KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADUINDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI - 2020

(CHOICE BASED CREDIT SYSTEM AND
OUTCOME BASED EDUCATION)
(For the students admitted during 2020 - 2021 and onwards)

MASTER OF ENGINEERINGDEGREE
IN
STRUCTURAL ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

KONGU
Assuring the Best

INDEX

KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Provide value based quality education for developing the student as a competent and responsible citizen
- Contribute to the nation and beyond through the state-of-the-art technology
- Continuously improve our services

DEPARTMENT OF CIVIL ENGINEERING

VISION

To develop the department as a center of excellence to take care of the local and regional needs related to Civil Engineering and to meet acute needs of trained specialists in the diverse field of Civil Engineering.

MISSION

Department of Civil Engineering is committed to:

MS1: To impart quality Education through effective teaching learning methods

MS2: To encourage students to pursue research activities and to collaborate with industries to promote consultancy activities.

MS3: To develop engineers who can participate in the technical advancement and social upliftment of the society

2020 REGULATIONS
PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Post Graduates of Structural Engineering will

PEO1: Analyze, design and execute projects based on the fundamental knowledge of Civil Engineering

PEO2: Implement feasible solution to overcome societal problems using professional knowledge which results in sustainability

PEO3: Exhibit professional and ethical attitude, good communication skills and pursue life-long learning skills needed for a successful professional career

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3
MS1	3	3	2
MS2	2	3	3
MS3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)	
Structural Engineering Post Graduates will be able to:	
PO1	Independently carry out research /investigation and development work to solve practical problems
PO2	Write and present a substantial technical report/document
PO3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4	Analyze a system, component or process in the areas of Structural Engineering using classical methods and advanced tools.
PO5	Design a system, component, or process in the areas of Structural Engineering as per codal recommendations.

MAPPING OF PEOs WITH POs

PEO\PO	PO1	PO2	PO3	PO4	PO5
PEO1	2	2	3	3	3
PEO2	3	2	3	3	3
PEO3	3	3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

CURRICULUM BREAKDOWN STRUCTURE						
Summary of Credit Distribution						
Category	**Semester**				**Total number of credits**	**Curriculum Content (% of total number of credits of the program)**
	I	**II**	**III**	**IV**		
FC	**7**	**-**	**-**	**-**	**7**	**9.72**
PC	**12**	**15**	**-**	**-**	**27**	**37.50**
PE	**3**	**6**	**3**	**6**	**18**	**25.00**
EC		**2**	**9**	**9**	**20**	**27.78**
Semester wise Total	**22**	**23**	**12**	**15**	**72**	**100.00**

Category	Abbreviation
Lecture hours per week	**L**
Tutorial hours per week	**T**
Practical, Project work, Internship, Professional Skill Training, Industrial Training hours per week	**P**
Credits	**C**

CATEGORISATION OF COURSES							
FOUNDATION COURSES (FC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20AMT11	Applied Mathematics for Civil Engineers	3	1	0	4	1
2.	20GET11	Introduction to Research	2	1	0	3	1
Total Credits to be earned						7	
PROFESSIONAL CORE (PC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20SET11	Advanced Structural Analysis	3	1	0	4	1
2.	20SET12	Design of Concrete Structures	3	0	0	3	1
3.	20SET13	Design of Steel Structures	3	0	0	3	1
4.	20SEL11	Computer Aided Design and Drafting Laboratory I	0	0	2	1	1
5.	20SEL12	Advanced Structural Engineering Laboratory	0	0	2	1	1
6.	20SET21	Theory of Elasticity & Plasticity	3	1	0	4	2

7.	20SET22	Design and Detailing of Earthquake Resistant Structures	3	1	0	4	2
8.	20SET23	Design of Prestressed and Prefabricated Structures	3	0	0	3	2
9.	20SET24	Theory of Structural Stability	3	0	0	3	2
10.	20SEL21	Computer Aided Design and Drafting Laboratory II	0	0	2	1	2
Total Credits to be earned						27	
PROFESSIONAL ELECTIVE (PE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
		Elective 1					
1.	20SEE01	Experimental Methods and Model Analysis	3	0	0	3	1
2.	20SEE02	Soil-Structure Interaction	3	0	0	3	1
3.	20SEE03	Structural Dynamics	3	0	0	3	1
		Elective 2 & 3					
4.	20SEE04	Optimization of Structures	3	0	0	3	2
5.	20SEE05	Fracture Mechanics of Concrete Structures	3	0	0	3	2
6.	20SEE06	Design of Plates and Shells	3	0	0	3	2
7.	20SEE07	Design of Industrial Structures	3	0	0	3	2
8.	20SEE08	Finite Element Analysis	3	0	0	3	2
9.	20SEE09	Mechanics of Composite Materials and Structures	3	0	0	3	2
		Elective 4					
10.	20SEE10	Structural Health Monitoring	3	0	0	3	3
11.	20SEE11	Design of Bridges	3	0	0	3	3
12.	20SEE12	Design of Tall Structures	3	0	0	3	3
		Elective 5&6					
13.	20SEE13	Design of Off Shore Structures	3	0	0	3	4
14.	20SEE14	Design of Steel Concrete Composite Structures	3	0	0	3	4
15.	20SEE15	Design of Substructures	3	0	0	3	4
16.	20SEE16	Metro Transportation System and Engineering	3	0	0	3	4
17.	20SEE17	Energy Efficient Buildings	3	0	0	3	4
18.	20SEE18	Machine Foundations	3	0	0	3	4

19.	20SEE19	Maintenance and Rehabilitation of Structures	3	0	0	3	4
20.	20SEE20	Green Building Management	3	0	0	3	4
21.		Innovation, Entrepreneurship & Venture development	3	0	0	3	4
Total Credits to be earned						18	
EMPLOYABILITY ENHANCEMENT COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20SEP21	Innovative project	0	0	4	2	2
2.	20SEP31	Industrial Project / Internship	0	0	18	9	3
3.	20SEP41	Project Work	0	0	18	9	4
Total Credits to be earned						20	

KEC R2020: SCHEDULING OF COURSES – ME:(Structural Engineering)

Sem.	Theory/ Theory cum Practical / Practical								Internship & Projects	Credits
	1	2	3	4	5	6	7	8	7	
I	20AMT11 Applied Mathematics for Civil Engineers (BS-3-1-0-4)	20GET11 Introduction to Research (PC-3-0-0-3)	20SET11 Advanced Structural Analysis (PC-3-1-0-4)	20SET12 Design of Concrete Structures (PC-3-0-0-3)	20SET13 Design of Steel Structures (PC-3-0-0-3)	Professional Elective - I (PE-3-0-0-3)	20SEL11 Computer Aided Design & Drafting Lab I (PC-0-0-2-1)	20SEL12 Advanced Structural Engineering (PC-0-0-2-1)		22
II	20SET21 Theory of Elasticity & Plasticity (PC-3-1-0-4)	20SET22 Design and Detailing of Earthquake Resistant Structures (PC-3-1-0-4)	18SET23 Design of Prestressed and Prefabricate d Structures (PC-3-0-0-3)	20SET24 Theory of Structural Stability (PC-3-0-0-3)	Professional Elective - II (PE-3-0-0-3)	Professional Elective –III (PE-3-0-0-3)	20SEL21 Computer Aided Design & Drafting Lab II (PC-0-0-2-1)		20SEP21 Innovative Project (EC-0-0-4-2)	23
III	Professional Elective - IV (PE-3-0-0-3)								20SEP31 Industrial project / Internship (EC-0-0-18-9)	12
IV	Professional Elective - V (PE-3-0-0-3)	Professional Elective - VI (PE-3-0-0-3)							20SEP41 Project Work (EC-0-0-18-9)	15

Total Credits: 72

MAPPING OF COURSES WITH PROGRAM OUTCOMES							
Sem.	**Course Code**	**Course Title**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
1	20AMT11	Applied Mathematics for Civil Engineers	✓	✓			
1	20GET11	Introduction to Research	✓	✓	✓		
1	20SET11	Advanced Structural Analysis	✓		✓	✓	
1	20SET12	Design of Concrete Structures	✓		✓	✓	✓
1	20SET13	Design of Steel Structures	✓		✓	✓	✓
1	20SEL11	Computer Aided Design and Drafting Laboratory I	✓	✓	✓	✓	✓
1	20SEL12	Advanced Structural Engineering Laboratory	✓	✓	✓	✓	✓
2	20SET21	Theory of Elasticity & Plasticity	✓		✓	✓	
2	20SET22	Design and Detailing of Earthquake Resistant Structures	✓		✓	✓	✓
2	20SET23	Design of Prestressed and Prefabricated Structures	✓		✓	✓	✓
2	20SET24	Theory of Structural Stability	✓		✓	✓	
2	20SEL21	Computer Aided Design and Drafting Laboratory II	✓	✓	✓	✓	✓
2	20SEP21	Innovative Project	✓	✓	✓	✓	✓
3	20SEP31	Industrial Project / Internship	✓	✓	✓	✓	✓
4	20SEP41	Project Work	✓	✓	✓	✓	✓
		Professional Elective Courses					
1	20SEE01	Experimental Methods and Model Analysis	✓		✓		
1	20SEE02	Soil-Structure Interaction	✓		✓	✓	

1	20SEE03	Structural Dynamics	✓		✓	✓	
2	20SEE04	Optimization of Structures	✓	✓	✓	✓	✓
2	20SEE05	Fracture Mechanics of Concrete Structures	✓		✓	✓	✓
2	20SEE06	Design of Plates and Shells	✓	✓	✓	✓	✓
2	20SEE07	Design of Industrial Structures	✓		✓	✓	✓
2	20SEE08	Finite Element Analysis	✓		✓	✓	
2	20SEE09	Mechanics of Composite Materials and Structures	✓		✓	✓	✓
3	20SEE10	Structural Health Monitoring	✓		✓	✓	
3	20SEE11	Design of Bridges	✓		✓	✓	✓
3	20SEE12	Design of Tall Structures	✓		✓	✓	✓
4	20SEE13	Design of Off Shore Structures	✓		✓	✓	✓
4	20SEE14	Design of Steel Concrete Composite Structures	✓		✓	✓	✓
4	20SEE15	Design of Substructures	✓		✓	✓	✓
4	20SEE16	Metro Transportation System and Engineering	✓		✓	✓	
4	20SEE17	Energy Efficient Buildings	✓		✓	✓	✓
4	20SEE18	Machine Foundations	✓		✓	✓	
4	20SEE19	Maintenance and Rehabilitation of Structures	✓		✓		
4	20SEE20	Green Building Management	✓	✓	✓		
4		Innovation, Entrepreneurship & Venture development					

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M.E. DEGREE IN STRUCTURAL ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2020-21 onwards)

SEMESTER – I

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory								
20AMT11	Applied Mathematics for Civil Engineers	3	1	0	4	50	50	100	FC
20GET11	Introduction to Research	2	1	0	3	50	50	100	FC
20SET11	Advanced Structural Analysis	3	1	0	4	50	50	100	PC
20SET12	Design of Concrete Structures	3	0	0	3	50	50	100	PC
20SET13	Design of Steel Structures	3	0	0	3	50	50	100	PC
	Professional Elective - I	3	0	0	3	50	50	100	PE
	Practical								
20SEL11	Computer Aided Design and Drafting Laboratory I	0	0	2	1	50	50	100	PC
20SEL12	Advanced Structural Engineering Laboratory	0	0	2	1	50	50	100	PC
				Total	**22**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure
*Alternate week

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M.E. DEGREE IN STRUCTURAL ENGINEERING

CURRICULUM

(For the candidates admitted from academic year 2020-21 onwards)

SEMESTER – II

Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory								
20SET21	Theory of Elasticity & Plasticity	3	1	0	4	50	50	100	PC
20SET22	Design and Detailing of Earthquake Resistant Structures	3	1	0	4	50	50	100	PC
20SET23	Design of Prestressed and Prefabricated Structures	3	0	0	3	50	50	100	PC
20SET24	Theory of Structural Stability	3	0	0	3	50	50	100	PE
	Professional Elective - II	3	0	0	3	50	50	100	PE
	Professional Elective - III	3	0	0	3	50	50	100	PE
	Practical								
20SEL21	Computer Aided Design and Drafting Laboratory II	0	0	2	1	50	50	100	PC
20SEP21	Innovative Project	0	0	4	2	100	0	100	EC
				Total	**23**				

CA – Continuous Assessment, ESE – End Semester Examination, CBS – Curriculum Breakdown Structure
*Alternate week

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M.E. DEGREE IN STRUCTURAL ENGINEERING

CURRICULUM
(For the candidates admitted from academic year 2020-21 onwards)

SEMESTER – III

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
	Professional Elective - IV	3	0	0	3	50	50	100	PE
20SEP31	Industrial Project / Internship	0	0	18	9	50	50	100	EC
	Total				**12**				

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CURRICULUM
(For the candidates admitted from academic year 2020-21 onwards)

SEMESTER – IV

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			CBS
		L	T	P		CA	ESE	Total	
	Theory/Theory with Practical								
	Professional Elective - V	3	0	0	3	50	50	100	PE
	Professional Elective - VI	3	0	0	3	50	50	100	PE
	Practical								
20SEP41	Project Work	0	0	18	9	50	50	100	EC
	Total				**15**				

Total Credits: 72

LIST OF PROFESSIONAL ELECTIVES						
Course Code	**Course Title**	**Hours/Week**			**Credit**	**CBS**
		L	**T**	**P**		
Semester I						
20SEE01	Experimental Methods and Model Analysis	3	0	0	3	PE
20SEE02	Soil-Structure Interaction	3	0	0	3	PE
20SEE03	Structural Dynamics	3	0	0	3	PE
Semester II						
20SEE04	Optimization of Structures	3	0	0	3	PE
20SEE05	Fracture Mechanics of Concrete Structures	3	0	0	3	PE
20SEE06	Design of Plates and Shells	3	0	0	3	PE
20SEE07	Design of Industrial Structures	3	0	0	3	PE
20SEE08	Finite Element Analysis	3	0	0	3	PE
20SEE09	Mechanics of Composite Materials and Structures	3	0	0	3	PE
Semester III						
20SEE10	Structural Health Monitoring	3	0	0	3	PE
20SEE11	Design of Bridges	3	0	0	3	PE
20SEE12	Design of Tall Structures	3	0	0	3	PE
Semester VI						
20SEE13	Design of Off Shore Structures	3	0	0	3	PE
20SEE14	Design of Steel Concrete Composite Structures	3	0	0	3	PE
20SEE15	Design of Substructures	3	0	0	3	PE
20SEE16	Metro Transportation System and Engineering	3	0	0	3	PE
20SEE17	Energy Efficient Buildings	3	0	0	3	PE
20SEE18	Machine Foundations	3	0	0	3	PE
20SEE19	Maintenance and Rehabilitation of Structures	3	0	0	3	PE
20SEE20	Green Building Management	3	0	0	3	PE
	Innovation, Entrepreneurship & Venture development	3	0	0	3	PE

20AMT11 APPLIED MATHEMATICS FOR CIVIL ENGINEERS
(Common to Construction Engineering & Management and Structural Engineering)

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	FC	3	1	0	4

Preamble	This course is designed to provide the solid foundation on topics in various statistical methods such as correlation and regression, principles of estimation theory and multivariate analysis which form the basis for modeling construction engineering problems and also provides a broad spectrum of mathematical techniques such as calculus of variations and tensor analysis which has wide applications in structures.	
Unit - I	**Correlation and Regression:**	**9+3**
Multiple and partial correlation – Method of least squares – Plane of regression – Properties of residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations – Regression and partial correlations in terms of lower order co - efficient.		
Unit - II	**Parameter Estimation**:	**9+3**
Point Estimation – Characteristics of estimators – Unbiasedness – Consistency – Efficiency – Sufficiency – Methods of point estimation – Method of moments –Method of Maximum likelihood.		
Unit - III	**Multivariate Analysis**:	**9+3**
Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components – Principal components from standardized variables.		
Unit - IV	**Calculus of Variations**:	**9+3**
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 – Isoperimetric problems – Direct methods – Ritz and Kantorovich methods.		
Unit - V	**Tensor Analysis:**	**9+3**
Summation convention – Contravariant and covariant vectors – Contraction of tensors – Arithmetic operations on tensors – Inner product – Metric tensor – Christoffel symbols – Covariant differentiation – Gradient - Divergence and curl.		

Lecture:45, Tutorial:15, Total:60

REFERENCES:

1	Jay L Devore, "Probability and Statistics for Engineering and the Sciences", Thomson Asia, 2002.
2	Gupta S.C. and Kapoor V.K. "Fundamentals of Mathematical Statistics" Sultan Chand and Sons,11th Edition 2002.
3	Johnson, R.A. and Wichern, D. W. "Applied Multivariate Statistical Analysis", Pearson Education, Asia, 6th Edition, 2007
4	Elsgolc, L.D., "Calculus of Variations", Dover Publications Inc., New York, 2007.
5	Kay, D. C., "Tensor Calculus", Schaum's Outline Series, Tata McGraw Hill Edition, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	measure the relationship between variables that exists in civil engineering problems.	Applying (K3)
CO2	use a sample data to compute point estimate.	Applying (K3)
CO3	perform exploratory analysis of multivariate data.	Applying (K3)
CO4	solve problems involving functional that occurs in various branches of engineering disciplines.	Applying (K3)
CO5	identify various tensors that occur in engineering problems.	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2			
CO2	2	2			
CO3	3	2			
CO4	3	2			
CO5	3	2			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	70	-	-	-	100
CAT2	10	20	70	-	-	-	100
CAT3	10	20	70	-	-	-	100
ESE	10	20	70	-	-	-	100

*** ±3% may be varied**

20GET11 INTRODUCTION TO RESEARCH
(Common to Engineering & Technology Branches)

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	FC	3	0	0	3

Preamble	This course will familiarize the fundamental concepts/techniques adopted in research, problem formulation and patenting. Also will disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.	
Unit - I	**Concept of Research:**	**9**
Meaning and Significance of Research: Skills, Habits and Attitudes for Research - Time Management - Status of Research in India. Why, How and What a Research is? - Types and Process of Research - Outcome of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords - Literature Collection – Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.		
Unit - II	**Research Methods and Journals:**	**9**
Interdisciplinary Research - Need for Experimental Investigations - Data Collection Methods - Appropriate Choice of Algorithms / Methodologies / Methods - Measurement and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations. Journals in Science/Engineering - Indexing and Impact factor of Journals - Citations - h Index - i10 Index - Journal Policies - How to Read a Published Paper - Ethical issues Related to Publishing - Plagiarism and Self-Plagiarism.		
Unit - III	**Paper Writing and Research Tools:**	**9**
Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study - When and Where to Publish? - Journal Selection Methods. Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process - Addressing Reviewer Comments. Use of tools / Techniques for Research - Hands on Training related to Reference Management Software - EndNote, Software for Paper Formatting like LaTeX/MS Office. Introduction to Origin, SPSS, ANOVA etc., Software for detection of Plagiarism.		
Unit - IV	**Effective Technical Thesis Writing/Presentation**	**9**
How to Write a Report - Language and Style - Format of Project Report - Use of Quotations - Method of Transcription Special Elements: Title Page - Abstract - Table of contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc. - Different Reference Formats. Presentation using PPTs.		
Unit - V	**Nature of Intellectual Property:**	**9**
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.		

Lecture:45,Total:45

REFERENCES:

1	DePoy, Elizabeth, and Laura N. Gitlin, “Introduction to Research-E-Book: Understanding and Applying Multiple Strategies”, Elsevier Health Sciences, 2015.
2	Walliman, Nicholas, “Research Methods: The basics”, Routledge, 2017.
3	Bettig Ronald V., “Copyrighting culture: The political economy of intellectual property”, Routledge, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	list the various stages in research and categorize the quality of journals.	Analyzing (K4)
CO2	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3	write, present a journal paper/ project report in proper format	Creating (K6)
CO4	select suitable journal and submit a research paper.	Applying (K3)
CO5	compile a research report and the presentation	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	1		
CO2	3	2	3		
CO3	3	3	1		
CO4	3	2	1		
CO5	3	2	1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		30	40	30			100
CAT2		30	40	30			100
CAT3			30	40	30		100
ESE		30	40	30			100

*** ±3% may be varied**

20SET11 ADVANCED STRUCTURAL ANALYSIS

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	1	0	4

Preamble	This course imparts knowledge on how to analyze the structure using flexibility and stiffness matrix method	
Unit - I	**Fundamental Concepts:**	**9+3**
Introduction - Forces and Displacement measurements - Principle of superposition - Methods of structural analysis - Betti's law - Stiffness and flexibility matrices of the elements - A review.		
Unit - II	**Transformation of Information:**	**9+3**
Relationship between element and system - Transformation of system force to element forces - Element flexibility to system flexibility - System displacement to element displacement - Transformation of forces and displacement in general, constrained, normal and orthogonal transformation.		
Unit - III	**Flexibility Method:**	**9+3**
Choice of redundant - ill and well-conditioned equations - Automatic choice of redundant - Rank technique - Transformation of one set of redundant to another set - Thermal expansion - Lack of fit - Application to pin-jointed plane truss - Continuous beams - Frames and grids.		
Unit - IV	**Stiffness Method:**	**9+3**
Development of stiffness method - Analogy between flexibility and stiffness - Analysis for settlement - Thermal expansion - Lack of fit - Application to pin-jointed plane truss - Continuous beams - Frames and grids -		
Unit - V	**Matrix Displacement Methods and Special Topics:**	**9+3**
Transfer Matrix Method - Symmetry and Anti symmetry of structures - Reanalysis technique - Static condensation Technique - Substructure technique. **Direct Stiffness Method:** Discrete system - Direct stiffness approach - Application to two dimensional pin-jointed trusses - Plane frames - Grids.		

Lecture: 45, Turorial:15, Total: 60

REFERENCES:

1. Mcguire and Gallagher R.H., "Matrix Structural Analysis", 2nd Edition, John Wiley, 2015.
2. Rajasekaran S. and Sankarasubramanian G., "Computational Structural Mechanics", Prentice Hall of India, New Delhi, 2001.
3. Natarajan C. and Revathi P., "Matrix Method of Structural Analysis", Eastern Economy Edition, PHI, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the fundamentals in the analysis of structural members	Applying (K3)
CO2	analyze the structural elements by transferring the information from system to element and vice-versa	Analyzing (K4)
CO3	analyze the structural elements using flexibility method	Analyzing (K4)
CO4	analyze the structural elements using stiffness method	Analyzing (K4)
CO5	analyze and apply solutions for structural elements using matrix displacement method and direct stiffness method	Analyzing (K4)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2		3	3	
CO2	2		3	3	
CO3	2		3	3	
CO4	2		3	3	
CO5	2		3	3	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**10**	**10**	**40**	**40**			100
CAT2	**10**	**10**		**80**			100
CAT3	**10**	**10**	**30**	**50**			100
ESE	**5**	**15**	**30**	**50**			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

(IS 456-2000 &IS1893-2002 (Part-I) code books are permitted)

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**	**1**	PC	**3**	**0**	0	3

Preamble	This course give the detailed concept to check the serviceability of reinforced concrete members, analysis and design of the flat slab, grid floors, walls subjected to lateral load, deep beams, corbels, slender columns and inelastic behavior of reinforced concrete structures.	
Unit - I	**Design Concepts & Limit State of Serviceability:**	**9**
Stress-strain relationship for concrete and steel - Design Philosophies - Working stress method, ultimate load method - Limit state method - Review of basic design of RC members under flexure, shear, combined shear and torsion, axial compression - Bond and anchorage requirements. Deflection - Calculation of short term deflection and long term deflection - Limits on deflection. Cracking - Causes of cracking - Factors influencing crack width - Mechanism of flexural cracking - Cracking control of flexural cracking in design - Calculation of crack width.		
Unit - II	**Design of slabs:**	**9**
Design of flat slab (IS methods) - Design of grid floors - Yield line theory and Hillerborgs strip method of design of slabs for various Boundary Conditions.		
Unit - III	**Design of RC walls and Deep Beams:**	**9**
Design of RC walls - ordinary and shear walls. Design of deep beams.		
Unit - IV	**Special RC Elements:**	**9**
Design of Slender Column. Strut and tie method of analysis and design for corbels. Design of spandrel beams.		
Unit - V	**Inelastic behavior of Concrete Structures:**	**9**
Moment - Rotation curves – Concept of plastic hinges – Inelastic analysis of RC beams - Moment redistribution - Detailing for ductility - Concrete cover - Fire resistance of structural members.		

Lecture:45, Total:45

REFERENCES:

1	Subramanian N., “Design of Reinforced Concrete Structures”, 1st Edition, Oxford University Press, 2014.
2	Unnikrishna Pillai and Devdas Menon, “Reinforced concrete Design”, 3rd Edition, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2006.
3	Varghese P.C., “Advanced Reinforced Concrete Design”, 2nd Edition, Prentice Hall of India, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	calculate the deflection and crack width in the flexural members	Analyzing (K4)
CO2	analysis and design the flat slabs and grid floors	Analyzing (K4)
CO3	design the R.C walls, deep beams and yield analysis of slab	Analyzing (K4)
CO4	formulate the procedure to design the slender column, corbels and spandrel beams	Analyzing (K4)
CO5	evaluate the inelastic behavior of concrete structures	Analyzing (K4)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		2	2	3
CO2	3		2	2	3
CO3	3		2	2	3
CO4	3		2	2	3
CO5	3		2	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**10**	**30**	**10**	**50**			**100**
CAT2	**10**	**15**	**15**	**60**			**100**
CAT3	**10**	**15**	**15**	**60**			**100**
ESE	**10**	**10**	**10**	**70**			**100**

*** ±3% may be varied**

20SET13 DESIGN OF STEEL STRUCTURES

(IS 800: 2007, IS 801, IS 811, IS 875 Part 3 & SP-06 are to be permitted)

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	0	0	3

Preamble	This course deals with the plastic analysis and design of steel structures. The design of members subjected to axial force and bending moment along with water tanks and chimneys were dealt in detail. In addition design of cold formed steel sections and pre-engineered buildings are also discussed.	
Unit - I	**Industrial Building:**	**9**
Roof trusses - Roof and side coverings - Design of truss elements - Design of purlins -Design of end bearings - Gable column, gable rafter, side rails, gable wind girder and end bracings of industrial buildings - Introduction to the design of steel structures for fire loads.		
Unit - II	**Plastic Analysis of Structures:**	**9**
Introduction - Shape factor - Moment redistribution - Static, kinematic and uniqueness theorem - Combined mechanisms - Analysis and design of continuous beams and portal frame - Effect of axial force and shear force on plastic moment.		
Unit - III	**Design of Connections:**	**9**
Bolted and welded connections - Types of connections for eccentric loading - Framed connections - Bracket connections - Seat connections - Moment resisting connections.		
Unit - IV	**Water Tanks and Chimneys:**	**9**
Water tanks - Water pressure on tank walls - Design of pressed steel water tank - Types of chimneys - Components of chimney - Design of self-supporting chimney (Lined).		
Unit - V	**Light Gauge Structures and Pre-Engineered Buildings:**	**9**
Types of cold formed cross sections - Local buckling - Design of compression and tension members - Design of beams - General concept of pre-engineered buildings - Simple portal frame design.		

Lecture:45, Total:45

REFERENCES:

1. Subramanian N, "**Design of Steel Structures**", 2nd Edition, Oxford University Press, New Delhi, 2015.
2. Dayaratnam P, "**Design of Steel Structures**", 3rd Edition, S. Chand & Company, New Delhi, 2013.
3. Wen Yu, "**Cold-Formed Steel Design**", 5th Edition, John Wiley & Sons, New York, 2019.
4. Duggal. S K, "**Limit State Design of Steel Structures**", 3rd Edition, McGraw Hill Private Limited, New Delhi, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	design the purlin and roof trusses	Analyzing (K4)
CO2	apply the knowledge of plastic analysis in steel design	Applying (K3)
CO3	analyse and design connection of members using weld and bolts	Applying (K3)
CO4	design steel water tank and chimney	Analyzing (K4)
CO5	evaluate the behavior of light gauge steel members and pre-engineered structures	Analyzing (K4)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	3	3
CO2	3		3	3	3
CO3	3		3	2	3
CO4	3		3	3	3
CO5	3		3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**10**	**10**	**40**	**40**			**100**
CAT2	**10**	**10**	**40**	**40**			**100**
CAT3	**10**	**10**	**20**	**60**			**100**
ESE	**10**	**10**	**40**	**40**			**100**

*** ±3% may be varied**

20SEL11 COMPUTER AIDED DESIGN AND DRAFTING LABORATORY I

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	0	0	2	1
Preamble	To gain knowledge on design and detailing of various reinforced concrete and steel structures as per IS codal provisions using Microsoft Excel, AutoCad and Staad Pro.						

List of Exercises / Experiments :

1.	Design and detailing of continuous beams by developing the design spread sheet
2.	Design and detailing of slabs by developing the design spread sheet
3.	Analysis and design of a multistorey RCC building using STAAD Pro
4.	Analysis and design of RCC water tanks using STAAD Pro
5.	Analysis and design of mat foundation water tanks using STAAD Pro
6.	Analysis and design of RCC silos using STAAD Pro
7.	Plastic analysis of continuous beams and portal frames by developing the design spread sheet
8.	Design of various types of connections using spread sheet
9.	Analysis and design of plane and space truss using STAAD Pro
10.	Analysis and design of steel water tanks using STAAD Pro
11.	Analysis and design of steel chimneys using STAAD Pro
12.	Design of light gauge sections using spread sheet

Practical : 30,Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Unnikrishna Pillai and Devdas Menon, “Reinforced concrete Design”, 3rd Edition, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2006.
2.	Subramanian N., “Design of Reinforced Concrete Structures”, 1st Edition, Oxford University Press, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	prepapre excel spreadsheet to design structural elements and draft the detailing using AutoCad.	Applying(K4), Manipulation (S2)
CO2	analyse and design RCC structures using Staad Pro	Analyzing (K4), Manipulation (S2)
CO3	design and detail steel structures using Staad Pro	Analyzing (K4), Manipulation (S2)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	3	3
CO2	3	2	2	3	3
CO3	3	2	2	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy					

20SEL12 ADVANCED STRUCTURAL ENGINEERING LABORATORY

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	0	0	2	1
Preamble	This course imparts knowledge on the behavior of beams, columns and frames under various loading conditions and non-destructive testing procedures.						

List of Exercises / Experiments :

1.	Fabrication, casting and testing of simply supported reinforced concrete beam for strength and deflection behavior.
2.	Testing of simply supported steel beam for strength and deflection behavior.
3.	Fabrication, casting and testing of reinforced concrete column subjected to concentric and eccentric loading
4.	Dynamic testing of cantilever steel beam (i) To determine the damping coefficients for free vibrations. (ii) To evaluate the mode shapes
5.	Static cyclic testing of single bay two storied steel frames to evaluate (i) Drift of the frame. (ii) Stiffness of the frame. (iii) Energy dissipation capacity of the frame
6.	Determination of in-situ strength and quality of concrete using (i) Rebound hammer (ii) Ultrasonic Pulse Velocity Test
7.	Rapid Chloride Penetration Test
8.	Acceleration Corrosion Test

Practical : 30,Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	evaluate the behavior of beams	Evaluating (K5), Manipulation (S2)
CO2	evaluate the behavior of the frames	Evaluating (K5), Manipulation (S2)
CO3	assess the quality of reinforced concrete by non-destructive test	Evaluating (K5), Manipulation (S2)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	2	3	2	2
CO3	3	2	3	2	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

20SET21 THEORY OF ELASTICITY AND PLASTICITY

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**2**	PC	**3**	**1**	0	4

Preamble	To create an awareness about the research, model development in the elastic and plastic regime	
Unit - I	**Introduction to Elasticity:**	**9+3**
Basic concepts of deformation of deformable bodies - Displacement - Stress and Strain Fields - Stress Transformation laws - Differential equations of equilibrium in two and three dimensions in Cartesian coordinates - Generalized Hooke's law - Lame's Constant**Topic 1:** Review of Engineering Failure Analysis- Modes of fracture failure, The Griffith energy Balance Approach - Crack tip Plasticity-Fracture toughness.		
Unit - II	**Two Dimensional Problems in Cartesian Coordinates**:	**9+3**
Plane Stress and Plane Strain Problems - Airy's Stress Function - Polynomials - Direct method of determining Airy's Stress Function - Two Dimensional Problems in Cartesian Coordinates - Bending of a Cantilever Loaded at Free End - Bending of a Beam under Uniform Loading.		
Unit - III	**Two Dimensional Problems in Polar Coordinates:**	**9+3**
Equations of Equilibrium in Polar Coordinates - Two Dimensional Problems in Polar Coordinates - Bending of Curved Beam - Thick Cylinder under Uniform Pressure - Flat Plate subjected to in plane traction and Shear with Circular Hole		
Unit - IV	**Torsion and Energy Theory:**	**9+3**
Torsion of Prismatic bars - Membrane Analogy of Torsion - Torsion of Rectangular Section - Torsion of Thin Tubes. Energy Methods - Principle of Virtual Work - Energy Theorems		
Unit - V	**Plastic Deformation:**	**9+3**
Strain Hardening, Idealized Stress - Strain Curve, Yield Criteria - Von Misses Yield Criterion - Tresca Yield Criterion, Plastic Stress - Strain Relations (Flow Rule), Plastic Problems of beams in Bending and Torsion		

Lecture:45, Tutorial:15, Total:60

REFERENCES:

1.	Chandramouli P.N., “Theory of Elasticity”, 1st Edition, Yesdee Publishing Pvt. Ltd., Chennai, 2017.
2.	Sadhu Singh, “Theory of Elasticity”, Khanna Publishers, New Delhi, 1988.
3.	Jane Helena H., “Theory of Elasticity and Plasticity”, Prentice Hall Publication, NewDelhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	calculate the stress and strain parameters	Applying (K3)
CO2	analyze the induced stress in the two dimensional problems in cartesian coordinates	Analyzing (K4)
CO3	interpret the induced stress in the two dimensional problems in polar coordinates	Applying (K3)
CO4	apply the energy theorem and torsion to elastic problems	Analyzing (K4)
CO5	determine the physical behavior of yield criteria of materials	Understanding (K2)

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3		3	3	
CO2	3		3	3	
CO3	3		3	3	
CO4	3		3	3	
CO5	3		3	3	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	**30**	**25**	**25**	**20**			**100**
CAT2	**25**	**25**	**25**	**25**			**100**
CAT3	**25**	**30**	**15**	**30**			**100**
ESE	**25**	**25**	**25**	**25**			**100**

*** ±3% may be varied**

20SET22 DESIGN AND DETAILING OF EARTHQUAKE RESISTANT STRUCTURES
(IS 1893:2002, IS13935:2009, IS 13920:2016 & IS 4326:1993 codes are permitted)

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	PC	3	1	0	4

Preamble	To study the effect of earthquakes, analysis and design of earthquake resistant structures.	
Unit - I		**9+3**
Earthquakes and Strong Ground Motion: Engineering Seismology (Definitions, Introduction to Seismic hazard, Earthquake phenomenon), - Plate tectonics- Quantification of earthquakes - Strong ground motion instrumentation - Lessons learnt in past Earthquakes.		
Unit - II		**9+3**
Characteristics of Earthquake: Estimation of earthquake parameters, Response spectra - Average response spectra - Design response spectra - Evaluation of Earthquake forces as per codal provisions - Seismic hazard analysis- Determination of probabilistic approaches.		
Unit - III		**9+3**
Earthquake Resistant Design of Masonry Structures: Behaviour of reinforced and unreinforced masonry buildings - Lessons learnt from past earthquakes. Structural systems - Types of buildings, Causes of damage, Planning considerations, Philosophy and principle of earthquake Resistant design, Guidelines for earthquake resistant design of masonry buildings - Design consideration - Seismic strengthening of masonry buildings		
Unit - IV		**9+3**
Earthquake Resistant Design of RC Structures: Mathematical modeling of multistoried RC buildings -Capacity based design - Earthquake resistant design of R.C.C buildings - Material properties - Lateral load analysis - Design and detailing - Rigid frames - Shear wall - Coupled shear wall.		
Unit - V		**9+3**
Vibration Control: Tuned mass dampers - Principles and application - Basic concept of Seismic Base isolation - Various systems - Case studies - Computer Analysis and design of Building systems subjected to Earthquake Loads.		

Lecture: 45, Turorial:15, Total: 60

REFERENCES:

1.	PankajAgarwal and Manish Shrikhande, “Earthquake Resistant Design of Structures”, 3rd Edition, Prentice Hall of India, 2006.
2.	Duggal, S.K., “Earthquake Resistant Design of Structures”, 2ndEdition, Oxford University Press, 2013.
3.	Roberto Villaverde, “Fundamentals of Concepts of Earthquake Engineering”,1stEdition, CRC Press, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recall the elements of seismology	Remembering (K1)
CO2	assess the earthquake parameters using different methods	Applying (K3)
CO3	illustrate the behavior of masonry buildings subjected to earthquake loading	Analyzing (K4)
CO4	analyse the RC buildings subjected to earthquake loading	Analyzing (K4)
CO5	apply various vibration control techniques on structures	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	3
CO2	3		3	2	3
CO3	3		3	2	3
CO4	3		3	2	3
CO5	3		3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**20**	**20**	**60**				**100**
CAT2	**10**	**20**	**10**	**60**			**100**
CAT3	**5**	**20**	**35**	**40**			**100**
ESE	**20**	**20**	**60**				**100**

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20SET23 DESIGN OF PRESTRESSED AND PREFABRICATED STRUCTURES
(IS 1343-1980, IS 784-2001, IS 784-1959 & IS 15916-2010 code books are to be permitted)

Programme& Branch	**M.E.-STRUCTURAL ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Design of Concrete Structures	**2**	PC	**3**	**0**	0	3

Preamble	This course enables the students to design the prestressed and prefabricated Concrete Structural elements	
Unit - I	**Design Concepts:**	**9**
Basic Concepts - Advantages - Materials - Methods of prestressing –Pretensioning and post tensioning - Review on analysis of sections for stresses by various concepts - Types of Losses and deflection in prestress.Design of Prestressed Flexural Member: Flexural strength - Shear resistance - Web shear crack – Flexure - shear cracks - Design principles for members with flexure and shear - Design of slabs - Design of sleepers - Design of Anchorage zone - IS method - Introduction to Launching and erection of prestressed girders.		
Unit - II	**Tension and Compression Members:**	**9**
Design of tension members - Design of compression members with and without flexure - Application in the design of prestressed pipes and prestressed concrete cylindrical water tanks.		
Unit - III	**Design of Composite Structures:**	**9**
Analysis for stresses - Estimate for deflections - Flexural and shear strength of composite members. Continuous Members: Advantages - Methods of achieving continuity - Concept of linear - Transformations - Primary moment - Secondary moment - Resultant moment - Pressure or thrust line - Line of prestress - Concordant cable profile - Analysis of continuous beams.		
Unit - IV	**Prefabricated Elements:**	**9**
Principles - Types of prefabrication - Modular Co-ordinate - Standardization - Systems - Manufacturing methods - Equipments for hoisting and erection - Techniques for erection of different types of members - Prefabricated components - Large panel construction - Disuniting of structures.		
Unit - V	**Design of Prefabricated Elements:**	**9**
Design of flexural member - Design of flat slab and hollow core slab- Design of Inverted -T beam and L-beam - Design principles of column - Joints for structural members.		

Lecture:45, Total:45

REFERENCES:

1.	Krishnaraju N. “Prestressed Concrete”. 5th Edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2012.
2.	Shinha N.C. and Roy S.K.“Fundamentals of Prestressed Concrete”, 2nd Edition, S.Chand and Company Ltd., 1985.
3.	“PCI Design Hand Book”, 6th Edition, Precast/Prestressed Concrete Institute, ACI, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	analyze and design the flexural members	Analyzing (K4)
CO2	design the tension and flexural member	Analyzing (K4)
CO3	analyze the composites structure and continuous member	Analyzing (K4)
CO4	enumerate the principles, manufacture and erection of prefabricated components	Analyzing (K4)
CO5	formulate the design procedure to design the prefabricated slabs and beams	Analyzing (K4)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	3
CO2	3		3	2	3
CO3	3		3	2	3
CO4	3		3	2	3
CO5	3		3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**10**	**15**	**10**	**65**			**100**
CAT2	**10**	**15**	**10**	**65**			**100**
CAT3	**10**	**10**	**15**	**65**			**100**
ESE	**5**	**5**	**2**	**88**			**100**

*** ±3% may be varied**

20SET24 THEORY OF STRUCTURAL STABILITY

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**2**	PC	**3**	**0**	0	3

Preamble	To understand the basic concepts & terminology on structural stability and describe conceptual procedures for testing stability	
Unit - I	**Fundamental Concepts of Stability:**	**9**
Criterion for design of structures: strength, stability and stiffness – Concepts of stability, instability and bifurcation – Stability criteria – Concepts of Equilibrium and Energy approaches – South well Plot.		
Unit - II	**Buckling of Columns:**	**9**
Governing differential equations – Higher order differential equations – Analysis for various boundary conditions – Behaviour of imperfect column – eccentrically loaded column – Rayleigh Ritz, Galerkin Methods – Effect of shear on buckling		
Unit - III	**Buckling of Beam – Column and Frames:**	**9**
Buckling of Beam – columns: Buckling of Beam – columns with concentrated lateral loads – Distributed loads – Effect of axial loads on bending stiffness. Buckling of frames: Mode of buckling – Single storey frames with and without sway.		
Unit - IV	**Lateral and Torsional Buckling:**	**9**
Differential equations for lateral buckling – Lateral buckling of beams in pure bending – Lateral buckling of simply supported I beams. Buckling of Thin Walled Open Sections: Introduction – Torsional buckling – Torsional flexural buckling.		
Unit - V	**Stability of Plates and Inelastic Buckling:**	**9**
Buckling of rectangular plates for various edge conditions – Finite difference method. Introduction to inelastic buckling – Double modulus theory (reduced modulus) - Tangent modulus theory - Shanley's theory.		

Lecture:45, Total:45

REFERENCES:

1.	Chajes A., "Principles of Structural Stability Theory", 4th Edition, Prentice Hall, 2008.
2.	Iyengar N.G.R., "Structural Stabilityof Columns and Plates", Affiliated East West Press Pvt. Ltd., New Delhi, 2000.
3.	Brush D.O. and Almorth B.O., "Buckling of Bars, Plates and Shells", 2nd Edition, McGraw Hill, 2006.
4.	Timoshnko S.O. and Gere J.M., "Theory of Elastic Stability", 2nd Edition, McGraw Hill, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the concepts of stability	Understanding (K2)
CO2	analyse the buckling of columns with various boundary conditions	Analyzing (K4)
CO3	analyze the buckling of frames and plates	Analyzing (K4)
CO4	apply the concept of lateral and torsional buckling	Applying (K3)
CO5	identify the torsional, lateral and inelastic buckling of plates	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	3	
CO2	3		3	3	
CO3	3		3	3	
CO4	3		3	3	
CO5	3		3	3	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**20**	**20**	**30**	**30**			**100**
CAT2	**10**	**20**	**10**	**60**			**100**
CAT3	**10**	**30**	**60**				**100**
ESE	10	20	30	40			**100**

*** ±3% may be varied**

20SEL21 COMPUTER AIDED DESIGN AND DRAFTING LABORATORY II

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Computer Aided Design and Drafting Laboratory I	2	PC	0	0	2	1
Preamble	To gain knowledge on finite element modeling, design and detailing of various reinforced concrete and steel structures as per IS codal provisions using ETABS.						

List of Exercises / Experiments:

1.	Analysis and design of a continuous beam.
2.	Analysis and design of a continuous slab.
3.	Analysis and design of a single storey RCC building.
4.	Analysis and design of a multistorey storey RCC building for gravity loads.
5.	Analysis and design of a multistorey storey RCC building for wind loads.
6.	Analysis and design of a multistorey storey steel building for gravity loads.
7.	Analysis and design of a multistorey storey steel building for seismic loads.
8.	Analysis and design of shear wall.
9.	Analysis and design of circular elevated reinforced concrete water tank.
10.	Analysis and design of rectangular reinforced concrete water tank resting on ground.
11.	Analysis and design of reinforced concrete silos.
12.	Analysis and design of composite continuous beam.

Practical: 30,Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Unnikrishna Pillai and Devdas Menon, “Reinforced concrete Design”, 3rd Edition, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2006.
2.	Subramanian N., “Design of Reinforced Concrete Structures”, 1st Edition, Oxford University Press, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Model, analyse and design RC elemets using ETABS.	Applying(K4), Manipulation (S2)
CO2	Analyse and design RCC and steel buildings using ETABS.	Analyzing (K4), Manipulation (S2)
CO3	Design storage structures using ETABS.	Analyzing (K4), Manipulation (S2)

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	3	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy					

20SEP21 - INNOVATIVE PROJECT

Programme & Branch	M.E. &Structural Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2	EC	0	0	4	2

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify the problem and formulate a problem statement	Applying (K3)
CO2	summarize the literature review	Understanding (K2)
CO3	develop a suitable methodology	Applying (K3
CO4	carry out experimental and/or theoretical work as per the specified methodology / design and prepare detailed drawing for various structural components using computer software	Creating (K6)
CO5	prepare and present the project report	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	2
CO2	3	3	3	2	2
CO3	3	3	3	2	2
CO4	3	3	3	2	2
CO5	3	3	3	2	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

20SEP31 - INDUSTRIAL PROJECT

Programme & Branch	M.E. &Structural Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	EC	0	0	18	9

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify the problem and formulate a problem statement	Applying (K3)
CO2	summarize the literature review	Understanding (K2)
CO3	develop a suitable methodology	Applying (K3
CO4	carry out experimental and/or theoretical work as per the specified methodology / design and prepare detailed drawing for various structural components using computer software	Creating (K6)
CO5	prepare and present the project report	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

20SEP41 - PROJECT WORK

Programme & Branch	M.E. &Structural Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	4	EC	0	0	18	9

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify the problem and formulate a problem statement	Applying (K3)
CO2	summarize the literature review	Understanding (K2)
CO3	develop a suitable methodology	Applying (K3
CO4	carry out experimental and/or theoretical work as per the specified methodology / design and prepare detailed drawing for various structural components using computer software	Creating (K6)
CO5	prepare and present the project report	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

20SEE01 EXPERIMENTAL METHODS AND MODEL ANALYSIS

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PE	3	0	0	3

Preamble	This course discuss mainly on the various instruments that are used in civil engineering and to demonstrate about the significance of measurements and applications.	
Unit - I	**General:**	**9**
Basic concept in measurements - Measurement in displacement, strain pressure, force, torque etc. - Type of strain gauges (Mechanical, Electrical resistance, Acoustical etc.) - Load calibration of testing machines- I.S. Code provisions.		
Unit - II	**Measurement System:**	**9**
Mechanical, Optical and Acoustical extensometers - Strain measurement - Electrical resistance strain gauges- Principle, Types, Performance, Uses- Strain Rosettes- Wheatstone Bridge- Electronic load cells-Proving rings- X Y Plotter - Wind Tunnels.		
Unit - III	**Testing and Analysis Method:**	**9**
Indication and Recording - Static and Dynamic data recording-Data (Digital and Analogue) acquisition and processing systems - Strain analysis methods-Rosette analysis - Static and Dynamic testing techniques		
Unit - IV	**Testing Techniques:**	**9**
Non destructive testing techniques - Photo elasticity - Optics of photo elasticity - Polariscope - Isoclinics and Isochromatics - Methods of stress separation - Holographic techniques.		
Unit - V	**Model Laws and Analysis:**	**9**
Laws of similitude-Model materials-Model testing- Necessity for Model analysis – Advantages – Applications - Types of similitude-Scale effect in Models- Indirect model study-Direct model study-Limitations of model investigations- Structural problems that may demand model studies - Usage of influence lines in model studies.		

Lecture:45, Total:45

REFERENCES:

1.	Sadhu Singh, “Experimental Stress Analysis”, 2nd Edition, Khanna Publishers, New Delhi, 1990.
2.	Rangan C.S., “Instrumentation – Devices and Systems”, 2nd Edition, Tata McGrawHill Publishing Co. Ltd., New Delhi, 21st Reprint 2008.
3.	Dally J.W. and Riley W.F., “Experimental Analysis”, 1st Edition, McGraw Hill Inc., New York, 1991.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	identify the basic structural outcomes for indicating strain gauges	Understanding (K1)
CO2	apply the instrument techniques for the measurement of structural related problem in civil engineering	Applying (K3)
CO3	apply dynamic instruments for measuring the vibration motion in structures	Applying (K3)
CO4	quantify the structural characteristics by using the various measuring instruments	Applying (K3)
CO5	explain the principle of model laws in vibrational systems	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3		
CO2	3		3		
CO3	3		3		
CO4	3		3		
CO5	3		3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**20**	**30**	**50**				**100**
CAT2	**20**	**30**	**50**				**100**
CAT3	**20**	**30**	**50**				**100**
ESE	**20**	**30**	**50**				**100**

*** ±3% may be varied**

20SEE02 SOIL STRUCTURE INTERACTION

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PE	3	0	0	3

Preamble	To provide an understanding of the relevance and significance of soil-structure interaction in the different cases of shallow foundation and pile foundation. It also focuses on idealization of soil response to various models and interaction analysis for machine foundation and retaining structures.	
Unit - I	**Introduction To SSI:**	**9**
Introduction to SSI- Importance of SSI- Applications and Examples of SSI for geotechnical engineer- Effect of structure roughness / smoothness on soil behavior.		
Unit - II	**SSI in Shallow Foundation**:	**9**
General soil-structure interaction problems- Shallow foundation, Sheet piles, Mat/Raft foundation, etc., Contact pressure and soil-structure interaction for shallow foundation, Fixed/ Flexible base, Differential foundation settlement for high rise buildings-Pressure-settlement prediction from constitutive laws.		
Unit - III	**SSI Models**:	**9**
Elastic continuum, Winkler's model, Multi parameter models, Hybrid models, Codal provisions, Machine foundation - Idealization of semi-infinite and finite beams-Analysis of finite plates, rectangular and circular plates-Numerical analysis of finite plates-simple solutions.		
Unit - IV	**Elastic Analysis of Pile:**	**9**
Elastic analysis of single pile, Theoretical solutions for settlement and load distribution, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.		
Unit - V	**SSI in Retaining Structures**:	**9**
Curved failure surfaces, their utility and analytical / graphical predictions from Mohr – Coulomb envelope and circle of stress, Earth pressure computations by friction circle method, Earth pressure on wall with limited / restrained deformations, Earth pressure on sheet piles, braced excavations, Design of supporting system for excavations.		

Lecture:45, Total:45

REFERENCES:

1.	Chandrakant S. Desai, Musharraf Zaman. "Advanced Geotechnical Engineering - Soil-Structure Interaction using Computer and Material Models". 1st edition, CRC Press (Taylor and Francis group), 2010.
2.	Michael J Tomlinson, John C Woodward. "Pile Design and Construction Practice". 6th edition, CRC Press, 2014.
3.	Edward Tsudik. "Analysis of Structures on Elastic Foundations". 1st edition, J. Ross Publishing, Cengage learning, Delhi, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate the overview of soil- structure interactions	Applying (K3)
CO2	analyze soil structure interaction problems in shallow foundation	Analyzing (K4)
CO3	Demonstrate different types of soil structure models	Applying (K3)
CO4	investigate soil structure interaction parameters involved in the pile foundation	Analyzing (K4)
CO5	analyze the soil structure interaction involved in retaining structures	Analyzing (K4)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3		
CO2	3		3		
CO3	3		3	3	
CO4	3		3		
CO5	3		3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		**20**	**50**	**30**			**100**
CAT2		**20**	**50**	**30**			**100**
CAT3		**20**	**40**	**40**			**100**
ESE		**20**	**40**	**40**			**100**

*** ±3% may be varied**

20SEE03 STRUCTURAL DYNAMICS
(IS 1893:2002, IS 13935:2009, IS 13920 :2016 & IS 4326:1993 codes are permitted)

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PE	3	1	0	4

Preamble	To expose the students about the principles and methods of dynamic analysis of structures and to prepare them for designing the structures for blast or earthquake and other dynamic loads	
Unit - I	**Principles of Vibration Analysis**:	**9+3**
Mathematical models of single degree of freedom systems - Free and forced vibration of SDOF systems - Response of SDOF system to special forms of excitation - Effect of damping - Transmissibility - Applications - Examples related to structural engineering.		
Unit - II	**Two Degree of Freedom Systems:**	**9+3**
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	**Multi-degree of Freedom Systems:**	**9+3**
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 - Response spectrum method – Applications.		
Unit - IV	**Continuous Systems:**	**9+3**
Mathematical models of continuous systems - Free and forced vibration of continuous systems - Rayleigh-Ritz method - Formulation using Virtual Work – Applications.		
Unit - V	**Response to General Dynamic Loading:**	**9+3**
Fourier series expression for loading (blast or earthquake) - Duhamel„s integral - Vibration analysis by Rayleigh„s method - Improved Rayleigh„s method - Earthquake response analysis of MDOF systems subjected to earthquake ground motion - Idealization of multi-storied frames.		

Lecture: 45, Turorial:15, Total: 60

REFERENCES:

1. Anil K. Chopra, “Dynamics of Structures”, 3rd Edition, Pearson Education, 2007.
2. Mario Paz, “Structural Dynamics: Theory and Computation”, 5th Edition, Kluwer Academic Publication, 2004
3. Roy R. Craig, Jr Andrew J. Kurdila, “Fundamentals of Structural Dynamics”, 2nd Edition, John Wiley & Sons, 2011

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the effects of vibration and damping on structures	Analyzing (K4)
CO2	determine the response of two degree of freedom systems	Applying (K3)
CO3	interpret the response of Multi Degree of Freedom systems	Applying (K3)
CO4	analyze the continuous systems using approximate methods	Analyzing (K4)
CO5	apply the approximate method to solve complex problems subjected to different loading condition	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	
CO2	3		3	2	
CO3	3		3	2	
CO4	3		3	2	
CO5	3		3	2	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		**20**	**20**	**60**			**100**
CAT2		**20**	**40**	**40**			**100**
CAT3		**30**	**40**	**30**			**100**
ESE		**30**	**40**	**30**			**100**

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20SEE04 OPTIMIZATION OF STRUCTURES

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	PE	3	0	0	3

Preamble	This course provides to present modern concepts of optimal design of structures. Basic ideas from optimization theory are developed with simple design examples.	
Unit - I	**Basic Principles and Classical Optimization Techniques:**	**9**
Definition - Objective Function; Constraints - Equality and inequality - Linear and non-linear, Side, Non-negativity, Behavior and other constraints - Design space - Feasible and infeasible - Convex and Concave - Active constraint - Local and global optima. Differential calculus -Optimality criteria - Single variable optimization - Multivariable optimization with no constraints- (Lagrange Multiplier method) - with inequality constraints (Khun - Tucker Criteria)		
Unit - II	**Linear Programming:**	**9**
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		
Unit - III	**Non Linear Programming:**	**9**
One Dimensional minimization methods: One-dimensional -Unimodal function - Exhaustive and unrestricted search - Dichotomous search – Fibonacci Method - Golden section method - Interpolation methods. Unconstrained optimization Techniques		
Unit - IV	**Geometric and Dynamic 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- 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 multistory buildings,Water tanks and bridges		

Lecture:45, Total:45

REFERENCES:

1. Rao S.S., "Engineering Optimization: Theory and Practice", 1st Edition, New Age International Pvt. Ltd., New Delhi, 2013.
2. Taha H.A., "Operations Research: An Introduction", 5th Edition, Macmillan, New York, 2013.
3. Hadley G., "Linear Programming", Narosa Publishing House, New Delhi, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	explain the concept of optimization	Applying (K3)
CO2	analyze linear programming	Analysis (K4)
CO3	design the nonlinear programming	Applying (K3)
CO4	develop the geometric and dynamic programming	Analysis (K4)
CO5	apply optimization technique in structural problems	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3				
CO2	2			2	
CO3	2		2	3	2
CO4	2	2	2	3	2
CO5	3	2	2	3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**20**	**20**	**40**	**20**			**100**
CAT2	**10**	**20**	**50**	**20**			**100**
CAT3	**10**	**10**	**40**	**40**			**100**
ESE	**10**	**10**	**40**	**40**			**100**

*** ±3% may be varied**

20SEE05 FRACTURE MECHANICS OF CONCRETE STRUCTURES

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	PE	3	0	0	3

Preamble	To make the students knowledgeable in predicting the crack front growth and instability under elastic and elastic plastic conditions and to compute the stress intensity factors and stain energy release rate.	
Unit - I	**Introduction**	**9**
Review of Engineering Failure Analysis- Modes of fracture failure, The Griffith energy Balance Approach - Crack tip Plasticity-Fracture toughness		
Unit - II	**Linear elastic fracture Mechanics**	**9**
Elastic crack tip theory, Stress and displacement fields in isotropic elastic materials- Westergaard's approach (opening mode) - Feddersen approach - Determination of R curve, Energy released rate for DCB specimen - K_{1c} Test techniques, Various test specimens - Critical energy release rate.		
Unit - III	**Elastic Plastic Fracture Mechanics**	**9**
Limitation of K approach -Approximate shape and size of the plastic zone- Effective crack length- Elastic plastic fracture concept-Crack tip opening displacement-Dugdale approach-Path independence, Critical J integral-Evaluation of CTOD-Relationship between CTOD, K_1 and G_1 for small scale yielding.		
Unit - IV	**Fatigue Crack Growth**	**9**
Fatigue crack growth to sharpen the tip-methods to determine J_{1c} Mechanism of Fatigue, Fatigue crack propagation-Paris law-Crack closure mechanism-Residual stresses at crack tip-Retardation effect fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor-Variable amplitude service loading, Interaction effects.		
Unit - V	**Crack Arrest & Numerical methods**	**9**
Principles of crack arrest, crack arrest in practice, K-R Curves, Crack resistance curve, Numerical Methods and Approaches in Fracture Mechanics, Methods to determine fracture parameters.		

Lecture:45, Total:45

REFERENCES:

1.	Simha K. R. Y, "Fracture Mechanics for Modern Engineering Design," University Press (India) Ltd, Hyderabad, 2001.
2.	Gdoutos E. E., "Fracture Mechanics – An introduction," Kluwer Academic Publishers, Dordrecht, 1993.
3.	David Broek, "Elementary Engineering Fracture Mechanics, " MartinusNijhoff Publishers, The Hague, 1982.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	articulate the fracture failure parameters	Applying (K3)
CO2:	determine the linear elastic fracture mechanics problems	Applying (K3)
CO3:	interpret the concept of elastic plastic fracture mechanics	Understanding (K2)
CO4:	determine the residual life of fatigue crack growth in structure	Applying (K3)
CO5:	find out suitable crack arrest parameters using various techniques	Understanding (K2)
CO6:	predict the fracture parameters using direct and indirect methods	Understanding (K2)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2		2		3
CO2	2		3		3
CO3	2		3		3
CO4	2		3		3
CO5	2		3		3
CO6	2		3		3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**25**	**25**	**50**				**100**
CAT2	**25**	**50**	**25**				**100**
CAT3	**25**	**50**	**25**				**100**
ESE	**25**	**25**	**50**				**100**

20SEE06 DESIGN OF PLATES AND SHELLS

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Design of Concrete Structures & Design of Steel Structures	**2**	PE	**3**	**0**	0	3

Preamble	To understand the basic concept, mathematical modelling, behaviour and analysis of plate and shell structures	
Unit - I	**Introduction to plate structures**:	**9**
Thin and thick plates - Structural action of plates – Assumptions involved in plate theories - Differential equation for cylindrical bending of plates – Cylindrical bending of uniformly loaded rectangular plates with simply supported and built-in edges – Small deflection theory of laterally loaded rectangular plates - Kirchoffs boundary conditions Corner effects		
Unit - II	**Analysis of Plate Structures:**	**9**
Simply supported rectangular plates under Sinu-soidal load - Navier solution - Levys method - Symmetrical bending of laterally loaded circular plates - Circular plates with simply supported and built-in edges - Bending of annular plates.		
Unit - III	**Introduction to shell structures**:	**9**
Classification of shells - Membrane action - Stressed shell element and stress resultants - Load transfer mechanism - Characteristics of shell surfaces -Structural behaviour of shells - Membrane theory of cylindrical shells		
Unit - IV	**Analysis of Shell Structures:**	**9**
Bending theory of circular cylindrical shells - Comparison of various bending theories - Introduction to other types of shells.		
Unit - V	**Design of Plates and Shell Structures**:	**9**
Necessary design inputs - Detailed design - Prismatic folded plates - Circular cylindrical barrel shell roofs - Spherical dome - Conical dome - HYPAR shell - Helicoids		

Lecture:45, Total:45

REFERENCES:

1.	G.S.Ramaswamy, “Design & Construction of Concrete Shell Roofs”,1st Edition ,CBS publishers & distributors pvt.ltd,New delhi,2019.
2.	Stephen Timoshenko, S Woinowsky-Krieger, “Theory of plates and shells”, 2nd Edition, McGraw-Hill, Chennai, 1959.
3.	N K Bairagi, “Shell Analysis”,1st Edition, Khanna Publishers, Delhi.1990

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	understandtheconceptsof plate structures	Understanding(K2)
CO2:	analyze plate structures various structuralloadings	Applying(K3)
CO3:	understandtheconceptsof shell structures	Understanding(K2)
CO4:	achieveknowledge of bending theory of shell structures	Applying(K3)
CO5:	design the various shell structures	Applying(K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	2
CO2	2	3	2	2	3
CO3	3	3	2	2	2
CO4	2	3	2	3	3
CO5	2	3	2	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**20**	**30**	**30**	**20**			**100**
CAT2	**20**	**20**	**30**	**30**			**100**
CAT3	**20**	**20**	**30**	**30**			**100**
ESE	**20**	**20**	**30**	**30**			**100**

*** ±3% may be varied**

20SEE07 DESIGN OF INDUSTRIAL STRUCTURES
(IS 800: 2007, IS 801, IS 811 & SP-06 are to be permitted)

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Design of Concrete Structures and Design of Steel Structures	**2**	PE	**3**	**0**	0	3

Preamble	To offer the design of steel structures as per limit state method. This course follows the recommendation of IS: 800 – 2007. It aims at determination of safe as well as economical steel section for various industrial and framed 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 – Steel:**	**9**
Roofs for Industrial Buildings - Gantry girders - components of the crane system - forces - impact factor - forms of gantry girder - design of Gantry Girders - steel bunkers and silos - components of bunkers - IS code specifications - design of silo.		
Unit - III	**Industrial Buildings – Concrete:**	**9**
Loads on the corbel - bearing stress - evaluation of internal forces - Design of Corbels and Nibs – Design limits of machine foundation for empirical methods - classifications of Machine foundations - various types of machine foundations - analyze and design of machine foundations.		
Unit - IV	**Power Plant Structures:**	**9**
Components of concrete bunkers - theories - IS code specifications - procedure for design of concrete bunkers - Design of concrete Silo - types of chimneys - loads on chimneys shell - design aspects - design procedure for concrete chimney.		
Unit - V	**Power Transmission Structures:**	**9**
Transmission line Towers - configuration - determination of tower height - clearances - critical parameters of tower - Types of towers - analysis - tower design - Substation Structures - procedure for design of Tower Foundations.		

Lecture:45, Total:45

REFERENCES:

1.	Subramanian N., “Design of Steel Structures Limit States Method”, 2nd Edition, Oxford University Press, New Delhi, 2016.
2.	SanthakumarA.R.and Murthy S.S., “Transmission Line Structures”, First edition, Tata McGraw Hill, 1992.
3.	Srinivasulu P and Vaidyanathan.C, “Handbook of Machine Foundations”, First edition, Tata McGraw Hill, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	classify and planning the industrial structures	Understanding(K2)
CO2:	design the gantry girders, bunkers and silos	Applying (K3)
CO3:	design the corbels and nibs	Applying (K3)
CO4:	apply the design concepts in the power plant structures	Applying (K3)
CO5:	apply the design principles of tower and its foundations.	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	3
CO2	3		3	2	3
CO3	3		3	2	3
CO4	3		3	2	3
CO5	3		3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	15	35	40	-	-	100
CAT2	-	20	30	50	-	-	100
CAT3	-	20	35	45	-	-	100
ESE	10	20	30	40	-	-	100

*** ±3% may be varied**

20SEE08 FINITE ELEMENT ANALYSIS

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Advanced Structural Analysis	**2**	PE	**3**	**0**	0	3

Preamble	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. 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	**One Dimensional Problems:**	**9**
One dimensional problems -Coordinate systems –global, local and natural coordinate systems, shape functions –Bar, beam and truss element -Generation of Stiffness Matrix and Load Vector.		
Unit - III	**Two and Three Dimensional Problems:**	**9**
Two Dimensional problems –Plane Stress, Plane Strain Problems –Triangular and Quadrilateral Elements –Isoparametric Formulation - Natural Coordinates, Shape function, stiffness matrix-Ax symmetric Problems -Higher Order Elements -Numerical Integration- Three dimensional elasticity-Governing differential equations-Higher order Isoparametric solid elements		
Unit - IV	**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-Numerical Evaluation of Element Stiffness - Formulation for 3 Dimensional Elements–Solution for simple frames		
Unit - V	**Applications:**	**9**
Finite Elements for Elastic Stability-Dynamic Analysis-Nonlinear, Vibration and Thermal Problems-Meshing and Solution Problems-Modeling and analysis using recent software's.		

Lecture:45, Total:45

REFERENCES:

1.	Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2006.
2.	Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
3.	Chandrupatla, R.T. and Belegundu, A.D., "Introduction to Finite Elements in Engineering", Prentice Hall of India, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	demonstrate the concept of Finite Element Analysis and Approximate solutions techniques	Understanding (K2)
CO2:	execute finite element analysis concept in one dimensional element problems	Applying (K3)
CO3:	apply the finite element analysis concept in two and three dimensional element problems	Applying (K3
CO4:	analyze the framed structures	Applying (K3)
CO5:	apply finite element analysis concept in Nonlinear, Vibration and Thermal problems	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	
CO2	3		3	2	
CO3	3		3	2	
CO4	3		3	2	
CO5	3		3	2	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**10**	**20**	**70**	**-**	**-**	**-**	**100**
CAT2	**-**	**20**	**80**	**-**	**-**	**-**	**100**
CAT3	**-**	**20**	**80**	**-**	**-**	**-**	**100**
ESE	**10**	**20**	**70**	**-**	**-**	**-**	**100**

*** ±3% may be varied**

20SEE09 MECHANICS OF COMPOSITE MATERIALS AND STRUCTURES

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	PE	3	0	0	3

Preamble	To gain knowledge about analysis, failure, fracture and stress strain relations of composite materials	
Unit - I	**Composite materials:**	**9**
Definitions, Classification, Advantages, commonly used fiber and matrix constituents, Composite construction, properties of unidirectional Long Fiber composites, Short Fiber composites and processing of FRP Composites.		
Unit - II	**Fibre reinforced composite structures:**	**9**
Introduction, Composite structural design, Design spiral, Design criteria, Design allowables and Material selection in composite design, Selection of configuration, Manufacturing process, Laminate selection, Laminate design procedure.		
Unit - III	**Analysis of Laminated composite plates:**	**9**
Governing equations for bending and buckling of laminated plates, Deflection and buckling of simply supported Angle-ply and cross-ply laminates, Laminate stiffness, Shear deformation plate theory, Static, dynamic and stability analysis for simpler cases of composite plates.		
Unit - IV	**Failure and Fracture of composites:**	**9**
Failure and Fracture of composites: Netting analysis, failure criterion, maximum stress, maximum strain, Application of fracture mechanics to composite materials, Sandwich Construction.		
Unit - V	**Stress strain relations:**	**9**
Stress - Strain relations for orthotropic and anisotropic materials, Linear elasticity for Anisotropic materials, rotations of stresses, strains, residual stresses, transformation of stress and strain and restriction on elastic constants.		

Lecture:45, Total:45

REFERENCES:

1.	Mukhopadhyay.M, “Mechanics of Composite Materials and Structures”, First Edition, University Press, India, 2004.
2.	Jones R.M., “Mechanics of Composite Materials”, McGraw - Hill, Kogakusha Ltd., Tokyo, 1975.
3.	Agarwal.B.D. and Broutman.L.J., “Analysis and Performance of Fiber Composites”, John Wiley and Sons, 1980.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	develop composite materials and its applications	Analyzing (K4)
CO2:	select material, select configuration and manufacturing process of composite materials.	Applying (K3)
CO3:	analyze problems on bending, buckling, vibration and failure criterion of laminated plates.	Analyzing (K4)
CO4:	identify the failure and apply the fracture mechanics to composite materials.	Applying (K3)
CO5:	solve mechanics of composite materials problems using classical methods.	Analyzing (K4)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	3
CO2	2		3	2	3
CO3	3		3	2	3
CO4	2		3	2	3
CO5	3		3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**30**	**50**	**10**	**10**			**100**
CAT2	**30**	**50**	**10**	**10**			**100**
CAT3	**20**	**30**	**30**	**20**			**100**
ESE	**20**	**20**	**40**	**20**			**100**

*** ±3% may be varied**

20SEE10 STRUCTURAL HEALTH MONITORING

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**3**	PE	**3**	**0**	0	3

Preamble	To monitor the health of the structures and to identify the proper solution for the structural problems.	
Unit - I	**Introduction to Structural Health Monitoring (SHM):**	**9**
An Overview of Structural Health Monitoring - Structural Health Monitoring and Smart Materials - Structural Health Monitoring versus Non Destructive Evaluation - Emerging SHM Technologies - Sensors - Piezoelectric Material - Magnetostrictive Material - Optical Fiber - LDV - Overview of Application Potential of SHM		
Unit - II	**Application of SHM in Civil Engineering:**	**9**
An overview of notable Applications of SHM - Civil engineering field applications - Case studies bridges, pretension and pre fabricated structures, external post tension cables, historical buildings - Capacitivemethods - Application on cover concrete.		
Unit - III	**Non Destructive Testing of Concrete Structures:**	**9**
Introduction to NDT- Situations and contexts, where NDT is needed, classification of NDT procedures, visual Inspection, half-Cell electrical potential methods, schmidt rebound hammer test, resistivity measurement, electromagnetic methods, radiographic testing, ultrasonic testing, infra Red thermography, ground penetrating radar, other methods.		
Unit - IV	**Vibration Control for SHM:**	**9**
Introduction to FE formulation - Constitutive Relationship - Element stiffness matrix and Element Mass Matrix for High Precision Finite Element - Developing Actuator and Sensor Influence Matrix - Estimating Sensor Voltage - Damping - A Case study of Performance Estimation for Different Patches		
Unit - V	**Rehabilitation and Retrofitting of Concrete Structure:**	**9**
Repairrehabilitation & retrofitting of structures, damage assessment of concrete structures, Materials and methods for repairs and rehabilitation, modeling of repaired composite structure, structural analysis and design -Importance of re-analysis, execution of rehabilitation strategy – Electromechanical impedance technique (EMI)- Case studies.		

Lecture:45, Total:45

REFERENCES:

1.	Daniel Balageas, Claus - Peter Fritzen, Alfredo Guemes, “Structural Health Monitoring”, 1st Edition, ISTE Publishing Ltd., U.K. 2006.
2.	Hand book on “Repair and Rehabilitation of RCC Buildings“,Director General, CPWD, Govt. of India, 2002.
3.	“Hand Book on Seismic Retrofitting of Buildings”, CPWD & Indian Building Congress in Association with IIT, Madras, Narosa Publishing House, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	adopt a proper health monitoring technique	Applying (K3)
CO2:	analyze the various health monitoring system and apply to the real problems	Analyzing (K4)
CO3:	identify the accurate non-destructive technique for existing structure	Applying (K3)
CO4:	explain the vibration control systems in the construction	Understanding (K2)
CO5:	suggest solution for the problems identified in the structures	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	
CO2	3		3	2	
CO3	3		3	2	
CO4	3		3	3	
CO5	3		3	2	
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	10	40	40			100
CAT2	10	30	40	20			100
CAT3	20	40	40	0			100
ESE	10	10	40	40			100

*** ±3% may be varied**

20SEE11 DESIGN OF BRIDGES

(IS456:2000, IS 458-1971,IRC 5-1998,IRC 6-2001,IRC 18-2000,IRC 21-2000,IRC 22-1986, IRC 24-2001,IRC 78-2000,IRC 83 Part 1-1989, IRC 83 Part 2-1987 codes are permitted)

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Design of Concrete Structures & Design of Steel Structures	3	PE	3	0	0	3

Preamble	This course offers the design of bridges such as RCC bridges, design principles of steel and prestressed concrete bridges, design principles of substructure and design of different types of bearings as per IRC loadings standards, Indian Railway standards bridge rules and most codes. It aims at determination of safe as well as economical section using different kinds of material used in construction and maintenance.	
Unit - I	**Introduction:**	**9**
Classification-Investigations and planning-Choice of type-I.R.C. specifications for road bridges-Standard live loads, other forces acting on bridges, general design considerations		
Unit - II	**Short Span Bridges:**	**9**
Load distribution theories-Analysis and design of slab culverts-Tee beam and slab Bridges.		
Unit - III	**Long Span Girder Bridges:**	**9**
Design principles of continuous bridges -Box girder bridges-Balanced cantilever bridges.		
Unit - IV	**Design of Prestressed Bridges:**	**9**
Minimum section Modules –Stress at transfer and service loads –Prestressing forces –Eccentricity of cables –End Block – Advantages of prestressed concrete bridges –Design of post tensioned prestressed concrete slab bridge deck –Design of post tensioned prestressed Tee beam and slab bridge.		
Unit - V	**Bearings and Substructures:**	**9**
Types of bearings -Design of masonry and concrete piers and abutments -Types of bridge foundations -Design of principles of deep foundations.		

Lecture:45, Total:45

REFERENCES:

1.	Johnson Victor D.,"Essentials of Bridge Engineering", 5th Edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2001.
2.	Ponnuswamy S., "Bridge Engineering", 2nd Edition, Tata Mc Graw Hill, 2008.
3.	Srinivasulu P., and Vaidyanathan C., "Handbook of Machine Foundations", 1st Edition, Tata McGraw Hill, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply knowledge in IRC specification	Applying (K3)
CO2:	analyze and design the short span bridges	Analyzing (K4)
CO3:	formulate the procedure to design the long span bridges	Analyzing (K4)
CO4:	analyze and design the prestressed concrete bridges	Analyzing (K4)
CO5:	simplify the stresses in sub-structure and design the piers and abutments	Analyzing (K4)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	3
CO2	3		3	2	3
CO3	3		3	2	3
CO4	3		3	2	3
CO5	3		3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**10**	**20**	**35**	**35**			**100**
CAT2		**20**	**40**	**40**			**100**
CAT3		**20**	**40**	**40**			**100**
ESE		**20**	**30**	**50**			**100**

*** ±3% may be varied**

20SEE12 DESIGN OF TALL STRUCTURES

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Design of Concrete Structures & Design of Steel Structures.	3	PE	3	0	0	3

Preamble	To gain the knowledge on design the tall buildings for earthquake, wind resistance and stability	
Unit - I	**Design Criteria:**	**9**
Design philosophy, loading, sequential loading, and materials – high performance concrete, fiber reinforced concrete, lightweight concrete, design mixes. Loading and Movement: Gravity loading: Dead and live load, methods of live load reduction, Impact, Gravity loading, Construction loads		
Unit - II	**Wind loading**:	**9**
static and dynamic approach, Analytical and wind tunnel experimentation method. Earthquake loading: Equivalent lateral force, modal analysis, combinations of loading, working stress design,Limitstatedesign,Plasticdesign.		
Unit - III	**Behavior of Various Structural Systems:**	**9**
Factors affectinggrowth, Height and structural form; High rise behavior, Rigid frames,braced frames, in-filled frames, shear walls, coupled shear walls, wall-frames, tubular, cores, Futigger– braced and hybrid mega system.		
Unit - IV	**Analysis and Design:**	**9**
Modeling for approximate analysis, accurate analysis and reduction techniques, analysis of building as total structural system considering overall integrity and major subsystem interaction, analysis for member forces; drift and twist, computerized general three dimensionalanalyses.		
Unit - V	**Stability of Tall Buildings:**	**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, Transnational, Torsional instability, out of plum effects, stiffness of member in stability, effect of foundation rotation. Structural elements: sectional shapes, properties and resisting capacities, design, deflection, cracking, pre-stressing, shear flow. Design for differential movement, creep and shrinkageeffects, temperature effects and fire.		

Lecture:45, Total:45

REFERENCES:

1.	TaranathB.S,"Structural Analysis and Design of Tall Buildings", 1st Edition, McGraw-Hill, New Delhi, 1988.
2.	Wilf gang Schuller, "High rise buildingstructures"1st Edition, John Wiley publisher,Noida, 1977.
3.	Bryan Stafford Smith &Alexcoull, "Tall building structures Analysis and Design", 1st Edition, John Wiley publisher,Noida, 1991.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	achieveknowledgeofdesignanddevelopmentofproblemsolvingskills.	Applying (K3)
CO2:	understandtheprinciplesofstrengthandstability.	Applying (K3)
CO3:	design and develop analyticalskills.	Applying (K3)
CO4:	summarize the behavior of various structuralsystems.	Applying (K3)
CO5:	understand the concepts of P-Deltaanalysis.	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	3
CO2	3		3	2	3
CO3	3		3	2	3
CO4	3		3	2	3
CO5	3		3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**20**	**40**	**40**				**100**
CAT2	**20**	**40**	**40**				**100**
CAT3	**30**	**30**	**40**				**100**
ESE	**30**	**30**	**40**				**100**

*** ±3% may be varied**

20SEE13 DESIGN OF OFFSHORE STRUCTURES

(IS4561 Part 1 – 1974, IS4561 Part 2 – 1989, IS4561 Part 3- 1974, IS4561 Part 4 - 1989, IS4561 Part 5 – 1980, IS9527 Part 1 – 1981, IS9527 Part 3 – 1983, IS9527 Part 4 – 1981, IS10020 Part 4 – 1981, IS875 Part 3 – 1987, SP64 – 2001 codes are permitted)

Programme& Branch	**M.E.-STRUCTURAL ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Design of concrete structures and Design of steel structures	**4**	PE	**3**	**0**	0	3

Preamble	The objective is to get the wave theories, offshore structural modeling and design.	
Unit - I	**Wind Effects:**	**9**
Wind on Structures - Rigid Structures - Flexible Structures - Static and dynamic effects.		
Unit - II	**Wave Hydrodynamics:**	**9**
Wave generation and propagation small and finite amplitudes wave theories - Wave energy and pressure distribution.		
Unit - III	**Wave Loading:**	**9**
Wave forces on vertical–inclined–cylinderical structures - Environmental loadings - Use of Morrison equation.		
Unit - IV	**Offshore Structure Modelling:**	**9**
Different types of structures - Foundation modeling - Static methods of analysis - Dynamics of Offshore Structures - Software applications.		
Unit - V	**Design of Offshore Structures:**	**9**
Loads - Design of platforms – Derricks – Helipads - Design principles and examples of Jacket Towers - Mooring cables.		

Lecture:45, Total:45

REFERENCES:

1.	Chakrabarti S.K., “Hydrodynamics of Offshore Structures”, NIT Press/Computational Mechanics Publications, 2003.
2.	Srinivasan Chandrasekaran, “Dynamic Analysis and Design of Offshore Structures”, 2nd Edition, Springer Singapore, 2018.
3.	API, “Recommended Practice for Planning, Designing and Construction, Fixed Offshore Platforms”, American Petroleum Institute Publication, RP2A, Dalls, Tex, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply the concepts of wind effects in offshore structures	Applying (K3)
CO2:	apply the concept of wave theories	Applying (K3)
CO3:	analysis the forces in offshore structures	Analyzing (K4)
CO4:	formulate the offshore structure modeling	Applying (K3)
CO5:	design the offshore structures	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	3
CO2	3		3	2	3
CO3	3		3	2	3
CO4	3		3	2	3
CO5	3		3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**20**	**30**	**50**				**100**
CAT2	**20**	**20**	**30**	**30**			**100**
CAT3	**20**	**30**	**50**				**100**
ESE	**20**	**20**	**40**	**20**			**100**

*** ±3% may be varied**

20SEE14 DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES
(IS: 800-2007, IS 11384-1985 & EURO code-4 are permitted)

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Design of Concrete Structures & Design of Steel Structures	**4**	PE	**3**	**0**	0	3

Preamble	To offer design and detailing of different types of composite members, trusses, types of connections and also some case studies about the composite construction in buildings were dealt in detail.	
Unit - I	**Theory of Composite Structures:**	**9**
Introduction to Steel - Concrete Composite Construction - Merits and demerits – Theory of composite structures - Introduction to IS and Euro codal provisions for steel concrete composites design - Local buckling and section classification - Limit states - Partial safety factors - Introduction to Steel - Concrete- Steel - Sandwich Construction.		
Unit - II	**Composite Beams:**	**9**
Introduction to composite beams - Advantages - Elastic behaviour of composite beams - No interaction and Full interaction - Shear connectors - Types and load bearing mechanism of shear connectors - Ultimate load behaviour of composite beam - Serviceability limit states - Types, merits and behaviour of profiled decking - Propped and unpropped conditions - Basic design considerations **-** Design of simply supported and continuous composite beam (with or without profile deck).		
Unit - III	**Composite Floors:**	**9**
Introduction to composite floors - Benefits - Sheeting parallel to span - Sheeting perpendicular to span - Ponding effect - Structural elements - Bending resistance - Shear resistance - Serviceability criteria - Analysis of internal forces and moments - Design of Composite floors.		
Unit - IV	**Composite Columns:**	**9**
Introduction to composite columns and its types - Advantages - Materials - Proposed design method - Design parameters and checks for structural adequacy - Resistance of encased composite column cross section and infilled composite column cross section under compression - Effective elastic flexural stiffness - Design of both encased and infilled composite column under axial compression, uniaxial bending and biaxial bending.		
Unit - V	**Composite Trusses:**	**9**
Introduction - Loads and analysis of trusses - Configuration of trusses - Behaviour and application of composite truss - Truss members - Composite connections - Design consideration - Stud specifications - Design of composite truss - Case studies on steel - concrete composite construction in buildings.		

Lecture:45, Total:45

REFERENCES:

1.	Johnson R.P., “Composite Structures of Steel and Concrete”, Volume I, Blackwell Publishing, U.K. 2008.
2.	“Teaching Resources for Structural Steel Design”, Volume 2 of 3, Institute for Steel Development and Growth (INSDAG), 2002.
3.	Narayanan R., “Composite steel structures – Advances, design and construction”, Elsevier, Applied Science, UK, 1987.

	COURSE OUTCOMES: On completion of the course, the students will be able to	**BT Mapped (Highest Level)**
CO1:	Understand the basic concepts of steel concrete composite construction	Understanding (K2)
CO2:	analyze and design composite beams with or without profile decking sheet	Analyzing (K4)
CO3:	design composite slabs with the provision of profile decking sheet	Analyzing (K4)
CO4:	design the encased and in-filled composite columns	Analyzing (K4)
CO5:	illustrate the design of composite trusses and case studies	Analyzing (K4)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	3
CO2	3		3	2	3
CO3	3		3	2	3
CO4	3		3	2	3
CO5	3		3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	15	35	40	-	-	100
CAT2	-	20	30	50	-	-	100
CAT3	-	20	35	45	-	-	100
ESE	10	20	30	40	-	-	100

*** ±3% may be varied**

20SEE15 DESIGN OF SUBSTRUCTURES

(IS 1904 - 1986, IS 6403-1981, IS 8009 – 1976 Part 1 & 2, IS 2950 - 1981, IS 456 -2000, IS 2911 Part 1 to 4 -2010, IS 2810-1979, IS 2974 -1992 Part 1- 5, IS 5249-1992, IS 13301 - 1992)

Programme& Branch	**M.E.-STRUCTURAL ENGINEERING**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Nil	**4**	PE	**3**	**0**	0	3

Preamble	This course makes the students to understand the design aspects of underground engineering structures and to gain knowledge of the design methods that can be applied to practical problems.	
Unit - I	**Shallow Foundations:**	**9**
Types of foundations and their specific applications – Depth of foundation – Bearing capacity and settlement estimates – Structural design of isolated-strip-rectangular -trapezoidal and combined footings – strap – raft foundation.		
Unit - II	**Pile Foundations:**	**9**
Types of piles and their applications – Load carrying capacity - Settlements - Group action - Design of piles and pile caps - Design of under reamed piles.		
Unit - III	**Piers and caissons:**	**9**
Drilled piers – construction – advantages and disadvantages – design and construction of open caissons – pneumatic caissons – floating caisson - piers and caissons for bridges - Foundations for towers, chimneys and silos.		
Unit - IV	**Machine Foundations:**	**9**
Types - General requirements and design criteria – vibration analysis of machine foundation – determination of natural frequency – foundation for reciprocating machine - vibration isolation and control.		
Unit - V	**Tunnel and Conduits:**	**9**
Stresses in soil around tunnels – construction of earth tunnels – arching in soils – types of underground conduits – ditch, positive and negative projecting conduits – surface load on conduits – construction of conduits.		

Lecture:45, Total:45

REFERENCES:

1.	Nayak N.V., “Foundation Design Manual for Practicing Engineers”, 2nd Edition, Dhanpatrai and Sons, 2012.
2.	Braja M. Das, “Principles of Foundations Engineering”, 7th Edition, Cengage Learning, 2011.
3.	Megaw T.M. and Bartlett J.V., “Tunnels: planning, design, construction”, 3rd Edition, John Wiley & Sons, Ellis Horwood, 1983.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	analyze and design different types of shallow and raft foundations	Analyzing (K4)
CO2:	calculate the load carrying capacity of the piles and pile group and design various types of piles	Applying (K3)
CO3:	design pier and caissons for tower, bridges and chimneys	Applying (K3)
CO4:	examine the structural aspects of machine foundation	Applying (K3)
CO5:	explain the concept of tunnel and conduits construction	Understanding (K2)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	3
CO2	3		3	2	3
CO3	3		3	2	3
CO4	3		3	2	3
CO5	3		3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**20**	**20**	**30**	**30**			**100**
CAT2	**20**	**30**	**50**				**100**
CAT3	**20**	**40**	**40**				**100**
ESE	**20**	**30**	**30**	**20**			**100**

*** ±3% may be varied**

20SEE16 METRO TRANSPORTATION SYSTEM AND ENGINEERING

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PE	3	0	0	3

Preamble	This course is to impart knowledge on the basic elements of metro transportation system	
Unit - I	**General:**	**9**
Overview of Metro transportation system - Need of Mass transport system - Types of mass transport systems - Peak Hour Peak Direction Traffic (PHPDT) demand studies and selection of suitable mass transport system - Comparison of Bus Rapid Transit (BRT) Vs. PHPDT - Train operation plan - prediction of Number of Rake, Car, and Head way - Mathematical model for the selection of best fit routing.		
Unit - II	**Alignment:**	**9**
Site survey - Factors influencing the alignment - Land acquisition within right of way - Horizontal and Vertical Curves - Super elevation - Points and Crossing - Types of crossings - Loop line - Shunting neck - Limiting train speed Vs. alignment curvature - Rail and Road Vehicle access (RRV).		
Unit - III	**Tunnel, Ramp, At Grade and Elevated corridor:**	**9**
Types of Tunnel and various construction methods - Cut and cover, Mined tunnel, Bored tunnel, NATM, Box/Pipe pushing - type of Cross passages and its requirements as per NFPA standard - Damage assessment studies and Instrumentation & Monitoring methods - Risk and mitigation measures of underground construction, Ramp and At Grade corridor - Types of elevated corridor, Construction methods of Viaduct, Portal and Girder system - Bearings and movement joints - Difference between Mono and Metro Rail system.		
Unit - IV	**Stations:**	**9**
Type of stations - selection of type and its locations - Components of elevated and under - ground (UG) stations, Platform level, Concourse level, Roof level, Paid & Unpaid areas, Public & Equipment operation room areas - Necessity of OTE, UPE, Draught relief and Vent shafts in UG stations, Tunnel ventilation Fan, Power supply and SCADA system. Size of station based on emergency evacuation methods as per NFPA standard - Fire and Ventilation system - Construction methods of Under - ground and Elevated stations - Cut and cover and Retaining wall system, Diaphragm wall and Pile systems.		
Unit - V	**Depot:**	**9**
Types of depot - Components of Depot - Stabling Yard - Infrastructure Shed, type of bogie wash, turn table - Auto coach wash plant - Depot Control Center (DCC) and its operations, Integrated Control Center (ICC) - Test track - Power supply stations, ASS and TSS - Water and Sewage Treatment plant.		

Lecture:45, Total:45

REFERENCES:

1. AvishaiCeder, “Urban Transit Systems and Technology”, 2nd Edition, John Wiley & Sons, New York, 2017.
2. Vukan R. Vuchic, “Public Transit Planning and Operation”, 3rd Edition, CRC Press, 2016.
3. William D. Middleton, “Metropolitan Railways: Rapid Transit in America”, 1st Edition, Indiana University Press, 2003.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	summarize the various elements of metro transportation system	Remembering (K1)
CO2:	explain the alignments in metro transportation system	Understanding (K2)
CO3:	elaborate the tunnel, ramp and elevated corridor used in metro transportation system	Applying (K3)
CO4:	classify the various stations in metro transportation system	Understanding (K2)
CO5:	classify the various depot in metro transportation system	Understanding (K2)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3		
CO2	3		3		
CO3	3		3		
CO4	3		3		
CO5	3		3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**10**	**90**					**100**
CAT2		**80**	**20**				**100**
CAT3		**100**					**100**
ESE	**10**	**80**	**10**				**100**

*** ±3% may be varied**

20SEE17 ENERGY EFFICIENT BUILDINGS

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PE	3	0	0	3

Preamble	To learn the green buildings concepts applicable to alternate design and to incorporate renewable energy systems in buildings	
Unit - I	**Introduction:**	**9**
Conventional versus Energy Efficient buildings – Historical perspective - Water – Energy – IAQ requirement analysis – Future building design aspects – Criticality of resources and needs of modern living.		
Unit - II	**Landscape and Building Envelopes**:	**9**
Energy efficient Landscape design - Micro-climates – various methods – Shading, water bodies-Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, Insulation, Design methods and tools.		
Unit - III	**Heating, Ventilation and Air-Conditioning**:	**9**
Natural Ventilation, Passive cooling and heating - Application of wind, water and earth for cooling, evaporative cooling, radiant cooling – Hybrid Methods – Energy Conservation measures, Thermal Storage integration in buildings		
Unit - IV	**Heat Transmission in Buildings:**	**9**
Surface co-efficient: air cavity, internal and external surfaces, overall thermal transmittance, wall and windows; Heat transfer due to ventilation/infiltration, internal heat transfer; Solar temperature; Decrement factor; Phase lag. Design of daylighting; Estimation of building loads: Steady state method, network method, numerical method, correlations; Computer packages for carrying out thermal design of buildings and predicting performance.		
Unit - V	**Passive Cooling & Renewable Energy in Buildings:**	**9**
Passive cooling concepts: Evaporative cooling, radiative cooling; Application of wind, water and earth for cooling; Shading, paints and cavity walls for cooling; Roof radiation traps; Earth air-tunnel. Introduction of renewable sources in buildings, Solar water heating, small wind turbines, stand-alone PV systems, Hybrid system – Economics.		

Lecture:45, Total:45

REFERENCES:

1.	Clarke, Joseph. “Energy simulation in building design”2ND Edition, Routledge, 2007
2.	Krishan, Arvind, ed. Climate responsive architecture: a design handbook for energy efficient buildings. Tata McGraw-Hill Education, 2001.
3.	Krieder, J and Rabi, A., Heating and Cooling of buildings : Design for Efficiency, McGraw Hill, 1994.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explain the climate responsive building design and concepts	Understanding (K2)
CO2:	explain the basic terminologies related to buildings	Understanding (K2)
CO3:	explain the passive (air) conditioning techniques	Understanding (K2)
CO4:	summarize the performance of buildings	Understanding (K2)
CO5:	Outline the renewable energy systems in buildings	Understanding (K2)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3	2	
CO2	3		3		3
CO3	3		3	3	
CO4	3		3		
CO5	3		3		3
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	**35**	**65**					**100**
CAT2	**40**	**60**					**100**
CAT3	**30**	**70**					**100**
ESE	**40**	**60**					**100**

*** ±3% may be varied**

20SEE18 MACHINE FOUNDATION

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PE	3	0	0	3

Preamble	To design different types of machine foundations based on the dynamic properties of soils and to get an exposure on vibration isolation techniques	
Unit - I	**Theory of Vibration:**	**9**
Introduction –Nature of dynamic loads –vibrations of single degree freedom system –free vibrations of spring –mass systems – forced vibrations –viscous damping Transmissibility –Principles of vibration measuring instruments effect of Transient and Pulsating loads –vibrations of multi degree freedom system.		
Unit - II	**Dynamic Soil Properties and Behavior**:	**9**
Dynamic stress –strain characteristics –principles of measuring dynamic properties –Laboratory Techniques –Field tests –Factors affecting dynamic properties -Typical values-Dynamic bearing capacity –Dynamic earth pressure.		
Unit - III	**Foundations for Reciprocating Machines:**	**9**
Types of Machines and Foundations –General requirements –Modes of vibration of a rigid foundation, block method of analysis –Linear Elastic weightless spring method –Elastic half –space method –Analog models**-** Design of Block foundation -Codal Provisions		
Unit - IV	**Foundation for Impact and Rotary Machines:**	**9**
Dynamic analysis of impact type machines –Design of Hammer foundations –use of vibrator Absorbers –design –Codal recommendation- Special consideration for Rotary machines –Design criteria –Loads on Turbo Generator Foundation –method of analysis –Dynamic soil –structure –Interaction**-**Codal Provisions.		
Unit - V	**Influence of Vibration and Remediation:**	**9**
Mechanism of Liquefaction–Influencing factors-evaluation of liquefaction potential based on SPT-force Isolation –motion Isolation –use of spring and damping materials –vibration control of existing machine foundation –screening of vibration –open trenches –Pile Barriers –salient construction aspects of machine foundations		

Lecture:45, Total:45

REFERENCES:

1.	Swami Saran, Soil Dynamics and Machine Foundation, 1st edition, Galgotia publications Pvt. Ltd. New Delhi 2010.
2.	Vaidyanathan, C.V., and Srinivasalu, P. “Handbook of Machine Foundations”. 1st edition, McGraw Hill, 2017.
3.	Prakash. S and Puri. V.K. “Foundations for machines”. 1st edition, John Wiley & Sons, 1988.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	compute the single degree of freedom with free vibration.	Applying (K3)
CO2:	determine the dynamic soil properties by stress –strain behavior	Applying (K3)
CO3:	design the foundations for reciprocating machines	Applying (K3)
CO4:	design the foundations for reciprocating machines	Applying (K3)
CO5:	analyze the principle of vibration in remediation works	Analyzing (K4)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3		
CO2	3		3		
CO3	3		3	3	
CO4	3		3	3	
CO5	3		3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		**40**	**60**				**100**
CAT2		**30**	**70**				**100**
CAT3		**30**	**40**	**30**			**100**
ESE		**20**	**40**	**40**			**100**

*** ±3% may be varied**

20SEE19– MAINTENANCE AND REHABILITATION OF STRUCTURES

(Common to Construction Engineering and Management & Structural Engineering branches)

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**4**	PE	**3**	**0**	0	3

Preamble	To identify the causes of deterioration and consequent modern rehabilitation strategy at optimum cost	
Unit - I	**General Aspects:**	**9**
Performance of construction materials and components in actual structure for strength, permeability, thermal properties and cracking effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, Effects of cover thickness.		
Unit - II	**Maintenance and Diagnosis of Failure:**	**9**
Maintenance, Repair and rehabilitation, Facets of Maintenance, Importance of Maintenance, Various aspects of inspection - Assessment procedure for evaluating a damaged structure. Diagnosis of construction failures.		
Unit - III	**Materials and Techniques for Repair:**	**9**
Special concretes and mortar, concrete chemicals, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement, Fiber reinforced concrete. Rust eliminators and polymers coating for rebar during repair foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning.		
Unit - IV	**Modern Techniques of Retrofitting:**	**9**
Structural first aid after a disaster, guniting, jacketing, use of chemicals in repair, application of polymers, ferrocement and fiber concretes as rehabilitation materials, rust eliminators and polymer coating for rebars, foamed concrete, mortar repair for cracks, shoring and underpinning, strengthening by prestressing.		
Unit - V	**Post repair Maintenance of Structures:**	**9**
Protection and Maintenance schedule against environmental distress to all those structures - Special cares in rehabilitation of heritage structures - high rise buildings - bridges and other special structures		

Lecture:45, Total:45

REFERENCES:

1.	Dayaratnam P. and Rao R., "Maintenance and Durability of Concrete Structures", 1st Edition, University Press, India, 1997.
2.	Denison Campbell, Allen and Harold Roper, "Concrete Structures, Materials, Maintenance and Repair", 1st Edition, Longman Scientific and Technical, UK, 1991.
3.	Dodge Woodson R., "Concrete Structures – protection, repair and rehabilitation", 1st Edition, Elsevier Butterworth – Heinmann, UK, 2009.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	comprehend the basic concepts related to maintenance management	Understanding (K2)
CO2:	choose repair and maintenance strategies for structures	Applying (K3)
CO3:	apply suitable post repair techniques for special structures	Applying (K3)
CO4:	adopt appropriate pre-stressing technique for special structures	Applying (K3)
CO5:	select the maintenance strategies for special structures	Applying (K3)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3		
CO2	3		3		
CO3	3		3		
CO4	3		3		
CO5	3		3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	60				100
CAT2	15	25	60				100
CAT3	20	30	50				100
ESE	20	30	50				100

*** ±3% may be varied**

20SEE20– GREEN BUILDING MANAGEMENT

(Common to Construction Engineering and Management & Structural Engineering branches)

Programme& Branch	M.E.-STRUCTURAL ENGINEERING	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PE	3	0	0	3

Preamble	To impart knowledge on Eco friendly building concepts and Building certification systems as per Indian and International Standards	
Unit - I	**Introduction to IGBC and Green Building Concept:**	**9**
Green Building Concept- Introduction to IGBC- Green Building Rating Tools - Green Project Management and Certification - Documentation and Certification		
Unit - II	**Introduction to Green Rating Systems:**	**9**
History of green Rating systems - LEED, GRIHA, BREEAM, IGBC - Need and use of green rating systems - Structure of the rating systems - Market response to various rating systems - Selection of the appropriate rating system.ZEB-NZEB-ZCB ratings		
Unit - III	**Alternative Construction Materials and Methods:**	**9**
Building and Material Reuse - Salvaged Materials - Material Content - Manufactured Materials - Recycled Content – Eco Block - Volatile Organic Compounds (VOC's) Natural Non-Petroleum Based Materials - Alternative Construction Methods - Waste Management and Recycling - Design For Deconstruction		
Unit - IV	**Performance Testing:**	**9**
Cost and Performance Comparisons and Benchmarking - Building Modeling & Energy Analysis - Cost Benefit Analysis - Energy, Shell and Systems Installation Testing - Blower Door - Duct Tightness - Thermal Imagery - Air Quality - Moisture Testing - Commissioning, Metering, Monitoring -Weatherization - Air Sealing – HVAC - Moisture Control - Energy Retrofits and Green Remodels		
Unit - V	**Future of Building Rating Systems:**	**9**
Role of Green building consultant - Determining the various green points - Green Accreditation examinations - Energy modeling and energy auditing in green building ratings - Consultancy scope and services for green rating systems - Codes and Certification Programs - Green Rating Registration - Green Remodel Ratings - International Green Construction Codes and ratings – Service life span - Case Study		

Lecture:45, Total:45

REFERENCES:

1.	Linda Reeder, "Guide to green building rating systems ", John Wiley & Sons, 3rd Edition 2010.
2.	Dru Meadows," Preparing a Building Service Life Plan for Green Buildings",McGraw-Hill Publications, 1st Edition, 2014.
3.	Abe Kruger," Green Building: Principles and Practices in Residential Construction", Cengage learning India Pvt Ltd, 1st Edition, 2012..

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	familiarize the concepts of green building	Understanding (K2)
CO2:	gain knowledge on existing green building rating systems	Understanding (K2)
CO3:	identify alternate construction materials and methods	Understanding (K2)
CO4:	rate the green buildings	Evaluating (K5)
CO5:	re-frame the codes for certification of green construction.	Understanding (K2)

Mapping of COs with POs and PSOs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3		3		
CO2	3		3		
CO3	3		3		
CO4	3		3		
CO5	3	3	3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	35	65					100
CAT2	20	30	30	20			100
CAT3	20	30	30	20			100
ESE	30	30	30	10			100

*** ±3% may be varied**