concrete ,Permeability of concrete and its measurement.

Construction materials that can be used to improve the durability performance, Construction processes for improved durability, Design aspects that reduce risk from deteriorating mechanisms, Elaboration and evaluation of different durability design options including appropriate structural detailing. Service life prediction in reinforced concrete structures exposed to harsh environments, Life-cycle management of concrete structures.

Reading:

1. P.K. Mehta and P.J.M. Monteiro., “Concrete: Microstructure, Properties and Materials”, 4th Edition, McGraw-Hill, 2013.
2. Neville, Adam M., “Properties of Concrete”; Prentice Hall/Pearson Education, 2009.
3. Zonghjin Li, “Advanced Concrete Technology”, John Wiley & Sons, INC, Newjersy, 2011.
4. A.R. Santhakumar, “Concrete Technology”, Oxford University press, New Delhi, 2009.

CE 5161	Underwater Construction	DEC	3 – 0 – 0	3 Credits

Pre-requisites: Soil Mechanics and Foundation Engineering.

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

CO1	Site preparation, drainage and shoring of excavation.
CO2	To implement underwater construction technologies.
CO3	To know underwater tunneling.
CO4	To design of underwater foundation for structures.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	-	-	-	1	-	1
CO2	2	2	2	1	-	2	-	1
CO3	2	1	-	-	-	-	-	1
CO4	2	3	-	-	-	-	-	1

Detailed Syllabus:

Introduction - site preparation - temporary roads - site drainage - deep trench and deep basement excavations - bulk excavation.

Coastal structures - stability of slopes to open excavations - support of excavation by timbering and sheet piling.

Offshore Platforms - retaining walls and sheet pile design - requirements for shorting and underpinning - methods of shoring of Underpinning.

Dewatering and Groundwater Control for Soft Ground Tunneling - Tunneling in touch, medium-tough and soft rocks - tunneling by borls shield tunneling.

Piping Systems - Culverts and conduits.

Deep water foundations - Design of piles - pile load tests - Foundation design for dynamic conditions.

Reading:

1. Ben C. Gerwick Jr., “Construction of Marine and Offshore Structures”, 3rd ed. CRC Press, 2007.
2. Patrick Powers. J., “Construction Dewatering: New Methods and Applications”, John Wiley and Sons, 1992.

CE 6242	Comprehensive Viva Voce	PCC	0 – 0 – 0	2 Credits

Pre-requisites: Both I & II Semester course work of I year.

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

CO1	Assimilate knowledge of different courses studied.
CO2	Develop overall comprehension about Structural Engineering.
CO3	Analyse real life Structural Engineering problems with theoretical knowledge learned.
CO4	Interpret and Articulate solutions to real life civil engineering problems in general and structural engineering problems in particular.

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	1	2	1	2	1	1
CO2	3	3	3	1	1	2	1	1
CO3	-	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-

Detailed Syllabus:

Entire course of study (All the required courses studied) up to II Semester of I Year

Reading:

1. Reading Material of all the courses.
2. Case Studies/Industrial training reports.
3. Mini projects taken up.

CE 6249	Dissertation Part-A	PCC	0 – 0 – 0	6 Credits

Pre-requisites: Both I & II Semester course work of I Year should be completed.

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

CO1	Define Research Problem Statement.
CO2	Critically evaluate literature in chosen area of research & establish scope of work.
CO3	Develop study methodology.
CO4	Carryout pilot theoretical study/experiment

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	2	-	-	-	2	2	2
CO2	2	2	-	2	1	-	2	2
CO3	3	3	2	2	1	2	1	2
CO4	3	3	3	2	2	1	1	2

Detailed Syllabus:

There is no prescribed syllabus. Students are required to search, collect and review various research articles published in chosen area of research. A student has to select a topic for his dissertation, based on his/her interest and the available facilities at the commencement of dissertation work. Students are required to submit a dissertation report on the research work carried out by him/her.

Reading:

1. Journal Publications.
2. Conference / Seminar Proceedings.
3. Handbooks / Research Digests/Codebooks.

CE 6299	Dissertation Part-B	PCC	0 – 0 – 0	12 Credits

Pre-requisites: Both I & II Semester course work of I Year should be completed.

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

CO1	Expand on the defined Research Problem in dissertation Part-A
CO2	Critically evaluate literature in defined research areas & clearly establish scope of work
CO3	Conduct Laboratory/analytical studies
CO4	Analyse Data, develop models and offer solutions

Mapping of course outcomes with program outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	2	3	2	2	-	1	2
CO2	-	2	2	1	1	-	2	-
CO3	2	3	3	2	-	2	-	2
CO4	3	3	3	2	1	1	2	2

Detailed Syllabus:

There is no prescribed syllabus. Students are required to search, collect and review various research articles published in chosen area of research. A student has to select a topic for his dissertation, based on his/her interest and the available facilities at the commencement of dissertation work. Students are required to submit a dissertation report on the research work carried out by him/her.

Reading:

1. Journal Publication.
2. Conference / Seminar Proceedings.
3. Handbooks / Research Digests/Codebooks.
4. Previous thesis books.