ACADEMIC CURRICULUM & SYLLABUS

(REGULATIONS 2019)

FOR

M.E. – STRUCTURAL ENGINEERING

POST GRADUATE PROGRAMME

CHOICE BASED CREDIT SYSTEM

(Applicable to the students admitted from the Academic Year 2019-20 onwards)

EASWARI ENGINEERING COLLEGE

(AUTONOMOUS INSTITUTION)

Bharathi Salai, Ramapuram, Chennai – 600 089

SEMESTER I								
Sl. NO.	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	
Theory								
1	192MAB101T	Advanced Mathematical Methods	B	3	2	-	-	4
2	192CEC101T	Dynamics of Structures	C	3	-	-	-	3
3	192CEC102T	Theory of Elasticity and Plasticity	C	3	-	-	-	3
4	192CEC103T	Advanced Concrete Structures	C	3	-	-	-	3
5		Professional Elective - I	E	3	-	-	-	3
Practical								
6	192CEC111L	Structural Engineering Laboratory	C	-	-	3	1	2
Employability Enhancement / Career Advancement Course								
7	192CEA111L	Term Paper Writing and Seminar	A	-	-	4	-	2
8	192CEA112I	Industry Supported Employability Enhancement Course (optional)*	A	-	-	-	-	ONE/TWO
9	192CEA113T	Online course (Optional)*	A	-	-	-	-	THREE
Total				**15**	**2**	**3**	**1**	**20**

SEMESTER II								
Sl. NO.	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	
Theory								
1	192CEC201T	Finite Element Analysis of Structures	C	3	-	-	-	3
2	192CEC202T	Advanced Steel Structures	C	3	-	-	-	3
3	192CEC203T	Experimental Techniques and Instrumentation	C	3	-	-	-	3
4	192CEC204T	Earthquake Resistant Design of Structures	C	3	-	-	-	3
5		Professional Elective - II	E	3	-	-	-	3
6		Open Elective	O	3	-	-	-	3
Mandatory Course								
7		Research Methodology and IPR / Foreign Language (Opt for any one)	M	2	-	-	-	TWO
Employability Enhancement / Career Advancement Course								
8	192CEP211L	Minor Project	A	-	-	-	4	2
9	192CEA211I	Internship / Industrial Training	A	-	-	-	-	1
10	192CEA212I	Industry Supported Employability Enhancement Course (optional)*	A	-	-	-	-	ONE/TWO
11	192CEA213T	Online course (Optional)*	A	-	-	-	-	THREE
Total				**20**	**0**	**0**	**4**	**21**

SEMESTER III								
Sl. NO.	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	
Theory								
1		Professional Elective – III	E	3	-	-	-	3
2		Professional Elective - IV	E	3	-	-	-	3
Practical								
3	192CEP311L	Project Work / Startup Phase I	A	-	-	-	16	8
Employability Enhancement / Career Advancement Course								
4	192CEA311L	Internship / Industrial Training	A	-	-	-	-	1
Total				**6**	**0**	**0**	**16**	**15**

SEMESTER IV								
Sl. NO.	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	
Practical								
1	192CEP411L	Project Work / Startup Phase II	A	-	-	-	28	14
Total				**0**	**0**	**28**	**0**	**14**
Total Credit								**70**

*Note: Refer regulation 2019 for earning credits

Subject Area / Semester	I	II	III	IV	Credit
Foundation Course (B)	4				**4**
Professional Core (C)	11	12			**23**
Professional Electives (E)	3	3	6		**12**
Open Electives (O)		3			**3**
Employability Enhancement Courses (A)	2	3	9	14	**28**
Credit	**20**	**21**	**15**	**14**	**70**

PROFESSIONAL ELECTIVE – I								
Sl. No.	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	C
1	192CEE001T	Advanced Concrete Technology	E	3	-	-	-	3
2	192CEE002T	Maintenance and Rehabilitation of Structures	E	3	-	-	-	3
3	192CEE003T	Smart Materials and Smart Structures	E	3	-	-	-	3
4	192CEE004T	Matrix Methods of Structural Analysis	E	3	-	-	-	3

PROFESSIONAL ELECTIVE – II								
Sl. No.	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	C
1	192CEE005T	Prefabricated Structures	E	3	-	-	-	3
2	192CEE006T	Prestressed Concrete Structures	E	3	-	-	-	3
3	192CEE007T	Theory of Plates	E	3	-	-	-	3
4	192CEE008T	Stability of Structures	E	3	-	-	-	3

PROFESSIONAL ELECTIVE – III								
Sl. No.	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	C
1	192CEE009T	Optimization of Structures	E	3	-	-	-	3
2	192CEE010T	Design of Tall Buildings	E	3	-	-	-	3
3	192CEE011T	Design of Steel Concrete Composite Structures	E	3	-	-	-	3
4	192CEE012T	Design of Bridges	E	3	-	-	-	3

PROFESSIONAL ELECTIVE – IV								
Sl. No.	Course Code	Course Title	Category	Hours / Week				Credits
				L	T	P	R	C
1	192CEE013T	Design of Substructure	E	3	-	-	-	3
2	192CEE014T	Industrial Structures	E	3	-	-	-	3
3	192CEE015T	Wind and Cyclone Effects on Structures	E	3	-	-	-	3
4	192CEE016T	Offshore Structures	E	3	-	-	-	3

OPEN ELECTIVE								
Sl. No.	**Course Code**	**Course Title**	**Category**	**Hours / Week**				**Credits**
				L	**T**	**P**	**R**	**C**
1		Industrial Safety	O	3	-	-	-	3
2		Cost Management of Engineering Projects	O	3	-	-	-	3
3		Operations Research	O	3	-	-	-	3
4		Energy Auditing	O	3	-	-	-	3
5		Business Analytics	O	3	-	-	-	3

192MAB101T	ADVANCED MATHEMATICAL METHODS	L	T	P	R	C
		4	0	0	0	4

OBJECTIVE:

To familiarize with numerical solution, numerical interpolation, numerical differentiation and numerical integration.

UNIT I FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS **12**

Fourier transform : Definitions – Properties – Transform of elementary functions – Dirac delta function – Convolution theorem – Parseval's identity – Solutions to partial differential equations : Heat equation – Wave equation – Laplace and Poisson's equations.

UNIT II - PROBABILITY AND RANDOM VARIABLES **12**

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT III - CALCULUS OF VARIATIONS **12**

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

UNIT IV - CONFORMAL MAPPING AND APPLICATIONS **12**

Introduction to conformal mappings and bilinear transformations – Schwarz Christoffel transformation – Transformation of boundaries in parametric form – Physical applications : Fluid flow and heat flow problems.

UNIT V - TENSOR ANALYSIS **12**

Summation convention – Contravariant and covariant vectors – Contraction of tensors – Inner product – Quotient law – Metric tensor – Christoffel symbols – Covariant differentiation – Gradient- Divergence and curl.

Total: 60 Hours

OUTCOMES:

After completing this course, students should demonstrate competency in the following skills:

- Application of Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.
- Maximizing and minimizing the functional that occur in various branches of Engineering Disciplines.
- Construct conformal mappings between various domains and use of conformal mapping in studying problems in physics and engineering particularly to fluid flow and heat flow problems.
- Understand tensor algebra and its applications in applied sciences and engineering and develops ability to solve mathematical problems involving tensors.
- Competently use tensor analysis as a tool in the field of applied sciences and related fields.

REFERENCE BOOKS:

1. Andrews L.C. and Shivamoggi, B., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., Delhi, 2003.
2. Elsgolc, L.D., "Calculus of Variations", Dover Publications Inc., New York, 2007.
3. Kay, D. C., "Tensor Calculus", Schaum's Outline Series, Tata McGraw Hill Edition, 2014.
4. Mathews, J. H., and Howell, R.W., "Complex Analysis for Mathematics and Engineering", 5th Edition, Jones and Bartlett Publishers, 2006.
5. Naveen Kumar, "An Elementary Course on Variational Problems in Calculus ", Narosa Publishing House, 2005.
6. Ramaniah. G. "Tensor Analysis", S. Viswanathan Pvt. Ltd., 1990.
7. Saff, E.B and Snider, A.D, "Fundamentals of Complex Analysis with Applications in Engineering, Science and Mathematics", 3rd Edition, Pearson Education, New Delhi, 2014.
8. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

192CEC101T	DYNAMICS OF STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

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

UNIT I PRINCIPLES OF VIBRATION ANALYSIS 9

Mathematical models of single degree of freedom systems - Free and forced vibration of SDOF systems, Response of SDOF to special forms of excitation, Effect of damping, Transmissibility.

UNIT II TWO DEGREE OF FREEDOM SYSTEMS 9

Mathematical models of two degree of freedom systems, free and forced vibrations of two degree of freedom systems, normal modes of vibration, applications.

UNIT III DYNAMIC RESPONSE OF MULTI-DEGREE OF FREEDOM SYSTEMS 9

Mathematical models of Multi-degree of freedom systems, orthogonality of normal modes, free and forced vibrations of multi degree of freedom systems, Mode superposition technique, Applications.

UNIT IV DYNAMIC RESPONSE OF CONTINUOUS SYSTEMS 9

Mathematical models of continuous systems, Free and forced vibration of continuous systems, Rayleigh – Ritz method – Formulation using Conservation of Energy – Formulation using Virtual Work, Applications.

UNIT V DIRECT INTEGRATION METHODS FOR DYNAMIC RESPONSE 9

Damping in MDOF systems, Nonlinear MDOF systems, step-by-step numerical integration algorithms, substructure technique.

Total: 45 Hours

OUTCOME:

The Student will be able to

- Apply knowledge in dynamic forces acting on structures
- Apply knowledge in Modes of vibrations of structures
- Measure the causes and effects of earthquakes
- Apply knowledge in determining the dynamic response of continuous systems
- Ability to analyze and design the structures for seismic forces

REFERENCES:

1. Anil K.Chopra, Dynamics of Structures, Pearson Education, 2007.
2. Leonard Meirovitch, Elements of Vibration Analysis, McGraw Hill, 1986, IOS Press, 2006.
3. Mario Paz, Structural Dynamics -Theory and Computation, Kluwer Academic Publishers, 2004.
4. Roy R.Craig, Jr, Andrew J. Kurdila, Fundamentals of Structural Dynamics, John Wiley & Sons, 2011.

192CEC102T	THEORY OF ELASTICITY AND PLASTICITY	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To understand the concept of 3D stress, strain analysis and its applications.

UNIT I ELASTICITY **9**

Analysis of stress and strain, Equilibrium Equations - Compatibility Equations - Stress Strain Relationship. Generalized Hooke's law – Constitutive Equations.

UNIT II 2D STRESS STRAIN PROBLEMS **9**

Plane stress and plane strain - Simple two dimensional problems in Cartesian and Polar Co-ordinates.

UNIT III TORSION OF NON-CIRCULAR SECTION **9**

St.Venant's approach - Prandtl's approach – Membrane analogy - Torsion of Thin Walled- Open and Closed sections- design approach to open web sections subjected to torsion.

UNIT IV BEAMS ON ELASTIC FOUNDATIONS **9**

Beams on Elastic foundation – Methods of analysis – Elastic line method – Idealization of soil medium – Winkler model – Infinite beams – Semi infinite and finite beams – Rigid and flexible – Uniform Cross Section – Point load and UDL – Solution by Finite Differences.

UNIT V PLASTICITY **9**

Physical Assumptions – Yield Criteria – Failure Theories – Applications of Thick Cylinder – Plastic Stress Strain Relationship. Elasto-Plastic Problems in Bending and Torsion.

Total: 45 Hours

OUTCOME:

The Student will be able to

- Understand the concept of 3D stress, strain analysis and its applications
- Understand the concept of plane stress and strain
- Analyze the two dimensional problems of Cartesian and polar coordinates
- Know the behavior of torsion for non circular sections
- Analyze the beam on elastic foundation and Know the behaviour of members in plastic state

REFERENCES:

1. Timoshenko, S. and Goodier J.N."Theory of Elasticity", McGraw Hill Book Co., New York, 2010.
2. Ansel.C.Ugural and Saul.K.Fenster, "Advanced Strength and Applied Elasticity," Fourth Edition, Prentice Hall Professional technical Reference, New Jersy, 2003.
3. Chakrabarty.J, "Theory of Plasticity", Third Edition, Elsevier Butterworth - Heinmann – UK, 2007.
4. Jane Helena H, "Theory of Elasticity and Plasticity", PHI Learning Pvt. Ltd., 2016 .
5. Slater R.A.C, "Engineering Plasticity", John Wiley and Son, New York, 1977.

192CEC103T	ADVANCED CONCRETE STRUCTURES	L T P R C 3 0 0 0 3

OBJECTIVE:

- To make the students be familiar with the limit state design of RCC beams and columns
- To design special structures such as Deep beams, Corbels, Deep beams, and Grid floors
- To make the students confident to design the flat slab as per Indian standard, yield line theory and strip method.
- To design the beams based on limit analysis and detail the beams, columns and joints for ductility

UNIT I BEHAVIOUR AND DESIGN OF R.C. BEAMS 9

Properties and behaviour of concrete and steel – Behaviour and design of R.C. beams in flexure, shear and torsion – modes of failure – Calculations of deflections and crack width as per IS 456.

UNIT II BEHAVIOUR AND DESIGN OF R.C. COLUMNS 9

Behaviour of short and long columns – behavior of short column under axial load with uniaxial and bi- axial moments – construction of Pu –Mu interaction curves – Design of slender columns.

UNIT III DESIGN OF SPECIAL R.C. ELEMENTS 9

Design of RC walls – design of corbels – strut and tie method – design of simply supported and continuous deep beams – analysis and design of gird floors.

UNIT IV FLAT SLABS AND YIELD LINE BASED DESIGN 9

Design of flat slabs according to IS method – Check for shear – Design of spandrel beams – Yield line theory and design of slabs – Virtual work method – equilibrium method.

UNIT V INELASTIC BEHAVIOUR OF CONCRETE STRUCTURES 9

Inelastic behavior of concrete beams – Moment – curvature curves – moment redistribution – Concept of Ductility – Detailing for ductility – Design of beams , columns for ductility – Design of cast – in –situ joints in frames.

Total: 45 Hours

OUTCOME:

The Student will be able to

- Gain knowledge for the limit state design of RC beams.
- Design special structures such as deep beams, corbels and grid floors.
- Design flat slab as per Indian standard.
- Design slab by yield line theory and strip method
- Analyze the inelastic behavior of beams and to evaluate ductility of beams.
- Design and detail the structural members for ductility.

REFERENCES:

1. Gambhir.M.L., “Design of Reinforced Concrete Structures”, Prentice Hall of India, 2012.
2. Purushothaman, P, “Reinforced Concrete Structural Elements: Behaviour Analysis and Design”, Tata McGraw Hill,1986.
3. Unnikrishna Pillai and Devdas Menon “Reinforced Concrete Design’, Third Edition, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2017.
4. Varghese, P.C, “Advanced Reinforced Concrete Design”, Prentice Hall of India, 2005.
5. Sinha.S.N., Reinforced Concrete Design”, Tata McGraw Hill Publishing company Ltd. 2014.

192CEC111L	STRUCTURAL ENGINEERING LABORATORY	L T P R C
		0 0 3 1 2

OBJECTIVE:

- To have exposure on instruments and to conduct experiments on various structural elements to identify its behaviour.

LIST OF EXPERIMENTS:

1. Introduction to LVDT, Load cell, Hydraulic jack, Strain gauges
2. Test on hardened concrete- Study of stress and strain characteristics, and determination of Young's modulus
3. Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behaviour.
4. Testing of simply supported steel beam for strength and deflection behaviour.
5. Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading.
6. Dynamic Response of cantilever steel beam
    a. To determine the damping coefficients from free vibrations.

    b. To evaluate the mode shapes.
7. Static cyclic testing of single bay two storied steel frames and evaluate
    a. Drift of the frame.
    b. Stiffness of the frame.
    c. Energy dissipation capacity of the frame.
8. Non-Destructive Test on concrete
    i) Rebound hammer and
    ii) ii) Ultrasonic Pulse Velocity Tester.
9. Testing the Chloride Penetration Resistance of Concrete
10. Flexural behaviour of RC Slabs

Total: 60 Hours

OUTCOME:

- On completion of this laboratory course students will be able to cast and test RC beams for strength and deformation behaviour.
- They will be able to test dynamic testing on steel beams, static cyclic load testing of RC frames and non-destruction testing on concrete.

REFERENCES:

1. Dally J W, and Riley W F, "Experimental Stress Analysis", McGraw-Hill Inc. New York, 1991.

192CEA111L **TERM PAPER WRITING ANDSEMINAR** **L T P R C**
0 0 4 0 2

OBJECTIVE:

- In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles.

SYLLABUS:

A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books, case studies) and then place it in logically developed ideas.

The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (at least 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the author's contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained. Activities to be carried Out.

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic Stating an Objective	You are requested to select an area of interest, topic and state an objective	2nd week	3 % Based on clarity of thought, current relevance and clarity in writing
Collecting Information about your area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area.	3rd week	3% (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• You have to provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them, • Favour papers from well-known journals and conferences, • Favour "first" or "foundational" papers in the field (as indicated in other people"s survey paper), Favour more recent papers,	4th week	6% (the list of standard papers and reason for selection)

	• Pick a recent survey of the field so you can quickly gain an overview, • Find relationships with respect to each other and to your topic area (classification scheme/categorization) • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered		
Reading and notes for first 5 papers	Reading Paper Process • For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • How does the work build on other's work, in the author's opinion? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? Conclude with limitations/issues not addressed by the paper (from the perspective of your survey)	5th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for next5 papers	Repeat Reading Paper Process	6th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for final 5 papers	Repeat Reading Paper Process	7th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	8% (this component will be evaluated based on the linking and classification among the papers)

Abstract	Prepare a draft abstract and give a presentation	9th week	6% (Clarity, purpose and conclusion) 6% Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	5% (clarity)
Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11th week	10% (this component will be evaluated based on the linking and classification among the papers)
Your conclusions	Write your conclusions and future work	12th week	5% (conclusions – clarity and your ideas)
Final Draft	Complete the final draft of your paper	13th week	10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th & 15th week	10% (based on presentation and Viva-voce)

Total: 60 Hours

OUTCOME:

- The students will be trained to face an audience and to tackle any problem during group discussion in the Interviews.

192CEC201T	FINITE ELEMENT ANALYSIS OF STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To study the basics of the Finite Element Technique, a numerical tool for the solution of different classes of problems.

UNIT I INTRODUCTION **9**

Approximate solutions of boundary value problems - Methods of weighted residuals, approximate solution using variational method, Modified Galerkin method, Boundary conditions and general comments.

Basic finite element concepts - Basic ideas in a finite element solution, General finite element solution procedure, Finite element equations using modified Galerkin method.

UNIT II APPLICATION: AXIAL DEFORMATION OF BARS, AXIAL SPRING ELEMENT. **9**

Natural Coordinates - Triangular Elements -Rectangular Elements - Lagrange and Serendipity Elements -Solid Elements - Isoparametric Formulation - Stiffness Matrix of Isoparametric Elements - Numerical Integration: One, Two and Three Dimensional - Examples.

UNIT III ANALYSIS OF FRAMED STRUCTURES **9**

Stiffness of Truss Member - Analysis of Truss -Stiffness of Beam Member-Finite Element Analysis of Continuous Beam -Plane Frame Analysis -Analysis of Grid and Space Frame – Two Dimensional Solids - 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 – Solution for simple frames.

UNIT IV PLATES AND SHELLS **9**

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.

UNIT V APPLICATIONS **9**

Finite Elements for Elastic Stability - Dynamic Analysis - Nonlinear, Vibration and Thermal Problems - Meshing and Solution Problems - Modelling and analysis using recent softwares.

Total: 45 Hours

OUTCOME:

The Student will be able to

- Apply certain finite element concepts, modelling considerations, choice of elements.
- Apply fem for energy principles and analysis of one dimensional problems
- Apply fem for analysis of stress in two dimensional problems
- Analysis of framed structure using Finite element analysis
- Analyse of plate and shells using Finite element
- Modeling and analysis of structure using recent software and Interpreting a complete numerical solution to practical problems

REFERENCES:

1. Bhavikatti.S.S, “Finite Element Analysis”, New Age International Publishers, 2007.
2. Chandrupatla, R.T. and Belegundu, A.D., “Introduction to Finite Elements in Engineering”, Prentice Hall of India, 2007.
3. David Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
4. Logan D. L., A First Course in the Finite Element Method, Thomson Learning, 2007.
5. Moaveni, S., “Finite Element Analysis Theory and Application with ANSYS”, Prentice Hall Inc., 1999.

192CEC202T	ADVANCED STEEL STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To study the behaviour of members and connections, analysis and design of Industrial buildings and roofs, chimneys. Study the design of with cold formed steel and plastic analysis of structures.

UNIT I GENERAL **9**

Design of members subjected to combined forces – Design of Purlins, Louver rails, Gable column and Gable wind girder – Design of simple bases, Gusseted bases and Moment Resisting Base Plates.

UNIT II DESIGN OF CONNECTIONS **9**

Types of connections – Welded and Bolted – Throat and Root Stresses in Fillet Welds – Seated Connections – Unstiffened and Stiffened seated Connections – Moment Resistant Connections – Clip angle Connections – Split beam Connections – Framed Connections.

UNIT III ANALYSIS AND DESIGN OF INDUSTRIAL BUILDINGS **9**

Analysis and design of different types of trusses – Analysis and design of industrial buildings – Sway and non sway frames – Aseismic design of steel buildings.

UNIT IV PLASTIC ANALYSIS OF STRUCTURES **9**

Introduction, Shape factor, Moment redistribution, Combined mechanisms, Analysis of portal frames, Effect of axial force - Effect of shear force on plastic moment, Connections - Requirement – Moment resisting connections. Design of Straight Corner Connections – Haunched Connections – Design of continuous beams.

UNIT V DESIGN OF LIGHT GAUGE STEEL STRUCTURES **9**

Introduction to Direct Strength Method - Behaviour of Compression Elements - Effective width for load and deflection determination – Behaviour of Unstiffened and Stiffened Elements – Design of webs of beams – Flexural members – Lateral buckling of beams – Shear Lag – Flange Curling – Design of Compression Members – Wall Studs.

Total: 45 Hours

OUTCOME:

The Student will be able to

- Knowledge about different forces flow in the different elements and design of steel elements for different load combinations.
- Differentiate the different connections in steel design and selection of a connection for particular cases.
- Gain confidents to analyse and Design the Industrial building.
- Determine the plastic capacity of the steel structure and planning and proportionate the steel sections for effective utilization.
- Get research interest and implement in application of light gauge steel structures for various purposes.
- Get a basic knowledge of steel structures and their behaviour.

REFERENCES:

1. Lynn S. Beedle, Plastic Design of Steel Frames, John Wiley and Sons, 1990.
2. Narayanan.R.et.al., Teaching Resource on Structural steel Design, INSDAG, Ministry of Steel Publishing, 2000.
3. Subramanian.N, Design of Steel Structures, Oxford University Press, 2014.
4. Wie Wen Yu, Design of Cold Formed Steel Structures, McGraw Hill Book Company, 1996

192CEC203T	EXPERIMENTAL TECHNIQUES AND INSTRUMENTATION	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

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

UNIT I FORCES AND STRAIN MEASUREMENT 9

Choice of Experimental stress analysis methods, Errors in measurements - Strain gauge, principle, types, performance and uses. Photo elasticity - principle and applications - Hydraulic jacks and pressure gauges – Electronic load cells – Proving Rings – Calibration of Testing Machines – Long-term monitoring – vibrating wire sensors– Fibre optic sensors.

UNIT II MEASUREMENT OF VIBRATION AND WIND FLOW 9

Characteristics of Structural Vibrations – Linear Variable Differential Transformer (LVDT) – Transducers for velocity and acceleration measurements. Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – wind tunnels – Flow meters – Venturimeter – Digital data Acquisition systems.

UNIT III DISTRESS MEASUREMENTS AND CONTROL 9

Diagnosis of distress in structures – Crack observation and measurements – corrosion of reinforcement in concrete – Half cell, construction and use – damage assessment – controlled blasting for demolition – Techniques for residual stress measurements – Structural Health Monitoring.

UNIT IV NON DESTRUCTIVE TESTING METHODS 9

Load testing on structures, buildings, bridges and towers – Rebound Hammer – acoustic emission – ultrasonic testing principles and application – Holography – use of laser for structural testing – Brittle coating, Advanced NDT methods – Ultrasonic pulse echo, Impact echo, impulse radar techniques, GECOR , Ground penetrating radar (GPR).

UNIT V MODEL ANALYSIS 9

Model Laws – Laws of similitude – Model materials – Necessity for Model analysis – Advantages – Applications – Types of similitude – Scale effect in models – Indirect model study – Direct model study - Limitations of models – investigations – structural problems –Usage of influence lines in model studies.

Total: 45 Hours

OUTCOME:

The Student will be able to

- Know about types of strain gauges, measurement of strain and their applications
- Know about measurement of vibrations and instrumentations
- Understand the construction of equipment and working principal of various vibration measuring equipments.
- Understand and apply acoustic and wind flow measures.
- Analyse the integrity and structural damage by non destructive testing methods
  Know about the advanced NDT methods to find out the structural integrity

REFERENCES:

1. Dalley .J. W and Riley. W. F, “Experimental Stress Analysis”, McGraw Hill Book Company, N.Y. 1991
2. Ganesan.T.P, “Model Analysis of Structures”, University Press, India, 2000.
3. Ravisankar.K.and Chellappan.A., “Advanced course on Non-Destructive Testing and Evaluation of Concrete Structures”, SERC, Chennai, 2007.
4. Sadhu Singh, “Experimental Stress Analysis”, Khanna Publishers, New Delhi, 2006.
5. Sirohi.R.S., Radhakrishna.H.C, “Mechanical Measurements”, New Age International (P) Ltd. 1997.

192CEC204T	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

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

UNIT I EARTHQUAKE GROUND MOTION **9**

Engineering Seismology (Definitions, Introduction to Seismic hazard, Earthquake Phenomenon), Seismotectonics and Seismic Zoning of India, Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters, Microzonation.

UNIT II EFFECTS OF EARTHQUAKE ON STRUCTURES **9**

Response Spectra - Evaluation of Earthquake Forces as per codal provisions-Determination of lateral forces – equivalent static lateral force method – response spectrum method – time history method – push over analysis - mathematical modeling of multistorey RC Building. - Effect of Earthquake on Different Types of Structures - Lessons Learnt From Past Earthquakes

UNIT III EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES **9**

Structural Systems - Types of Buildings - Causes of damage - Planning Considerations - Philosophy and Principle of Earthquake Resistant Design - Guidelines for Earthquake Resistant Design - Earthquake Resistant Masonry Buildings - Design consideration – Guidelines.

UNIT IV EARTHQUAKE RESISTANT DESIGN OF RC STRUCTURES **9**

Earthquake Resistant Design of R.C.C. Buildings - Material properties - Lateral load analysis – Capacity based Design and detailing – Rigid Frames – Shear walls.

UNIT V VIBRATION CONTROL TECHNIQUES **9**

Vibration Control - Tuned Mass Dampers – Principles and application, Basic Concept of Seismic Base Isolation – various Systems- Case Studies, Important structures.

COMPUTER AIDED ANALYSIS AND DESIGN: (For internal assessment only – not for theory examination) computer aided analysis and design of building systems for earthquake loads – response spectrum - time history analysis – capacity based design – hands on session using computer software.

Total: 45 Hours

OUTCOME:

The Student will be able to

- Develop systematic knowledge of earthquake and its causes
- Understand the basic concepts related to structural design for earthquake loads
- Understand the basic concepts related to structural design for earthquake loads for masonry structures
- Understand the basic concepts related to structural design for earthquake loads for RC structures
- Familiarize with design and detailing of various types of systems
- Develop an idea about various structural systems adopted in vibration control

REFERENCES:

1. Bruce A Bolt, “Earthquakes” W H Freeman and Company, New York, 2004.
2. Duggal S K , “Earthquake Resistant Design of Structures”, Oxford University Press, 2007.
3. Brebbia C. A.,”Earthquake Resistant Engineering Structures VIII”,WIT Press, 2011
4. Mohiuddin Ali Khan “Earthquake-Resistant Structures: Design, Build and Retrofit”, Elsevier Science & Technology, 2012
5. Pankaj Agarwal and Manish Shrikhande, “Earthquake Resistant Design of Structures”, Prentice Hall of India, 2009.
6. Paulay,T and Priestley, M.J.N., “Seismic Design of Reinforced Concrete and Masonry buildings”, John Wiley and Sons, 1992.

192GEM201T	RESEARCH METHODOLOGY AND IPR	L T P R C 2 0 0 0 TWO

OBJECTIVE:

To understand the research information and the technologies involved in research. To know about the importance of IPR.

UNIT I

Lecture Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT II

Effective literature studies approaches, analysis Plagiarism, Research ethics

UNIT III

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT IV

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT VI

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Total: 30 Periods

OUTCOME:

At the end of this course, students will be able to Understand research problem formulation.

- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

REFERENCES:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

192CEP211L	MINOR PROJECT	L	T	P	R	C
		0	0	0	4	2

OBJECTIVE:

To develop knowledge on design and detailing of structures

SYLLABUS:

Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the design problem based on the recent trends and analyse the structural system using various techniques.

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted analysis, design and detailing of the entire structural system.

Continuous assessment of Design Project will be monitored by the departmental committee.

Total: 60 Periods

OUTCOME:

- The students are able Identify structural engineering problems, Familiarize with the various loads and load combinations.
- Acquire hands on experience in the analysis, design and preparation of structural drawings of entire structure as per IS codes.

192CEA211L	INTERNSHIP / INDUSTRIAL TRAINING (2 WEEKS)	L	T	P	R	C
		0	0	0	0	1

OBJECTIVE:

- To train the students in the field work so as to have a firsthand knowledge of practical problems related to Structural Engineering in carrying out engineering tasks.
- To develop skills in facing and solving the field problems.

SYLLABUS:

The students individually undertake training in reputed Industries during the summer vacation for a specified period of two weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

OUTCOME:

- They are trained in tackling a practical field/industry orientated problem related to Structural Engineering.

192CEA311L **INTERNSHIP / INDUSTRIAL TRAINING (2 WEEKS)** **L T P R C**
0 0 0 0 1

OBJECTIVE:

- To train the students in the field work so as to have a firsthand knowledge of practical problems related to Structural Engineering in carrying out engineering tasks.
- To develop skills in facing and solving the field problems.

SYLLABUS:

The students individually undertake training in reputed Industries during the summer vacation for a specified period of two weeks. At the end of training, a detailed report on the work done should be submitted within ten days from the commencement of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

OUTCOME:

- They are trained in tackling a practical field/industry orientated problem related to Structural Engineering.

192CEP311L **PROJECT WORK (PHASE I)** **L T P R C**
0 0 0 16 8

OBJECTIVE:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS:

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 240 HOURS

OUTCOME:

- At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.

192CEP401L **PROJECT WORK (PHASE II)** **L T P R C**
0 0 0 28 14

OBJECTIVE:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS:

The student should continue the phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 420 HOURS

OUTCOME:

- On completion of the project work students will be in a position to take up any challenging practical problem and find better solutions.

192CEE001T	ADVANCED CONCRETE TECHNOLOGY	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To study the properties of concrete making materials, tests, mix design, special concretes and various methods for making concrete

UNIT I CONCRETE MAKING MATERIALS **9**

Aggregates classification, IS Specifications, Properties, Grading, Methods of combining aggregates, specified gradings, Testing of aggregates. Cement, Grade of cement, Chemical composition, Testing of concrete, Hydration of cement, Structure of hydrated cement, special cements. Water Chemical admixtures, Mineral admixture.

UNIT II TESTS ON CONCRETE **9**

Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and shrinkage – Durability of concrete – Micro structural Characterization (SEM, EDAX, TGA, XRD, FTIX, XRF).

UNIT III MIX DESIGN **9**

Principles of concrete mix design, Methods of concrete mix design, IS Method, ACI Method, DOE Method – Statistical quality control – Sampling and acceptance criteria.

UNIT IV SPECIAL CONCRETE **9**

Light weight concrete, Fly ash concrete, Fibre reinforced concrete, Sulphur impregnated concrete, Polymer Concrete – High performance concrete. High performance fiber reinforced concrete, SelfCompacting-Concrete, Geo Polymer Concrete, Waste material based concrete – Ready mixed concrete.

UNIT V CONCRETING METHODS **9**

Process of manufacturing of concrete, methods of transportation, placing and curing. Extreme weather concreting, special concreting methods. Vacuum dewatering – Underwater Concrete.

Total: 45 Hours

OUTCOME:

- On completion of this course the students will know various tests on fresh, hardened concrete, special concrete and the methods of manufacturing of concrete.

REFERENCES:

1. Gambhir.M.L., Concrete Technology, McGraw Hill Education, 2006.
2. Gupta.B.L., Amit Gupta, “Concrete Technology, Jain Book Agency, 2010.
3. Neville, A.M., Properties of Concrete, Prentice Hall, 1995, London.
4. Job Thomas, “Concrete Technology”, Cencage Learning India Pvt Ltd. New Delhi 2015.
5. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi, 2003.

192CEE002T	MAINTENANCE AND REHABILITATION OF STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To study the damages, repair and rehabilitation of structures.

UNIT I INTRODUCTION **9**

General Consideration – Distresses monitoring – Causes of distresses – Quality assurance – Defects due to climate, chemicals, wear and erosion – Inspection – Structural appraisal – Economic appraisal.

UNIT II BUILDING CRACKS **9**

Causes – diagnosis – Thermal and Shrinkage cracks – unequal loading – Vegetation and trees – Chemical action – Foundation movements – Remedial measures - Techniques for repair – Epoxy injection.

UNIT III MOISTURE PENETRATION **9**

Sources of dampness – Moisture movement from ground – Reasons for ineffective DPC – Roof leakage – Pitched roofs – Madras Terrace roofs – Membrane treated roofs - Leakage of Concrete slabs – Dampness in solid walls – condensation – hygroscopic salts – remedial treatments – Ferro cement overlay – Chemical coatings – Flexible and rigid coatings.

UNIT IV DISTRESSES AND REMEDIES **9**

Concrete Structures: Introduction – Causes of deterioration – Diagnosis of causes – Flow charts for diagnosis – Materials and methods of repair – repairing, spalling and disintegration – Repairing of concrete floors and pavements.

Steel Structures : Types and causes for deterioration – preventive measures – Repair procedure – Brittle fracture – Lamellar tearing – Defects in welded joints – Mechanism of corrosion – Design of protect against corrosion – Design and fabrication errors – Distress during erection.

Masonry Structures: Discoloration and weakening of stones – Biotical treatments – Preservation – Chemical preservatives – Brick masonry structures – Distresses and remedial measures.

UNIT V STRENGTHENING OF EXISTING STRUCTURES **9**

General principle – relieving loads – Strengthening super structures – plating – Conversation to composite construction – post stressing – Jacketing – bonded overlays – Reinforcement addition – strengthening substructures – under pinning – Enhancing the load capacity of footing – Design for rehabilitation.

Total: 45 Hours

OUTCOME:

- At the end of this course students will be in a position to point out the causes of distress in concrete, masonry and steel structures and also they will be able to suggest the remedial measures.

REFERENCES:

1. Allen R.T and Edwards S.C, “Repair of Concrete Structures”, Blakie and Sons, UK, 1987
2. Dayaratnam.P and Rao.R, “Maintenance and Durability of Concrete Structures”, University Press, India, 1997.
3. Denison Campbell, Allen and Harold Roper, “Concrete Structures, Materials, Maintenance and Repair”, Longman Scientific and Technical, UK, 1991.
4. Dodge Woodson.R,”Concrete Structures – protection, repair and rehabilitation”, Elsevier Butterworth – Heinmann, UK, 2009.
5. Peter H.Emmons, “Concrete Repair and Maintenance Illustrated”, Galgotia Publications Pvt. Ltd., 2001.
6. Raikar, R.N., “Learning from failures - Deficiencies in Design, Construction and Service” – Rand D Centre (SDCPL), Raikar Bhavan, Bombay, 1987.

192CEE003T	SMART MATERIALS AND SMART STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To give an exposure on measuring techniques, sensors and actuators.

UNIT I - INTRODUCTION **9**

Properties of smart materials - mechanisms – instrumented structures functions and response sensing system – self diagnosis – signal processing consideration – actuation systems and effectors

UNIT II - MEASURING TECHNIQUES **9**

Strain measuring techniques using electrical strain gauges, types – resistance-capacitance – inductance-wheatstone bridges-pressure transducers-load cells- temperature compensation –strain rosettes

UNIT III - SENSORS AND ACTUATORS **9**

Sensing technology – types of sensors – physical measurement using piezo electric strain measurement – inductively read transducers – LVDT – fiber techniques - fiber optic strain sensors - Actuator techniques – Actuator and Actuator materials - piezo electric and electro resistive material – magneto structure material – shape memory alloys – electro ortheological fluids – electromagnetic actuation – role of actuators and actuator materials

UNIT IV - SIGNAL PROCESSING AND CONTROL SYSTEMS **9**

Data Acquisition and processing – signal processing and control for smart structures – sensors as geometrical processors – signal processing – control system – linear and non linear.

UNIT V - INTRODUCTION TO STRUCTURAL HEALTH MONITORING (SHM) **9**

Definition & motivation for SHM, SHM – a way for smart materials and structures – SHM and bio mimetic – analog between the nervous system of a man and a structure with SHM, SHM as a part of system management, Passive and Active SHM, NDE, SHM and NDECS – basic components of SHM – Applications – SHM of a bridge – applications for external post tensioned cables, monitoring historical buildings.

Total: 45 Hours

OUTCOME:

- On completion of this course the students are able to Gain knowledge on smart materials, function and response sensing systems and structures. Familiarize about Structural Health Monitoring system and its application in civil field.

REFERENCES:

1. Brain Culshaw, **"Smart structures and mateials Artech – Borton",** London.
2. L.S.Srinath, **"Experimental stress analysis",** Tata McGraw Hill, 1998.
3. J.W.Dally & W.F. **"Riley, Experimental stress analysis",** Tata McGraw Hill, 1998.
4. Daniel Balageas, Claus - Peter FritzenamI Alfredo Guemes, **"Structural Health Monitoring",** Published by ISTE Ltd., U.K. 2006.
5. Guide Book on Non-destructive Testing of Concrete Structures,Training course series No. 17,International Atomic Energy Agency,Vienna, 2002.
6. Hand book on **"Repair and Rehabilitation of RCC Buildings",** Published by Director General, CPWD, Govt. of India, 2002.
7. Hand Book on Seismic Retrofitting of Buildings, Published by CPWD & Indian Building Congress in Association with IIT, Madras, Narosa Publishing House, 2008.

192CEE004T	MATRIX METHODS FOR STRUCTURAL ANALYSIS	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To Study the Energy Concepts in Structures, Characteristics and Transformation of Structures using matrix approach

UNIT I ENERGY CONCEPTS IN STRUCTURES **9**

Introduction – Strain Energy – Symmetry of The Stiffness And Flexibility Matrices – Strain Energy in Terms of Stiffness And Flexibility Matrices – Stiffness And Flexibility Coefficients in Terms of Strain Energy – Additional properties of [a] and [k] – another Interpretation of coefficients aij and kij – Betti's law – Applications of Betti's law: Forces not at the coordinates – Strain energy in systems and in Elements.

UNIT II CHARACTERSTICS OF STRUCTURES – STIFFNESS AND FLEXIBILITY **9**

Introduction – Structure with Single Coordinate- Two Coordinates-Flexibility and Stiffness Matrices in Coordinates- Examples-Symmetric Nature of Matrices- Stiffness and Flexibility Matrices in Constrained Measurements- Stiffness and Flexibility of Systems and Elements-Computing Displacements and Forces form Virtual Work-Computing Stiffness and Flexibility Coefficients.

UNIT III TRANSFORMATION OF INFORMATION IN STRUTURES **9**

Determinate- Indeterminate Structures-Transformation of System Forces to Element Forces Element Flexibility to System Flexibility - System Displacement to Element Displacement-Element Stiffness to System Stiffness-Transformation of Forces and Displacements in General –Stiffness and Flexibility in General –Normal Coordinates and Orthogonal Transformation-Principle of Contregradience

UNIT IV FLEXIBILITY METHOD **9**

Statically Determinate Structures –Indeterminate Structures-Choice of Redundant Leading to Ill and Well Conditioned Matrices-Transformation to One Set of Redundant to Another-Internal Forces due to Thermal Expansion and Lack of Fit-Reducing the Size of Flexibility MatrixApplication to Pin-Jointed Plane Truss-Continuous Beams-Frames-Grids.

UNIT V STIFFNESS METHOD **9**

Introduction-Development of Stiffness Method- Stiffness Matrix for Structures with zero Force at some Coordinates-Analogy between Flexibility and Stiffness-Lack of Fit-Stiffness Matrix with Rigid Motions-Application of Stiffness Approach to Pin Jointed Plane Trusses-Continuous Beams Frames-Grids-Space Trusses and Frames-Introduction Only-Static Condensation Technique Choice of Method-Stiffness or Flexibility.

Total: 45 Hours

OUTCOME:

- On completion of this course students will be able to use matrix approach for solving structural engineering problems
- Students will have a thorough understanding of both flexibility and stiffness approach of analysis.

REFERENCES:

1. Rubinstein.F.M., " Matrix Computer Methods of Structural Analysis", Prentice Hall, Inc. N.J., 1966
2. Dr. Devadas Menon., "Advanced Structural Analysis", Narosa Publishing House, New Delhi, 2009
3. Pandit G.S. and Gupta S.P., "Structural Analysis-A Matrix Approach", Tata McGraw-Hill PublishingCompany Limited, New Delhi, 1997
4. Reddy C.S., "Basic Structural Analysis", Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997

192CEE005T	PREFABRICATED STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To Study the design principles, analysis and design of elements**.**

UNIT I DESIGN PRINCIPLES 9

General Civil Engineering requirements, specific requirements for planning and layout of prefabrication plant. IS Code specifications. Modular co-ordination, standardization, Disuniting of Prefabricates, production, transportation, erection, stages of loading and code provisions, safety factors, material properties, Deflection control, Lateral load resistance, Location and types of shear walls.

UNIT II REINFORCED CONCRETE 9

Prefabricated structures - Long wall and cross-wall large panel buildings, one way and two way prefabricated slabs, Framed buildings with partial and curtain walls, -Connections – Beam to column and column to column.

UNIT III FLOORS, STAIRS AND ROOFS 9

Types of floor slabs, analysis and design example of cored and panel types and two-way systems, staircase slab design, types of roof slabs and insulation requirements, Description of joints, their behaviour and reinforcement requirements, Deflection control for short term and long term loads, Ultimate strength calculations in shear and flexure.

UNIT IV WALLS 9

Types of wall panels, Blocks and large panels, Curtain, Partition and load bearing walls, load transfer from floor to wall panels, vertical loads, Eccentricity and stability of wall panels, Design Curves, types of wall joints, their behaviour and design, Leak prevention, joint sealants, sandwich wall panels, approximate design of shear walls.

UNIT V INDUSTRIAL BUILDINGS AND SHELL ROOFS 9

Components of single-storey industrial sheds with crane gantry systems, R.C. Roof Trusses, Roof Panels, corbels and columns, wind bracing design. Cylindrical, Folded plate and hyper-prefabricated shells, Erection and jointing, joint design, hand book based design.

Total: 45 Hours

OUTCOME:

- At the end of this course student will have good knowledge about the prefabricated elements and the technologies used in fabrication and erection.
- They will be in a position to design floors, stairs, roofs, walls and industrial buildings, and various joints for the connections.

REFERENCES:

1. Koncz.T., Manual of Precast Concrete Construction, Vol.I II and III & IV Bauverlag,1971.
2. Laszlo Mokk, Prefabricated Concrete for Industrial and Public Structures, Akademiai Kiado, Budapest, 2007.
3. Lewicki.B, Building with Large Prefabricates, Elsevier Publishing Company, Amsterdam/ London/New York, 1998.
4. Structural Design Manual, Precast Concrete Connection Details, Society for the Studies in the use of Precase Concrete, Netherland Betor Verlag, 2009.
5. Warszawski, A., Industrialization and Robotics in Building - A managerial approach, Harper and Row, 1990.

192CEE006T	PRESTRESSED CONCRETE STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- Principle of prestressing, analysis and design of prestressed concrete structures**.**

UNIT I PRINCIPLES OF PRESTRESSING 9

Basic concepts of Prestressing - Types and systems of prestressing - Need for High Strength materials, Analysis methods, losses of prestress – Short and Long term deflections – Cable layouts.

UNIT II DESIGN OF FLEXURAL MEMBERS 9

Behaviour of flexural members, determination of ultimate flexural strength – Various Codal provisions - Design of flexural members, Design for shear, bond and torsion. Transfer of prestress – Box girders.

UNIT III DESIGN OF CONTINUOUS AND CANTILEVER BEAM 9

Analysis and design of continuous beams - Methods of achieving continuity - concept of linear transformations, concordant cable profile and gap cables – Analysis and design of cantilever beams.

UNIT IV DESIGN OF TENSION AND COMPRESSION MEMBERS 9

Design of tension members - application in the design of prestressed pipes and prestressed concrete cylindrical water tanks - Design of compression members with and without flexure - its application in the design piles, flag masts and similar structures.

UNIT V DESIGN OF COMPOSITE MEMBERS 9

Composite beams - analysis and design, ultimate strength - their applications. Partial prestressing - its advantages and applications.

Total: 45 Hours

OUTCOME:

- On completion of this course students will have sufficient knowledge on various methods of prestressing and the concepts of partial pre-stressing.
- They will be in a position to design beams, pipes, water tanks, posts and similar structures.

REFERENCES:

1. Arthur H. Nilson, “Design of Prestressed Concrete”, John Wiley and Sons Inc, New York, 2004.
2. Krishna Raju, “Prestressed Concrete”, Tata McGraw Hill Publishing Co., New Delhi, 2008.
3. Lin.T.Y.,and Burns.H “Design of Prestressed Concrete Structures”, John Wiley and Sons Inc, New York, 2009.
4. Rajagopalan.N, “Prestressed Concrete”, Narosa Publications, New Delhi, 2008.
5. Sinha.N.C.and.Roy.S.K, “Fundamentals of Prestressed Concrete”, S.Chand and Co., 1998.
7. Hand book on seismic retrofit of Building by CPWD and IIT Madras,2003.

192CEE007T	THEORY OF PLATES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To study the behaviour and analysis of thin plates and the behaviour of anisotropic and thick plates.

UNIT I INTRODUCTION TO PLATES THEORY **9**

Thin Plates with small deflection. Laterally loaded thin plates, governing differential equation, various boundary conditions.

UNIT II RECTANGULAR PLATES **9**

Rectangular plates. Simply supported rectangular plates, Navier solution and Levy's method, Rectangular plates with various edge conditions, plates on elastic foundation.

UNIT III CIRCULAR PLATES **9**

Simply supported solid circular plates subjected to UDL of intensity and end moment – Solid circular plate fixed or clamped along the boundaries – Circular plates subjected to Asymmetric load.

UNIT IV SPECIAL AND APPROXIMATE METHODS. **9**

Energy methods, Ritz method, Galerkin Method, Finite Element Method.

UNIT V ANISOTROPIC PLATES AND THICK PLATES **9**

Orthotropic plates and grids, moderately thick plates.

Total: 45 Hours

OUTCOME:

- At the end of this course students will be able to analyze different types of plates (rectangular and circular) under different boundary connections by various classical methods and approximate methods.

- They will also know behavior of orthotropic and thick plates and grids.

REFERENCES:

1. Ansel C.Ugural, ”Stresses in plate and shells”, McGraw Hill International Edition, 1999.
2. Bairagi, “Plate Analysis”, Khanna Publishers, 1996.
3. Chandrashekahara, K. Theory of Plates, University Press (India) Ltd., Hyderabad, 2001.
4. Reddy J N, “Theory and Analysis of Elastic Plates and Shells”, McGraw Hill Book Company, 2006.
5. Szilard, R., “Theory and Analysis of Plates – classical and numerical methods, Prentice Hall Inc., 2004.
6. Timoshenko.S.P, and Krieger S.W. “Theory of Plates and Shells”, McGraw Hill Book Company, New York, 2003.
7. Bulson.P.S.,”Stability Of Flat Plates.,American Elsevier Publisher. Co.,1969.

192CEE008T	STABILITY OF STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To study the concept of buckling and analysis of structural elements

UNIT I BUCKLING OF COLUMNS **9**

States of equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem. Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy methods. Approximate methods - Rayleigh Ritz, Galerkins approach - Numerical Techniques - Finite difference method - Effect of shear on buckling.

UNIT II BUCKLING OF BEAM-COLUMNS AND FRAME **9**

Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributed load and end couples Analysis of rigid jointed frames with and without sway – Use of stability function to determine the critical load.

UNIT III TORSIONAL AND LATERAL BUCKLING **9**

Torsional buckling – Combined Torsional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions. Lateral buckling of beams, pure bending of simply supported and cantilever beams.

UNIT IV BUCKLING OF PLATES **9**

Governing differential equation - Buckling of thin plates, various edge conditions -Analysis by equilibrium and energy approach – Finite difference method.

UNIT V INELASTIC BUCKLING **9**

Double modulus theory - Tangent modulus theory - Shanley's model - Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behaviour of plates.

Total: 45 Hours

OUTCOME:

- On completion of this course student will know the phenomenon of buckling and they are in a position to calculate the buckling load on column, beam – column, frames and plates using classical and approximate methods.

REFERENCES:

1. Ashwini Kumar, "Stability Theory of Structures", Allied publishers Ltd., New Delhi, 2003.
2. Chajes, A. "Principles of Structures Stability Theory", Prentice Hall, 1974.
3. Gambhir, "Stability Analysis and Design of Structures", springer, New York, 2004.
4. Simitser.G.J and Hodges D.H, "Fundamentals of Structural Stability", Elsevier Ltd., 2006.
5. Timoshenko.S.P, and Gere.J.M, "Theory of Elastic Stability", McGraw Hill Book Company, 1963.

192CEE009T **OPTIMIZATION OF STRUCTURES** **L T P R C**
3 0 0 0 3

OBJECTIVE:

- To study the optimization methodologies applied to structural engineering

UNIT I BASIC PRINCIPLES AND CLASSICAL OPTIMIZATION TECHNIQUES 9

Definition - Objective Function; Constraints - Equality and inequality - Linear and non-linear, Side, Non-negativity, Behaviour and other constraints - Design space - Feasible and infeasible - Convex and Concave - Active constraint - Local and global optima. Differential calculus - Optimality criteria - Single variable optimization - Multivariable optimization with no constraints - (Lagrange Multiplier method) - with inequality constraints (Khun - Tucker Criteria).

UNIT II LINEAR AND NON-LINEAR PROGRAMMING 9

LINEAR PROGRAMMING: Formulation of problems - Graphical solution - Analytical methods - Standard form - Slack, surplus and artificial variables - Canonical form - Basic feasible solution - simplex method - Two phase method - Penalty method - Duality theory - Primal - Dual algorithm.

NON LINEAR PROGRAMMING: One Dimensional minimization methods: Unidimensional - Unimodal function - Exhaustive and unrestricted search - Dichotomous search - Fibonacci Method - Golden section method - Interpolation methods. Unconstrained optimization Techniques.

UNIT III GEOMETRIC PROGRAMMING 9

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

UNIT IV DYNAMIC PROGRAMMING 9

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

UNIT V STRUCTURAL APPLICATIONS 9

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

Total: 45 Hours

OUTCOME:

- On completion of this course students will have sufficient knowledge on various optimization techniques like linear programming, non-linear programming, geometric and dynamic programming and they will also in a position to design various structural elements for minimum weight.

REFERENCES:

1. Iyengar.N.G.R and Gupta.S.K, "Structural Design Optimization", Affiliated East West Press Ltd, New Delhi, 1997
2. Rao,S.S. "Optimization theory and applications", Wiley Eastern (P) Ltd., 1984
3. Spunt, "Optimization in Structural Design", Civil Engineering and Engineering Mechanics Services, Prentice-Hall, New Jersey 1971.
4. Uri Krish, "Optimum Structural Design", McGraw Hill Book Co. 1981

192CEE010T	DESIGN OF TALL BUILDINGS	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To study the behaviour, analysis and design of tall structures.

UNIT I LOADING AND DESIGN PRINCIPLES 9

Loading- sequential loading, Gravity loading, Wind loading, Earthquake loading, - Equivalent lateral force, modal analysis - combination of loading, – Static and Dynamic approach - Analytical and wind tunnel experimental methods - Design philosophy - working stress method, limit state method and plastic design.

UNIT II EHAVIOUR OF VARIOUS STRUCTURAL SYSTEMS 9

Factors affecting growth, height and structural form. High rise behaviour, Rigid frames, braced frames, In filled frames, shear walls, coupled shear walls, wall-frames, tubulars, cores, outrigger - braced and hybrid mega systems.

UNIT III ANALYSIS AND DESIGN 9

Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of buildings as total structural system considering overall integrity and major subsystem interaction, Analysis for member forces, drift and twist - Computerized three dimensional analysis – Assumptions in 3D analysis – Simplified 2D analysis.

UNIT IV STRUCTURAL ELEMENTS 9

Sectional shapes, properties and resisting capacity, design, deflection, cracking, prestressing, shear flow, Design for differential movement, creep and shrinkage effects, temperature effects and fire resistance.

UNIT V STABILITY ISSUES 9

Overall buckling analysis of frames, wall-frames, Approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first-order and P-Delta analysis, Translational, Torsional instability, out of plumb effects, stiffness of member in stability, effect of foundation rotation.

Total: 45 Hours

OUTCOME:

- On completion of this course students will be able to know the behavior of tall buildings due to various types of loads.
- They will be able to analyze and design such buildings by approximate, accurate and simplified methods.

REFERENCES:

1. Taranath B.S., “Structural Analysis and Design of Tall Buildings”, McGraw Hill, 1988.
2. Beedle.L.S., “Advances in Tall Buildings”, CBS Publishers and Distributors, Delhi, 1986.
3. Bryan Stafford Smith and Alexcoull, “Tall Building Structures - Analysis and Design”, John Wiley and Sons, Inc., 2005.
4. Gupta.Y.P.,(Editor), Proceedings of National Seminar on High Rise Structures - Design and Construction Practices for Middle Level Cities, New Age International Limited, New Delhi,1995.
5. Lin T.Y and Stotes Burry D, “Structural Concepts and systems for Architects and Engineers”, John Wiley, 1988.

192CEE011T	DESIGN OF STEEL - CONCRETE COMPOSITE STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To develop an understanding of the behaviour and design concrete composite elements and structures.

UNIT I INTRODUCTION **9**

Introduction to steel - concrete composite construction – Codes – Composite action – Serviceability and Construction issues in design.

UNIT II DESIGN OF COMPOSITE MEMBERS **9**

Design of composite beams, slabs, columns, beam – columns - Design of composite trusses.

UNIT III DESIGN OF CONNECTIONS **9**

Shear connectors – Types – Design of connections in composite structures – Design of shear connectors – Partial shear interaction.

UNIT IV COMPOSITE BOX GIRDER BRIDGES **9**

Introduction - behaviour of box girder bridges - design concepts.

UNIT V CASE STUDIES **9**

Case studies on steel - concrete composite construction in buildings - seismic behaviour of composite structures.

Total: 45 Hours

OUTCOME:

- At the end of this course students will be in a position to design composite beams, columns, trusses and box-girder bridges including the related connections.
- They will get exposure on case studies related to steel-concrete constructions of buildings.

REFERENCES:

1. Johnson R.P., “Composite Structures of Steel and Concrete Beams, Slabs, Columns and Frames for Buildings”, Vol.I, Blackwell Scientific Publications, 2004.
2. Oehlers D.J. and Bradford M.A., “Composite Steel and Concrete Structural Members, Fundamental behaviour”, Pergamon press, Oxford, 1995.
3. Owens.G.W and Knowles.P, ”Steel Designers Manual”, Steel Concrete Institute(UK), Oxford Blackwell Scientific Publications, 1992.

192CEE012T	DESIGN OF BRIDGES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

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

UNIT I GENERAL INTRODUCTION AND SHORT SPAN RC BRIDGES 9

Types of bridges and loading standards - Choice of type - I.R.C. specifications for road bridges – Design of RCC solid slab bridges - analysis and design of slab culverts, Tee beam and slab bridges.

UNIT II LONG SPAN RC BRIDGES 9

Design principles of continuous girder bridges, box girder bridges, balanced cantilever bridges – Arch bridges – Box culverts – Segmental bridges.

UNIT III PRESTRESSED CONCRETE BRIDGES 9

Flexural and torsional parameters – Courbon's theory – Distribution co-efficient by exact analysis – Design of girder section – maximum and minimum prestressing forces – Eccentricity – Live load and dead load shear forces – Cable Zone in girder – check for stresses at various sections – check for diagonal tension – Diaphragms – End block – short term and long term deflections.

UNIT IV STEEL BRIDGES 9

General – Railway loadings – dynamic effect – Railway culvert with steel beams – Plate girder bridges – Box girder bridges – Truss bridges – Vertical and Horizontal stiffeners.

UNIT V BEARINGS AND SUBSTRUCTURES 9

Different types of bearings – Design of bearings – Design of piers and abutments of different types – Types of bridge foundations – Design of foundations.

Total: 45 Hours

OUTCOME:

- At the end of this course students will be able to design different types of RCC bridges, Steel bridges and pre-stressed concrete bridges with the bearings and substructures.

REFERENCES:

1. Jagadeesh.T.R. and Jayaram.M.A., "Design of Bridge Structures", Prentice Hall of India Pvt. Ltd. 2004.
2. Johnson Victor, D. "Essentials of Bridge Engineering", Oxford and IBH Publishing Co. New Delhi, 2001.
3. Ponnuswamy, S., "Bridge Engineering", Tata McGraw Hill, 2008.
4. Raina V.K." Concrete Bridge Practice" Tata McGraw Hill Publishing Company, New Delhi, 1991.

192CEE013T	DESIGN OF SUB STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To gain familiarity with different types of foundation.
- To expose the students to the design of shallow foundations and deep foundations.
- To understand the concepts of designing well, machine and special foundations.

UNIT I SHALLOW FOUNDATIONS **9**

Soil investigation – Basic requirements of foundation – Types and selection of foundations. Bearing capacity of soil - plate load test – Design of reinforced concrete isolated, strip, combined and strap footings – mat foundation.

UNIT II PILE FOUNDATIONS **9**

Introduction – Types of pile foundations – load carrying capacity - pile load test – structural design of straight piles –configuration of piles- different shapes of piles cap – structural design of pile cap.

UNIT III WELL FOUNDATIONS **9**

Types of well foundation – Grip length – load carrying capacity – construction of wells – Failures and Remedies – Design of well foundation – Lateral stability.

UNIT IV MACHINE FOUNDATIONS **9**

Introduction – Types of machine foundation – Basic principles of design of machine foundation – Dynamic properties of soil – vibration analysis of machine foundation – Design of foundation for Reciprocating machines and Impact machines – Reinforcement and construction details – vibration isolation.

UNIT V SPECIAL FOUNDATIONS **9**

Foundation on expansive soils – choice of foundation – under-reamed pile foundation. Foundation for concrete Towers, chimneys – Design of anchors- Reinforced earth retailing walls.

Total: 45 Hours

OUTCOME:

- On completion of this course students will be able to select appropriate foundation type based on available soil conditions.
- They will be in a position to determine the load carrying capacity of each type of foundation.
- They will gain thorough knowledge about the design of reinforced concrete shallow foundations, pile foundations, well foundations, and machine foundations.

REFERENCES:

1. Bowles .J.E., “Foundation Analysis and Design”, McGraw Hill Publishing co., New York, 1997.
2. Swamy Saran, Analysis and Design of substructures, Oxford and IBH Publishing Co. Pvt. Ltd., 2006.
3. Tomlinson.M.J, “Foundation Design and Construction”, Longman, Sixth Edition, New Delhi, 1995.
4. Varghese.P.C, “Design of Reinforced Concrete Foundations” – PHI learning private limited, New Delhi – 2009.

192CEE014T	INDUSTRIAL STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To study the requirements, planning and design of Industrial structures**.**

UNIT I PLANNING AND FUNCTIONAL REQUIREMENTS 9

Classification of Industries and Industrial structures - planning for Layout Requirements regarding Lighting, Ventilation and Fire Safety - Protection against noise and vibration - Guidelines of Factories Act.

UNIT II INDUSTRIAL BUILDINGS 9

Steel and RCC - Gantry Girder, Crane Girders - Design of Corbels and Nibs – Design of Staircase.

UNIT III POWER PLANT STRUCTURES 9

Types of power plants – Containment structures - Cooling Towers - Bunkers and Silos - Pipe supporting structures

UNIT IV TRANSMISSION LINE STRUCTURES AND CHIMNEYS 9

Analysis and design of steel monopoles, transmission line towers – Sag and Tension calculations, Methods of tower testing – Design of self supporting and guyed chimney, Design of Chimney bases.

UNIT V FOUNDATION 9

Design of foundation for Towers, Chimneys and Cooling Towers - Machine Foundation - Design of Turbo Generator Foundation.

Total: 45 Hours

OUTCOME:

- On completion of this course student will be able to plan industrial structures for functional requirements.
- They will be able to design various structures such as Bunkers, Silos, Cooling Towers, Chimneys, and Transmission Towers with required foundations.

REFERENCES:

1. Jurgen Axel Adam, Katharria Hausmann, Frank Juttner, Klauss Daniel, Industrial Buildings: A Design Manual, Birkhauser Publishers, 2004.
2. Manohar S.N, Tall Chimneys - Design and Construction, Tata McGraw Hill, 1985
3. Santhakumar A.R. and Murthy S.S., Transmission Line Structures, Tata McGraw Hill,1992.
4. Srinivasulu P and Vaidyanathan.C, Handbook of Machine Foundations, Tata McGraw Hill, 1976.

192CEE015T	WIND AND CYCLONE EFFECTS ON STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

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

UNIT I INTRODUCTION **9**

Introduction, Types of wind – Characteristics of wind – Wind velocity, Method of measurement, variation of speed with height, shape factor, aspect ratio, drag effects - Dynamic nature of wind – Pressure and suctions - Spectral studies, Gust factor.

UNIT II WIND TUNNEL STUDIES **9**

Wind Tunnel Studies, Types of tunnels, - Prediction of acceleration – Load combination factors – Wind tunnel data analysis – Calculation of Period and damping value for wind design - Modeling requirements, Aero dynamic and Aero-elastic models.

UNIT III EFFECT OF WIND ON STRUCTURES **9**

Classification of structures – Rigid and Flexible – Effect of wind on structures - Static and dynamic effects on Tall buildings – Chimneys.

UNIT IV DESIGN OF SPECIAL STRUCTURES **9**

Design of Structures for wind loading – as per IS, ASCE and NBC code provisions – design of Tall Buildings – Chimneys – Transmission towers and steel monopoles– Industrial sheds.

UNIT V CYCLONE EFFECTS **9**

Cyclone effect on – low rise structures – sloped roof structures - Tall buildings. Effect of cyclone on claddings – design of cladding – use of code provisions in cladding design – Analytical procedure and modeling of cladding.

Total: 45 Hours

OUTCOME:

- On completion of this course, students will be able to design high rise structures subjected wind load, even structures exposed to cyclone.
- Students will be conversant with various code provisions for the design of structures for wind load.

REFERENCES:

1. Cook.N.J., “The Designer's Guide to Wind Loading of Building Structures”, Butterworths, 1989.
2. Kolousek.V, Pirner.M, Fischer.O and Naprstek.J, “Wind Effects on Civil Engineering Structures”, Elsevier Publications, 1984
3. Lawson T.V., “Wind Effects on Building Vol. I and II”, Applied Science Publishers, London, 1980.
4. Peter Sachs, “Wind Forces in Engineering”, Pergamon Press, New York, 1978.

192CEE016T	OFFSHORE STRUCTURES	L	T	P	R	C
		3	0	0	0	3

OBJECTIVE:

- To study the concept of wave theories, forces and design of jacket towers, pipes and cables**.**

UNIT I WAVE THEORIES **9**

Wave generation process, small, finite amplitude and nonlinear wave theories.

UNIT II FORCES OF OFFSHORE STRUCTURES **9**

Wind forces, wave forces on small bodies and large bodies - current forces - Morison equation.

UNIT III OFFSHORE SOIL AND STRUCTURE MODELLING **9**

Different types of offshore structures, foundation modeling, fixed jacket platform structural modeling.

UNIT IV STEEL BRIDGES **9**

Static method of analysis, foundation analysis and dynamics of offshore structures.

UNIT V BEARINGS AND SUBSTRUCTURES **9**

Design of platforms, helipads, Jacket tower, analysis and design of mooring cables and pipelines.

Total: 45 Hours

OUTCOME:

- On completion of this course students will be able to determine the forces due to ocean waves and analyze and design offshore structures like platform, helipads, jackets, towers etc.,

REFERENCES:

1. API RP 2A-WSD, Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design - API Publishing Services, 2005
2. Chakrabarti, S.K., Handbook of Offshore Engineering by, Elsevier, 2005.
3. Chakrabarti, S.K., Hydrodynamics of Offshore Structures, WIT press, 2001.
4. Dawson.T.H., Offshore Structural Engineering, Prentice Hall Inc Englewood Cliffs, N.J. 1983.
5. James F. Wilson, Dynamics of Offshore Structures, John Wiley & Sons, Inc, 2003.
6. Reddy, D.V. and Arockiasamy, M., Offshore Structures, Vol.1 and Vol.2, Krieger Publishing Company, 1991.
7. Turgut Sarpkaya, Wave Forces on Offshore Structures, Cambridge University Press, 2010.
8. Reddy.D.V and Swamidas A.S.J.,Essential of offshore structures.CRC Press.2013