PUDUCHERRY TECHNOLOGICAL UNIVERSITY
PUDUCHERRY–605014

(A Technological University of Government of Puducherry)

Curriculum and Syllabi

for

M.Tech. (Structural Engineering)

(With effect from Academic year 2020-21)

(Approved in Sixth Academic Council Meeting held on 20th March 2021)

CURRICULUM

The curriculum of M.Tech. (Structural Engineering) is designed to fulfil the Programme Educational Objectives (PEO) and Programme Outcomes (PO) listed below:

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1	Strengthening the fundamental concepts	(i) To prepare and train students in the fundamentals concepts and advance knowledge of the applications of Structural Engineering, and Modelling to understand the behaviour of structural system. (ii) To analyse and design a structural system for the desired needs and constraints such as economic, environmental, social, political, ethical, health, safety and sustainability.
PEO2	Core competence	To provide and develop the core-competency in students so that they are able to handle existing and future structural engineering issues at national and international levels throughout their professional life time.
PEO3	Research and Consultancy Approach	To develop the research attitude using latest developments in structural engineering and encourage the students to participate in conferences, training programmes and internships in research organisations.
PEO4	Professionalism & Management Skills	To highlight to the students the managerial and organizational skills, ethics and the soft skills that are needed to tackle real-life problems, become an entrepreneur/professional engineer/ academician/ researcher, either individually or in collaboration with other engineers.

PROGRAMME OUTCOMES (PO)

PO1	An ability to independently carry out research and development work for solving the practical problems of Structural Engineering
PO2	An ability to conduct investigations and write and present a technical report/document of the structural engineering field problems.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.
PO4	Utilize skill and apply advance knowledge of Planning, Analysis and Design fundamentals appropriate to the specialization.
PO5	Address modern issues and understanding of the various civil engineering of professional, ethical, legal, security and social issues and responsibilities.
PO6	Understanding of Structural engineering and management principles and apply these to one’s work to practice as consultant, as a team leader, to manage projects and continuously engage in professional development throughout their life.

Distribution of Credits among the subjects grouped under various categories:

Courses are grouped under various categories and the credits to be earned in each category of courses are as follows:

Sl. No.	Category	Credits	Course Category Code (CCC)
1	Programme Core Course	22	PCC
2	Programme Specific Elective Courses	15	PSE
3	Open Elective Courses	03	OEC
4	Professional Activity Courses (Project Work, Seminar)	28	PAC
5	Mandatory Audit Courses	Non Credit	MAC
	Total	**68**	

Semester Wise Courses and Credits

Semester I

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CE251	Advanced Structural Analysis	PCC	3	0	0	3
CE252	Advanced Solid Mechanics	PCC	3	0	0	3
CEZNN	Programme Specific Elective - 1	PSE	3	0	0	3
CEZNN	Programme Specific Elective - 2	PSE	3	0	0	3
CE253	Structural Design Lab	PCC	0	0	4	2
CE254	Advanced Concrete Lab	PCC	0	0	4	2
CE255	Research Methodology and IPR	PCC	2	0	0	2
AD2NN	Audit Course - I	MAC	2	0	0	0
		Total	**24**			**18**

Semester II

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CE256	FEM in Structural Engineering	PCC	3	0	0	3
CE257	Structural Dynamics	PCC	3	0	0	3
CEZNN	Programme Specific Elective - 3	PSE	3	0	0	3
CEZNN	Programme Specific Elective - 4	PSE	3	0	0	3
CE258	Model Testing Lab	PCC	0	0	4	2
CE259	Numerical Analysis Lab	PCC	0	0	4	2
CE260	Mini Project and Seminar	PAC	0	0	4	2
AD2NN	Audit Course - II	MAC	2	0	0	0
		Total	**26**			**18**

Semester III

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CEZNN	Programme Specific Elective - 5	PSE	3	0	0	3
OE2NN	Open Elective	OEC	3	0	0	3
CE261	Dissertation – Phase I	PAC	0	0	20	10
		Total	**26**			**16**

Semester IV

Course Code	Course	CCC	Periods			Credits
			L	T	P	
CE262	Dissertation – Phase II	PAC	0	0	32	16
		Total	**32**			**16**

Total Credits: 68

Audit Courses (MAC)

AD201	English for Academic Writing (HS)
AD202	Disaster Management (CE)
AD203	Value Education (HS)
AD204	Constitution of India (HS)
AD205	Pedagogy Studies (HS)
AD206	Stress Management by Yoga (HS)

Open Elective Courses (OEC)

OE201	Business Analytics (IT)
OE202	Industrial Safety and Maintenance (ME)
OE203	Operations Research (ME)
OE204	Cost Management of Engineering Projects (CE)
OE205	Composite Materials (PH)
OE206	Waste to Energy (CE)

Programme Specific Electives (PSE):

PSE - 1	**CEZ01**	Theory of Plates
	CEZ02	Theory and Applications of Cement Composites
	CEZ03	Design of Advanced Concrete Structures
	CEZ04	Structural Health Monitoring
PSE -2	**CEZ05**	Theory of Structural Stability
	CEZ06	Experimental Techniques and Instrumentations
	CEZ07	Seismic Design of Structures
	CEZ08	Design of Masonry Structures
PSE -3	**CEZ09**	Advanced Steel Design
	CEZ10	Design of Steel Concrete Composite Structures
	CEZ11	Advanced Design of Foundations
	CEZ12	Fracture Mechanics of Concrete Structures
PSE - 4	**CEZ13**	Design of Prestressed Concrete Structures
	CEZ14	Design and construction of prefabricated structure
	CEZ15	Design of Bridges
	CEZ16	Design Of Shell Structures
PSE - 5	**CEZ17**	Design of Industrial Structure
	CEZ18	Structural Optimization
	CEZ19	Design of Machine Foundations
	CEZ20	Structural Design of Infrastructure Facilities

XX – Department Code; **NN** – Running double digit number; **N** – Running single digit number

Department : **Civil Engineering**	Programme: **M. Tech.(Structural Engineering)**	
Semester **: I**	Course Category Code: **PCC**	Semester Exam Type: **TY**

Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE251	**ADVANCED STRUCTURAL ANALYSIS**	3	0	0	3	40	60	100

Prerequisite:		
Course Outcome:	At the end of the course, students will be able to	
	CO1	Analyse the transformation of forces from element to system.
	CO2	Analyse the beams and frames by matrix flexibility method.
	CO3	Analyse the transformation of displacements from element to system.
	CO4	Analyse the beams and frames by matrix stiffness method.
	CO5	Analyse the structures by matrix displacement method.

UNIT – I	**Fundamental concepts**	**Periods : 9**
Introduction – Force and Displacement measurements – Principle of superposition – Transformation of forces – Element flexibility to system flexibility. Matrix flexibility method – Analysis of pin-jointed frames – effects due to lack of fit and temperature changes.		**CO1**
UNIT – II	**Analysis of Structures by Flexibility method**	**Periods : 9**
Analysis of statically indeterminate beams and rigid jointed plane frames – effect of support settlements and elastic supports. Application to space frames – Direct flexibility approach.		**CO2**
UNIT – III	**Introduction to Stiffness method**	**Periods : 9**
Matrix stiffness method – Transformation of displacements – Element stiffness to system stiffness – Application to pin-jointed plane frames – support settlements – lack of fit and temperature effect.		**CO3**
UNIT – IV	**Analysis of Structures by Stiffness method**	**Periods : 9**
Application to continuous beams and rigid jointed plane frames– effects of support settlements and elastic supports. Analysis of three dimensional pinned frames.		**CO4**
UNIT – V	**Matrix Displacement methods**	**Periods : 9**
Special topics – Condensation, Sub structuring – reanalysis techniques – transfer matrix method. Symmetric and Anti symmetric of structures. Analysis of frames with semi rigid connections.		**CO5**

Lecture Periods : 45	**Tutorials Periods : -**	**Practical Periods: -**	**Total Periods : 45**

<u>Reference Books</u>

1. Waver W and Gere, J., Matrix Analysis of Framed Structures, CBS Publishers and Distributors, 2004.
2. Pandit G.S. and Gupta, S.P., “Structural Analysis – A Matrix Approach”, Tata McGraw Hill Publishing Co., New Delhi, 2008.
3. Rajasekaran S., and SankaraSubramaninan, G., “Computational Structural Mechanics”, Prentice Hall of India Pvt. Ltd., New Delhi, First Edition 2001.
4. Wang C.K., “Intermediate Structural Analysis”, McGraw Hill Publishing Co., New York, 1989.
5. William weaver and James M Gere, “Matrix Analysis of Framed Structures”, CBS Publishers, New Delhi, 3rd edition, 1990.
6. H.C. Martin, Introduction to Matrix Methods of Structural Analysis, McGraw-Hill, 1966.
7. Dr. Devadas Menon., Advanced Structural Analysis, Narosa Publishing House, New Delhi, 2018.
8. Reddy C.S., “Basic Structural Analysis”, Tata Mc Graw-Hill Publishing Company Limited, New Delhi,2010.
9. C. Natarajan and P. Revathi, “Matrix Methods of Structural Analysis- Theory and Problems”, Prentice Hall of India Pvt. Ltd., New Delhi, First Edition2014.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3			1
CO2	1	2	3			1
CO3	1	2	3			1
CO4	1	2	3			1
CO5	1	2	3			1

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**		Programme: **M. Tech.(Structural Engineering)**							
Semester : **I**		Course Category Code: **PCC**				Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks			
		L	T	P	C	CA	SE	TM	
CE252	**ADVANCED SOLID MECHANICS**	3	0	0	3	40	60	100	
Prerequisite:									

Course Outcome:	At the end of the course, students will be able to	
	CO1	Illustrate the 2D and 3D stresses and strains in Cartesian and polar coordinate systems and also Transfer these stresses and strains
	CO2	Calculate the induced stress in the 2D system using Airy's stress function
	CO3	Calculate the induced stress in the 2D system in polar coordinates
	CO4	Calculate the capacity of circular, non-circular sections both solid and tubular sections using St.Venant's approach and Prandtl approach
	CO5	Understand the physical behaviour of yield criteria of material

UNIT – I	**Analysis of stresses and strains**	**Periods : 9**	
Basic concepts of deformation of bodies, Elementary Concept of Strain, Strain at a Point, Strain and Stress Fields, Equations of Elasticity, Differential Equations of Equilibrium, Strain Displacement and Compatibility Relations, Transformation of stresses and strains , Principal stresses and Strains & Principal Axes.			**CO1**
UNIT – II	**Two-Dimensional Problems in Cartesian Coordinates**	**Periods : 9**	
Plane Stress and Plane Strain Problems, Airy's stress Function applied to beam bending, Simply supported beams and cantilever beam with concentrated load and uniformly distributed load			**CO2**
UNIT – III	**Two-Dimensional Problems in Polar Coordinates**	**Periods : 9**	
Equations of equilibrium and compatibility. Stress distribution in Curved beams, Thick cylinder with internal and external pressure and rotating disc.			**CO3**
UNIT – IV	**Torsion of Prismatic Bars**	**Periods : 9**	
Torsion of non-circular sections-Saint Venant's Method, Torsion of elliptical section. Prandtl's Membrane Analogy, Torsion of Rectangular Bar, Torsion of Thin Tubes			**CO4**
UNIT – V	**Plasticity**	**Periods : 9**	
Plastic Stress-Strain Relations, Strain Hardening, Idealized Stress- Strain curve, Theories of failure and Yield Criteria, Von Mises Yield Criterion, Tresca Yield Criterion. Application to bending of beams			**CO5**

Lecture Periods : 45	**Tutorials Periods : -**	**Practical Periods: -**	**Total Periods : 45**

<u>Reference Books</u>

1. Theory of Elasticity, Timoshenko S. andGoodier.J. N., McGraw Hill,2010.
2. Theory of Elasticity, Sadhu Singh, Khanna Publishers 2000
3. Computational Elasticity, AmeenM.,Narosa,2014.
4. Advanced Mechanics of Solids, SrinathL.S., Tata McGrawHill,2008.
5. Theory of Plasticity, Sadhu Singh Khanna Publishers Third Edition 1990

<u>CO – PO Mapping</u>

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3		
CO2	1	2		3		
CO3	1	2		3		
CO4	1	2		3		
CO5	1	2		3		

<u>Score</u>: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="1">Department:
Civil Engineering</td><td colspan="8">Programme: M.Tech.(Structural Engineering)</td></tr>
<tr><td>Semester: I</td><td colspan="4">Course Category Code: PCC</td><td colspan="4">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CE253</td><td>Structural Design Lab</td><td>-</td><td>-</td><td>4</td><td>2</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8"></td></tr>
<tr><td rowspan="5">Course Outcome</td><td>CO1</td><td colspan="7">Understanding the analysis of beams and frames</td></tr>
<tr><td>CO2</td><td colspan="7">Understanding the design and detailing of RC structural elements</td></tr>
<tr><td>CO3</td><td colspan="7">Understanding the design of industrial buildings</td></tr>
<tr><td>CO4</td><td colspan="7">Understanding the seismic analysis of buildings</td></tr>
<tr><td>CO5</td><td colspan="7">Understanding the design of deck slab bridges</td></tr>
<tr><td colspan="9">List of Experiments :</td></tr>
<tr><td colspan="8">1. Analysis of Continuous beams and multi-bay frames under various types of static loading
2. Design and Detailing of RCC structural elements (beam, slab, column and foundation)
3. Plastic Analysis and Design of an Industrial Building
4. Seismic Analysis of buildings as per IS code
5. Design of Deck slab bridge as per IRC code</td><td>CO1
to
CO5</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td colspan="2">Lecture Periods: -</td><td>Tutorial Periods:
-</td><td colspan="3">Practical Periods: 60</td><td colspan="3">Total Periods: 60</td></tr>
<tr><td colspan="9"><u>Reference Books</u></td></tr>
<tr><td colspan="9"></td></tr>
</table>

<u>CO – PO Mapping</u>

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Civil Engineering**	Programme: **M.Tech.(Structural Engineering)**							
Semester: **I**	Course Category Code: **PCC**			Semester Exam Type: **LB**				
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE254	**Advanced Concrete Lab**	-	-	4	2	40	60	100
Prerequisite								
Course Outcome	**CO1**	Study the stress-strain curve behaviour of high strength concrete						
	CO2	Design high grade concrete and study the parameters affecting its performance.						
	CO3	Study the effect of bond between concrete and steel.						
	CO4	Conduct Non Destructive Tests on existing concrete structures.						
	CO5	Apply engineering principles to understand behaviour of structural/elements.						
List of Experiments :								
1. Study of stress-strain curve for high strength concrete, 2. Correlation between cube strength, cylinder strength and modulus of rupture. 3. Effect of bond strength on steel and concrete. 4. Non-Destructive testing of existing concrete members. 5. Behavior of Beams under flexure, Shear andTorsion.						**CO1 to CO5**		
Lecture Periods: -		**Tutorial Periods: -**		**Practical Periods: 60**		**Total Periods: 60**		
<u>Reference Books</u>								

<u>CO – PO Mapping</u>

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

<u>Score</u>: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="2">Department :Civil Engineering</td><td colspan="5">Programme: M. Tech.(Structural Engineering)</td><td colspan="4"></td></tr>
<tr><td colspan="2">Semester: I</td><td colspan="5">Course Category Code: PCC</td><td colspan="4">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CE255</td><td colspan="2">RESEARCH METHODOLOGY AND IPR</td><td>2</td><td>0</td><td>0</td><td>2</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="9"></td></tr>
<tr><td rowspan="6">Course Outcome:</td><td colspan="9">At the end of the course, students will be able to</td></tr>
<tr><td>CO1</td><td colspan="8">Understand the research problem formulation</td></tr>
<tr><td>CO2</td><td colspan="8">Analyze and Follow ethics while formulating the research problem.</td></tr>
<tr><td>CO3</td><td colspan="8">Understand that today’s world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.</td></tr>
<tr><td>CO4</td><td colspan="8">Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.</td></tr>
<tr><td>CO5</td><td colspan="8">UnderstandthatIPRprotectionprovidesanincentivetoinventorsforfurtherresearch. Work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.</td></tr>
<tr><td>UNIT – I</td><td colspan="6">Introduction</td><td colspan="3">Periods : 6</td></tr>
<tr><td colspan="9">Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations</td><td>CO1</td></tr>
<tr><td>UNIT – II</td><td colspan="6">Literature Review</td><td colspan="3">Periods : 6</td></tr>
<tr><td colspan="9">Effective literature studies approaches, analysis plagiarism, and Research ethics.</td><td>CO2</td></tr>
<tr><td>UNIT – III</td><td colspan="6">Technical Writing and Presentation</td><td colspan="3">Periods: 6</td></tr>
<tr><td colspan="9">Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee</td><td>CO3</td></tr>
<tr><td>UNIT – IV</td><td colspan="6">Nature of Intellectual Property</td><td colspan="3">Periods : 6</td></tr>
<tr><td colspan="9">Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.</td><td>CO4</td></tr>
<tr><td>UNIT – V</td><td colspan="6">Patent Rights</td><td colspan="3">Periods : 6</td></tr>
<tr><td colspan="9">Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs</td><td>CO5</td></tr>
<tr><td colspan="2">Lecture Periods : 30</td><td>Tutorials Periods : -</td><td colspan="4">Practical Periods: -</td><td colspan="3">Total Periods : 30</td></tr>
</table>

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

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department **: Civil Engineering**		**Programme: M. Tech.(Structural Engineering)**						
Semester: **II**		Course Category Code: **PCC**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE256	**FEM IN STRUCTURAL ENGINEERING**	3	0	0	3	40	60	100
Prerequisite:	Knowledge on mathematics, Matrix method of structural Analysis.							

Course Outcome:	At the end of the course, students will be able to	
	CO1	Understanding the basic procedure of Finite Elements Methods
	CO2	Understanding the Shape functions in Finite Element Method
	CO3	Understanding the development of element stiffness matrix
	CO4	Able to carry out 2 Dimensional Structural Analysis
	CO5	Understanding the 3D shape functions and Pre and Post Process using software.

UNIT – I	**Introduction**	**Periods : 9**	
Need for numerical technique- approximate methods- principle of stationary potential energy –Rayleigh Ritz method - generalized concept of FEM - advantages and disadvantages of FEM –basic step by step procedure of FEM.			**CO1**
UNIT – II	**Element properties: Development of shape function**	**Periods : 9**	
Typical finite elements- Displacement models – interpolation or shape functions- development of shape functions in x-y system for one dimensional and two dimensional elements- generalized coordinate, setting up equation of lines and Lagrangian polynomials method.– development of Shape function or Interpolation function in natural coordinate systems - Linear and quadratic elements - Lagrange & Serendipity elements- Strain displacement matrix			**CO2**
UNIT – III	**Development of Element stiffness matrix**	**Periods : 9**	
Two dimensional isoparametric elements - Four noded quadrilateral elements – triangular elements- development of element stiffness matrix for line, plane and isoparametric elements - numerical integration(Gauss quadrature) -Convergence criteria for isoparametric elements. Assemblage of elements – Direct stiffness method- Special characteristics of stiffness matrix- Boundary condition & reaction - Gauss elimination and matrix decomposition techniques - Basic steps in finite element analysis.			**CO3**
UNIT – IV	**2D – Elements**	**Periods : 9**	
Analysis of framed Structures- development of element stiffness matrix for plane truss element and two dimensional beam element. Analysis of plate bending - displacement functions - plate bending Elements.			**CO4**
UNIT – V	**3D – Elements**	**Periods : 9**	
Introduction to 3 Dimensional elements – element stiffness matrix for truss element in space. Introduction to finite element softwares– Pre and Post processors.			**CO5**

Lecture Periods : 45	**Tutorials Periods : -**	**Practical Periods: -**	**Total Periods : 45**

Reference Books
1. Krishnamoorthy, C.S, Finite Element Analysis Theory and Programming, McGraw- Hill, 1995. 2. Desai C.S and Abel, J.F., Introduction to the Finite Element Method, Affiliated East West Press Pvt. Ltd. New Delhi 2000. 3. Ramachandiran, J., Boundary and Finite Elements, Theory and Problems, Narosa Publishing House, Chennai, 2000. 4. Logan.D. L, A First Course in the Finite Element Method, Thomson India Edition, New Delhi, 2007.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	1	1
CO2	2	1	3	2	1	1
CO3	2	1	3	2	1	1
CO4	2	1	3	2	1	1
CO5	2	1	3	2	1	1

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**		Programme: **M. Tech.(Structural Engineering)**						
Semester : **II**		Course Category Code: **PCC**				Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE257	**STRUCTURAL DYNAMICS**	3	0	0	3	40	60	100
Prerequisite:								

Course Outcome:	**CO1**	Analyze and study the dynamic response of single degree of freedom system using fundamental theory and equation of motion.
	CO2	Analyze and study the dynamicresponseof Multi degree freedom system using fundamental theory and equation of motion.
	CO3	Use numerical methods to give solution to response of the system.
	CO4	Analyze and study the dynamic response of beams.
	CO5	Use the available software for dynamic analysis.

UNIT – I	**Single Degree of Freedom System**	**Periods : 9**	
Introduction:Importance of Vibration Analysis, Nature of Exciting force, Mathematical Modeling of Dynamic Systems. SingleDegreeofFreedomSystem:Freeand Forced Vibration with and without Damping, response to Harmonic Loading, Response to General Dynamic Loading using Duhamel's Integral.			**CO1**
UNIT – II	**Multiple Degree of Freedom System (**Lumpedparameter**)**	**Periods : 9**	
Two Degree of Freedom System, Multiple Degree of Freedom System (Lumped Parameter), Iteration Method for determination of Natural Frequencies and Mode Shapes, Dynamic Response by Modal Superposition Method, DirectIntegration of Equationof Motion.			**CO2**
UNIT – III	**Numerical Solution to Response**	**Periods : 9**	
NumericalSolutiontoResponseusingNewmarkMethodandWilson Method, Numerical Solution for State Space Response using Direct Integration.			**CO3**
UNIT – IV	**Multiple Degree of Freedom System**	**Periods : 9**	
Multiple Degree of Freedom System (Distributed Mass and Load)**:** Single Span Beams, Free and Forced Vibration, Generalized Single Degree of Freedom System.			**CO4**
UNIT – V	**Special Topics**	**Periods : 9**	
Dynamic Effects of Wind Loading, Impact Loads,Blasting, Foundations for Industrial Machinery, Base Isolation.			**CO5**

Lecture Periods : 45	**Tutorials Periods : -**	**Practical Periods: -**	**Total Periods : 45**

Reference Books

1. DynamicsofStructures,CloughR.W.andPenzienJ.,McGrawHill,2010
2. StructuralDynamics-Theoryand Computation,PazMario,CBSPublication,2004
3. StructuralDynamicsand IntroductiontoEarthquakeEngineering,ChopraA.K., Prentice-Hall, 2002
4. DynamicsofStructures,HumarJ.L.,PrenticeHall,2002
5. Vibrationof Structures– ApplicationinCivilEngineeringDesign,SmithJ.W.,Chapman And Hall,1988
6. Structural Dynamics for Structural Engineers, Gary C.Hart, Kevin Wong, John Wiley and Sons Inc,2000.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	3			2
CO2	1	3	3			2
CO3	1	3	3			2
CO4	1	3	3			2
CO5	1	3	3			2

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Civil Engineering**		Programme: **M.Tech.(Structural Engineering)**						
Semester: **II**		Course Category Code :**PCC**			Semester Exam Type: **LB**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE258	**Model Testing Lab**	-	-	4	2	40	60	100
Prerequisite								
Course Outcome		**CO1**	Understand the response of structures.					
		CO2	Prepare the models.					
		CO3	Conduct model testing for static loading					
		CO4	Conduct model testing for free and forced vibrations					
		CO5	Understand the Vibration Characteristics of RC Beams					
List of Experiments :								
1. Response of structures and its elements against extreme loading Events. 2. Static - testing of plates, shells, and frames Models. 3. Free and forced vibrations, Evaluation of dynamic Modulus. 4. Beam vibrations, Vibration isolation, Shear wall building model 5. Time and frequency-domain study, Vibration Characteristics of RC Beams using Piezoelectric Sensors etc.							**CO1 to CO5**	
Lecture Periods: -		**Tutorial Periods: -**	**Practical Periods: 60**		**Total Periods: 60**			
Reference Books								

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: Civil Engineering		Programme: M.Tech. (Structural Engineering)						
Semester: **II**		Course Category Code:**PCC**			Semester Exam Type: **LB**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE259	**Numerical Analysis Lab**	-	-	4	2	40	60	100
Prerequisite								

Course Outcome	**CO1**	Find Roots of non-linear equations by Bisection method and Newton's method.
	CO2	Do curve fitting by least square approximations
	CO3	Solve the system of Linear Equations using Gauss - Elimination/ Gauss - Seidal Iteration/ Gauss – Jorden Method
	CO4	To Integrate Numerically Using Trapezoidal and Simpson's Rules
	CO5	Find Numerical Solution of Ordinary Differential Equations by Euler's Method, Runge-Kutta Method.

List of Experiments :

(1) Find the Roots of Non-Linear Equation Using Bisection Method. (2) Find the Roots of Non-Linear Equation Using Newton's Method. (3) Curve Fitting by Least Square Approximations. (4) Solve the System of Linear Equations Using Gauss – Elimination Method. (5) Solve the System of Linear Equations Using Gauss - Seidal Iteration Method. (6) Solve the System of Linear Equations Using Gauss – Jorden Method. (7) Integrate numerically using Trapezoidal Rule. (8) Integrate numerically using Simpson's Rule. (9) Numerical Solution of Ordinary Differential Equations By Euler's Method. (10) Numerical Solution of Ordinary Differential Equations By Runge- Kutta Method.	**CO1 to CO5**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 60**	**Total Periods: 60**

Reference Books

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

Department: **Civil Engineering**		Programme: **M.Tech.(Structural Engineering)**						
Semester: **II**		Category : **PAC**			Semester Exam Type: **LB**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CE260	**Mini Project and Seminar**	-	-	4	2	40	60	100
Prerequisite								
Course Outcome		**CO1**	Identify structural engineering problems reviewing available literature.					
		CO2	Study different techniques used to analyse complex structural systems.					
		CO3	Work on the solutions given and present solution by using his/her technique applying engineering principles.					

List of Experiments :

Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution. Continuous assessment of Mini Project at Mid Semester and End Semester will be monitored by the departmental committee.	**CO1** **CO2** **CO3**

Lecture Periods: -	**Tutorial Periods: -**	**Practical Periods: 60**	**Total Periods: 60**

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="2">Department: Civil Engineering</td><td colspan="7">Programme: M.Tech.(Structural Engineering)</td></tr>
<tr><td colspan="2">Semester: III</td><td colspan="4">Course Category Code:PAC</td><td colspan="3">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CE261</td><td>Dissertation Phase-I</td><td>-</td><td>-</td><td>20</td><td>10</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8"></td></tr>
<tr><td colspan="2" rowspan="3">Course Outcome</td><td>CO1</td><td colspan="6">Identify structural engineering problems reviewing available literature.</td></tr>
<tr><td>CO2</td><td colspan="6">Identify appropriate techniques to analyse complex structural systems.</td></tr>
<tr><td>CO3</td><td colspan="6">Apply engineering and management principles through efficient handling of project.</td></tr>
<tr><td colspan="9">List of Experiments :</td></tr>
<tr><td colspan="8" rowspan="3">Dissertation-I will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions and must bring out individuals contribution. Continuous assessment is done at the Mid Semester and End Semester and it will be monitored by the departmental committee.</td><td>CO1</td></tr>
<tr><td>CO2</td></tr>
<tr><td>CO3</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td colspan="2">Lecture Periods: -</td><td colspan="2">Tutorial Periods: -</td><td colspan="3">Practical Periods: 300</td><td colspan="2">Total Periods: 300</td></tr>
<tr><td colspan="9"></td></tr>
</table>

CO – PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="2">Department: Civil Engineering</td><td colspan="7">Programme: M.Tech. (Structural Engineering)</td></tr>
<tr><td colspan="2">Semester: IV</td><td colspan="3">Course Category Code: PAC</td><td colspan="4">Semester Exam Type: LB</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CE262</td><td>Dissertation Phase-II</td><td>-</td><td>-</td><td>32</td><td>16</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite</td><td colspan="8"></td></tr>
<tr><td colspan="2" rowspan="3">Course Outcome</td><td>CO1</td><td colspan="6">Able to solve complex structural problems by applying appropriate techniques and tools</td></tr>
<tr><td>CO2</td><td colspan="6">Exhibit good communication skill to the engineering community and society</td></tr>
<tr><td>CO3</td><td colspan="6">Demonstrate professional ethics and work culture</td></tr>
<tr><td colspan="9">List of Experiments :</td></tr>
<tr><td colspan="8" rowspan="3">Dissertation – II will be extension of the work on the topic identified in Dissertation – I.
Continuous assessment should be done of the work done by adopting the methodology decided involving numerical analysis/ conduct experiments, collection and analysis of data, etc. There will be submission of project report at the end of academic term. After the approval the student has to submit the detail report and external examiner is called for the viva-voce to assess along with guide.</td><td>CO1</td></tr>
<tr><td>CO2</td></tr>
<tr><td>CO3</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td colspan="2">Lecture Periods: -</td><td colspan="2">Tutorial Periods: -</td><td colspan="2">Practical Periods: 480</td><td colspan="3">Total Periods: 480</td></tr>
<tr><td colspan="9"></td></tr>
</table>

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3

Score: **3** – High; **2** – Medium; **1** – Low

PROGRAMME SPECIFIC ELECTIVES (PSE)

<table>
<tr><td colspan="2">Department :Civil Engineering</td><td colspan="6">Programme: M.Tech. (Structural Engineering)</td></tr>
<tr><td colspan="2">Semester : I</td><td colspan="4">Course Category Code: PSE</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CEZ01</td><td>THEORY OF PLATES</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="5">Course Outcome:</td><td>CO1</td><td colspan="7">Understanding the differential equation of thin plates with small deflection.</td></tr>
<tr><td>CO2</td><td colspan="7">Understanding the Rectangular plate theories with various boundary conditions.</td></tr>
<tr><td>CO3</td><td colspan="7">Understanding the Analysis of Circular plate with and without hole at the centre</td></tr>
<tr><td>CO4</td><td colspan="7">Understanding the energy and finite element analysis of plates</td></tr>
<tr><td>CO5</td><td colspan="7">Understanding the analysis of plates, grids and thick plates</td></tr>
<tr><td>UNIT – I</td><td colspan="5">Thin Plate Differential Equation</td><td colspan="3">Hours : 9</td></tr>
<tr><td colspan="7">Thin Plates with small deflection - Laterally loaded thin plates, governing differential equation, various boundary conditions.</td><td colspan="2">CO1</td></tr>
<tr><td>UNIT – II</td><td colspan="5">Analysis of Rectangular Plates</td><td colspan="3">Hours : 9</td></tr>
<tr><td colspan="7">Rectangular plates - Simply supported rectangular plates, Navier solution and Levy's method, Rectangular plates with various edge conditions, plates on elastic foundation.</td><td colspan="2">CO2</td></tr>
<tr><td>UNIT – III</td><td colspan="5">Analysis of Circular Plates</td><td colspan="3">Hours : 9</td></tr>
<tr><td colspan="7">Symmetrical bending of circular plates- uniformly loaded circular plates, circular plates with circular hole at the centre, circular plates concentrically loaded at the centre.</td><td colspan="2">CO3</td></tr>
<tr><td>UNIT – IV</td><td colspan="5">Approximate Methods</td><td colspan="3">Hours : 9</td></tr>
<tr><td colspan="7">Energy methods, Finite difference and Finite element methods.</td><td colspan="2">CO4</td></tr>
<tr><td>UNIT – V</td><td colspan="5">Anisotropic Plates and Thick Plates</td><td colspan="3">Hours : 9</td></tr>
<tr><td colspan="7">Orthotropic plates and grids, moderately thick plates.</td><td colspan="2">CO5</td></tr>
<tr><td colspan="2">Lecture Periods : 45</td><td colspan="2">Tutorial Periods : -</td><td colspan="3">Practical Periods : -</td><td colspan="2">Total Periods : 45</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
<tr><td colspan="9">1. Timoshenko S. & Krieger S.W. “Theory of Plates & Shells”, McGraw Hill Book Company, New York, 1990.
2. Bairagi “Plate Analysis”, Khanna Publishers, 1996.
3. Reddy J N, “Theory and Analysis of Elastic Plates and Shells”, McGraw Hill Book Company, 2006.
4. Szilard R., “Theory and Analysis of Plates”, Prentice Hall Inc., 1995.
5. Chandrashekahara K. Theory of Plates, University Press (India) Ltd., Hyderabad, 2001.</td></tr>
</table>

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2			3	1	2
CO2	2			3	1	2
CO3	2			3	1	2
CO4	2			3	1	2
CO5	2			3	1	2

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**			Programme: **M. Tech.(Structural Engineering)**						
Semester : **I**			Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CEZ02	**THEORY AND APPLICATIONS OF CEMENT COMPOSITES**		3	0	0	3	40	60	100
Prerequisite:									
Course Outcome:	At the end of the course, students will be able to								
	CO1	Understanding the composite material characteristics							
	CO2	Understanding the mechanics of composite materials.							
	CO3	Understanding the constituents, for the preparation of cement composites							
	CO4	Understanding the behavior and durability of cement composites							
	CO5	Understanding the modelling and application of cement composite materials.							
UNIT – I	**Composite Material Properties**						**Periods : 9**		
Classification and Characteristics of Composite Materials- Basic Terminology, Advantages. Stress-Strain Relations- Orthotropic and Anisotropic Materials, Engineering Constants for Orthotropic Materials, Restrictions on Elastic Constants, Plane Stress Problem, Biaxial Strength, Theories for an Orthotropic Lamina.									**CO1**
UNIT – II	**Mechanical Behaviour**						**Periods : 9**		
Mechanics of Materials Approach to Stiffness- Determination of Relations between Elastic Constants, Elasticity Approach to Stiffness- Bounding Techniques of Elasticity, Exact Solutions - Elasticity Solutions with Continuity, Halpin, Tsai Equations, Comparison of approaches to Stiffness.									**CO2**
UNIT – III	**Cement Composites**						**Periods : 9**		
Types of Cement Composites, Terminology, Constituent Materials and their Properties, Construction Techniques for Fibre Reinforced Concrete - Ferro cement, SIFCON, Polymer Concretes, Preparation of Reinforcement, Casting and Curing.									**CO3**
UNIT – IV	**Mechanical Properties of Cement Composites**						**Periods : 9**		
Behavior of Ferro cement, Fiber Reinforced Concrete in Tension, Compression, Flexure, Shear, Fatigue and Impact, Durability and Corrosion.									**CO4**
UNIT – V	**Application of Cement Composites**						**Periods : 9**		
FRC and Ferro cement- Housing, Water Storage, Boats and Miscellaneous Structures. Composite Materials- Orthotropic and Anisotropic behaviour, Constitutive relationship, Elastic Constants.									**CO5**
Lecture Periods : 45		**Tutorials Periods : -**	**Practical Periods: -**				**Total Periods : 45**		
Reference Books									
1. Mechanics of Composite Materials, Jones R. M,, 2nd Ed., Taylor and Francis, BSP Books, 1998. 2. Ferro cement – Theory and Applications, Pama R. P., IFIC, 1980. 3. New Concrete Materials, Swamy R.N., 1st Ed., Blackie, Academic and Professional, Chapman & Hall,1983.									

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3	1	
CO2	1	2		3	1	
CO3	1	2		3	1	
CO4	1	2		3	1	
CO5	1	2		3	1	

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme**: M. Tech.(Structural Engineering)**						
Semester : **I**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ03	**DESIGN OF ADVANCED CONCRETE STRUCTURES**	3	0	0	3	40	60	100

Prerequisite:		
Course Outcome:	**CO1**	Understand the behavior of Concrete Material subjected to various conditions
	CO2	Understand the limit state design of columns and beams
	CO3	Understand the serviceability limit state in short and long term conditions
	CO4	Understand the special RC structural elements
	CO5	Understand the Limiting analysis of beams and slabs

UNIT – I	**Introduction**	**Periods : 9**	
Behaviour of concrete under uni-axial compression, Tension, and combined stresses- Modulus of Elasticity and Poisson's Ratio-Creep, shrinkage and temperature effects on concrete- Bearing strength of Concrete- Moment curvature relationship and ductility of R.C. members under monotonic and cyclic loading-Confined Concrete- Reinforcing steel.			**CO1**
UNIT – II	**Design Philosophy**	**Periods : 9**	
Behavior of short and long columns – Limit State Design of Short and Long Columns with Biaxial bending - Interaction curves- Design of beam column joints (problem for type1 only)-Design of curved beams.			**CO2**
UNIT – III	**Serviceability Limit States**	**Periods : 9**	
Estimation of deflections and crack widths in RC members.			**CO3**
UNIT – IV	**Special RC Members**	**Periods : 9**	
Behaviour and design of special RC member - deep beams, design of shear walls, corbels, and pile caps.			**CO4**
UNIT – V	**Analysis of RC Members**	**Periods : 9**	
Limit analysis of RC members: moment redistribution in continuous beams, Yield Line theory of slabs, Introduction to Strip theory for the analysis of slabs. Detailing of special structural members.			**CO5**

Lecture Periods : 45	**Tutorials Periods : -**	**Practical Periods: -**	**Total Periods : 45**

Reference Books

1. R. Park and T. Paulay "Reinforced Cement Concrete Structures", MISL-WILEY Series, Wiley India Pvt. Ltd, 2009.
2. P. Purushothaman "Reinforced concrete structural elements", Tata McGraw Hill 1994.
3. Unnikrishna Pillai and Devdas Menon "Reinforced concrete Design", Tata McGraw Hill Publishers Company Ltd., New Delhi, 2011.
4. Varghese P.C., "Limit State Design of Reinforced Concrete", Prentice Hall of India, 2013.
5. Varghese P.C, "Advanced Reinforced Concrete Design", Prentice Hall of India, 2011.
6. Sinha N.C. and Roy S.K "Fundamentals of Reinforced Concrete", S. Chand and Company Limited, New Delhi, 2013.
7. IS 456:2000, "Indian Standard: Plain and reinforced concrete – code of practice", Bureau of Indian Standards, New Delhi.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3		
CO2	1	2		3		
CO3	1	2		3		
CO4	1	2		3		
CO5	1	2		3		

Score: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="3">Department : Civil Engineering</td><td colspan="9">Programme: M. Tech.(Structural Engineering)</td></tr>
<tr><td colspan="3">Semester : I</td><td colspan="5">Course Category Code: PSE</td><td colspan="4">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course Name</td><td colspan="3">Periods / Week</td><td colspan="2">Credit</td><td colspan="4">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td colspan="2">C</td><td colspan="2">CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CEZ04</td><td colspan="2">STRUCTURAL HEALTH MONITORING</td><td>3</td><td>0</td><td>0</td><td colspan="2">3</td><td colspan="2">40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="11"></td></tr>
<tr><td rowspan="6">Course Outcome:</td><td colspan="11">At the end of the course, students will be able to</td></tr>
<tr><td>CO1</td><td colspan="10">Able to model the structure to understand the behaviour</td></tr>
<tr><td>CO2</td><td colspan="10">Understanding the type of sensors and its data acquisition system</td></tr>
<tr><td>CO3</td><td colspan="10">Understanding the structural monitoring system for the condition assessment</td></tr>
<tr><td>CO4</td><td colspan="10">Analyse the data procured and its interpretation</td></tr>
<tr><td>CO5</td><td colspan="10">Able to conduct investigations to both new and aged structures</td></tr>
<tr><td>UNIT – I</td><td colspan="6">Structural Modelling and Finite Element Models</td><td colspan="5">Periods : 9</td></tr>
<tr><td colspan="10">Review of Structural Modelling and Finite Element Models: Modelling for damage and collapse behaviour of structures, finite element modelling, theoretical prediction of structural failures.</td><td colspan="2">CO1</td></tr>
<tr><td>UNIT – II</td><td colspan="6">Signals, Systems, Sensors and Data Acquisition Systems</td><td colspan="5">Periods : 9</td></tr>
<tr><td colspan="10">Review of Signals, Systems and Data Acquisition Systems: Frequency and time domain representation of systems, Fourier/Laplace transforms, modelling from frequency response measurements, D/A and A/D converters, programming methods for data acquisition systems. Sensors for Health Monitoring Systems: Acoustic emission sensors, ultrasonic sensors, piezo ceramic sensors and actuators, fibre optic sensors and laser stereography techniques, imaging techniques.</td><td colspan="2">CO2</td></tr>
<tr><td>UNIT – III</td><td colspan="6">Monitoring Systems</td><td colspan="5">Periods : 9</td></tr>
<tr><td colspan="10">Health Monitoring/Diagnostic Techniques: Vibration signature analysis, modal analysis, neural network-based classification techniques. Integrated Health Monitoring Systems:
Intelligent Health Monitoring Techniques, Neural network classification techniques, extraction of features from measurements, training and simulation techniques, and connectionist algorithms for anomaly detection, multiple damage detection, and case studies.</td><td colspan="2">CO3</td></tr>
<tr><td>UNIT – IV</td><td colspan="6">Information Technology for Health Monitoring</td><td colspan="5">Periods : 9</td></tr>
<tr><td colspan="10">Information Technology for Health Monitoring: Information gathering, signal analysis, information storage, archival, retrieval, security; wireless communication, telemetry, real time remote monitoring, network protocols, data analysis and interpretation.</td><td colspan="2">CO4</td></tr>
<tr><td>UNIT – V</td><td colspan="6">Project Based Health Monitoring Techniques</td><td colspan="5">Periods : 9</td></tr>
<tr><td colspan="10">Project Based Health Monitoring Techniques: Health monitoring techniques based on case studies, practical aspects of testing large bridges for structural assessment, optimal placement of sensors, structural integrity of aging multistory buildings, condition monitoring of other types of structures</td><td colspan="2">CO5</td></tr>
<tr><td colspan="2">Lecture Periods : 45</td><td colspan="4">Tutorials Periods : -</td><td colspan="3">Practical Periods: -</td><td colspan="3">Total Periods : 45</td></tr>
</table>

Reference Books
1. Philip W., Industrial sensors and applications for condition monitoring, MEP, 1994. 2. Armer G.S.T (Editor), Monitoring and assessment of structures, Spon, London, 2001. 3. Wu, Z.S. (Editor), Structured health monitoring and intelligent infrastructure, Vols. 1 & 2, Balkema, 2003. 4. Harris C.M., Shock vibration handbook, McGraw-Hill, 2000. 5. Rao J.S., Vibratory condition monitoring of machines, Narosa Publishing House, India, 2000.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3		1
CO2	1	2		3		1
CO3	1	2		3		1
CO4	1	2		3		1
CO5	1	2		3		1

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**			Programme: **M. Tech.(Structural Engineering)**					
Semester : **I**			Course Category Code: **PSE**			Semester Exam Type: **TY**		
Course Code	Course Name	Periods/ Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ05	**THEORY OF STRUCTURAL STABILITY**	3	0	0	3	40	60	100
Prerequisite:								

Course Outcome:	At the end of the course, students will be able to	
	CO1	Understanding the stability of columns
	CO2	Understanding the numerical methods for the stability analysis
	CO3	Understanding the various parameters influencing the stability of beams and beams with columns
	CO4	Understanding the modes buckling and critical load calculation of frames
	CO5	Understanding the plate buckling and critical load calculation for various boundary conditions.

UNIT – I	**Buckling of columns**	**Periods : 9**
Introduction – concepts of stability – methods of Neutral Equilibrium – Euler column – Eigen value problem – Axially loaded column – Eccentrically loaded column.		**CO1**
UNIT – II	**Energy principle**	**Periods : 9**
Raleigh Ritz method – Galerkin method – Numerical methods (New mark's Finite Difference and matrix methods)		**CO2**
UNIT – III	**Beams and Beam columns**	**Periods : 9**
Introduction – lateral buckling of beams – Beam column with concentrated and distributed loads – effect of axial load on bending stiffness		**CO3**
UNIT – IV	**Buckling of frames**	**Periods : 9**
Introduction – modes of buckling – Critical load using various methods Neutral equilibrium – slope deflection equations, matrix method.		**CO4**
UNIT – V	**Buckling of plates**	**Periods : 9**
Differential equation of plate buckling – Critical load on plates for various boundary conditions – Energy method – Finite difference method – Shear deformation of plates.		**CO5**

Lecture Periods : 45	**Tutorials Periods : -**	**Practical Periods: -**	**Total Periods : 45**

Reference Books

1. Timoshenko and Gere, "Theory of elastic stability", McGraw Hill Book Company, 1981.
2. AlexandarChajes, "Principles of Structural Stability Theory", Prentice Hall, New Jersey, 1980.
3. Iyenger N.G.R. "Structural Stability of columns and plates", Affiliated East west press Pvt Ltd., 1990.
4. Bleich F, "Buckling Strength of metal structures", McGraw Hill 1991.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3		
CO2	1	2		3		
CO3	1	2		3		
CO4	1	2		3		
CO5	1	2		3		

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**			Programme**: M. Tech.(Structural Engineering)**						
Semester : **I**			Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CEZ06	**EXPERIMENTAL TECHNIQUES AND INSTRUMENTATIONS**		3	0	0	3	40	60	100
Prerequisite:									
Course Outcome:	At the end of the course, students will be able to								
	CO1	Understand the working principles and uses of different types of strain Gauges.							
	CO2	Understand the different types of Non destructing test methods used in structures							
	CO3	Design the suitable model after applying the principle of model analysis to the prototype							
	CO4	Understand the distress measurements of various structures							
	CO5	Understand the working principle of various measuring display Instrumentation.							

UNIT – I	**Strain Gauges**	**Periods : 9**
mechanical strain gauge – optical strain gauge – electrical resistance strain gauge - description and operation – inductance and capacitance strain gauges-strain rosettes – measurement of static and dynamic strain – effect of transverse strains –use of strain recorders and load cells –calibration of testing machines		**CO1**
UNIT – II	**NDT Methods**	**Periods : 9**
Load testing towers - brittle coating method - Moire fringe method- Ultra sonic pulse velocity technique - Rebound hammer method - X-ray method - Gamma ray method - corrosion measurements - linear polarization resistance - rapid chloride ion penetration test-open circuit potential measurements –Electrical impedance spectroscopy		**CO2**
UNIT – III	**Model Analysis**	**Periods : 9**
Structural similitude – use of models –structural and dimensional analysis – Buckingham pi theorem – Muller Breslau's principle for direct and indirect analysis – use of BeggEny'sdeformeter– moment indicators – design of models for direct and indirect analysis.		**CO3**
UNIT – IV	**Distress Measurements**	**Periods : 9**
Diagnosis of distress in structures - crack observation and measurement Cracking due to corrosion of reinforcement in concrete construction and use - Damage assessment - controlled blasting for demolition.		**CO4**
UNIT – V	**Vibration Measurements**	**Periods : 9**
LVDT(linear variable differential transducer) –transducers for velocity and acceleration measurement vibration meter – seismographs – vibration analyser –display and recording signals –cathode ray oscillograph – XY plotter - chart plotter – digital acquisition systems		**CO5**

Lecture Periods : 45	**Tutorials Periods : -**	**Practical Periods: -**	**Total Periods : 45**

Reference Books
1. Dally J. W. & Riley W.F , "Experimental Stress Analysis" , McGraw Hill Book Company, New York , USA,1991. 2. Dove.R.C. & Aedams .P.H, "Experimental Stress Analysis and Motion measurements", Prentice Hall of india Ltd ,NewDelhi ,1965. 3. Sadhu Singh , "Experimental Stress Analysis" , Khanna Publishers , New Delhi , 2000 4. Sirohi.R.SRadhakrishna.H.C "Mechanical measurements", new Age International (p) Ltd.1997 5. Srinath. L.S , "Experimental Stress Analysis" , Tata McGraw Hill Publishing Co. Ltd, New Delhi 1991.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3	1	
CO2	1	2		3	1	
CO3	1	2		3	1	
CO4	1	2		3	1	
CO5	1	2		3	1	

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**		Programme: **M. Tech.(Structural Engineering)**						
Semester : **I**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Hours / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ07	**SEISMIC DESIGN OF STRUCTURES**	3	0	0	3	40	60	100

Prerequisite:	Knowledge on Structural Dynamics	
Outcome:	At the end of the course, students will be able to	
	CO1	Understand the basics of earthquake engineering
	CO2	Calculate earthquake load using Static analysis
	CO3	Apply the codal provisions for building systems
	CO4	Analyse and design the structures using dynamic analysis
	CO5	Understand the Cyclic loading behaviour of RCC and PSC elements

UNIT – I	**Engineering seismology**	**Periods : 9**	
Elements of engineering seismology - characteristics of earthquake– rebound theory – plate tectonics – types of seismic waves – earthquake size and various scales – local site effects – Indian seismicity – seismic zones of India.			**CO1**
UNIT – II	**Design Concepts and Structural Systems**	**Periods : 9**	
Performance of structures under past earthquakes- lessons learnt from past earthquakes–soil liquefaction -Seismic design concepts – load path – floor and roof diaphragms – seismic resistant building architecture – plan configuration – vertical configuration – pounding effects – mass and stiffness irregularities – torsion in structural system			**CO2**
UNIT – III	**Introduction to IS Codes and moment resisting frame**	**Periods : 9**	
Provision of seismic code IS1893 & IS 13920 – Building systems – frames – shear wall – braced frames – layout design of Moment Resisting Frames (MRF) – ductility of MRF – Infill walls – Non-structural elements			**CO3**
UNIT – IV	**Analysis and Design**	**Periods : 9**	
Design earthquake loads – equivalent static force procedure -Respose spectrum method– 3D modelling of building systems and analysis (theory only) Design and detailing of frames, shear wall, and frame walls			**CO4**
UNIT – V	**Cyclic loading behaviour**	**Periods : 9**	
Cyclic loading behaviour of RC steel and pre-stressed concrete elements - modern concepts – base isolation – Adoptive systems – case studies, Seismic Detailing Practices.			**CO5**
Lecture Periods : 45	**Tutorials Periods : -**	**Practical Periods: -**	**Total Periods : 45**

<u>Reference Books</u>

1. PankajAgarwal and Manish ShriKhande, Earthquake Resistant Design of Structures, Prentice- Hall of India, 2007, New Delhi
2. BullenK.E., Introduction to the Theory of Seismology, Great Britain at the University Printing houses, Cambridge University Press 1996.
3. S K Duggal, “Earthquake Resistant Design of Structures”, Oxford University Press, 2007.
4. Paulay,T and Priestly, M.N.J., “A seismic Design of Reinforced Concrete andMasonry buildings”, John Wiley and Sons, 1991.

<u>CO – PO Mapping</u>

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3	2	
CO2	1	2		3	2	
CO3	1	2		3	2	
CO4	1	2		3	2	
CO5	1	2		3	2	

<u>Score</u>: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**					Programme**: M. Tech.(Structural Engineering)**				
Semester : **I**					Course Category Code: **PSE**		Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks			
		L	T	P	C	CA	SE	TM	
CEZ08	**DESIGN OF MASONRY STRUCTURES**	3	0	0	3	40	60	100	
Prerequisite:									

Course Outcome:	At the end of the course, students will be able to	
	CO1	Investigate the Properties of Masonry Materials
	CO2	Understand the Permissible stresses in Masonry Structures with and without opening in the walls.
	CO3	Design the masonry structural elements
	CO4	Understand the Reinforced masonry
	CO5	Understand the Advanced studies in Masonry

UNIT – I	**Properties of Masonry Materials**	**Periods : 9**
Brick, Stone and Block masonry units- Strength, Modulus of Elasticity and water absorption of masonry materials- Classification and Properties of mortars, selection of mortars- Strength and Stability of Concentrically loaded masonry walls- Effect of unit strength, mortar strength, joint thickness, rate of absorption- Effect of ageing, workmanship- Strength formulae and mechanism of failure of masonry subjected to direct compression.		**CO1**
UNIT – II	**Stresses and Axial Load on Masonry**	**Periods : 9**
Permissible compressive stresses, Stress reduction and shape reduction factors, increase in permissible stresses for eccentric vertical and lateral loads, Permissible tensile and shear stresses- Load considerations for masonry: wall carrying axial load, eccentric load with different eccentric ratios- Walls with openings and free standing walls.		**CO2**
UNIT – III	**Design of Masonry Walls**	**Periods : 9**
Design Considerations: Effective height of walls and columns, Opening in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action and lintels.		**CO3**
UNIT – IV	**Design of Reinforced Masonry**	**Periods : 9**
Flexural Strengthof Reinforced Masonry Members: In plane and Out-of-plane Loading. Interactions: Structural Wall, Columns and Pilasters, Retaining Wall, Pier and Foundation.Shear Strengthand Ductility of Reinforced Masonry Members.		**CO4**
UNIT – V	**Advances in Masonry Structures**	**Periods : 9**
Prestressed Masonry - Stability of Walls, Coupling of Masonry Walls, Openings, Columns,Beams. Elastic and Inelastic Analysis, Modelling Techniques, Static Push Over Analysis and use ofCapacity Design Spectra.		**CO5**

Lecture Periods : 45	**Tutorials Periods : -**	**Practical Periods: -**	**Total Periods : 45**

Reference Books

1. Henry.A.W, "Structural Masonry", Macmillan Education Ltd,1990
2. Dayarathnam.P, "Brick and Reinforced Brick Structures", Oxford & IBH Publication, 1987.
3. Sinha, B.P and Davies, S.R., "Design of Masonry Structures", E& FN spon.1997.
4. Design of Reinforced Masonry Structures, Narendra Taly, ICC, 2nd Edn,
5. Masonry Structures: Behavior and Design, Hamid Ahmad A. and Drysdale Robert G., 1994.
6. Mechanics of Masonry Structures, Editor: Maurizio Angelillo, 2014.
7. Earthquake-resistant Design of Masonry Buildings,Toma evi Miha, Imperial College Press, 1999.
8. IS: 1905-1987 (3rd revision), "Code of Practice for Structural use of unreinforced masonry", BIS, New Delhi.
9. SP 20 (S&T) 1991, "Hand book on masonry design and construction (1st revision)", BIS, New Delhi.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3		
CO2	1	2		3		
CO3	1	2		3		
CO4	1	2		3		
CO5	1	2		3		

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**		Programme**: M. Tech.(Structural Engineering)**							
Semester : **II**		Course Category Code: **PSE**				Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks			
		L	T	P	C	CA	SE	TM	
CEZ09	**ADVANCED STEEL DESIGN**	3	0	0	3	40	60	100	
Prerequisite:									

Course Outcome:	On the successful completion of course, student will able to	
	CO1	Analyse the continuous beam and frames using plastic theory
	CO2	Understand the behavior of Industrial Buildings and bents
	CO3	Design the beam to beam and beam to column connections
	CO4	Design the tower, Chimney and its foundation
	CO5	Design the cold formed steel cross section under axial/ bending effects

UNIT – I	**Plastic Analysis of structures**	**Periods : 9**
Theory and assumptions, yield criteria, plastic modulus and Shape factor, Moment redistribution, Combined mechanisms, Analysis of portal frames- Analysis of multi bay- single storey rectangular portal frames- Analysis and Design of continuous beams.		**CO1**
UNIT – II	**Behaviour of Industrial Buildings and bents**	**Periods : 9**
Design of members subjected to lateral loads and axial loads, Analysis and design of Industrial Buildings and bents, Sway and non-sway frames, Design of Purlins, Louver rails, Gable column and Gable wind girder - Design of Moment Resisting Base Plates.		**CO2**
UNIT – III	**Design of Connections**	**Periods : 9**
. Types of connections – Bolted and Welded – Seated Connections – Unstiffened and Stiffened seated Connections – Moment Resistant Connections – Clip angle Connections – Split beam Connections – Framed Connections.		**CO3**
UNIT – IV	**Analysis & Design of Towers & chimney**	**Periods : 9**
Analysis and Design of Microwave / Transmission Line Towers - Types of bracing patterns – Analysis and Design of Self-supporting Chimney and Guyed steel chimney subjected to wind and earthquake forces– Design of Base Plates, Foundations and Anchor bolts		**CO4**
UNIT – V	**Design of Cold formed Structures**	**Periods : 9**
Behaviour of Compression Elements - Effective width for load and deflection determination – Behaviour of Unstiffened and Stiffened Elements – Design of webs of beams – Flexural members – Lateral buckling of beams – Shear Lag – Flange Curling – Design of Compression Members.		**CO5**

Lecture Periods : 45	**Tutorials Periods : -**	**Practical Periods: -**	**Total Periods : 45**

Reference Books

1. Subramanian.N, “Design of Steel Structures”, Oxford University Press, 2008.
2. Dayaratnam.P, “Design of Steel Structures”, A.H.Wheeler, India, 2007.
3. Linton E. Grinter, “Design of Modern Steel Structures”, Eurasia Publishing House, New Delhi, 1996.
4. John E. Lothers, “Design in Structural Steel”, Prentice Hall of India, New Delhi, 1990.
5. Lynn S. Beedle, “Plastic Design of Steel Frames”, John Wiley and Sons, New York, 1990.
6. Wie Wen Yu, “Design of Cold Formed Steel Structures”, McGraw Hill Book Company, New York, 1996.
7. Shiyekar, M. R., “Limit State Design In Structural Steel”3rd edition,Prentice Hall of India, New Delhi, 2017.
8. IS: 800-2007, Code of Practice for general construction in steel, BIS, New Delhi.
9. IS: 875 (Parts 1 to 5) -2015, Code of Practice for Design loads for buildings and Structures, BIS, New Delhi.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3		2
CO2	1	2		3		2
CO3	1	2		3		2
CO4	1	2		3		2
CO5	1	2		3		2

Score: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="2">Department : Civil Engineering</td><td colspan="7">Programme: M. Tech.(Structural Engineering)</td></tr>
<tr><td colspan="2">Semester : II</td><td colspan="4">Course Category Code: PSE</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods/ Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CEZ10</td><td>DESIGN OF STEEL CONCRETE COMPOSITE STRUCTURES</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="6">Course Outcome:</td><td colspan="8">At the end of the course, students will be able to</td></tr>
<tr><td>CO1</td><td colspan="7">Understand the mechanism of composite action between steel and concrete and thereby determining capacity of shear studs</td></tr>
<tr><td>CO2</td><td colspan="7">Design a composite beams with or without profile decking sheet either simply supported or continuous end conditions using Indian and Euro code-4</td></tr>
<tr><td>CO3</td><td colspan="7">Design a composite slab with the provision of profile decking sheet using Euro code – 4</td></tr>
<tr><td>CO4</td><td colspan="7">Design an encased as well as in-filled composite columns using Euro code – 4.</td></tr>
<tr><td>CO5</td><td colspan="7">Understand the mechanism of connections in composite structures and the concept of sandwich construction</td></tr>
<tr><td>UNIT – I</td><td colspan="4">Introduction</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="8">Composite Structures- Advantages, Types and Materials used, Shear Connection- Composite action-No interaction-Full interaction, slip in composite structures. Shear Connectors- Types (Rigid, Flexible and Bond), strength of shear connectors – Test on shear connectors.</td><td>CO1</td></tr>
<tr><td>UNIT – II</td><td colspan="4">Design of Composite Beams</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="8">propped condition – un-propped condition – simply supported and continuous beams – beam with and without profile sheeted deck slab – Analysis and design of composite beams without profile sheet and with profile sheet</td><td>CO2</td></tr>
<tr><td>UNIT – III</td><td colspan="4">Design of Composite Slabs</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="8">Composite floors – Introduction of composite floors – shear transferring mechanism in profile deck system – Bending resistance of composite slab – Design consideration of composite floor - propped condition – un-propped condition.Design of simply supported and continuous Composite floor</td><td>CO3</td></tr>
<tr><td>UNIT – IV</td><td colspan="4">Design of Composite Columns</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="8">Types of Composite columns – design of encased columns – design of in-filled columns – axial and uni-axially loaded columns</td><td>CO4</td></tr>
<tr><td>UNIT – V</td><td colspan="4">Miscellanies Topics</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="8">Case studies on steel concrete composite construction in buildings, Composite bridges, Connections in composite structures, Steel concrete composite sandwich construction</td><td>CO5</td></tr>
<tr><td colspan="2">Lecture Periods : 45</td><td colspan="2">Tutorials Periods : -</td><td colspan="2">Practical Periods: -</td><td colspan="3">Total Periods : 45</td></tr>
<tr><td colspan="9"><u>Reference Books</u></td></tr>
</table>

1. Johnson R.P., “Composite Structures of Steel and Concrete”’ Volume-I, Black Well Scientific Publication, U.K., 1994.
2. Teaching Resources for “Structural Steel Design”. Vol.2 of 3, Institute of Steel Development and Growth (INSDAG), 2000.
3. Collings D., “Steel Concrete Composite Buildings”, Thomas Telford Ltd, 2010.
4. Narayanan R, “Composite steel structures – Advances, design and construction”, Elsevier, Applied science, UK, 1987.
5. IS: 11384, Code of practice for composite construction in Structural Steel and Concrete.
6. Provisions of IS 800 : 2007, Code of practice for General construction in Stee .
7. Provisions of Euro Code-4-2004, Design of composite steel and concrete structures.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3		
CO2	1	2		3		
CO3	1	2		3		
CO4	1	2		3		
CO5	1	2		3		

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**			Programme: **M. Tech.(Structural Engineering)**					
Semester : **II**		Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ11	**ADVANCED DESIGN OF FOUNDATIONS**	3	0	0	3	40	60	100
Prerequisite:								
Course Outcome:	At the end of the course, students will be able to							
	CO1	Understanding the geotechnical reports of deep explorations.						
	CO2	Understanding the design of shallow foundations.						
	CO3	Understanding the design of Pile foundation.						
	CO4	Understanding the design of deep foundations for special structures.						
	CO5	Understanding the design of machine foundations.						

UNIT – I	**Sub Surface Exploration**	**Periods : 9**	
Purpose – Programme and Procedures – Interpretation of bore logs, soil data and exploration reports.			**CO1**
UNIT – II	**Shallow Foundation**	**Periods : 9**	
Types of foundations and their specific applications – depth of foundation – bearing capacity and settlement estimates – structural design of isolated, strip, rectangular and trapezoidal combined footings – strap – balanced footings – raft foundation – Approximate flexible method of raft design – Compensated foundations.			**CO2**
UNIT – III	**Deep Foundations**	**Periods : 9**	
Types of Piles and their applications – Load capacity – Settlements – Group action – Design of piles and pile caps – Lateral load capacity of piles.			**CO3**
UNIT – IV	**Foundation For Miscellaneous Structures**	**Periods : 9**	
Drilled shaft foundations and caissons for bridges – Foundations for towers – Chimneys – Silos.			**CO4**
UNIT – V	**Machine Foundations**	**Periods : 9**	
Types – General requirements and design criteria – General analysis of machine foundations – soil system – Stiffness and damping parameters – Tests for design parameters – Guide lines for design of reciprocating engines, impact type machines, rotary type machines, framed foundations.			**CO5**
Lecture Periods : 45	**Tutorials Periods : -**	**Practical Periods: -**	**Total Periods : 45**

Reference Books

1. Thomlinson, M.J. and Boorman. R., "Foundation Design and Construction", ELBS Longman VI edition, 1995.
2. Nayak, N.V., "Foundation Design manual for Practicing Engineers", Dhanpat Rai and Sons, 1982.
3. Winterkorn H.F., and Fang H.Y., "Foundation Engineering Hand Book", Van Nostrars – Reinhold, 1976.
4. Brain J. Bell and M. J. Smith, "Reinforced Concrete Foundations", George Godwin Ltd.
5. Braja M. Das, "Principles of Foundations Engineering", Thomson Asia (P) Ltd.
6. Bowels J. E., "Foundation Analysis and Design", McGraw-Hill International Book Co.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3	2	
CO2	1	2		3	2	
CO3	1	2		3	2	
CO4	1	2		3	2	
CO5	1	2		3	2	

Score: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="3">Department : Civil Engineering</td><td colspan="8">Programme: M. Tech.(Structural Engineering)</td></tr>
<tr><td colspan="3">Semester : II</td><td colspan="5">Course Category Code: PSE</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td colspan="2" rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CEZ12</td><td colspan="2">FRACTURE MECHANICS OF CONCRETE STRUCTURES</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="9"></td></tr>
<tr><td rowspan="6">Course Outcome:</td><td colspan="9">At the end of the course, students will be able to</td></tr>
<tr><td>CO1</td><td colspan="8">Evaluate the fracture failure parameters</td></tr>
<tr><td>CO2</td><td colspan="8">Evaluate the linear elastic fracture mechanics problems</td></tr>
<tr><td>CO3</td><td colspan="8">Explain the concept of elastic plastic fracture mechanics</td></tr>
<tr><td>CO4</td><td colspan="8">Estimate the residual life of fatigue Crack Growth in structure.</td></tr>
<tr><td>CO5</td><td colspan="8">Suggest suitable crack arrest parameters using various techniques</td></tr>
<tr><td>UNIT – I</td><td colspan="5">Introduction</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="8">Review of Engineering Failure Analysis-Brittle fracture-Ductile fracture Modes of fracture failure, The Griffith energy Balance Approach-Crack tip Plasticity-Fracture toughness.</td><td colspan="2">CO1</td></tr>
<tr><td>UNIT – II</td><td colspan="5">Linear elastic fracture Mechanics</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="8">Elastic crack tip stress field Stress and displacement fields in isotropic elastic materials-Westergaard’s approach (opening mode)- Plane Strain Fracture toughness (KIC) testing-Feddersen approach Determination of R curve, Energy released rate for DCB specimen</td><td colspan="2">C02</td></tr>
<tr><td>UNIT – III</td><td colspan="5">Elastic Plastic Fracture Mechanics</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="8">Limitation of K approach -Approximate shape and size of the plastic zone Effective crack length-Effect of plate thickness-Elastic plastic fracture concept-Crack tip opening displacement-Dugdale approach-Path independence, Critical J integral-Evaluation of CTOD-Relationship between CTOD, K1 and G1 for small scale yielding.</td><td colspan="2">C03</td></tr>
<tr><td>UNIT – IV</td><td colspan="5">Fatigue Crack Growth</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="8">Fatigue crack growth to sharpen the tip-methods to determine J1cMechanism 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.</td><td colspan="2">CO4</td></tr>
<tr><td>UNIT – V</td><td colspan="5">Crack Arrest & Numerical methods</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="8">Principles of crack arrest, crack arrest in practice, K-R Curves, Crack resistance curve, Numerical Methods and Approaches in Fracture Mechanics, Direct methods to determine fracture parameters Indirect methods to determine fracture parameters.</td><td colspan="2">CO5</td></tr>
<tr><td colspan="2">Lecture Periods : 45</td><td>Tutorials Periods : -</td><td colspan="4">Practical Periods: -</td><td colspan="3">Total Periods : 45</td></tr>
<tr><td colspan="10"><u>Reference Books</u></td></tr>
<tr><td colspan="10">1. Barson M. &Stanely T. Rolfe, “Fracture and Fatigue Control in Structure,” Prentice Hall Inc, USA, 1987.
2. Bhushan L. Karihaloo, “Fracture Mechanics and Structural Concrete,” Longman Scientific Publishers, USA, 1972.
3. David Broek, “Elementary Engineering Fracture Mechanics, “ MartinusNijhoff Publishers, The Hague, 1982.
4. Jean Lemative & Jean Louis Chboche, “Mechanics of Solid Materials,” Cambridge University Press, Cambridge, 1987.</td></tr>
</table>

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3		1
CO2	1	2		3		1
CO3	1	2		3		1
CO4	1	2		3		1
CO5	1	2		3		1

Score: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="3">Department : Civil Engineering</td><td colspan="7">Programme: M.Tech. (Structural Engineering)</td></tr>
<tr><td colspan="3">Semester : II</td><td colspan="4">Course Category Code :PSE</td><td colspan="3">Semester Exam type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2" colspan="2">Course Name</td><td colspan="3">Hours / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CEZ13</td><td colspan="2">DESIGN OF PRESTRESSED CONCRETE STRUCTURES</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="9"></td></tr>
<tr><td>Objectives:</td><td colspan="9"></td></tr>
<tr><td rowspan="5">Outcome:</td><td>CO1</td><td colspan="8">Able to do Limit State Design of Prestressed Concrete Beams</td></tr>
<tr><td>CO2</td><td colspan="8">Able to design the Indeterminate Prestressed Concrete beams and frames</td></tr>
<tr><td>CO3</td><td colspan="8">Able to design composite sections of cast in situ slab with precast girders</td></tr>
<tr><td>CO4</td><td colspan="8">Able design the deck slab and T-beam bridges with end blocks</td></tr>
<tr><td>CO5</td><td colspan="8">Able design the columns, tanks, pipes and slabs</td></tr>
<tr><td>UNIT – I</td><td colspan="5">Analysis of Prestressed Concrete Members</td><td colspan="4">Hours : 9</td></tr>
<tr><td colspan="8">Limit state of collapse against flexure, shear, and torsion – limit state of serviceability – Limit State design of partially prestressed concrete beams – Crack widths in Prestressed concrete members.</td><td colspan="2">CO1</td></tr>
<tr><td>UNIT – II</td><td colspan="5">Statically Indeterminate Structures</td><td colspan="4">Hours : 9</td></tr>
<tr><td colspan="8">Analysis and design of continuous beams and frames –Methods of achieving Continuity - Choice of cable profile – linear transformation – concordant cable profile.</td><td colspan="2">CO2</td></tr>
<tr><td>UNIT – III</td><td colspan="5">Composite Sections</td><td colspan="4">Hours : 9</td></tr>
<tr><td colspan="8">Composite sections of prestressed concrete beam and cast in situ RC slab – analysis of stresses – differential shrinkage – deflections – Flexural and shear strength of composite sections – Design of composite sections.</td><td colspan="2">CO3</td></tr>
<tr><td>UNIT – IV</td><td colspan="5">Prestressed Concrete Bridges</td><td colspan="4">Hours : 9</td></tr>
<tr><td colspan="8">Advantages, Pretensioned and post-tensioned prestressed concrete bridge decks, Design of post-tensioned prestressed concrete slab bridge deck and T-beam slab bridge deck. Design of end block – Anchorage zone stresses for post tensioned members-Anchorage Zone Reinforcements.</td><td colspan="2">CO4</td></tr>
<tr><td>UNIT – V</td><td colspan="5">Miscellaneous Structures</td><td colspan="4">Hours : 9</td></tr>
<tr><td colspan="8">Analysis and design of prestressed concrete pipes, tanks, one way and two way slabs (numerical problems restricted to pipes and tanks only). Design of Columns with moment.</td><td colspan="2">CO5</td></tr>
<tr><td colspan="2">Total Contact Hours : 45</td><td colspan="2">Total Tutorials : 0</td><td colspan="3">Total Practical Class : 0</td><td colspan="3">Total Hours : 45</td></tr>
<tr><td colspan="10">Reference Books</td></tr>
<tr><td colspan="10">1. N. Krishna Raju “Prestressed Concrete”, Tata Mc.Graw-Hill Company Ltd., New Delhi, 2018.
2. Lin T.Y., “Prestressed Concrete Structures”, John Wiley & Sons, 1982.
3. V. Guyon “Prestressed Concrete Vol. I and II”, Contractors Record Ltd., London, 1995.
4. S.K. Mallick and A.P. Gupta “Prestressed concrete”, Oxford and IBH Publishing Co., New Delhi, 1983.
5. Abels P.W., “An Introduction to Prestressed Concrete”, Vol – I & II, Concrete Pub. Ltd., London, 1981.
6. Raja Gopalan N. “Prestressed Concrete”, Narosa Publishing House, New Delhi, 2002.
7. Sinha N.C and Roy S.K, “Fundamentals of Prestressed Concrete”, S.Chand and Co., 1998.
8. IS: 1343 – 2012, “Code of Practice of Prestressed Concrete”, Indian Standards Institution.
9. IRC:112-2011- Code of Practice for Concrete Road Bridges
10. 10. IS:3370- Part-IV- Code of Practice for Concrete Structures for the storage of liquids</td></tr>
</table>

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3		
CO2	1	2		3		
CO3	1	2		3		
CO4	1	2		3		
CO5	1	2		3		

Score: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**			Programme**: M. Tech.(Structural Engineering)**						
Semester : **III**			Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CEZ14	**DESIGN AND CONSTRUCTION OF PREFABRICATED STRUCTURE**		3	0	0	3	40	60	100
Prerequisite:									
Course Outcome:	At the end of the course, students will be able to								
	CO1	Understanding materials and moulds for standardization							
	CO2	Understanding the stages in precast construction							
	CO3	Understanding the precast concrete floor construction							
	CO4	Understanding the precast concrete column connections							
	CO5	Understanding precast products and mass housing in precast technology.							
UNIT – I	**Materials in Precast Structures**					**Periods : 9**			
Materials, admixtures, pigments – Modular co-ordination, standardization and tolerances-system of pre-fabrication. Pre-cast concrete manufacturing techniques, Moulds –construction design, maintenance and repair.									**CO1**
UNIT – II	**Precast Construction Techniques**					**Periods : 9**			
Pre-casting techniques – Planning, analysis and design considerations – Handling techniques - Transportation Storage and erection of structures. Curing techniques including accelerated curing such as steam curing, hot air blowing, etc									**CO2**
UNIT – III	**Precast concrete floors and beams**					**Periods : 9**			
Simplified frame analysis, Precast concrete flooring options, flooring arrangements, structural design of individual units, design of composite floors, Composite and non-composite reinforced beams									**CO3**
UNIT – IV	**Precast concrete columns and connections**					**Periods : 9**			
Precast concrete columns and their design. Basic mechanism of joints and connections, compression joints, shear joints, tension joints. Connections-pin jointed and moment resisting connections.									**CO4**
UNIT – V	**Application of Prefabricated structures**					**Periods : 9**			
Pre-cast and pre-fabricating technology for low cost and mass housing schemes. Small pre-cast products like door frames, shutters, Ferro-cement in housing – Water tank service core unit.									**CO5**
Lecture Periods : 45		**Tutorials Periods : -**			**Practical Periods: -**		**Total Periods : 45**		

<u>Reference Books</u>

1. Levitt. M., Precast concrete – Materials, Manufacture Properties and Usage, Applied Science Publs. 1982.
2. Konex.T., Handbook of Pre-cast Construction, Vol..1.2&3.
3. Kim S Elliott, Precast Concrete Structures, Butterworth Heinemann Publishers. 2002
4. Richardson,J.G., Pre-cast concrete Production, Cement and Concrete Association, London, 1973.
5. MadhavaRao.A-G., Modern Trends in Housing in Developing Countries, Oxford & UBH
6. Publishing co., 1985.
7. Lewicki.B., Building with Large Pre-fabrications, Elsevier Publishers

<u>CO – PO Mapping</u>

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1		3		
CO2	2	1		3		
CO3	2	1		3		
CO4	2	1		3		
CO5	2	1		3		

<u>Score</u>: **3** – High; **2** – Medium; **1** – Low

Department :**Civil Engineering**			Programme**: M. Tech.(Structural Engineering)**						
Semester : **III**			Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CEZ15	**DESIGN OF BRIDGES**		3	0	0	3	40	60	100
Prerequisite:									
Outcome:	**CO1**	Understand the fundamentals, codes of practice and bridge failures.							
	CO2	Understand the estimation of forces for the design bridge structural elements							
	CO3	Design of the slab and girder beam bridges using appropriate method							
	CO4	Understand the design principles of long span bridges							
	CO5	Understand the design of substructure components							
UNIT – I	**Introduction**					**Periods : 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, bridge failures.									**CO1**
UNIT – II	**Loads on Bridges**					**Periods : 9**			
Indian Road Congress (IRC) bridge codes – dimensions – dead and live loads – impact effect – wind and seismic forces – longitudinal and centrifugal forces – hydraulic forces – earth pressure – temperature effect and secondary stresses.									**CO2**
UNIT – III	**Slab and T – Beam Bridges**					**Periods : 9**			
Design of slab bridges – skew slab culverts – box culverts. T –Pigeaud curves –Courbon's theory – Hendry Jaegar method design of T – beam bridges.									**CO3**
UNIT – IV	**Long Span Bridges**					**Periods : 9**			
Design Principles of box girder bridges, balanced cantilever bridges, continuous girder bridges, Cable Stayed bridges and Suspension bridges- Design of Prestressed concrete bridges by Courbon's theory (Girder section only) – Design of Steel Concrete composite bridges by Courbons's theory (Girder section only)- Seismic Isolation and damping devices									**CO4**
UNIT – V	**Bearings and Substructure**					**Periods : 9**			
Different types of bearings – Design of bearings – Design of masonry and concrete piers and abutments – Types of bridge foundations – Design of Open and deep foundations (well foundation only).									**CO5**
Lecture Periods : 45		**Tutorials Periods : -**	**Practical Periods: -**				**Total Periods : 45**		

Reference Books

1. Johnson Victor D, "Essentials of Bridge Engineering", Oxford and IBH Publishing Co.Pvt.Ltd.,New Delhi, 2006.
2. Krishna Raju N. "Design of Bridges", fourth edition Oxford & IBM Publishing Co, Bombay, 2018.
3. Raina V.K. "Concrete Bridge Practice", Tata McGraw Hill Publishing Co., New Delhi – 1991.
4. Taylor F.W, Thomson S.E. and Smulski. E. "Reinforced Concrete Bridges", John Wiley & Sons, New York, 1955.
5. Conference Proceedings, 'Advances and Innovations in Bridge Engineering', IIT, Madras and Indian Institute of Bridge Engineering Tamilnadu, Allied Publisher, New Delhi, 1999.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3	1	1
CO2	1	2		3	1	1
CO3	1	2		3	1	1
CO4	1	2		3	1	1
CO5	1	2		3	1	1

Score: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="2">Department :Civil Engineering</td><td colspan="7">Programme: M.Tech. (Structural Engineering)</td></tr>
<tr><td colspan="2">Semester : III</td><td colspan="4">Course Category Code: PSE</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CEZ16</td><td>DESIGN OF SHELL STRUCTURES</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="8"></td></tr>
<tr><td rowspan="5">Course Outcome:</td><td>CO1</td><td colspan="7">Know the Basics of the classical theory of shells.</td></tr>
<tr><td>CO2</td><td colspan="7">Understand the limitations and differences of shell theories within context of the theory of elasticity.</td></tr>
<tr><td>CO3</td><td colspan="7">Design of Cylindrical Shell Roof and Folded Plate Roof System.</td></tr>
<tr><td>CO4</td><td colspan="7">Understanding of theories of doubly curved shells.</td></tr>
<tr><td>CO5</td><td colspan="7">Understanding the buckling strength of shells and supporting system</td></tr>
<tr><td>UNIT – I</td><td colspan="5">Membrane Theory</td><td colspan="3">Hours : 9</td></tr>
<tr><td colspan="8">Classification of shells – types of shells – Structural action – shells of revolution & shells of translation – examples – membrane theory – limitation of membrane theory</td><td>CO 1</td></tr>
<tr><td>UNIT – II</td><td colspan="5">Flexural Theory</td><td colspan="3">Hours : 9</td></tr>
<tr><td colspan="8">Flexure theory – Design of cylindrical shell by D.K.J. Method -other theories of analysis – use of ASCE manual for the design of cylindrical shells – prestressing of shells</td><td>CO 2</td></tr>
<tr><td>UNIT – III</td><td colspan="5">Cylindrical Shells and Folded Plates</td><td colspan="3">Hours : 9</td></tr>
<tr><td colspan="8">Beam method of analysis of cylindrical shell by Lundgren – limitations – Detailed design of cylindrical shells - Hyper shells & conoidal shells. Element of Buckling of shells & shell structures, Analysis and Design of Folded plates.</td><td>CO 3</td></tr>
<tr><td>UNIT – IV</td><td colspan="5">Doubly Curved Shells</td><td colspan="3">Hours : 9</td></tr>
<tr><td colspan="8">Bending theory of doubly curved shells- Hyperbolic parabolic shells subjected to external loads and gravity loads- shells of revolution.</td><td>CO 4</td></tr>
<tr><td>UNIT – V</td><td colspan="5">Buckling of RC Roof Shells and Pyramids</td><td colspan="3">Hours : 9</td></tr>
<tr><td colspan="8">Slenderness of beams – Circular shells – Buckling strength of supporting members – Software's for analysis – Design of pyramid roofs, Design and detailing of simple shells</td><td>CO 5</td></tr>
<tr><td colspan="2">Lecture Periods : 45</td><td colspan="3">Tutorial Periods : -</td><td colspan="4">Practical Periods : - Total Periods : 45</td></tr>
<tr><td colspan="9">Reference Books:</td></tr>
</table>

1. Ramaswamy G.S, "Design and Construction of Concrete Shell Roofs", CBS Publishers, 1986.
2. Timoshenko S & S.W. Krieger, "Theory of Plates & Shells", McGraw Hill and Co, 1959.
3. Dr. N.K. Bairagi "Shell Analysis", Khanna Publishers, 1990.
4. Design of Cylindrical Concrete Shells, No.31, ASCE Manual of Engineering Practice.
5. Rudolph S zilard, "Theory and analysis of Plates; Classical and Numerical Methods", Prentice – Hall, 1973.
6. G.E.OWidra, Chung.H.,D.Hui, "Design and Analysis of Plates and Shells",Amer Society of Mechanical, 1986.
7. Varghese P.C, "Design of Reinforced Concrete Shells and Folded Plates", PHI Learning Pvt Ltd, New Delhi, 2010.
8. IS 2210-1988, "Criteria for Design of Reinforced Concrete Shell Structures and Folded Plates", BIS New Delhi.
9. ASCE Manual, No. 31, American Society of Civil Engineering, USA, 1952.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2			3	1	2
CO2	2			3	1	2
CO3	2			3	1	2
CO4	2			3	1	2
CO5	2			3	1	2

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**			Programme: **M. Tech.(Structural Engineering)**						
Semester : **III**			Course Category Code: **PSE**			Semester Exam Type: **TY**			
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CEZ17	**DESIGN OF INDUSTRIAL STRUCTURES**		3	0	0	3	40	60	100
Prerequisite:									
Course Outcome:	At the end of the course, students will be able to								
	CO1	Design Steel Gantry Girders.							
	CO2	Design Steel Portal, Gable Frames.							
	CO3	Design Steel Bunkers and Silos.							
	CO4	Design Chimneys.							
	CO5	Design Water Tanks.							
UNIT – I	**Steel Gantry Girders**						**Periods : 9**		
Introduction, loads acting on gantry girder, permissible stress, types of gantry girders and crane rails, crane data, maximum moments and shears, construction detail, design procedure.									**CO1**
UNIT – II	**Portal Frames**						**Periods : 9**		
Design of portal frame with hinge base, design of portal frame with fixed base - Gable Structures – Lightweight Structures									**CO2**
UNIT – III	**Steel Bunkers and Silos**						**Periods : 9**		
Design of square bunker – Jansen's and Airy's theories – IS Code provisions – Design of side plates – Stiffeners – Hooper – Longitudinal beams Design of cylindrical silo – Side plates – Ring girder –stiffeners.									**CO3**
UNIT – IV	**Chimneys**						**Periods : 9**		
Introduction, dimensions of steel stacks, chimney lining, breech openings and access ladder, loading and load combinations, design considerations, stability consideration, design of base plate, design of foundation bolts, design of foundation.									**CO4**
UNIT – V	**Pressed steel water tank**						**Periods : 9**		
Design of stays – Joints – Design of hemispherical bottom water tank – side plates – Bottom plates – joints – Ring girder –Design of staging and foundation. **Concepts of pre-engineering buildings**, limitations, advantages and comparison with conventional steel buildings.									**CO5**
Lecture Periods : 45		**Tutorials Periods : -**			**Practical Periods: -**		**Total Periods : 45**		
Reference Books									

1. Ram Chandra & Virendra Gehlot, Design of Steel Structures, 12th Ed., Standard Publishers, 2009.
2. Subramanian. N, "Design of Steel Structures", Oxford University Press, 2008.
3. Dayaratnam. P, "Design of Steel Structures", A. H. Wheeler, India, 2007.
4. IS: 800-2007, Code of Practice for general construction in steel, BIS, New Delhi.
5. IS: 875 (Parts 1 to 5) -2015, Code of Practice for Design loads for buildings and Structures, BIS, New Delhi.
6. John E. Lothers, "Design in Structural Steel", Prentice Hall of India, New Delhi, 1990.
7. Shiyekar, M. R., "Limit State Design In Structural Steel" 3rd edition, Prentice Hall of India, New Delhi, 2017.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3		
CO2	1	2		3		
CO3	1	2		3		
CO4	1	2		3		
CO5	1	2		3		

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**			Programme**: M. Tech.(Structural Engineering)**						
Semester : **III**			Course Category Code: **PSE**				Semester Exam Type: **TY**		
Course Code	Course Name		Periods / Week			Credit	Maximum Marks		
			L	T	P	C	CA	SE	TM
CEZ18	**STRUCTURAL OPTIMIZATION**		3	0	0	3	40	60	100
Prerequisite:									
Course Outcome:	At the end of the course, students will be able to								
	CO1	Able to form the objective function based on the constraints							
	CO2	Understanding the optimization methods for the design of structural elements							
	CO3	Use the computer search methods to identify the optimum point by iterations							
	CO4	Understanding the structural theorems and constraints such as stresses and deflections for make optimization							
	CO5	Understanding of the game theories to improve the performance of optimization techniques							
UNIT – I	**Introduction**						**Periods : 9**		
Basic concepts of minimum weight, minimum cost design, and objective function, constraints, classical methods.									**CO1**
UNIT – II	**Optimization Techniques And Algorithms**						**Periods : 9**		
Linear, Integer, quadratic, dynamic and Geometric programming methods for optimal design of structural elements.									**CO2**
UNIT – III	**Computer Search Methods**						**Periods : 9**		
Linear programming methods for plastic design of frames, computer search methods for univariate and multivariate Minimization.									**CO3**
UNIT – IV	**Optimization Theorems**						**Periods : 9**		
Optimization by structural theorems, Maxwell, Mitchell and Heyman's theorems for trusses and frames, Fully stressed design with deflection constraints, optimality criterion methods.									**CO4**
UNIT – V	**Game Theory**						**Periods : 9**		
Strategies and their properties - Pure and mixed strategies, Two person zero games, Minimax Maximin, saddle point, value of game - Rule of Dominance - Graphical solution.									**CO5**
Lecture Periods : 45		**Tutorials Periods : -**		**Practical Periods: -**			**Total Periods : 45**		

Reference Books

1. Uri Krisch, "Optimum Structural Design", McGraw Hill, 1981.
2. Richard Bronson, "Operation Research", Schaum's Outline series, MacGraw Hill Book Co, Singapore, 1983.
3. Pun, "Introduction to Optimization in Practice", John Wiley Eastern Limited, New Delhi, 1997.
4. Haugen, "Probabilistic Approaches to Design", John Wiley Eastern Limited, New Delhi, 1997.
5. Fox, R.C., "Optimization methods for Engineering Design" Wesley, 1997.
6. Rao S.S., "Optimization Theory and applications", Limited, New Delhi, 2004.
7. Spunt, "Optimum structural Design", Civil Engineering and Engineering Mechanics Services, Prentice hall, New Jersey, 1986.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3	1	
CO2	1	2		3	1	
CO3	1	2		3	1	
CO4	1	2		3	1	
CO5	1	2		3	1	

Score: **3** – High; **2** – Medium; **1** – Low

<table>
<tr><td colspan="4">Department :Civil Engineering</td><td colspan="7">Programme: M. Tech.(Structural Engineering)</td></tr>
<tr><td colspan="4">Semester : III</td><td colspan="4">Course Category Code: PSE</td><td colspan="3">Semester Exam Type: TY</td></tr>
<tr><td rowspan="2">Course Code</td><td colspan="2" rowspan="2">Course Name</td><td colspan="3">Periods / Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>SE</td><td>TM</td></tr>
<tr><td>CEZ19</td><td colspan="2">DESIGN OF MACHINE FOUNDATIONS</td><td>3</td><td>0</td><td>0</td><td>3</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Prerequisite:</td><td colspan="9"></td></tr>
<tr><td rowspan="6">Course Outcome:</td><td colspan="9">At the end of the course, students will be able to</td></tr>
<tr><td>CO1</td><td colspan="8">Understanding the dynamic loads causing the vibrations in structures and its measuring equipment’s</td></tr>
<tr><td>CO2</td><td colspan="8">Understanding the dynamic properties of soil</td></tr>
<tr><td>CO3</td><td colspan="8">Understanding the design of foundation of reciprocating machines</td></tr>
<tr><td>CO4</td><td colspan="8">Understanding the design of foundation of rotary and impact related equipment’s.</td></tr>
<tr><td>CO5</td><td colspan="8">Understanding the passive and active measures to control the vibrations in machine foundations</td></tr>
<tr><td>UNIT – I</td><td colspan="5">Theory of vibration</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="9">Introduction, nature of dynamic loads free vibrations of spring mass systems, forced vibrations viscous damping, principles of vibration measuring equipment’s.</td><td>CO1</td></tr>
<tr><td>UNIT – II</td><td colspan="5">Dynamic soil properties and behavior</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="9">Dynamic properties of soils: Elastic properties of soils, coefficient of elastic uniform and non-uniform compression and shear, effect of vibration on the dissipative properties of soils , determination of dynamic properties of soils , Codal provisions.</td><td>CO2</td></tr>
<tr><td>UNIT – III</td><td colspan="5">Foundations Of Reciprocating Machines</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="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 Recommendations.</td><td>CO3</td></tr>
<tr><td>UNIT – IV</td><td colspan="5">Foundation For Impact And Rotary Machines</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="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 T.G. Foundation – method of analysis – Design; Dynamic soil – structure – Interaction, Codal Recommendations.</td><td>CO4</td></tr>
<tr><td>UNIT – V</td><td colspan="5">Vibration Control</td><td colspan="4">Periods : 9</td></tr>
<tr><td colspan="9">Vibration isolation, passive and active isolation, use of springs and springs and damping materials, construction aspects of machine foundations.</td><td>CO5</td></tr>
<tr><td colspan="2">Lecture Periods : 45</td><td>Tutorials Periods : -</td><td colspan="4">Practical Periods: -</td><td colspan="3">Total Periods : 45</td></tr>
</table>

<u>Reference Books</u>

1. Srinivasulu.P., C. V. Vaidyanathan, Handbook Of Machine Foundations, Tata McGraw-Hill, 2012.
2. Bhatia.K.G., Foundations for Industrial Machines D-CAD Publishers, 2008
3. Braja M. Das, G. V. Ramana Principles of Soil Dynamics Cengage Leaning,2011
4. ShamsharPrakash ,VijaykumarPuri, Foundations for machines: analysis and design, John Wiley& Sons (P) Ltd, 2012.
5. Barkon,D.D., Dynamics of basis of foundation, MGH,1974.
6. Swami Saran, Soil Dynamics and Machine Foundation, Galgotia publications Pvt. Ltd.,2012.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2		3	2	
CO2	1	2		3	2	
CO3	1	2		3	2	
CO4	1	2		3	2	
CO5	1	2		3	2	

Score: **3** – High; **2** – Medium; **1** – Low

Department : **Civil Engineering**			Programme**:** M.Tech. (**Structural Engineering**)					
Semester : **III**			Course Category Code**: PSE**			Semester Exam Type: **TY**		
Course Code	Course Name	Periods / Week			Credit	Maximum Marks		
		L	T	P	C	CA	SE	TM
CEZ20	**STRUCTURAL DESIGN OF INFRASTRUCTURE FACILITIES**	3	0	0	3	40	60	100

Prerequisite:		
Course Outcome:	**CO1**	Understanding the design of Pipes made of concrete and steel
	CO2	Understanding the design of storage structures for water and sewage treatment
	CO3	Understanding design of water retaining structures and Environmental structures
	CO4	Understanding the repair and rehabilitation of structures
	CO5	Understanding the steel and lattice structures

UNIT – I	**Design of Pipes**	Hours : 9
Structural Design of Concrete, Prestressed Concrete, Steel and cast iron piping mains		**CO1**
UNIT – II	**Analysis and Design of Water Tanks**	Hours : 9
I.S. Codes for Design of Water retaining Structures - Design of concrete roofing system. Cylindrical, Spherical, Conical Shapes using membrane theory. Design of Circular, Rectangular, Spherical and Intze types of tanks using concrete. Design of prestressed concrete cylindrical tanks, Sewage tanks design.		**CO2**
UNIT – III	**Special Structures**	Hours : 9
Design of Special purpose structures - Underground reservoirs and swimming pools, intake towers, structural design including foundation of water retaining structures such as settling tanks, clarifloculators, aeration tanks, Imhoff tanks.		**CO3**
UNIT – IV	**Repair and Rehabilitation of Structures**	Hours : 9
Diagnosing the cause and damage, identification of different types of structural and non-structural cracks - Repair and rehabilitation methods for masonry, concrete and steel structures.		**CO4**
UNIT – V	**Sewerage Works**	Hours : 9
Design of Steel, Lattice Structures used in water and sewerage works, Protection methods of both RC and Steel structures.		**CO5**

Lecture Periods : 45	**Tutorial Periods : -**	**Practical Periods : - Total Periods : 45**

Reference Books:

1. Timoshenko S. & Krieger S.W. “Theory of Plates & Shells”, McGraw Hill Book Company,New York, 1990.
2. Bairagi “Plate Analysis”, Khanna Publishers, 1996.
3. Reddy J N, “Theory and Analysis of Elastic Plates and Shells”, McGraw Hill Book Company, 2006.
4. Szilard R., “Theory and Analysis of Plates”, Prentice Hall Inc., 1995.
5. Chandrashekahara K. Theory of Plates, University Press (India) Ltd., Hyderabad, 2001.

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2			3	1	2
CO2	2			3	1	2
CO3	2			3	1	2
CO4	2			3	1	2
CO5	2			3	1	2

Score: **3** – High; **2** – Medium; **1** – Low