# **UNIVERSITY OF MUMBAI**



# **Master of Engineering**

in

# **Civil Engineering with Structural Engineering**

(REV2022 Scheme) from Academic Year2022 - 2023

Under

FACULTY OF SCIENCE & TECHNOLOGY

Semester I	
------------	--

Course Code	Course Nome	Teaching Scheme (Contact Hours)				Credi			
Course Code	Course Name	Theor	<b>y</b> ]	Pract.	Tut.	Theory	Pract.	Tut.	Total
STRC101	Theory of Elasticity	3				3			3
	and Elastic Stability								
STRC102	Structural Dynamics	3				3			3
STRPE101X	Program Elective 1	3				3			3
STRPE102X	Program Elective 2	3				3			3
STRIE101X	Institute Elective 1	3				3			3
STRL101	Program Lab-I			2			1		1
STRSBL101	Skill Based Lab-I			4\$			2		2
	Total	15		06		15	03		18
					Examinatio	on Scheme			
		Theory							
				Theo	ry			Pract	
Course Code	Course Name	Internal	l Assessn	Theo nent	ry End Sem	Exam.	Term	Pract	Total
Course Code	Course Name	Internal Test-1	Assessm Test-2	Theo nent Avg	ry End Sem. Exam	Exam. Duration	Term Work	Pract / Oral	Total
Course Code	Course Name	Internal Test-1	l Assessn Test-2	Theo nent Avg	ry End Sem. Exam	Exam. Duration (in Hrs)	Term Work	Pract / Oral	Total
Course Code STRC101	Course Name Theory of Elasticity and Elastic Stability	Internal Test-1 20	Assessn Test-2 20	Theorem nent Avg 20	ry End Sem. Exam 80	Exam. Duration (in Hrs) 3	Term Work 	Pract / Oral	<b>Total</b> 100
Course Code STRC101 STRC102	Course Name Theory of Elasticity and Elastic Stability Structural Dynamics	Internal Test-1 20 20	Assessn Test-2 20 20	Theorem Theore	ry End Sem. Exam 80 80	Exam. Duration (in Hrs) 3 3	Term Work 	Pract / Oral 	<b>Total</b> 100 100
Course Code STRC101 STRC102 STRPE101X	Course Name Theory of Elasticity and Elastic Stability Structural Dynamics Program Elective 1	Internal           Test-1           20           20           20           20	Assessm           Test-2           20           20           20           20	Theo           ent           Avg           20           20           20           20	ry End Sem. Exam 80 80 80	Exam. Duration (in Hrs) 3 3 3 3	Term Work  	Pract / Oral	<b>Total</b> 100 100 100
Course Code STRC101 STRC102 STRPE101X STRPE102X	Course Name Theory of Elasticity and Elastic Stability Structural Dynamics Program Elective 1 Program Elective 2	Internal           Test-1           20           20           20           20           20           20           20	Assessn           Test-2           20           20           20           20           20	Avg           20           20           20           20           20	ry End Sem. Exam 80 80 80 80 80	Exam. Duration (in Hrs) 3 3 3 3 3	Term Work   	Pract / Oral  	<b>Total</b> 100 100 100 100
Course Code STRC101 STRC102 STRPE101X STRPE102X STRIE101X	Course Name Theory of Elasticity and Elastic Stability Structural Dynamics Program Elective 1 Program Elective 2 Institute Elective 1	Internal           Test-1           20           20           20           20           20           20           20           20           20           20           20           20           20           20	Assessm           Test-2           20           20           20           20           20           20           20           20           20           20           20           20           20	Theo:           ient           Avg           20           20           20           20           20           20           20           20           20           20           20	ry End Sem. Exam 80 80 80 80 80 80	Exam. Duration (in Hrs) 3 3 3 3 3 3 3	Term Work    	Pract / Oral   	<b>Total</b> 100 100 100 100 100 100
Course Code STRC101 STRC102 STRPE101X STRPE102X STRIE101X STRL101	Course Name Course Name Theory of Elasticity and Elastic Stability Structural Dynamics Program Elective 1 Program Elective 1 Institute Elective 1 Program Lab-I	Internal Test-1 20 20 20 20 20 20 	Assessn           Test-2           20           20           20           20           20           20           20           20           20           20           20           20           20           20           20           20           20           20	Theo:           aent           Avg           20           20           20           20           20           20           20           20           20           20           20           20           20           20           20	ry End Sem. Exam 80 80 80 80 80 80 	Exam. Duration (in Hrs) 3 3 3 3 3 3 3 	Term Work    25	Pract / Oral    25	<b>Total</b> 100 100 100 100 100 50
Course Code STRC101 STRC102 STRPE101X STRPE102X STRIE101X STRL101 STRSBL101	Course Name Theory of Elasticity and Elastic Stability Structural Dynamics Program Elective 1 Program Elective 2 Institute Elective 1 Program Lab-I Skill Based Lab-I	Internal Test-1 20 20 20 20 20 20  	Assessm           Test-2           20           20           20           20           20           20           20           20           20           20           20           20           20           20           20           20           20           20           20	Theo:           lent           Avg           20           20           20           20           20           20	ry End Sem. Exam 80 80 80 80 80 80  	Exam. Duration (in Hrs) 3 3 3 3 3 3  	Term Work    25 50	Pract / Oral   25 50	<b>Total</b> 100 100 100 100 100 50 100

# Semester I

Pro	ogram Elective 1	Program Elective 2					
Course Code	Course Name	Course Code Course Name					
STDDE1011	Advanced Numerical	STDDE1021	Analysis and Design of				
SIKPEIUII	Methods	SIRPEIUZI	Multi-storey Buildings				
STDDE1012	Analysis of Composite	STDDE1022	Advanced Design of				
SIRFEIUIZ	Structures	SIRPEIUZZ	Concrete Structures				
STDDE1012	Advanced Pre-stressed	STDDE1022	Ground Improvement				
SIRPEIUIS	Concrete Structures	SIRPE1025	Techniques				
Advanced Geo-technical		STDDE 1024	Advanced Structural				
SIKE1014	Engineering	SIKPE1024	Mechanics				

Institute Level Elective-1 (Any One)							
STRILE1011	Product Life Cycle Management	STRILE1015	Operations Research				
STRILE1012	Reliability Engineering	STRILE1016	Cyber Security and Laws				
STRILE1013	Management Information Systems	STRILE1017	Disaster Management and Mitigation Measures				
STRILE1014	Design of Experiments	STRILE1018	Energy Audit and Management				

Course	Correct Norma	Teaching Sch						
Code	Course Name	Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
STRC201	Finite Element Analysis	3			3			3
STRC202	Theory of Plates and Shells	3			3			3
STRPE201X	Program Elective 3	3			3			3
STRPE202 X	Program Elective 4	3			3			3
STRILE201	Institute Elective 2	3			3			3
STRL201	Program Lab-II		2			1		1
STRSBL201	Skill Based Lab-II		4 <sup>\$</sup>			2		2
	Total	15	06		15	03		18

# Semester II

		Examination Scheme								
Course				Theor	y			Pract		
Code	Course Name	Interna	l Assessm	ent	End	Exam.	Term		Total	
		Test - 1	Test - 2	Avg	Sem. Exam	Duration (in Hrs)	Work	Oral		
STRC201	Finite Element Analysis	20	20	20	80	3			100	
STRC202	Theory of Plates and Shells	20	20	20	80	3			100	
STRPE201X	Program Elective 3	20	20	20	80	3			100	
STRPE202X	Program Elective 4	20	20	20	80	3			100	
STRILE201	Institute Elective 2	20	20	20	80	3			100	
STRL201	Program Lab-II						25	25	50	
STRSBL201	Skill Based Lab -II						50	50	100	
	Total			100	400		75	75	650	

# Note 1

Skill Based Lab- I and II are focused on the learning through experience. SBL shall facilitate the learner to acquire the fundamental aspects of practical engineering in his or her specialization in a project-oriented learning environment. The learning through skill base can be useful in facilitating their research work and hence useful in early completion of their dissertation.

Pro	ogram Elective 3	Program Elective 4			
Course Code	Course Name	Course Code	Course Name		
STRPE2031	Earthquake Engineering	STRPE2041	Design of Industrial Structure		
STRPE2032	Health Monitoring and Rehabilitation of Structures	STRPE2042	Design of Green Buildings		
STRPE2033	Advanced Concrete Technology	STRPE2043	Analysis and Design of Environmental & Hydraulic Structures		
STRPE2034	Advanced Finite Element Methods	STRPE2044	Design of Bridge Structures		

Semester 1	Ι
------------	---

Institute Level Elective-II (Any One)								
STRILE2011	Project Management	STRILE2016	Research Methodology					
STRILE2012	Finance Management	STRILE2017	Intellectual Property Rights and Patenting					
STRILE2013	Entrepreneurship Development and Management	STRILE2018	Digital Business Management					
STRILE2014	Human Resources Management	STRILO2019	Environment Management					
STRILE2015	Professional Ethics and Corporate Social Responsibility (CSR)							

# Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)				Credits Assigned				
		Theor	y	Pract.	Tut.	Theory	Pract.	Tut.	Total	
STRMP301	Major Project: Dissertation -I			20			10		10	
	Total			20	00	00	10		10	
		Examination Scheme								
	Course Name	Theory				т				
Course Code		Internal Assessment		ment	End Exam.		l erm Work	Pract/	Total	
		Test-1	Test-2	Avg	Sem. Exam	Duration (in Hrs)	,, or it	Oral		
STRMP301	Major Project: Dissertation -I						100		100	
Total							100		100	

# **Online Credit Courses**

Course Code	Course Name	Teac (Co	ching Sche ntact Hour	me rs)	Credits Assigned			
			Pract.	Tut.	Theory	Pract.	Tut.	Total
STROCC301	Online Credit Course - I							3
STROCC302	Online Credit Course - II							3
Total					00	00	00	06

**Note 2**: It is mandatory to complete the Online Credit Courses (OCC) available on NPTEL / Swayam /MOOC or similar platform approved by UOM. These two courses shall be completed in any semester I or II or III, but no later than end of the Semester III. University shall make a provision that credits earned with OCC- I and OCC-II shall be accounted in the third semester grade-sheet with actual name of courses. The learner shall be allowed to take up these courses from his or her institute or organization/ industry where his / her major project is carried out. The candidate shall complete the courses and qualify the exam conducted by the respective authorities/ instructor from the platform. The fees for any such courses and the corresponding examination shall be borne by the learner.

# **Online Credit Course – I**

The learner shall opt for the course in the domain of Research Methodology or Research & Publication Ethics or Intellectual Property Rights. The opted course shall be of 3 credits of equivalent number of weeks.

# **Online Credit Course –II**

The learner shall opt for the course recommended by Faculty Advisor/ Project Supervisor from the institute. The opted course shall be of 3 credits of equivalent number of weeks.

Semester 1	IV
------------	----

Course Code	Course Name	Teaching Scheme (Contact Hrs)				Credits Assigned			
		Theory		Pract.	Tut.	Theory	Pract.	Tut.	Total
STRMP401	Major Project: Dissertation -II			32			16		16
			32			16		16	
		Examination Scheme							
<b>Course Code</b>	Course Name	Incory			Duration	Term	Pract/	T-4-1	
		Tost 1	Tost 2		Enu Sem. Exam	(in Hrs)	WORK	Oral	Totai
		1681-1	Test-2	Avg	Laum	(111113)			
STRMP401	Major Project: Dissertation -II						100	100	200
						100	100	200	

Total Credits: 68

**Note 3:** The Dissertation -II submission shall not be permitted till the learner completes all the requirements ME course.

Note 4: The contact hours for the calculation of load of the teacher for Major Project are as follows: Major Project Dissertation I and II - 02 Hour / week / student

# **Guidelines for Dissertation-I**

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format. Guidelines for Assessment of Dissertation-I.

# Dissertation-I should be assessed based on following points

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization
- Clarity of objective and scope Dissertation-I should be assessed through a presentation by a panel of Internal examiners and external examiner appointed by the Head of the Department/Institute of respective Programme.

# **Guidelines for Assessment of Dissertation II**

Dissertation II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted or learner contribution
- Validation of results
- Quality of Written and Oral Presentation

Students should publish at least one paper based on the work in referred National/International Conference/Journal of repute.

Dissertation II should be assessed by Internal and External Examiners appointed by the University of Mumbai.

# **Semester I**

## Semester I

Course Code	Code Course Name			
STRC101	Theory of Elasticity and Elastic Stability	03		

(	Contact Hours		Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03	-	-	03

Theory					To Pra			
Inte	rnal Asse	ssment	End	Term	<b>D</b> (		Total	
Test- I	Test- II	Average	Sem Exam	End Sem Exam	Work	Pract.	Oral	
20	20	20	80	03 hours	-	-	-	100

# Rationale

Theory of Elasticity and Elastic Stability is a vital branch of Mechanics of deformable Bodies. There are many practical cases where elementary methods of Strength of Materials are insufficient to provide detailed information regarding stress distribution around Engineering Structures. A course in Theory of Elasticity and Elastic Stability is necessary for structural engineering students to understand the behaviour of elastic solids under applied loads. This course introduces more powerful methods to investigate the deformations and stress distributions of elastic solids. This course also focuses on the fundamental concepts of structural stability.

# Objectives

- 1. To analyse the stresses and strains for two dimensional elements in Cartesian and polar coordinate systems.
- **2.** To understand how to apply the compatibility conditions and equations of equilibrium.
- 3. To solve elementary problems of elasticity in three-dimensional Coordinate system.
- 4. To understand the basic concept of elastic stability and buckling.
- 5. To analyse buckling behaviour of conventional structural components.
- 6. To apply the concepts of lateral and torsional buckling in analysis of beams.

		Detailed Syllabus	
Module		Course Module / Contents	Hrs
	Theor	y of Elasticity- I	
	1.1	Introduction: Elasticity, Notations for forces and stresses, components of stresses, components of strain. Hooke's law	
1	1.2	Plane stress and plane strain analysis: stress at a point, strain at a point	5
	1.3	Differential equations of equilibrium, boundary conditions, Strain Displacement Relations	
	1.4	Compatibility equations	
	Theor	y of Elasticity - II	
	2.1	Two dimensional problems in rectangular coordinates: – Airy's Stress function, Biharmonic Equation, solution by polynomials	
2	2.2	Saint-Venant's principle, bending of a cantilever loaded at the end, bending of a uniformly loaded simply supported beam.	Q
2	2.3	Two dimensional problems in polar coordinates: - equations of equilibrium in polar coordinates	o
	2.4	Bending of curved bars by a concentrated force	
	2.5	Rotating circular disc	
	2.6	Stress concentration around circular holes	
	Theor	ry of Elasticity III	
	3.1	Analysis of Three-Dimensional Problems: General Theorems, Differential equations of equilibrium, conditions of compatibility	
3	3.2	Equations of equilibrium in terms of displacements, principle of super position, uniqueness of solution, Reciprocal theorem	8
	3.3	Elementary problems of elasticity in three dimensions: Twist of Circular shafts Pure bending of Prismatic bars, plates	
	3.4	Torsion of prismatic bars, Membrane analogy	
	Elasti	c Stability	
4	4.1	Concepts of elastic stability, different forms of structural instability	5
•	4.2	BEAM-COLUMNS: differential equation for beam columns. Analysis of beam columns with different load cases and support conditions.	
	Elasti	c Buckling of Bars and Frames	
5	5.1	COLUMNS: Euler's buckling load, Governing differential equation, standard cases of columns with different boundary conditions, elastically restrained columns, eccentrically loaded columns. Energy methods for buckling problems	6
	5.2	Buckling of single span frames	
	5.3	Buckling of Continuous beams	

	Buckling in Structural Members					
6	6.1	Torsional buckling: Pure torsion of thin-walled bars of open cross section, torsional buckling,	6			
	6.2	Buckling by torsion and flexure				
	6.3	Lateral Buckling of beams: differential equation for lateral buckling, lateral buckling of beams in pure bending				

# **Contribution to Outcome**

On completion of this course, the students will be able to:

- 1 Understand the elastic behaviour of materials.
- 2 Apply concepts of stress-strain relations for linearly elastic solids.
- 3 Derive governing equations for 2D and 3D elastic problems.
- 4 Analyse torsion in prismatic members.
- 5 Understand the various numerical methods for treatment of stability problems.
- 6 Analyse buckling behaviour of conventional structural components.

# **Internal Assessment**

Consisting Two Compulsory Class Tests - First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

# **End Semester Examination**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total six questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

# **Recommended Books:**

- 1 Timoshenko, S., and Goodier, T.N., 'Theory of Elasticity', McGraw- Hill Book Co.Inc
- 2 Timoshenko, S.: 'Theory of Elastic Stability', McGraw Hill Book Co.Inc
- 3 Wang: 'Applied Elasticity', McGraw Hill Book Co.Inc
- 4 L S Srinath: 'Advanced Mechanics of Solids' Tata McGraw Hill
- 5 Aswini Kumar: 'Stability Theory of Structures', *McGraw Hill Book Co.Inc.*
- 6 N.G.R. Iyengar: 'Structural Stability of Columns and Plates', Affiliated East West Press

# 80 Marks

# 20 Marks

- 7 Mohammed Ameen: 'Computational Elasticity' Narosa Publishing House
- 8 Boresi A.P, Chang K.P, Lee J.D, 'Elasticity in Engineering Mechanics' *John Wiley & Sons Inc.*
- 9 Sitharam T.G, Govindaraju L, 'Theory of Elasticity' Springer
- 10 Brush, D.O. and. Almorth, B.O.: 'Buckling of Bars, Plates and Shells', *McGraw Hill, Kogakusha Ltd.*
- 11 Sadhu Singh: 'Theory of Elasticity' Khanna Publishers

# **Reference Books:**

- 1 Fung Y.C.: 'Foundations of Solid Mechanics' *Prentice-Hall Inc.*
- 2 Den Hartog J.P. 'Advanced Strength of Materials' *Dover Publishing*
- 3 Shames I.H: 'Mechanics of Deformable Bodies' Kreiger Publishing Co.
- 4 Hearn E.J: 'Mechanics of Materials 2' *Elsevier Science*
- 5 Sadd, M. H. "Elasticity: Theory, Applications and Numeric", Academic Press

#### Semester I

Course Code	Course Name	Credits
STRC102	Structural Dynamics	3

#### **Teaching Scheme**

(	Contact Hours		Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03			03

# **Evaluation Scheme**

Theory				Term Work/Practical/Oral				
Inte	Internal Assessment End Duration of						Total	
Test- I	Test- II	Average	Sem Exam	End Sem Exam	TW	PR	OR	
20	20	20	80	3 Hrs				100

# Rationale

Conventional structural analysis is based on the concept of static forces, whereas in present course structures are subjected to dynamic loading conditions. Structural Dynamics is an extension of the conventional static structural analysis, which considers the effect of time varying forces. Although much less used by practicing engineers than conventional structural analysis, the use of Structural Dynamics has gradually increased with worldwide acceptance of its importance. At present, it is being used for the analysis of tall/ high rise buildings, bridges, towers subjected to blast sway forces/load, wind, earthquake etc. Partial or complete collapse of structures occurs due to devastating earthquakes, which leads to great loss of life and livelihood. The lateral loads due to earthquake acting on structure are calculated using theory of structural dynamics. Therefore, the understanding of structural dynamics, characteristic of earthquakes and its effect on structure is essential for safe design of civil engineering structures.

# **Course Objectives**

- 1 Study the various types as well as characteristics of loading and formulate the equations of motion.
- 2 Learn the response of un-damped and damped SDOF systems under various loadings.
- 3 Employ the approximate and iterative methods to model continuous vibratory systems.
- 4 Use the seismic codes in analysis and design of civil engineering structures.
- 5 Understand the dynamic response by numerical methods.

6 Learn the response of un-damped and damped MDOF systems under various loadings

# **Detailed Syllabus**

Module	<b>Course Module / Contents</b>				
	Intro	duction to Structural Dynamics			
Ι	1.1Purpose of dynamic analysis,Static and Dynamics Loads, Nature of exciting forces, Loading Classifications, Basic terms				
	1.2	Degrees of freedom, Dynamic influence, mathematical modelling of dynamic systems, Response of structure, Effective stiffness			
	Singl	e Degree of Freedom (SDOF) Systems			
	2.1	Equations of Motions by Simple harmonic motion, Newton's law of motion, Energy method and D'Alembert's Principal.			
	2.2	Response of un-damped and damped free vibrations of SDOF systems			
	2.3	Damping in structures, viscous damping and Coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, Logarithmic decrement			
2	2.4	Response of un-damped and damped forced vibrations of SDOF systems, Dynamic magnification factor, transmissibility			
	2.5	Response of structure subjected to General dynamic load, Duhamel's Integral Numerical Evaluation of Dynamic Response of SDOF systems	13		
	2.6	Response of structure in frequency domain subjected to non- periodic forces: suddenly applied load-step and ramp excitation and impulsive force of short duration: Half-sine pulse - Rectangular pulse - Triangular Pulse, Dynamic load factor.			
	2.7	Distributed mass system idealized as SDOF system, use of Rayleigh's method. Response of SDOF system subjected to ground motion			
	Lum	ped Mass Multi-Degree of Freedom (MDOF) System,			
	3.1	Direct determination of frequencies of vibration and mod shape.			
	3.2	Orthogonality principle.			
3	3.3	Vibration of MDOF systems with initial conditions	09		
	3.4	Approximate method of determination of natural frequencies of vibration and mode shapes – Vector Integration Method			
	3.5	Energy methods and use of Lagrange's method in writing equation of motions decoupling of equations of motion, modal equation of motion, concept of modal mass and modal			

		stiffness.	
	3.6	Forced vibration of MDOF system, Modal Analysis. Application to multi-storey rigid frames subjected to lateral dynamic loads.	
	3.7	Concepts of Tuned Mass Dampers	
	Struc Diffe	cture with Distributed Mass System, Use of Partial rential Equation.	
4	4.1	Free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes	04
	Eartl	nquake Analysis	
	5.1	Introduction, Elastic rebound theory, Tectonic plates, Plate boundary, Faults, seismic waves, Seismicity of a region, causes and mitigation of earthquake	
5	5.2	Measurement of Earthquake ground motion, Intensity of earthquake, Richter Scale, Seismogram, construction of seismograph	09
	5.3	I.S code provisions for seismic analysis of buildings.	
	5.4	Approximate method of earthquake analysis– Seismic co- efficient method and its limitation Introduction to history analysis.	
	5.5	Application of modal analysis concept to seismic disturbance, Response spectrum method.	

# **Contribution to Outcome**

On completion of this course, the learner will be able to

- 1 Know the fundamental theory of dynamic equation of motions and analysis methods for dynamic systems.
- 2 Evaluate the response of SDOF and MDOF systems to different types of dynamic loads including ground motions.
- 3 Understand the basics of random vibrations and the application of this concept to analyze Linear SDOF systems
- 4 Interpret the dynamic analysis results for design, analysis and research purposes.

#### **Internal Assessment**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for either the tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **Theory Examination:**

# End Semester Examination

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total **six** questions, each carrying 20 marks.
- 2 There can be an internal choice in various sub-questions/questions in order to accommodate the questions on all the topics/ sub-topics.
- 3 The students will have to attempt any four questions out of total six questions
- 4 The questions can be of mixed nature irrespective of modules

# **Recommended Books:**

- 1 Anil K Chopra Dynamics of Structures Theory and Applications to Earthquake Engineering, Prentice-Hall Publications
- 2 Dynamics of structures--Poultre, Wiley India
- 3 R.W Clough and J Penzin Dynamics of Structures, McGraw Hill Publications
- 4 R.C. Roy Structural Dynamics an Introduction to Computer Methods, John Wiley & Sons Publications.
- 5 Madhujit Mukhopadhyay Structural Dynamics Vibrations and Systems, Ane Books India Publishers
- 6 John M. Biggs: 'Structural Dynamics'; Tata Mc-Graw Hill.

# **Reference Books:**

- 1 Mario Paz Structural Dynamics Theory and Computation, CBS Publications
- 2 Craig R.R.: 'Structural Dynamics-An Introduction to Computer Methods'; John Wiley and Sons.
- 3 IS: 1893 (Part-I)- 2016: Criteria For Earthquake Resistant Design of Structures
- 4 IS:13920-2016: Ductile Detailing of Reinforced Concrete Structures Subjected to
- <sup>4</sup> Seismic Forces Code of Practice

# 20 Marks

# 80 Marks

# Semester I

Course Code	Course Name	Credits
STRPE1011	Advanced Numerical Method	03

#### **Teaching Scheme**

(	Contact Hours		Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03			03

# **Evaluation Scheme**

Theory						Term Work/ Practical/Oral			
Internal Assessment		End	Duration of		DD	<b>OD</b>	Total		
Test- I	Test- II	Average	Sem Exam	End Sem Exam	ΤW	РК	OR		
20	20	20	80	03 Hours	-	-	-	100	

# Rationale

Classical theory-based analysis of various Civil Engineering problems involves solution of higher degree differential/integral /simultaneous/nonlinear etc equations. Thus solving these equations becomes time consuming clumsy and complicated process. Hence it involves the use of Numerical methods for solving these classical based higher degree equations. Though the Numerical methods involves laborious process, the availability of computational tools are utilised to get the approximate solutions.

# **Course Objectives**

The objectives of this course are

- 1. To master basic Programming fundamentals, Fundamentals of numerical methods
- 2. Determine errors present in numerical solutions to engineering problems.
- 3. Utilize programming logic, structure and syntax to develop multifunctional algorithms to solve engineering problems
- 4. Identify and classify the numerical problem to be solved.
- 5. Choose the most appropriate numerical method for its solution based on characteristics of the problem
- 6. Understand the characteristics of the method to correctly interpret the results.

# **Detailed Syllabus**

Module	Course Module / Contents	Contact hours				
	Introduction:					
1	Roots of a non-linear equation and Roots of a polynomial of nth degree [Incremental search method; Method of successive approximations; Newton's method; Bisection method; Secant method; Müller's method; Synthetic division; Bairstow's method]and convergence study.					
	Solution of (non-homogeneous) linear algebraic equations:					
2	Review of matrix algebra;Gauss elimination method; Cholesky's decomposition method; Householder method; Gauss-Seidal iterative method	3				
	Solution of non-linear algebraic equations:					
3	Method of successive approximation; Newton's method; Modified Newton – Raphson method; Secant method	4				
	Eigen values and Eigen vectors:					
4	Reduction of generalized Eigen value problem to thestandard Eigen value problem; methods for obtaining Eigen values and Eigen vector [Polynomial method; Vector iteration method; Mises power method; Jacobi method].	5				
	Time marching schemes for solution of problems in time domain:					
5	Numerical integration (2 – D) [Newton – Cotes method; Gauss – Legendre method].	5				
	Solution of differential equations:					
6	Ordinary and partial differential equations, Taylor series, Euler's method; Runge – Kutta method; Simple applications in structural mechanics such as critical loads of struts, beam columns, Solution of transcendental equation, applications of buckling of simple portal frames	7				
	Finite difference method:					
7	Simple applications to problems of beam and plates , Laplacian equation, consolidation equation, laterally loaded piles etc.	5				
	Regression Analysis:					
8	Least square method, Polynomial function curve fitting Interpolation- Polynomial approximation, Lagranges method, Spline interpolation	5				
	Contribution to Outcomes					

Upon successful completion of the course, students should have an ability of

- 1. Root finding; solutions for nonlinear algebraic equations
- 2. Solving sets of linear equations
- 3. Interpolation and curve fitting models
- 4. Numerical Differentiation and Integration
- 5. Understand fundamentals of numerical methods.

# **Internal Assessment**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for either the tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **Theory Examination:**

# **End Semester Examination**

# 80 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total **six** questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

# **Recommended Books:**

- 1 Chapra, S. C. and Canale R. P.: 'Numerical Methods for Engineering', Tata McGraw Hill
- <sup>2</sup> Carnahan, B., Luther, H. A. and Wilkes, J. O.: 'Applied Numerical Methods', *John Wiley*
- <sup>3</sup> Heath, M. T.: 'Scientific Computing: An Introductory Survey', *McGraw Hill*
- 4 Douglas Faires, J. and Richard Burden: 'Numerical Methods', *Thomson*
- 5 Rajasekaran, S.: 'Numerical Methods in Science and Engineering', S. Chand
- 6 E. Balguruswamy: 'Numerical Methods', *TMH Publications*
- 7 Pallab Ghosh: 'Numerical Methods with Computer Programming in C++', PHI Pvt. Ltd.
- 8 John F.Flemming: 'Computer Analysis of Structural Systems', *Mc Graw Hill International Edition*
- 9 Atkinson, K.E.:' An Introduction to Numerical Analysis', J. Wiley and Sons
- 10 Wilkinson, J.H.: 'The Algebric Eigen Value Problems', Oxford University Press.

# Semester I

# 20 Marks

Course Code	Course Name	Credits
STRPE1012	Analysis of Composite Structures	03
	Program Elective-I	

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03			03			03

Theory					Term Work/Practical/Or al			Total
Inter	nal Assess	sment	End	Duration of				
Test	Test-	Aver	Sem	End Sem	TW	PR	OR	
-I	Π	age	Exam	Exam				
20	20	20	80	03	-	-	-	100

# **Course Objectives**

The objectives of this course are

- 1. To introduce the general set of composite materials
- 2. To show the advantages of composites over metals
- 3. To explain the fabrication processes
- 4. To analyse the structural mechanics of composite materials.
- 5. To explain the deformation and failure of composite materials under the influence of different loads.
- 6. To know the effect of hydro-thermal environment on composite materials

# **Detailed Syllabus**

Module	Course Modules / Contents	Contact
		hours
	Introduction	05 hrs
	Definition of fibre reinforced composites, applications and various	
1	reinforcement and matrix materials	
	Mechanics of a Lamina	10 hrs
	Linear elastic stress-strain relations, elastic constants based on	
2	micromechanics, plane stress constitutive relations, transformation of	
	stresses and strains, transformation of material coefficients, thermal	
	stresses and strains.	
	Laminated Composites	10hrs
	Types of laminated composites, displacement field approximations for	-
2	classical laminate theory, laminate strains, stress resultants, stiffness	
5	matrices, stresses and strains due to applied loads, introduction to first	
	order shear deformation theory.	
	Failure Theories of a Lamina	08hrs
4	Maximum stress failure theory, maximum strain failure theory, Tsai-	
	Hill failure theory, Tsai-Wu failure theory	
_	Mechanical Properties Determination	06 hrs
5	Tensile properties, compressive properties, flexure properties, in-plane	
	shear properties, inter laminar shear strength.	
	Total	39

# **Contribution to Outcome**

On successful completion of the course, students should be able to

- 1. Learn use of composite materials in real structures.
- 2. Composite material: classification, characterization, fabrication techniques.
- 3. Structural mechanics of composite materials: Calculation of strength and stresses.
- 4. De lamination, knowledge about inters laminar stresses.
- 5. Environmental effect on composite material.

# **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **Theory Examination:**

- 1. Question paper will comprise of six questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of mixed nature irrespective of modules

# **Recommended Books:**

- 1) Composite structure of steel and concrete (by Johnson)
- 2) Mechanics of composite material and structure by M. Mukhopadhay (university press)
- 3) An Introduction to Composite Material by D. Hull (Cambridge University Press)
- 4) Engineering Mechanics of Composite Material by Isaac M. Daniel & Ori Ishai (OUP)
- 5) Steel Concrete and Composite Design of Tall Building by Bunga

# **Reference Books**

- 1. Jones R. M., Mechanics of Composite Materials, McGraw-Hill, Kogakusha Ltd., Tokyo, 1975.
- 2. Agarwal B. D. and Broutman L. J., Analysis and Performance of Fiber Composites, John Wiley and Sons, 1980.
- 3. Kaw A. K., Mechanics of Composite Materials, CRC Press, Florida, 1997.
- 4. Hyer M. W., Stress Analysis of Fiber-Reinforced Composite Materials, McGraw Hill, 1999.
- 5. Mukhopadhyay M., Mechanics of Composite Materials and Structures, University Press, India, 2004.
- 6. Daniel and Ishai, Engineering Mechanics of Composite Materials, Oxford University Press, 2005.
- 7. Christensen R. M., Mechanics of Composite Materials, Dover Publications, New York, 2005.
- 8. Mota Soares C. A., Mota Soares C. M., and Freitas Manuel J.M., Mechanics of Composite Materials and Structures (Proceedings), Springer Science & Business Media, 1999

Course Code	Course Name	Credits
<b>STRPE 1013</b>	Advanced Prestressed Concrete Structures	03
	Program Elective-1	

# **Teaching Scheme**

Contact Hours			<b>Credits</b> assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03			03			03

# **Evaluation Scheme**

Theory					Term work/Practical/Oral			Total
Internal Assessment			End	Duration	TW	PR	OR	
Test 1	Test 2	Average	Sem Exam	ofEnd Sem Exam				
20	20	20	80	03	-			100

# Rationale

Pre-stressed concrete combines high strength steel and high strength concrete in an active manner. Today, pre-stressed concrete is being used in the construction of wide range of structures. It helps an engineer to achieve a much economical section for carrying heavy loads over larger span lengths. Thus, the use of pre-stressed concrete has become a standard practice for long span bridges. A Prestressed Concrete section improves performance/efficiency, reduces structural thickness, and material savings compared with reinforced cement concrete sections. This course involves typical applications of prestressed concrete that include Beam, Slab and Frame, Shells and Folded Plate Structures. Pre-stress concrete pipes, tanks, poles, piles, sleepers and pavements, bridges and composite constructions etc.

- 1. To understand the basic concepts of in pre- stressed concrete structures in relation to its applications.
- 2. To study the design of prestressed concrete Beam, Slab and portal Frames.
- 3. To understand the design concepts of Shells and Folded Plate Structures.
- 4. To study the design of Pre-stress concrete Pipes, tanks, poles, piles, sleepers and pavements.
- 5. To study the design of prestressed concrete bridges.
- 6. To understand the design concepts of Composite construction of Prestressed and in situ concrete.

# **Detailed Syllabus**

Module	Course Modules / Contents	Periods
1	Introduction:	
	Introduction to Prestressed concrete, system and devices, materials, losses	
	in pre-stress, stresses at transfer and service loads, maintenance of pre-	05 Hrs
	stressed concrete structure, limit state method-limit state of collapse	
	against flexure, shear, torsion - limit state of serviceability. Short term and	
	long term deflection of uncracked members.	
2.	Beam, Slab and Portal Frame:	08 Hrs
	Continuous beams- primary and secondary moments -Elastic analysis of	
	continuous beams. Design of one way and two way slabs. Design of Flat	
	slabs. Analysis and design of Grid floors. Design of Prestressed portal	
	frames.	
3	<b>Shells and Folded Plate Structures:</b> Shells: method of pre-stressing, design of circular cylindrical shell and hyperboloid shell.	07 Hrs
	Folded Plate: Introduction, different cross section of folded plates,	
	deformation characteristic of folded plate, Design of folded plate	
	structures.	

4	<b>Pre-stress concrete Pipes, tanks, poles, piles, sleepers and pavements:</b> Introduction, principal of circular pre-stressing, methods of design, General analysis and design of Prestressed concrete pipes, design of Liquid storage tanks, Ring beams, poles, piles sleepers and pavements.	06 Hrs
5	<b>Pre-stress concrete bridges:</b> Introduction, Pre-tensioned and post tensioned concrete bridge decks; analysis of section for flexure shear and bond; Design of post-tension prestressed concrete slab bridge deck, T-beam slab bridge decks; analysis and design of anchorage block; box girder bridge.	07 Hrs
6	<b>Composite construction of Prestressed and in situ concrete :</b> Composite Section of pre-stressed concrete beam and cast in situ RC slab- analysis of stresses, deferential shrinkage, deflections, flexure, and shear strength of composite section, analysis and design of composite section.	05 Hrs

# **Contributions to Outcome**

On successful completion of the course, the learner will be able to

- 1. Understand the basic concepts of in pre- stressed concrete structures in relation to itsapplications
- 2. Study the design of prestressed concrete Beam, Slab and portal Frames.
- 3. Understand the design concepts of Shells and Folded Plate Structures.
- 4. Study the design of Pre-stress concrete Pipes, tanks, poles, piles, sleepers and pavements.
- 5. Study the design of prestressed concrete bridges.
- 6. Understand the design concepts of Composite construction of Prestressed and in situ concrete

# **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either test. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **Theory Examination:**

1. Question paper will comprise of **six** questions. Question number one will be compulsory and will have the weightage of 32 marks.

- 2. The students will have to attempt **any three** questions out of **remaining five** questions which willbe having the weightage of 16 marks each.
- 3. There can be an **internal** choice in various sub-questions/ questions in order to accommodate thequestions on all the topics/ sub-topics.
- 4. The questions can be of **mixed nature** irrespective of modules

# **Recommended Books:**

- 1. Krishna Raju (2000): 'Prestressed Concrete', Tata McGraw Hill Publishing Co.
- 2. Sinha.N.C. and.Roy.S.K. (1998): 'Fundamentals of Prestressed Concrete', S.Chand and Co.
- 3. V. K. Raina (1994): 'Concrete Bridge Practice Analysis Design and Economics', *Tata McGrawHill*, 2<sup>nd</sup> Edition, 1994.
- 4. S. Ramamrutham (2013): 'Prestressed Concrete', Dhanpat Rai Publishing Company
- 5. Lin, T.Y. and Burns, N.H. (2004): 'Design of Prestressed Concrete Structures',

3<sup>rd</sup>Edition, JohnWiley and Sons.

6. IS: 1343, "Code of Practice of Prestressed Concrete", Indian Standards Institution.

Semester I	

<b>Course Code</b>	Course Name	Credits
--------------------	-------------	---------

<b>STDDE 101</b>	`Advanced Geotechnical Engineering	02
51 KPE 1014	Program Elective-I	05

#### **Teaching Scheme**

(	Contact Hours			Credits A	Assigned	
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03			03

# **Evaluation Scheme**

Theory					Work/	Term Practical	/Oral	
Internal Assessment Test- Test- Average		ssment Average	End Sem	Duration of End Sem	TW	PR	OR	Total
Ι	II	iveruge	Exam	Exam				
20	20	20	80	03	-	-	-	100

# Rationale

The present syllabus is designed assuming that the students have the prerequisite knowledge of basic geotechnical engineering at their UG level. All the structures, except those flying, or floating, rest on soil, and or rock The basic philosophy of this syllabus is to address the overview of geotechnical engineering concepts, laboratory and field tests, data interpretation and various geotechnical applications keeping in view that the students must be aware of the importance of interactions between structural and geotechnical engineers. This course aims to confer the understanding of the various available geotechnical tests, design techniques and influencing factors, and different foundation systems.

# **Course Objectives**

- 1. To impart knowledge on the various properties of soil, overview of different laboratory and field tests and some soil exploration techniques.
- 2. To understand the interpretation of data from field and laboratory tests.
- 3. To understand the different techniques to evaluate the bearing capacity of shallow foundation systems.
- 4. To understand the different techniques to evaluate the capacity of single pile and group of piles, overview of anchored sheet piles and deep excavation systems.
- 5. To understand the basic concept of soil dynamics and its application to the machine foundations.
- 6. To learn the necessity of stability of slopes, ground improvement, design of stone columns and vertical drains, and types of geosynthetics.

# **Detailed Syllabus**

Module		Course Module / Content's	Contact Hours
1	Over	view of Geotechnical Engineering	8
	1.1	Overview of Geotechnical Engineering; Definitions and scope	
		of Soil Mechanics, Soil Dynamics, Rock Mechanics, etc.	
	1.2	Basic relationship among void ratio, porosity, degree of	
		saturation, air content, %air voids, water content, specific	
		gravity, bulk unit weight, dry unit weight, submerged unit	
		weight, saturated unit weight, unit weight of soil solid, etc.	
	1.3	Hydraulic properties (an overview): Co-efficient of	
		permeability, hydraulic gradient, total head, seepage	
		phenomenon, uplift pressure; Basic understanding of effective	
		stress principal; Consolidation properties: co-efficient of	
		compression, co-efficient of consolidation, coefficient of	
		compressibility $(a_v)$ , $m_v$ , degree of consolidation, pre-	
		consolidation pressure, normally and over-consolidated soil;	
		Shear parameters: cohesion (c), angle of internal friction $(\phi)$ ,	
		adhesion, angle of wall friction.	
	1.4	Laboratory tests (an overview): water content, specific gravity,	
		grain size distribution, field density tests (core cutter & sand	
		replacement), standard and modified Proctor tests,	
		permeability test, consolidation test, CBR test, etc.; Shear	
		strength tests (direct shear and triaxial tests): Different types	
		of tests based on drainage conditions (UU, $\overline{U}\overline{U}$ CU, $\overline{C}\overline{U}$ ,	
		CD), relevance in field, i.e., how to choose which test to be	
		carried out? (Note: A teacher may take a typical case of earth	
		dam and show that all these cases are seen in one project itself.)	
	1.5	Overview of field tests: field permeability tests, field vane	
		shear test, SPT, CPT (SCPT & DCPT), pressuremeter test	
		(PMT), plate load test, pile load test, etc.	
	1.6	Soil exploration, number of boreholes & depth of exploration,	

		sequence of boring & testing, boring procedure, size of boring	
		in soil and rock, single, double&triple core barrels; soil	
		samplers; Geophysical exploration: Seismic refraction,	
		electrical resistivity	
2	Inter	pretation of Data from Field and Laboratory Tests	5
	2.1	Plotting of cross-sectional profile (lateral and longitudinal) and	
		how to take a decision on depth of foundation. (Note: Teacher	
		may collect a typical geotechnical report from the nearby	
		project and explain the same to the class.)	
	2.2	Analysis of results and graphs from consolidation test:	
		determination of $c_v$ , degree of consolidation; consolidation	
		settlement; field method to estimate pre-consolidation	
		pressure; graphical method to determine pre-consolidation	
		pressure; methods to obtain field virgin compression curve.	
	2.3	Analysis of results and graphs from shear strength tests:	
		deviator stress at failure, Mohr circles, c, $\phi$ ; Relations among	
		$\sigma_1, \sigma_3, c, \phi.$	
3	Shall	<b>ow Foundation</b> (Teacher can take a case study of nearby site	6
	and e	xplain articles 3.1 to 3.6.)	
	3.1	Introduction to shallow foundation; modes of failure; ultimate	
		versus net ultimate bearing capacity, factor of safety,	
		allowable bearing capacity in soil.	
	3.2	Bearing capacity equations as per Vesic and IS code; influence	
		of ground water table on bearing capacity; eccentric loading on	
		footing.	
	3.3	Footing adjacent to slopes, footings on stratified soils,	
		foundations on peat, expansive soil and highly compressible	
		foundations on peat, expansive soil and highly compressible soil.	
	3.4	foundations on peat, expansive soil and highly compressible soil. Determination of bearing capacity based on penetration tests	
	3.4	foundations on peat, expansive soil and highly compressible soil. Determination of bearing capacity based on penetration tests (SPT, SCPT, DCPT), plate load test and pressure meter test.	
	3.4	<ul> <li>foundations on peat, expansive soil and highly compressible soil.</li> <li>Determination of bearing capacity based on penetration tests (SPT, SCPT, DCPT), plate load test and pressure meter test.</li> <li>Allowable bearing pressure for permissible total settlement,</li> </ul>	
	3.4	foundations on peat, expansive soil and highly compressible soil. Determination of bearing capacity based on penetration tests (SPT, SCPT, DCPT), plate load test and pressure meter test. Allowable bearing pressure for permissible total settlement, Terzaghi-Peck, Meyerhoff, Peck-Hanson-Thornburn analyses	

	3.6	Bearing pressure on rock based on core strength, pressure	
		meter test.	
4	Pile F	Foundation(A teacher can take a case study of nearby site and	8
	explai	in articles 4.1 to 4.5)	
	4.1	Introduction to piles, pile classification, capacity of individual	
		pile under axial vertical compression load; selection of design	
		parameters: selection of test methods, types of strength	
		parameters (drained/ undrained), generalized sub-soil	
		profiles; pile capacity from static formulae, pile capacity in	
		rock; pile capacity from dynamic formulae, validity of	
		dynamic formulae.	
	4.2	Pile capacity from pile load test, standard penetration test	
		(SPT) and cone penetration test (SCPT, DCPT);group	
		efficiency of pile; pile group in sand and clay, group capacity	
		of piles, settlement of pile group. Refer IS 2911 part 1 to part	
		4 and IRC 78.	
	4.3	Negative skin friction, steps to eliminate negative skin	
		friction; under-reamed piles; length of fixity of pile	
	4.4	Anchored sheet piles (Pressure diagrams, application)	
	4.5	Deep excavation: braced cut, deep excavation with piles	
5	Soil I	Dynamics and Machine Foundation	7
	5.1	Introduction to vibration; relationship between frequency and	
		amplitude; free vibration without and with damper, forced	
		vibration without and with damper (Single degree of freedom	
		system, only final equations, derivations not required);	
		logarithmic decrement	
	5.2	Wave propagation in an elastic infinite medium; method based	
		on elastic half space; lumped mass approach; velocity of	
		primary, secondary, Rayleigh and love waves; waves	
		generated by a circular surface footing undergoing vertical	
		oscillations;	
	5.3	IS 5249 - Determination of dynamic soil properties: block	
		vibration, steady state vibration, down the hole, up the hole,	

		cross borehole tests, cyclic plate load test.	
	5.4	Criteria of satisfactory machine foundation; methods of	
		analysis; degrees of freedom of a block foundation; Definition	
		of soil spring stiffness, Indian standard for design and	
		construction of foundation for reciprocating machines, design	
		procedure for a block foundation.	
6	Slope	Stability, Geosynthetic and Ground Improvement	5
	6.1	Stability of slopes based on methods of slices (Felleniu's	
		method) and Bishop's simplified method	
	6.2	Types and selection of ground improvement techniques (IS	
		13094)	
	6.3	IS 15284 part 1: Stone column; IS 15284 part 2:	
		Preconsolidation using vertical drains; liquefaction and	
		mitigation measures	
	6.4	Geo-synthetics types (basic concept): geo-textiles, geo-grids,	
		geo-cell, geo-membrane, geo-composite, geo-net; multi-	
		functions of geo-synthetics: separation, reinforcement,	
		drainage, filtration, erosion control, etc.; How to select	
		appropriate Geo-synthetics based on applications?	
1	1		

# **Contribution to Outcomes**

On completion of this course, the learner will be able to

- 1. Evaluate soil properties by performing laboratory and field tests, and understand the necessity along with some techniques of soil exploration.
- 2. Analyze the obtained results from field and laboratory tests.
- 3. Understand modes of failure and evaluate bearing capacity of shallow foundation.
- 4. Estimate the safe load on single and group pile systems.
- 5. Understand the dynamic soil properties and get an overview of machine foundation systems.
- 6. Design safe slopes, understand the necessity of ground improvement, stone columns and pre-consolidation using vertical drains, select appropriate geo-synthetics based on applications.

# **Internal Assessment**

# 20 Marks

The internal assessment consists of two tests, i.e., mid-semester and end semester. The

learner/s shall be asked to appear for either the tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **Theory Examination**

# **End Semester Examination**

# Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total **six** questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be of mixed in nature.
- 4 The students will have to attempt **any four** questions out of **total six** questions.

# **Recommended Books:**

1	Nayak, N. V.(2018), "Foundation Design Manual". Dhanpatrai Publication, New
	Delhi.
2	Singh, A. (2006), "Modern Geotechnical Engineering". CBS Publishers and
	Distributors Pvt. Ltd., New Delhi.
3	Som, N. N. and Das, S. C. (2003), "Theory and Practice of Foundation
	Design". Prentice Hall of India private limited, New Delhi.
4	Terzaghi, K. and Peck, R. B. (1967), "Soil Mechanics in Engineering Practice".2 <sup>nd</sup>
	edition, John Wiley and sons, Inc., Canada.
5	Tomlinson, M. J. (1986), "Foundation design and construction".7 <sup>th</sup> edition, Prentice
	Hall, New Jersey, United States.
6	Winterkorn, H. F. and Fang, H. Y. (2018), "Handbook Geotechnical
	Engineering".Galgotia book source, New Delhi.
7	Samsher Prakash, (1981), "Soil Dynamics". McGraw-Hill Book Company, New York.

# **Reference Books and IS codes:**

1	Bowles, J. E., 1996, "Foundation analysis and design", 5 <sup>th</sup> edition, The McGraw-Hill
	Companies, Inc.
2	Coduto, D. P., 2002, "Geotechnical Engineering principles and practices", Prentice
	Hall of India private limited, New Delhi.
3	Das, B. M., 1998, "Principles of geotechnical engineering", PWS series in civil engineering.
4	Gulhati, S. K. and Datta, M., 2005, "Geotechnical engineering", Tata McGraw-Hill
	Companies.
5	Han Jie, "Principles and Practice of Ground Improvement" Wiley
6	Korner; "Designing with Geosynthetics"

# 80 Marks

7	Lambe, W. T. and Whitman, R. V., "Soil Mechanics, SI version", John Wiley, and
	sons.
8	BS8006, "Code of practice for Strengthened/reinforced soil and other fills".
9	IRC 78 2014, "Standard Specifications and Code of Practice for Road Bridges, Section
	VII, Foundations and Substructure, (Revised Edition)".
10	IS: 1080-1988, "Design and construction of Shallow Foundations in Soils (other than
	raft, ring, and shell)".
11	IS: 1498-1970, "Classification and Identifications of soils for General Engineering
	Purposes".
12	IS: 1888-1982, "Method of Load Test on soils".
13	IS: 1892-1979, "Code of Practice for Subsurface Investigations for Foundations".
14	IS: 1904-1986, "Design and Construction of Foundations in Soils, General
	Requirements".
15	IS:2132-1986, 'Code of Practice for Thin-Walled Tube Sampling of Soils".
16	IS: 2911-Part I-Sect. 1-1979, "Design and Construction of Pile Foundations-Driven
	Cast in-situ concrete Piles".
17	IS: 2911-Part I-Sect. 3-1979,Design and construction of Pile Foundation-Driven
	Precast Piles".
18	IS; 2911-Part 3-1980, "Code of Practice for Design and Construction of Pile
	Foundation- Under-reamed Piles".
19	IS: 2911-Part 4-1974, "Load Test on Piles".
20	IS; 2950 A-I 1974 1 "Code of Practice for Design and Construction of Raft
	Foundations".
21	IS: 2974-Part 1-1982, "Foundation for Reciprocating Type Machines".
22	IS; 2974-Part 2-1980, "Foundation for Impact Type machines (Hammer Foundation)".
23	IS: 2974-Part 3-1975, "Foundation for Rotary Type machines (Medium and Highway
	Frequency)".
24	IS: 2974-Part 4-1979, "Foundations for Rotary Type Machines for Low Frequency".
25	IS: 2974-Part 5-1970, "Foundations for Impact Type Machines other than Hammers
	(Forging and Stamping Press, Pig-breaker, Elevator and Hoist Tower).
26	IS: 3764-1970, "Safety Codes for Excavation work".
27	IS: 3955-1967, "Code of Practice for Design and Construction of well Foundations".
28	IS: 4434-1978, "Code of Practice for In-situ vane Shear Test for soils".
29	IS: 4453-1980, "Code of Practice for Sub-surface Exploration by Pits, Trenches, Drifts
	and Shafts."
30	IS: 4968-Part 2-1976, "Dynamic Method using cone and Bentonite Slurry".
31	IS: 4968-Part 3-1976, "Static cone Penetration Test".
32	IS 5249 1992 "Design of dynamic properties of soil-Method of tests".
33	IS: 5121-1969, "Safety code for Piling and other Deep Foundations".
34	IS: 6403-1981, "Code of Practice for Determination of Bearing Capacity of Shallow
	Foundations".
35	IS: 8009-Part 1-1976, "Shallow Foundation Subjected to Symmetrical Static Vertical

	Loads".
36	IS: 8009-Part 2-1980, "Code of Practice for calculations of settlement of Foundation-
	Deep Foundation subjected To Symmetrical Static Vertical Loading.
37	IS 11089-1984, "Code of practice for design and construction of ring foundation".
38	IS 12070 (1987): Code of practice for design and construction of shallow foundations
	on rock [CED 48: Rock Mechanics].
39	IS 13094-1992 "Selection of ground improvement techniques for foundation in week
	soils-Guidelines".
40	IS 14593-1998 "Design and construction of bored cast-in-situ pile foundation on rocks-
	Guidelines".
41	IS 15284: Part 1: 2003 Design and construction for ground improvement-stone column
42	IS 15284-Part 2-2004 "Design and construction of ground improvement-Guidelines
	Part 2: Pre-consolidation using vertical drains".

Semester-	I
-----------	---

Course Code	Course Name	Credits
STR PE1021	Analysis And Design of Multi-storey Buildings	03
	Program Elective -II	

(	Contact Hour	S	Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03			03			03

Theory						Term Practic		
Inter Test-I	nal Asses Test-II	sment Avera ge	End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total
20	20	20	80	03	-	-	-	100

# Rationale

The basis is study of knowledge of analysis and design of multistoried buildings for static and dynamic loading. The subject involves Building frames, frame-shear wall buildings; Braced Buildings with mathematical modeling. The course contents are earthquake analysis and ductility detailing of frames for seismic forces. The study involves special aspects in Multi-storied buildings like Effect of torsion, flexible first story, P-delta effect, soil-structure interaction and design of fire resistant structure.

# **Course Objectives**

- 1. To understand the complete analysis and design of building frames using relevant IS codes and mathematical modelling of buildings with different structural systems.
- 2. To impart knowledge on static and dynamic wind analysis, design of multi-storeyed buildings
- 3. To impart the knowledge of ductile detailing of earthquake resistant structures.

- 4. To understand the complete Special aspects in Multi-storeyed buildings.
- 5. To develop the students well versed with concepts of Analysis and Design of multi-storeyed buildings with masonry infills.
- 6. To familiarize students with the Indian codes/Standards for static and dynamic wind analysis, as well as fire resistant structures. design and design for Fire Resistant.

**Detailed Syllabus** 

Module	Course Modules / Contents	Periods
I.	Building frames, frame-shear wall buildings; Braced Buildings, Mathematical modelling of buildings with different structural systems with and without diaphragms.	04 hrs
II.	Earthquake, wind and other (i.e. blast and snow) load calculations along with dead load and live loads and their combinations.	12 hrs.
III.	Ductile Detailing of Frames for Seismic Forces: Introduction, General principles, Factors that increase ductility, Specifications of materials for ductility, Ductile detailing of beams – Requirements, Ductile detailing of columns and frame members with axial load (P) and moment (M) – Requirements. Design of shear walls, Joints in frames.	07 hrs.
IV.	Special aspects in Multi-storeyed buildings: Effect of torsion, flexible first story, P-delta effect, soil-structure interaction on building response, drift limitation.	06 hrs.
V	Analysis and Design of multi-storeyed buildings with masonry infills, Sequential analysis for multi-storeyed buildings.	06 hrs.
VI	Design for Fire Resistant, Creep, Shrinkage and Thermal stresses.	04 hrs.

# **Contribution to Outcomes**

# On successful completion of the course, the candidate shall be able

- 1. To develop mathematical model, perform analysis and design Reinforced Concrete buildings
- 2. To present methods of static and dynamic wind analysis of multistoried buildings.
- 3. To present the knowledge of ductile detailing of earthquake resistant structures.
- 4. To design multi-storeyed buildings by relevant Indian Codes/Standards for RCC structures and special aspects in Multi-storeyed buildings.
- 5. To analyze and Design of multi-storeyed buildings with masonry infills.
- 6. To design the Fire Resistant structures.

# Internal Assessment:

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **Theory Examination:**

- 1. Question paper will comprise of **six** questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of **mixed nature** irrespective of modules

# **Recommended Books:**

- Farzad Naeim (2001): 'Handbook on Seismic Analysis and Design of Structures', *Kluwer Academic Publisher*
- Paulay, T. and Prestiley, M.J.N. (1999): 'Seismic Design of R.C.C.and Masonry Buildings', John Willey and Sons (2<sup>nd</sup> Edition)
- 3. Booth, E. (1994): 'Concrete Structures in Earthquake Regions', Longman Higher Education
- 4. Park, R. and Paulay, T. (1975): 'Reinforced Concrete Structures', John Willey and Sons (2<sup>nd</sup>Edition)
- 5. Fintel, M. (1986): 'Handbook of Concrete Engineering', CBS Publishers, Delhi (2<sup>nd</sup> Edition)

6 Pankaj Agqrwal and Manish Shrikhande : "Earthquqke Resistant Design of Structures "Prentice-Hall

of India Private limited New Delhi

7 S. K. Duggal "Eartrhquake Resistant Design of Structures " Oxford
~ -
Semester I

Course Code	Course Name	Credits
STRPE1022	Advanced Design of Concrete Structures	03
	Program Elective-II	

Contact Hours				Credits A	ssigned	
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03			03			03

Theory					Term Work/Practical/Oral			
Internal Assessment     Test   Test-   Aver		End Sem	Duration of End Sem	TW	PR	OR	Total	
-1 20	11 20	age 20	Exam 80	03	-	-	-	100

#### Rationale

Reinforced concrete construction is widely used for residential, commercial and industrial structures., Students will learn advanced topics related to the behavior and design of reinforced concrete. This advance topic includes Ultimate Load Analysis of RC slabs by using Yield line theory, Design of flat plate and flat slab, Design of Portal Frame, Design of combined footing, Raft foundation, Pile foundation including pile cap, Design of Silos and Bunkers, Analysis and design of beams curved in plans, Design of structures like Folded plate roofs, Arched Slab System, Deep beams, Corbels, Nibs etc.

# **Course Objectives**

- 1. To understand the design philosophy of two-way slab using ultimate load method.
- 2. To study the concept of the design of flat slab, flat plate slab.
- 3. To study design of portal frame and special types of foundations such as raft foundations and pile foundations including pile cap.
- 4. To understand the design concept for bunkers and silos.
- 5. To study the analysis of the beams curved in plan and extend its application for the design of such beams.
- 6. To understand the concept for the design of structures like folded plate roofs, arched slab system, deep beams corbels, nibs etc.

# **Detailed Syllabus**

Module	Course Modules / Contents	Contact
		Hours
	Yield line theory	06 hrs
	Ultimate Load Analysis of RC slabs using Yield line theory (Virtual	
т	work and equilibrium method); Application for the analysis and	
1	design to orthotropically reinforced square/rectangular slabs with	
	various boundary conditions under uniformly distributed loads.	
	Design of flat slabs	05 hrs
п	Behaviour of flat slab, Method of analysis (Direct design method,	
11	Equivalent frame method, Transfer of moments of column), Shear in	
	flat plates and flat slabs, Design of flat plate and flat slab.	
	Design of Portal Frame and Special Foundations	08 hrs
тт	Design of Portal Frame using LSM.	
III	Special Foundations: Design of combined footing, Raft foundation,	
	Pile foundation including pile cap.	
	Design of Silos and Bunkers	07 hrs
IV	Lateral pressure as per Janssen's and Airy's theory, Design	
1.	consideration for square, rectangular and circular shapes, Design of	
	Hopper and Support structures.	
	Analysis and design of beams curved in plans	05 hrs
V	Beams curved in plans loaded perpendicular to their plane, Fixed and	
	continuous curved beams, Design of beams curved in plan.	
	Design of miscellaneous structures	08 hrs
	Folded plate roofs, Arched Slab System.	
VI	Deep beams - Steps of Designing Deep Beams, Design by IS 456,	
	Checking for Local Failures, Detailing of Deep Beams, Analysis of	
	Forces in a Corbels, Design of Procedure of Corbels, Design of Nibs.	

# **Contribution to Outcome**

On successful completion of the course, the candidate will be able to:

- 1. Design philosophy of two-way slab using ultimate load method.
- 2. Understand the concept of the design of flat slab, flat plate slab.

- 3. Design the portal frame and special types of foundations such as raft foundations and pile foundations including pile cap.
- 4. Understand the design concept for bunkers and silos.
- 5. Analyze of the beams curved in plan and extend its application for the design of such beams.
- 6. Understand the concept for the design of structures like folded plate roofs, arched slab system, deep beams corbels, nibs etc.

# Internal Assessment:

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall beasked to appear for the either tests. However, at least one test is mandatory and the learner/s may be askedto undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **Theory Examination:**

- 5. Question paper will comprise of six questions; each carrying 20 marks.
- 6. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 7. The students will have to attempt any **four** questions out of **total six** questions.
- 8. The questions can be of mixed nature irrespective of modules

#### **Recommended Books:**

- V. Ramakrishnan and P.D. Arthur: 'Ultimate Strength design for structural concrete', Wheeler Publishing Co.
- S.R. Karve and V.L. Shah: 'Design of reinforced cement concrete structures using Limit State Approach', Structures Publishers.
- 3. 3. O.P. Jain and Jaikrishna: 'Plain and reinforced concrete (Vol-II)'; Nemchand and Bros., Roorkee.
- 4. S. Ramamrutham :'Design of reinforced Concrete Structures', Dhanpat Rai Publishing Co., New Delhi
- 5. P. C. Varghese: 'Design of Reinforced concrete Foundations', PHI Learning Pvt. Ltd., New Delhi
- 6. P. C. Varghese: 'Advanced Reinforced Concrete Design', PHI Learning Pvt. Ltd., New Delhi
- 7. Ramachandra: 'Design of Concrete Structures (Vol. I and II), Standard Book House.New Delhi
- 8. N.C. Sinha and S.K. Roy: 'Fundamentals of Reinforced Concrete'; S. Chand Publications, New Delhi
- 9. B.C. Punimia, Ahok Kumar Jain and Arun Kumar Jain: Reinforced Cement Concrete Designs'; Laxmi Publishers, New Delhi
- 10. N. Subramanian: 'Design of Reinforced Concrete Structures'; Oxford University Press
- K. Krishna Raju: 'Advanced Reinforced Concrete Design'; CBS Publishers and Distributers, New Delhi 12.
   S.S. Bhavikatti: 'Advanced RCC Design (Vol. II)'; New Age Publishers, New Delhi.

#### Semester I

Course Code	Course Name	Credits
STRPE1023	Ground Improvement Techniques	03

#### **Teaching Scheme**

Contact Hours				Credits A	Assigned	
Theory	Practical	Tutorial	Theory Practical Tutorial			Total
03	-	-	03			03

# **Evaluation Scheme**

Theory				Term Work/Practical/Oral				
Inter Test-	rnal Asses	ssment	End Sem	Duration of End Sem	TW	PR	OR	Total
I	I	Average	Exam	Exam				
20	20	20	80	3	-	-	-	100

#### Rationale

With the tremendous infrastructural development taking place all over the world it becomes necessary for the learners to be exposed to various problems associated with soil deposits and methods to evaluate them. The learners should be aware of the methods to improve the characteristics of difficult soils.

#### **Course Objectives**

- 1. Understanding the engineering behaviour of various natural and manmade soil deposits
- **2.** Explains the concept of various ground improvement techniques and the types of compactions and its effect on soil properties
- 3. Explains the types of drains and various stabilization techniques
- 4. Informs about the types of reinforcement and design principles, grouting techniques
- 5. Introduction of various type of geotextiles and their functions

# **Detailed Syllabus**

Module	e Course Module / Contents						
1	Introdu 1.1 1.2 1.3	Inction to Ground improvement techniquesRock cycle, classification of rocks and rock forming minerals.Weathering process and formation of soil. Engineering properties of the soft, weak and manmade deposits, Role of ground improvement in foundation engineeringMethods of dewatering and pressure relief-deep well drainage vacuum dewatering systemsDrainage and Dewatering - drainage by electroosmosis – analysis and design of dewatering systems — installation and operation of dewatering systems well point system shallow &	11				
	In-situ	deep well system, vacuum dewatering, electro osmosis densification methods in granular soils	_				
	2.1	Introduction-mechanical stabilization-deep dynamic compaction-vibro compaction- blasting. In-situ densification methods in cohesive soils	-				
2	2.2	Preloading- Concept of three-dimensional consolidation –sand drain design and methods of their installation – fabric drains- stone columns & lime piles (installation techniques only) Cement and lime stabilization	10				
	2.3	Cement stabilization-types of soil cement-factors affecting soil cement mixing, Lime stabilization effect of lime on soil properties					
	Introdu	iction to grouts and grouting					
	3.1	Basic functions –permeation grouting, compaction grouting, hydro fracturingGrout ability Ratio - Classification of grouts	-				
3	3.2	Suspension grouts –cement grouts –admixtures used & their role – bentonites grouts –cement and bentonite grouts – lime grouts – asphaltic emulsion grouts – Solution grouts – aqueous solution - non-aqueous solutions – colloidal solutions – advantages and disadvantages of solution grouts over suspension grouts.	9				
	3.3	Properties of grouts: viscosity, fluidity, stability, rigidity, thixotropy, Applications of grouting					
	Earth F	Reinforcement					
4	4.1	Concept of reinforced earth –load transfer mechanism and strength development					
	4.2	Stability analysis of reinforced earth retaining walls-external stability analysis, internal stability analysis (brief mention about the methods only) - application areas.	9				
	4.3	Geosynthetics: Classification- Functions of geotextiles as separators, reinforcement, filters and in drainage-damage and durability of geotextiles.					

# **Contribution to Outcomes**

On completion of this course, the learner will be able to:

- 1. Remember various ground improvement techniques
- 2. Identify the problems associated with the existing ground condition
- 3. Select different stabilization process of soil using lime, fly ash etc
- 4. Remember principles and methods of grouting techniques
- 5. Understand various types of geosynthetics and its applications

**Internal Assessment** 

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for either the tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **Theory Examination:**

# **End Semester Examination**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total **six** questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

#### **Recommended Books:**

- 1 Shashi K. Gulhati & Manoj Datta –Geotechnical Engineering, Tata McGraw Hill
- 2 G. L. Sivakumar, G. L. Babu, Soil Reinforcement and Geosythetics, University Press
- 3 Shroff AV and Shah. D.L –Grouting technology in tunneling and Dam construction, Oxford and IBH
- 4 Purushothama Raj P Ground Improvement techniques, Laxmi Publications(P) Ltd., New Delhi

Reference Books:

- 1 Robert M. Koerner "Designing with Geosynthetics", Prentice Hall Mc Graw Hill
- 2 C.J.F.P Jones Earth Reinforcement and soil structures, Buuterworths
- 3 Robert M. Koerner Construction and Geotechnical Methods in Foundation Engineering, Mc Graw Hill

#### 20 Marks

# 80 Marks

Seme	ester I

Course Code	Course Name	Credits
	<b>Advanced Structural Mechanics</b>	03
STRPE1024	Program Elective-II	

Contact Hours				Credits A	ssigned	
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03			03			03

Theory					Work/P			
Inter	Internal Assessment		End	Duration of				Total
Test	Test-	Aver	Sem	End Sem	TW	PR	OR	
-I	II	age	Exam	Exam				
20	20	20	80	03	-	-	-	100

#### Rationale

The preparation for this course should cover the subjects of statics and dynamics of particles and rigid bodies, mechanics of deformable solids, structural analysis, mechanical vibrations and elementary structural dynamics, as they normally taught to UG courses in Civil or Mechanical engineering.

# Objectives

This course is concerned with the development of analytical methods for solving problems in mechanics of materials that are generally considered beyond the scope of basic course in the discipline. As such, the developments tend to evolve from fundamentals principles such as equilibrium and conservation of energy.

## **Detailed Syllabus**

Module	Course Modules / Contents	Contact Hours
1	Unsymmetrical bending, flexural stresses due to bending in two planes, shear center, bending of unsymmetrical section.	6
2	Bending of beams with large initial curvature. Application of analysis of hooks, bends and curved links, etc	7
3	Beams curved in plans loaded perpendicular to there plane, Fixed and continuous curved beams	6
4	Theories of failure, Max stress theory, max shear stress theory, max strain theory, Von Mises & Trescas failure theories.	6
5	Beams on Elastic foundation, Beams of unlimited length, Semi- infinite lengths and finite lengths on elastic foundation.	6
6	Analysis of deep beams, determination of stresses and deflection	6

# **Contribution to Outcome**

On successful completion of the course, the learner will be able to:

- 1. Apply stiffness method of analysis for beams, frames and grids structural elements.
- 2. Apply structural mechanics principles to unsymmetrical and open-thin walled cross sections
- 3. Apply structural mechanics principals to beams curved in plan and beams curved in elevation and for deep beams
- 4. Apply structural mechanics principles to beams resting on elastic foundations.
- 5. Use different theories of failure for structural analysis and design.

#### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall beasked to appear for the either tests. However, at least one test is mandatory and the learner/s may be askedto undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

**Theory Examination:** Question paper will comprise of **six** questions; each carrying 20 marks. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/

sub-topics. The students will have to attempt any **four** questions out of **total six** questions. The questions can be of **mixed nature** irrespective of modules

# **Recommended Books:**

- 1. Wang, "Applied Elasticity", McGraw Hill book Co.
- 2. Timoshenko, "Theory of Elasticity", McGraw Hill book Co.
- 3. J. Chakrabarti, "Theory of Plasticity", McGraw Hill book Co.
- 4. Timoshenko S., "Strength of Materials Vol I & II", CBS Publishers
- 5. Shames I. H., "Mechanics of Deformable Solids", Prentice Hall India
- 6. Boresi A. P., "Advanced Mechanics of Material", John Wiley & Sons.
- 7. Srinath L. S., "Advanced Mechanics of Solids", Tata McGraw Hill

Product Life cycle Management	

Teaching Scheme							
C	Credits Assigned						
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total	
03			03			03	

## **Evaluation Scheme**

Theory					Term work / Practical / Oral			T-4-1
Intern Test 1	al Asses Test 2	sment Average	End Sem Exam	Duration of End Sem Exam	TW	PR	OR	l otal Marks
20	20	20	80	03 Hrs.	-			100

# **Course Objectives:**

- To familiarize the students with the need, benefits and components of PLM
- To acquaint students with Product Data Management & PLM strategies
- To give insights into new product development program and guidelines for designing and developing a product
- To familiarize the students with Virtual Product Development

	Detailed Syllabus	
Module	Course Module / Contents	Hrs
I	Introduction to Product Lifecycle Management (PLM): Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
II	<b>Product Design:</b> Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
III	Product Data Management (PDM):	05
	Product and Product Data, PDM systems and importance, Components of	

	PDM, Reason for implementing a PDM system, financial justification of			
	PDM, barriers to PDM implementation			
	Virtual Product Development Tools:			
TX7	For components, machines, and manufacturing plants, 3D CAD systems and			
1 V	realistic rendering techniques, Digital mock-up, Model building, Model	05		
	analysis, Modeling and simulations in Product Design, Examples/Case studies			
	Integration of Environmental Aspects in Product Design:			
	Sustainable Development, Design for Environment, Need for Life Cycle			
V	Environmental Strategies, Useful Life Extension Strategies, End-of-Life	05		
	Strategies, Introduction of Environmental Strategies into the Design Process,			
	Life Cycle Environmental Strategies and Considerations for Product Design			
	Life Cycle Assessment and Life Cycle Cost Analysis:			
	Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO			
VI	Standards, Fields of Application and Limitations of Life Cycle Assessment,			
	Cost Analysis and the Life Cycle Approach, General Framework for LCCA,			
	Evolution of Models for Product Life Cycle Cost Analysis			

# **Contribution to Outcomes:**

On successful completion of the course, students should be able

- Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
- Illustrate various approaches and techniques for designing and developing products.
- Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
- Acquire knowledge in applying virtual product development tools for components, machiningand manufacturing plant

## **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, so lely at the discretion of the course instructor.

# **End Semester Examination:**

- Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
- Question paper will comprise of total **six** questions, each carrying 20 marks.
- Question 1 will be compulsory and should cover maximum contents of the curriculum.
- Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- Only Four questions need to be solved. <u>References:</u>
  - 1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product

Realisation", Springer-Verlag, 2004. ISBN: 1852338105

- 2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
- 3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
- 4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

	Semester 1							
Course Code			Course Name		(	Credits		
STRILE	E1012	Institu	Institute Level Elective -I					
	Reliability Engineering							
		Tea	<u>ching Scheme</u>					
	Contac	t Hours		Credits Assig	gned			
Theory	Practical	Tutorial	Theory	Practical	Tutor ial	Total		
03			03			03		

Evaluation Scheme								
Theory				Term work / Practical / Oral				
Internal Assessment			End	Duration of				10tai Morke
Test 1	Test 2	Averag	Sem	End Sem	TW	PR	OR	
I est I	1051 2	e	Exam	Exam				
20	20	20	80	03 Hrs.				100

# Objectives

- To familiarize the students with various aspects of probability theory
- To acquaint the students with reliability and its concepts
- To introduce the students to methods of estimating the system reliability of simple and complexsystems
- To understand the various aspects of Maintainability, Availability and FMEA procedure

Detailed Syllabus					
Module	Course Module / Contents	Hrs			
I	<ul> <li>Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.</li> <li>Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.</li> <li>Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard</li> </ul>	08			
	Deviation, Variance, Skewness and Kurtosis.				
П	<ul> <li>Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.</li> <li>Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.</li> <li>Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.</li> </ul>	08			
III	<b>System Reliability:</b> System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05			
IV	<b>Reliability Improvement:</b> Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08			
v	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects	05			

	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis,	
VI	severity/criticality analysis, FMECA examples. Fault tree construction, basic	05
	symbols, development of functional reliability block diagram, Fault tree analysis	
	and Event tree Analysis	

#### **Contribution to Outcomes**

Students will be able to...

- Understand and apply the concept of Probability to engineering problems
- Apply various reliability concepts to calculate different reliability parameters
- Estimate the system reliability of simple and complex systems
- Carry out a Failure Mode Effect and Criticality Analysis

#### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall beasked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of six questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of mixed nature irrespective of modules

#### **References:**

- 1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
- 2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
- 3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
- 4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
- 5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
- 6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Semester I					
Course CodeCourse NameCr					
STRILE1013 Institute Level Elective- I					
	Managemen	t Information System			
Teaching Scheme					
			_		

	Credits Assigned					
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03			03			03

Theory					Term work / Practical / Oral			Total	
Inte Tes t 1	ernal Ass Test 2	Sessment Average	End Sem Exam	Duration of End Sem Exam	TW	PR	OR	l otal Marks	
20	20	20	80	03 Hrs.				100	

# **Objectives:**

- The course is blend of Management and Technical field.
- Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
- Define and analyze typical functional information systems and identify how they meet he needs of the firm to deliver efficiency and competitive advantage
- Identify the basic steps in systems development

	Detailed Syllabus				
Module	Course Module / Contents	Hrs			
	Introduction To Information Systems (IS): Computer Based				
Ι	InformationSystems, Impact of IT on organizations, Imporance of IS to	4			
	Society.				
	Organizational Strategy, Competitive Advantages and IS.				
	Data and Knowledge Management: Database Approach, Big Data,				
т	Datawarehouse and Data Marts, Knowledge Management.	7			
11	Business intelligence (BI): Managers and Decision Making, BI for Data	1			
	analysis and Presenting Results				
тт	Ethical issues and Privacy: Information Security. Threat to IS, and Security				
111	Controls	/			
	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping,				
IV	Marketing, Operational and Analytic CRM, E-business and E-commerce -	7			
	B2B B2C. Mobile commerce.				
V	Computer Networks Wired and Wireless technology, Pervasive computing,	6			
v	Cloud computing model.	U			
	Information System within Organization: Transaction Processing Systems,				
	Functional Area Information System, ERP and ERP support of Business				
VI	Process.				
	Acquiring Information Systems and Applications: Various System				
	development life cycle models.				

#### **Contribution to Outcomes**

Students will be able to:

- Explain how information systems Transform Business
- Identify the impact information systems have on an organization
- Describe IT infrastructure and its components and its current trends
- Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
- Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

#### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

#### **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of six questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of **mixed nature** irrespective of modules

#### **References:**

- 1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
- 2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10<sup>th</sup> Ed., Prentice Hall, 2007.
- 3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Semester I						
Course Code	Course Name	Credits				
STRILE1014	Institute Level Elective- I	03				
	Design of Experiments					

# **Teaching Scheme**

	Contact			Credits A	ssigned		
	Hours				_		
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total	
03			03			03	
Evaluation Scheme							

Theory					Tern			
Inter	rnal Asse	ssment	End Duration of					I otal Masilar
Test 1	Test 2	Average	Sem	End Sem	TW	PR	OR	Marks
I Cot I	1050 2	ni ver uge	Exam	Exam				
20	20	20	80	03 Hrs.				100

# **Objectives:**

- To understand the issues and principles of Design of Experiments (DOE)
- To list the guidelines for designing experiments
- To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Detailed Syllabus					
Module	Course Module / Contents	Hrs			
I	<b>Introduction</b> Strategy of Experimentation, Typical Applications of Experimental Design Guidelines for Designing Experiments, Response Surface Methodology	06			
Ш	<b>Fitting Regression Models</b> Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression, Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit	08			
ш	<b>Two-Level Factorial Designs</b> The 22 Design, The 23 Design, The General2k Design, A Single Replicate of the 2k Design, The Addition of Center Points to the 2k Design, Blocking in the 2 <sup>k</sup> Factorial Design, Split-Plot Designs	07			
IV	<b>Two-Level Fractional Factorial Designs</b> The One-Half Fraction of the 2 <sup>k</sup> Design, The One-Quarter Fraction of the 2 <sup>k</sup> Design, The General 2 <sup>k-p</sup> Fractional Factorial Design, Resolution III Designs Resolution IV and V Designs, Fractional Factorial Split-Plot Designs	07			
v	<b>Response Surface Methods and Designs</b> Introduction to Response Surface Methodology, The Method of Steepest Ascent, Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces	07			
VI	Taguchi ApproachCrossed Array Designs and Signal-to-Noise Ratios, Analysis Methods,Robust design examples	04			

## **Contribution to Outcomes**

Students will be able to

- Plan data collection, to turn data into information and to make decisions that lead to appropriateaction
- Apply the methods taught to real life situations
- Plan, analyze, and interpret the results of experiments

#### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test be solely at the discretion of the course instructor.

# **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of **six** questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the

questions on all the topics/ sub-topics.

- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of **mixed nature** irrespective of modules

#### **References:**

- Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3<sup>rd</sup>edition, John Wiley & Sons, New York, 2001
- 2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
- 3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2<sup>nd</sup> Ed. Wiley
- 4. W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
- 5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss

Semester I					
Course Code	Course Name	Credits			
STRILE1015	Institute Level Elective- I	03			
	Operation Research				

Teaching Scheme							
	Credits Assigned						
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total	
03			03			03	
Evaluation Scheme							

Theory						Term work / Practical /			
č				Oral			Total		
Inter	nal Asses	sment	End Som	<b>Duration</b> of				Total Morka	
Teat 1	Test?	Avorago	Ella Selli Evom	End Sem	TW	PR	OR	warks	
1 est 1	Test2 Average	Exam	Exam						
20	20	20	80	03 Hrs.			-	100	

# **Objectives:**

• Formulate a real-world problem as a mathematical programming model.

• Understand the mathematical tools that are needed to solve optimization problems.

• Use mathematical software to solve the proposed models.

	Detailed Syllabus	
Module	Course Module / Contents	Hrs
Ι	Introduction to Operations Research: Introduction, , Structure of the Mathematical Model, Limitations of Operations ResearchLinear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity AnalysisTransportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14

II	<b>Queuing models</b> : queuing systems and structures, single server and multi- server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
III	<b>Simulation</b> : Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
IV	<b>Dynamic programming</b> . Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
V	<b>Game Theory</b> . Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
VI	<b>Inventory Models</b> : Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

# **Contribution to Outcomes:**

Students will be able to

- Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
- Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
- Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
- Understand the applications of integer programming and a queuing model and computeimportant performance measures

#### Internal Assessment:

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

## **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **six** questions; each carrying 20 marks.

2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

3. The students will have to attempt any **four** questions out of **total six** questions.

4. The questions can be of **mixed nature** irrespective of modules

#### **References:**

- 1. Taha, H.A. "Operations Research An Introduction", Prentice Hall, (7th Edition), 2002.
- 2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
- 3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
- 4. Operations Research, S. D. Sharma, Kedar Nath Ram Nath-Meerut.
- 5. Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Semester I			
Course Code	Course Name	Credits	
STRILE1016	Institute Level Elective-I	03	
	Cyber Security and Laws		

# **Teaching Scheme**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	TheoryPracticalTutorial		
03			03			03

#### **Evaluation Scheme**

Theory				Term work / Practical / Oral			Tatal	
Intern	al Assess	ment	End	<b>Duration of</b>				1 otai Morka
Test 1	Test 2	Average	Sem Exam	End Sem Exam	TW	PR	OR	Marks
20	20	20	80	03 Hrs.				100

# **Objectives:**

- To understand and identify different types cybercrime and cyber law
- To recognized Indian IT Act 2008 and its latest amendments
- To learn various types of security standards compliances

Detailed Syllabus				
Module	Course Module / Contents	Hrs		
	Introduction to Cybercrime: Cybercrime definition and origins of the			
I	world, Cybercrime and information security, Classifications of cybercrime,	1		
L	Cybercrime and the	-		
	Indian ITA 2000, A global Perspective on cybercrimes.			
	Cyber offenses & Cybercrime: How criminal plan the attacks, Social Engg,			
	Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud			
	computing, Proliferation of Mobile and Wireless Devices, Trends in			
	Mobility, Credit Card Frauds in			
п	Mobile and Wireless Computing Era, Security Challenges Posed by Mobile	0		
	Devices, Registry Settings for Mobile Devices, Authentication Service	,		
	Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security			
	Implications for Organizations, Organizational Measures forHandling			
	Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies			
	and Measures in Mobile Computing Era, Laptops			
	Tools and Methods Used in Cyber line			
	Phishing, Password Cracking, Keyloggers and Spywares, Virus and			
III	Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer	6		
	Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID			
	Theft)			

IV	The Concept of Cyberspace E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking, The Need for an Indian Cyber Law	8
V	<b>Indian IT Act.</b> Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
VI	<b>Information Security Standard compliances</b> SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

# **Contribution to Outcomes**

Students will be able to:

- Understand the concept of cybercrime and its effect on outside world
- Interpret and apply IT law in various legal issues
- Distinguish different aspects of cyber law
- Apply Information Security Standards compliance during software design and development

# **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **six** questions; each carrying 20 marks.

2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

3. The students will have to attempt any **four** questions out of **total six** questions.

The questions can be of **mixed nature** irrespective of modules

# **References:**

- 1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
- 2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
- 3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
- 4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
- 5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
- 6. Kennetch J. Knapp, Cyber Security & Global Information Assurance Information Science Publishing.
- 7. William Stallings, Cryptography and Network Security, Pearson Publication
- 8. Websites for more information is available on : The Information Technology ACT, 2008-TIFR : https://www.tifrh.res.in

9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primerprofessionals-33538

Semester I					
Course Code	Course Name	Credits			
	Institute Level Elective-I				
STRILE1017	Disaster Management and	03			
	Mitigation Measures				
	Teaching Scheme				

Contact Hours				Credits	Assigned	
Theory	Practical	Tutorial	Theor y	Practical Tutorial		Total
03			03			03

# **Evaluation Scheme**

Theory				Term work / Practical / Oral			T-4-1	
Interr	nal Asses	sment	End	EndDuration ofemEnd SemxamExam			1 otai Morka	
Test 1	Test 2	Average	Sem Exam		TW	PR	OR	Marks
20	20	20	80	03 Hrs.				100

# Objectives

- To understand physics and various types of disaster occurring around the world
- To identify extent and damaging capacity of a disaster
- To study and understand the means of losses and methods to overcome /minimize it.
- To understand role of individual and various organization during and after disaster
- To understand application of GIS in the field of disaster management
- To understand the emergency government response structures before, during and after disaster

	Detailed Syllabus	
Module	Course Module / Contents	Hrs
I	<ul> <li>Introduction</li> <li>1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.</li> </ul>	03
II	Natural Disaster and Manmade disasters: Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, StormSurge, climate change, global warming, sea level rise, ozone depletion Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
ш	<ul> <li>Disaster Management, Policy and Administration</li> <li>Disaster management: meaning, concept, importance, objective of</li> <li>disaster management policy, disaster risks in India, Paradigm shift in</li> <li>disaster management.</li> <li>Policy and administration:</li> </ul>	06

1		
	Importance and principles of disaster management policies, command	
	and co-ordination of in disaster management, rescue operations-how	
	to start with and how to proceed in due course of time, study of	
	flowchart showing the entire process.	
	Institutional Framework for Disaster Management in India:	
	Importance of public awareness, Preparation and execution of	
	emergency management programme. Scope and responsibilities of National	
	Institute of Disaster Management (NIDM) and National disaster	
187	management authority (NDMA) in India.Methods and measures to avoid	06
IV	disasters, Management of casualties, set up of emergency facilities,	UO
	importance of effective communication amongstdifferent agencies in such	
	situations.	
	Use of Internet and softwares for effective disaster management.	
	Applications of GIS, Remote sensing and GPS in this regard.	
	Financing Relief Measures:	
	Ways to raise finance for relief expenditure, role of government	
	agencies and NGO's in this process, Legal aspects related to finance	
V	raising as well as overall management of disasters. Various NGO's and the	09
	works they have carried out in the past on the occurrence of various	
	disasters, Ways to approach these teams.	
	International relief aid agencies and their role in extreme events.	
	Preventive and Mitigation Measures:	
	Pre-disaster, during disaster and post-disaster measures in some events	
	in general. Structural mapping: Risk mapping, assessment and analysis, sea	
	walls and embankments, Bio shield, shelters, early warning and	
	communication	
VI	Non Structural Mitigation: Community based disaster preparedness, risk	06
	transfer and risk financing, capacity development and training, awareness	
	and education, contingency plans.	
	Do's and don'ts in case of disasters and effective implementation of	
	relief aids.	

#### **Outcomes:**

Students will be able to...

- Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
- Plan of national importance structures based upon the previous history.
- Get acquainted with government policies, acts and various organizational structure associated with an emergency.
- Get to know the simple do's and don'ts in such extreme events and act accordingly.

#### Internal Assessment:

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of **six** questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of **mixed nature** irrespective of modules

# **References:**

- 1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
- 2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
- 3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
- 4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
- 5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
- 6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation R B Singh, Rawat Publications
- 7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

	Semester I	
Course Code	Course Name	Credits
	Institute Level Elective-I	03
STRILE1018	Energy Audit and	
	Management	

#### **Teaching Scheme**

	Credits Assigned					
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03			03			03

## **Evaluation Scheme**

Theory				Term wor (	Tatal			
Interna Test 1	al Assess Test 2	sment Avg	End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Marks
20	20	20	80	03 Hrs.				100

# **Objectives:**

- To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
- To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
- To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Detailed Syllabus						
Module	Course Module / Contents	Hrs				
I	<b>Energy Scenario:</b> Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04				
П	Energy Audit Principles: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08				
III	<b>Energy Management and Energy Conservation in Electrical System:</b> Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and	10				

	appliances, star ratings.			
	Energy efficiency measures in lighting system, Lighting control:			
	Occupancy sensors, daylight integration, and use of intelligent controllers.			
	Energy conservation opportunities in: water pumps, industrial drives,			
	Induction motors, motor retrofitting, soft starters, variable speed drives.			
	Energy Management and Energy Conservation in Thermal Systems:			
	Review of different thermal loads; Energy conservation opportunities			
	in:Steam distribution system, Assessment of steam distribution losses,			
	Steamleakages, Steam trapping, Condensate and flash steam recovery			
IV	system.			
	General fuel economy measures in Boilers and furnaces. Waste heat			
	recovery use of insulation types and application HVAC system:			
	Contraction of the system.			
	Coefficient of performance, Capacity, factors affecting Refrigeration and			
	Air Conditioning system performance and savings opportunities.			
	Energy Performance Assessment:			
*7	On site Performance evaluation techniques, Case studies based on: Motors	0.4		
V	and variable speed drive, pumps, HVAC system calculations;	04		
	LightingSystem: Installed Load Efficacy Ratio (ILER) method, Financial			
	Analysis.			
	Energy conservation in Buildings:			
VI	Energy Conservation Building Codes (ECBC): Green Building LEED	03		
	rating Application of Non-Conventional and Renewable Energy Sources			
1	ranng, Application of Non-Conventional and Kenewable Energy Sources	i		

#### **Contribution to Outcomes:**

Students will be able to:

- To identify and describe present state of energy security and its importance.
- To identify and describe the basic principles and methodologies adopted in energy audit of anutility.
- To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
- To describe the energy performance evaluation of some common thermal installations and dentify the energy saving opportunities
- To analyze the data collected during performance evaluation and recommend energy saving measures

#### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

# **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of **six** questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of **mixed nature** irrespective of modules

## **References:**

- 1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
- 2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
- 3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
- 4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
- 5. Energy Management Principles, C.B.Smith, Pergamon Press
- 6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
- 7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
- 8. www.energymanagertraining.com www.bee-india.nic.in

	Semester I	
Course Code	Course Name	Credits
STRL101	Program Lab-I	01

Teaching Scheme							
	Credits Assigned						
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total	
-	2 -		-	1	-	01	

Evaluation Scheme								
Theory					Term Wor			
Int Test 1	Internal AssessmentEndTest 1Test 2AverageExampleExample		End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total
-	-	-	-	-	25	-	25	50

# **Objectives:**

- To impart knowledge of smart materials. Perform statistical quality analysis
- To illustrate principles of structural health monitoring.
- To provide quantitative means to assess the structural integrity loss a system undergoes after natural disasters and other hazardous events.
- To understand the physics of the problem
- To be familiar with hands on practice.

Detailed Syllabus					
Module	Course Module / Contents	Hrs			
	Reinforcement Detailing: Minimum two site visits to ongoing Major	10			
Ι	construction sites (High rise building/ Bridge/ Offshore structure etc.) to study				
	the reinforcement detailing and use of special/ advanced construction				
	techniques /equipment associated with ongoing major construction works.				
	Visit Report to be submitted in written form				
	Structural audit: Students will be asked to work upon minimum two of the	10			
II	following topics during the semester. They will submit the report of each topic				
	containing the information (as per need of topic) like: introduction, general				
	information, usage/application (if any) detailed description of work/process,				
	relevant diagrams, drawings & tabulation (if any), observation and results (as				
	applicable) or any other relevant information as per topic.				
	• Visit the existing old bridge and prepare a detailed condition assessment				
	report.				
	• Visit the existing old RC building and prepare a detailed condition				
	assessment report. Identify structural deficiencies and suggest suitable				
	retrofitting strategies.				
	• Laboratory testing of various retrofitted elements like column, beam, slab				
	and joints under the action of flexure, shear and axial loading.				
VI	ONE assignment on each subject.	-			

# **Contribution to Outcomes**

Students will be able to:

- Observe very keenly various activities/processes going on at various construction sites and hence comment on how consistently they are performed and hence suggest improvement measures
- Write effective project reports highlighting the pros & cons of the technologies envisaged for the project.
- Perform on-field tests to check the quality of materials/ technology used and hence draw inferences from the results thus obtained
- Demonstrate effective interpersonal soft skills w.r.t putting forwards one's viewpoint, group discussion, etc.

	Semester I	
<b>Course Code</b>	Course Name	Credits
STRSBL101	Skill Based Lab-I	02

Teaching Scheme							
	Credits Assigned						
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total	
-	4	-	-	2	-	02	

	Evaluation Scheme								
Theory					Term V				
Int	ternal As	sessment	End Sem	Duration of End	TW	PR	OR	Total	
Test 1	Test 2	Average	Exam	Sem Exam					
-	-	-	-	-	50	-	50	100	

# Objectives

- Use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively
- To make students aware about the difference between listening and hearing
- To enhance speaking and technical writing skills.
- To prepare students to face interviews, group discussions.
- Produce effective dialogue for business related situations

Detailed Syllabus						
Module	Course Module / Contents	Hrs				
Ι	Listening Skills: Barriers to listening, Kinds of Listening & Note making.	03				
II	<b>Speaking Skills:</b> Voice Modulation, Good Pronunciation, Speaking without fear, Extempore & Prepared speaking, Body Language, Telephone Etiquette/ Mobile /Video conferences.	04				
III	Reading Skills: SQ3R Reading Technique, Skimming and Scanning	04				
IV	<b>Defining the Features of Technical Writing</b> Principles and Strategies of Technical Report, Knowing Your Audience, Purpose and Length of Report. Writing clear sentences and paragraphs. Remove jargon, redundancy and wordiness	08				
V	<b>Presentation Skills:</b> Planning, preparing, Organizing, Delivery, Feedback. Punching Up the Presentation Kinds of graphics and their messages, Suitability for placement in a graphic representation, Group Practice and Interactive Session, Spotting common language problems (lengthy and confusing sentence structures, weak vocabulary, etc), Editing Content, Logic and Language, Guided writing practice with examples	10				

VI	Interview: Pre-Interview Preparation, Interview Question Answer, Resume			
	& Job Application, Group Discussion, Telephone Interviews.			

#### **Contribution to Outcomes**

#### Students will be able to:

- Differentiate between listening and hearing
- Analyze critically different concepts / principles of communication skills
- Develop speaking and technical writing skills
- Execute interviews, group discussions and presentation skill
- Demonstrate productive skills and have a knack for structured conversations
- Appreciate, analyze, evaluate business reports and research papers
- Summarize technical articles and write technical papers in reputed journals

#### **Reference Books**

- 1. Effective Technical Communication- M. Ashraf Rizvi (Tata McGraw Hill)
- 2. HBR Guide to Better Business Writing- Bryan A. Garner (Harvard Busines
- **3.** Shirley Taylor, "Model Business Letters, Emails and Other Business Documents" (seventh edition), Prentice Hall.
- **4.** Thomas Huckin, Leslie Olsen "Technical writing and Professional Communications for Nonnative speakers of English", McGraw Hill
- 5. Raman Sharma, "Technical Communication", Oxford University Press 2
- **6.** Raymond Murphy "Essential English Grammar" (Elementary & Intermediate) Cambridge University Press 3
- 7. Mark Hancock "English Pronunciation in Use" Cambridge University Press
- 8. NPTEL :: Humanities and Social Sciences NOC: Interpersonal Skills 2 Mod-10 Lec-
  - 01 Oral Presentation Lecture-01 YouTube

# **Semester II**

Semester- II						
Course Code	Course Name	Credits				
STRC201	Finite Element Analysis	03				

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03			03			03

Work/Practic	Term Work/Practical/Oral		
Internal AssessmentEndDuration ofTest-IIAvgSemEnd SemTWFromFromFrom	OR	Total	
20         20         20         80         03         -         -	-	100	

Finite Element analysis is a numerical technique for solving differential equations that describe many engineering problems. Main reason for its popularity is that the method results in computer codes which are versatile in nature that can solve many practical problems with minimum training. This course of finite element analysis covers the fundamental concept and is designed for students in civil engineering, researchers and design engineers in the structural engineering field. The course presents the FEM as a tool to find approximate solution of differential equations and thus can be used by students. Applications include analysis of structural frameworks, stress analysis etc.

#### **Course Objectives**

- 1. To understand the basics, advantages and significance of finite element analysis.
- 2. To study the various methods used in finite element formulation.
- 3. To compute stresses and strains in simple structural elements using finite element methods.
- 4. To understand geometric non-linearity, material non-linearity in two dimensional elements and general formulation of a physically non-linear problem.
- 5. To understand the consistence mass matrix and assembly of Mass Matricesformulation of Physically Non-linear Problems.
- 6. To understand the formulation and solution of Problems in Structural Mechanics.
| Module | Course Modules / Contents   |        |  |  |
|--------|---|--------|--|--|
|        |   | Hrs.   |  |  |
|        | Introduction  | 06 hrs |  |  |
|        | Review of Variation methods, Calculus of variation, Variational     |        |  |  |
|        | Principles of solid Mechanics. Principe of Minimum Potential        |        |  |  |
|        | Energy, Principal of Complementary Energy Hamilton Principal,       |        |  |  |
|        | The Basic component- Concept of an element- Various Element         |        |  |  |
| Ι      | Shapes- Displacement models- Formulation of Finite Element          |        |  |  |
|        | Method. Using principle of virtual Displacement- Derivation of      |        |  |  |
|        | Element Stiffness and loads for Pin Jointed Bar element, Beam       |        |  |  |
|        | element, Triangular Plate element (In-plane forces), Triangular and |        |  |  |
|        | Rectangular Plate Elementin Bending.                                |        |  |  |
|        | Variational formulation of finite element methods                   | 07 hrs |  |  |
|        | Variational Formulation of Finite Element Method (FEM),             |        |  |  |
| п      | Isoparametric element- Local vs. Natural Co-ordinates system,       |        |  |  |
| 11     | Line, Triangular, Quadrilateral and Tetrahedral Element-            |        |  |  |
|        | Interpolation Displacement Models Formulation of Isoparametric      |        |  |  |
|        | Finite element matrices in Local and Global Coordinate system.      |        |  |  |
|        | General steps involved in finite element analysis                   | 07 hrs |  |  |
|        | Implementation of FEM – Discretization of the Structure-            |        |  |  |
| Ш      | Calculation of Element Stiffness, Mass and Equivalent Nodal         |        |  |  |
|        | loads, Assemblage of Structures Matrices, Boundary Conditions-      |        |  |  |
|        | Solutions of the overall problem. Calculations of Element Stresses, |        |  |  |
|        | Computer Program Organization.                                      |        |  |  |
|        | Non Linear analysis using finite element methods                    | 07 hrs |  |  |
|        | Introduction to Non Linear Analysis- Geometric Non-Linearity-       |        |  |  |
|        | Geometric Stiffness of an Axial Element, Stability of Bar Spring    |        |  |  |
|        | System. General Formulation of a Geometrically Non- linear          |        |  |  |
| IV     | problem. Geometric Stiffness of a Beam-Column of Triangular         |        |  |  |
|        | element. Non-linear material behaviour. Non-linear spring-          |        |  |  |
|        | Elastic Plastic Analysis by FEM-Elasto-Plastic Analysis of          |        |  |  |
|        | Truss-Two Dimensional Element Formulations- General                 |        |  |  |
|        | Formulation of a Physically Non-linear Problem.                     |        |  |  |
| V      | Dynamic analysis  | 06 hrs |  |  |

	Introduction to Dynamic Analysis by FEM- Formulation of Inertial Properties- Lumped Mass vs. Consistent Mass matrices- Condensation and Assembly of Mass Matrices- Formulation of a							
	Physically Non-linear Problems.							
	Module Name- Application of finite element methods in	06 hrs						
VI	structural mechanics							
	Formulation and solution of Problems in Structural Mechanics							
	using the above methods.							

## **Contribution to Outcome**

On completion of this course, the students will be able to:

- 1. Understand the basics, advantages and significance of finite element analysis.
- 2. Study the various methods used in finite element formulation.
- 3. Compute stresses and strains in simple structural elements using finite element methods.
- 4. Understand geometric non-linearity, material non-linearity in two dimensional elements and general formulation of a physically non-linear problem.
- 5. Understand the consistence mass matrix and assembly of Mass Matrices-Formulation of Physically Non-linear Problems.
- 6. Understand the formulation and solution of Problems in Structural Mechanics.

## **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

## **Theory Examination:**

- 1. Question paper will comprise of **six** questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of **mixed nature** irrespective of modules

#### **Recommended Books:**

- 1. Zienkiewicz, O.C.: 'The Finite Element Method in Engineering Science', *McGraw Hill Book Co.*
- 2. J.N. Reddy: 'Finite Element Analysis', McGraw Hill Book Co.
- 3. Chandragupta, T.R. and Belagundu, A.D. :'Introduction to Finite Elements in Engineering', *Prentice Hall of India Pvt. Ltd.*
- 4. Rajshekaran, S.: 'Finite Element Analysis', Wheeler Publishing.
- 5. Krishnamoorthy, C. S.: 'Finite Element Analysis', McGraw Hill Book Co.
- 6. Cook, R.D., Malkus, D.S. and Plesha, M. E .: 'Concepts and Applications of Finite ElementAnalysis', *John Wiley and Sons (Asia) Pvt. Ltd.*
- 7. Bickford, W.B.: 'A First Course in Finite Element Method', IRWIN, Homewood, IL 60430
- 8. Rao, S.S.: 'The Finite Element Method in Engineering', *Pergamon Press*.
- 9. Weaver, W. and Johnston, P. R.: 'Finite Element for Structural Analysis', Prentice Hall.
- 10. M. Asghar Bhatti, "Fundamental Finite Element Analysis and Applications with Mathematical and MATLAB Computations", *Wiley India Pvt. Ltd.*
- 11. Chandrupatla and Belegundu, "Introduction to Finite Elements in Engineering" *PHI* /*Pearson Education*, 2003.
- 12. Logan. D.L. "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002.
- 13. S. S. Bhavikatti "Finite Element Analysis" New Age International Publication.
- 14. Y. M. Desai "Finite Element Method" Pearson

#### Semester II

Course Code	Course Name	Credits
STRC202	Theory of Plates and Shells	03

#### **Teaching Scheme**

Contact Hours				Credits A	Assigned	
Theory	Practical	Tutorial	Theory Practical Tutorial To			
03	-	-	03			03

## **Evaluation Scheme**

Theory				Term Work/Practical/Oral				
Internal Assessment Test- Test- I II Average		End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total	
20	20	20	80	03 Hours	-	-	-	100

#### Rationale

Plates and Shells have become important structural forms of modern infrastructures. Analysis of such structure requires mathematical Solutions. It is essential to understand structural behavior and analysis of plates and shells for their safe design.

#### **Course Objectives**

- 1 To understand theory of plates and shells
- 2 To understand pure bending of plates and also symmetrical bending of circular plates
- 3 To understand deflection of lateral loaded plates and Rectangular plates with edge condition
- 4 To understand the Mathematical representation of shell surface and member theory
- 5 To understand cylindrical bending of shells

## **Detailed Syllabus**

Module		Course Module / Contents	Contact hours		
	Indu	ction to Theory of Plates			
1	1.1	Introduction to theory of plates with small and large deflections:	3		
	1.2	Distinction between Plate and Shell action	-		
	Pure	Bending of plates			
2	2.1	Pure bending of Thin Plates, Curvature at point, Circle of curvature, Moment Curvature relationships ,Relationships Between Twisting moment and Twist of Surface.	4		
	Sym	netrical Bending of Circular Plates			
3	3.1	Symmetricalbendingofthincircularplateswithsmalldeflectionunderaxi- symmetrictransverse loads	6		
3	3.2	Differential equation of equilibrium for Symmetrical bending for Different support conditions, Plates with overhangs, Plates with co- axial circular opening	U		
	Defle	ction of lateral loaded plates & rectangular plates with various			
	edge	condition			
	4.1	Small deflection theory for lateral loaded thin rectangular plates, Various support conditions.			
4	4.2 Navier and Levis solution for uniformly distributed and concentrated loads. Use of numerical technique for the solution of plates.		10		
	4.3	Concept of Influence Surface, Study of simply supported plates with continuous edge moment.	-		
	Intro	duction to shell structures			
	5.1	Introduction to Structural behavior of thin shells ,membrane and bending actions	-		
5	5.2	Mathematical representation of a shell surface, Principal curvatures, Gauss curvature, Classification of shells.	10		
	5.3 Membrane theory of thins hells, Stress resultant, Application to cylindrical shells under symmetrical loads and surfaces of revolution under axi-symmetric loads				
	Cylin	ndrical Bending			
6	6.1	Bending theory of closed circular cylindrical shell, stiffness coefficients at free edges along radial and rotational directions.	6		
	6.2	Bending theory of spherical shells. Geckelers approximations, stiffness coefficients			

## **Contribution to Outcome**

On completion of this course, the candidate will be able to

- 1. Understand the importance of the concepts of theory of Plates and shells.
- 2. Understand the concept of pure bending of plates.
- 3. Understand the Concept of small deflections of laterally loaded plates

4. Understand the mathematical representation of shell surface, membrane theory and cylindrical bending of shells

## **Internal Assessment**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for either the tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

## **Theory Examination:**

## **End Semester Examination**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total **six** questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

## **Recommended Books:**

- 1 Timoshenko: 'Theory of PlatesandShells', McGrawHillBookCo
- <sup>2</sup> Chandrashekhara: 'AnalysisofThinConcreteShells', *McGrawHillBookCo*.
- <sup>3</sup> Ramaswamy G. S : 'DesignandConstructionofConcreteShellRoofs', *McGrawHillBookCo*.
- 4 VaradanT.K.and Bhaskar K 'Analysis of Plates Theory and Problems', *Narros Publishing* House
- 5 J. N. Reddy, "Theory and Analysis of Elastic Plates and Shells", CRC Press, 2006.

## **Reference Books:**

- 1 E. Ventsel and T. Krauthammer, "Thin Plates and Shells", Marcel Dekker, Inc., 2001.
- 2 A. Ugural, "Stresses in Plates and Shells", McGraw Hill, 1999.
- 3 P. L. Gould, "Analysis of Shells and Plates", Springer-Verlag, 1988
- 4 C. L.Dym., "Introduction to the Theory of Shells", Hempshire Publishing Corp., 1990
- 5 Glibson J. E., "Theory of Cylindrical Shells", North-Holland Publishing Co

## 20 Marks

## 80 Marks

#### Semester II

Course Code	Course Name	Credits
STRPE2031	Earthquake Engineering	03

#### **Teaching Scheme**

Contact Hours			Credits assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03			03			03

#### **Evaluation Scheme**

	Theory					TermWork/Practical/Oral			
Internal Assessment E			End Duration of					Tota	
Test 1	Test 2	Averag e	Sem Exam	m End m Sem Exam	TW	PR	OR		
20	20	20	80	03	-			100	

#### **Course Objectives**

- 1. To expose students to fundamentals of earthquake engineering.
- 2. To learn method of deterministic seismic hazard analysis.
- 3. To illustrate the earthquake characteristics and associated effects on structures.
- 4. To communicate the concepts of dynamic analysis for civil engineering applications.
- 5. To study the various methods for strength, stress and load-resistant design.
- 6. To impart the basic principles for seismic design and construction of structures in accordance with the provisions of Indian Standard Codes.

## **Detailed Syllabus**

Module	Content	Hours
I.	Origin of earthquakes, Engineering geology, Seismicity of the world, Faults, Propagation of earthquake waves. Characteristics of Earthquakes: Earthquake terminology, Indian Earthquakes	6
Π	Quantification of earthquake (magnitude, energy, intensity of earthquake), Measurements of earthquake (accelerograph, accelogram recording), Determination of magnitude, Epicenter distance, focal depth, etc	8
III.	Ground motion and their characteristics, Factors affecting ground motions. Concept of response spectra, generation of site-specific spectrum, Estimation of PGA, Earthquake design spectrum and inelastic spectra.	6
IV.	Concept of earthquake Resistant design, design philosophy, Four virtues of EQRD: Stiffness, Strength, ductility and Configurations,	7
<b>V.</b>	Introduction to Capacity design concepts and performance based design concepts	6
VI.	Introduction to IS: 1893, Seismic Coefficient, Response Spectrum Method and Time History Method	6
	TOTAL	39

## **Contribution to Outcome**

On successful completion of the course students will be able to

- 1. Understand the fundamentals of earthquake engineering and seismicity conditions of the country and world.
- 2. Perform site specific deterministic seismic hazard analysis.
- 3. Analyze earthquake characteristics and associated effects on structures, including linear responses.
- 4. Understand the concepts of dynamic equations of motion and perform analysis for dynamic systems in civil engineering applications.
- 5. Evaluate the magnitude and distribution of seismic loads for strength, stress and load-resistant design.
- 6. Apply the basic principles for seismic design and construction of structures in accordance with the provisions of Indian Standard Codes.

#### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either test. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

## **Theory Examination:**

1. Question paper will comprise of six questions; each carrying 20 marks.

2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

3. The students will have to attempt any **four** questions out of **total six** questions.

4. The questions can be of **mixed nature** irrespective of modules

## **Recommended Books:**

## **Recommended Books:**

- *1.* R. W. Clough and Joseph Penziene: 'Dynamics of Structures', *Mc Graw Hill Publication.*
- 2. A. K. Chopra: 'Dynamics of Structures- Theory and Application to Earthquake Engineering',

Prentice Hall Publication.

- 3. David Key: 'Earthquake Design Practice for Buildings'; Thomas Telford Publishers.
- 4. James M. Kelly: 'Earthquake Resistant Design with Rubber'; *Springler- Verlag Publication.*
- 5. D. J. Dowrick: 'Earthquake Resistant Design for Engineers and Architects'; *Johnn Wiley andSons*.
- 6. Robinson: 'Passive Vibration control'
- Agrawal, P. and Shrikhande, M. : 'Earthquake Resistant Design of Structures'; *Prentice HallIndia, New Delhi, 4th Edition, 2007.*

8. Duggal, S.K: 'Earthquake Resistant Design of Structures'; Oxford University Press, New Delhi

#### Semester II

Course Code	Course Name	Credits	
STRPE2032	Health Monitoring and Rehabilitation of Structures	03	
	Program Elective -III		

#### **Teaching Scheme**

Contact Hours				Credits A	Assigned	
Theory	Practical	Tutorial	Theory Practical Tutorial Total			
03	-	-	03			03

#### **Evaluation Scheme**

Theory					Term Work/Practical/Oral			
Inter Test-	Internal Assessment		End Sem	Duration of End Sem	TW	PR	OR	Total
I	II	Average	Exam	Exam				
20	20	20	80	03	-	-	-	100

## **Course Objectives**

- 1. To get familiar with Durability of Structure and Factors affecting durability of concrete structure.
- 2. To study the Structural health monitoring, condition survey, evaluation and assessment of damage of structure and Testing methods.
- 3. To acquire the knowledge Repair Materials for Structural Rehabilitation.
- 4. To study the Repair Methods for Structural Rehabilitation.
- 5. To implement Retrofitting of Structures and Demolition of Structure.
- 6. To learn the Rehabilitation process implementation and safety during repairs.

## **Detailed Syllabus**

Module	Course Module / Contents				
1	Structural Health:				
	1.1 Durability of Structure, Factors affecting durability, Causes of distresses, Structural Defects due to physical, chemical and environmental factors, climate, chemicals, wear and erosion	7			
	1.2 Structural Health, factors affecting health of structures, effect of leakage, age, creep, workmanship, quality of materials used, corrosion, fatigue, regular maintenance, alterations on life of structure				
2	Structural health monitoring:	8			
	2.1 Structural Audit, Bye laws, Assessment of health of structure, visual survey, Collapse and investigation, limitations on investigator, tools for investigation, Various Destructive, semi destructive and non- destructive Methods for assessing strength of structure.				
	2.2 Investigation management, review of assimilated information, interviews and statements, Categorization of structure, quantification and preparation of report.				
3	Repair Materials for Structural Rehabilitation:	4			
	different types and their uses -Cement, Grouts, Latex modified mortars, Polymer modified mortars, Micro concrete, corrosion inhibitors, Concrete chemicals, epoxy, solvents, bonding chemicals, coatings, waterproofing chemicals, Types of Paints.				
4	Repair Methods for Structural Rehabilitation:				
	parameters for assessment for restoration strategies, selection of construction methodology during restoration, Specification for important items of work in restoration, Structural detailing for restoration, and Various techniques of retrofitting, Waterproofing, Structural repairs- jacketing, FRP bonding, Shotcrete, Guniting, Ferroconcrete, Steel plate jacketing Quantity calculations	8			
5	Retrofitting of Structures and Demolition of Structure:				
	Retrofitting of columns, beams, bridge deck and piers, study of structural system and structural drawings, need and importance for demolition, outline of various demolition methods and their evaluation, partialand controlled demolition, role of safety measures, temporary support structures indemolition. Recycling of demolished materials, contracts.	4			
6	Rehabilitation process implementation and safety during repairs:	8			

Role of client, consulting structural engineer & contractor. Flow of	
Processes – Bill of quantities and estimate, Tendering, Work order,	
Agreement and contract, Measurements, Bills/ R. A. Bills, Security	
deposits, Payment, Role of Project management consultant.	
Safety during construction- Reasons of accidents, Safety measures, Barricading and fencing, First aid, Insurance, Temporary support structures- formwork, centering, shuttering and staging.	

## **Contribution to Outcome**

On completion of this course, the candidate will be able to

- 1 Diagnose the destress in Civil Engineering Structures.
- 2 Apply the theoretical concepts of crack repairing in the field.
- 3 Comparison of verities of rehabilitation techniques according to requirement.
- 4 Select the suitable repair technique for deteriorated concrete structures

#### **Internal Assessment**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for either the tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

## **Theory Examination:**

## **End Semester Examination**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total **six** questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be of mixed in nature.
- 4 The students will have to attempt **any four** questions out of **total six** questions.

## 20 Marks

80 Marks

# **Recommended Books:**

1	Guha, P.K, "Maintenance and Repairs of Buildings", New Central Book Agency (P) Ltd, Calcutta, 2011.
2	Ghosh, S.K, "Repair and Rehabilitation of Steel Bridges", Oxford and IBH Publishing Co., New Delhi, 1988.

## **Reference Books and IS codes:**

1	. Macdonald, S, "Concrete - Building Pathology", Blackwell Science Limited, Oxford, 2008.
2	Shetty, M.S, "Concrete Technology – Theory and Practice", S. Chand and Company Ltd, New Delhi, 2012.
3	Chudley, R, "The Maintenance and Adaptation of Buildings", Longman Group Ltd, New York, 2002.
4	Strecker, P.P, "Corrosion Damaged Concrete – Assessment and Repair", Butterworths, London, 1987.
5	Johnson, S.M, "Deterioration, Maintenance and Repair of structures", Krieger Publishing Company, Melbourne, 1980.
6	A.R. Santakumar, "Concrete Technology", Oxford University Press, New Delhi, 2006.
7	P.K. Mehta and P.J.M. Monteiro, "Concrete - Microstructure, Properties and Materials", McGraw-Hill, New York, 2014.
8	. Modi, P.I., Patel, C.N., "Repair and Rehabilitation of Concrete Structures", PHI I

## Semester II

Course Code	Course Name	Credits
STRPE2033	Advance Concrete Technology	03
	Program Elective-III	

#### **Teaching Scheme**

Contact Hours			Credits assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorials	Total
03			03			03

Theory				TermWork				
Inter	nal Assess	sment End Duration of						Tota
Test 1	Test 2	Averag e	Sem Exam	End Sem Exam	TW	PR	OR	1
20	20	20	80	03	-			100

#### **Evaluation Scheme**

## Rationale

Basic concept of concrete technology is essential for civil engineering students to execute the civil engineering projects as per the standards laid down time to time. Advancements in concrete technology is the backbone strength of infrastructure of civil engineering field. This course provide necessary knowledge about various concreting and testing operations during and after construction. This course is intended for gaining knowledge about the properties of materials, especially concrete and to maintain quality of construction projects. This course will also provide knowledge to the students about the criteria to be remembered during the selection of materials, its mix proportioning, mixing, placing, compacting, curing and finishing.

## **Course Objectives**

To understand the various constituent materials of concrete.

- To study the different properties of fresh and hardened concrete.
- To understand the concept and optimization of the mix design of concrete by using various codes.
- To understand the evaluation technique of concrete using semi and non-destructive techniques for better stability and safety of structures periodically.
- To study the various constituents, properties, significance and applications of special concrete.
- To understand the concept of durability and deterioration in concrete.
- To understand the significance of parameters in concreting under extreme environmental conditions.

**Detailed Syllabus** 

Module	Content	Hours
I.	Constituent Materials of Concrete:	03
	Components of modern concrete and developments in the process and constituent materials.	01
	Mineral and Chemical Admixtures: Fly Ash (Physical and Chemical properties), Silica Fume (Physical and Chemical properties), Rice Husk Ash, Metakaolin, Ground Granulated Blast Furnace Slag (Physical and Chemical properties).Introduction to accelerators, retarders, plasticizers, super plasticizers, viscosity modifying admixtures, water proofers, miscellaneous admixtures.	02
II	Properties of Fresh and Hardened Concrete:	09
	Properties of fresh Concrete: Workability, Compactability, Mobility, Stability, Consistency, Segregation and Bleeding, w/c ratio, w/b ratio, gel space ratio, and aggregate cement bond strength.	02
	Rheological Models of Fresh Concrete: Introduction, Simple Flow Test, Rheological Models, Schematic Differences in flow curves, Factors affecting rheological properties and effects.	02
	Hardened Concrete: Strength Under Uniaxial and multiaxial stresses, Failure Modes, Tensile strength, Fatigue, Impact Strength, Abrasion Resistance, Fracture properties of concrete.	02
	Dimensional Stability of Concrete: Introduction, Modulus of Elasticity (Static and Dynamic), Factors affecting modulus of elasticity, Poisson's Ratio, Mechanics of setting and hardening, shrinkage, creep and thermal properties of concrete	03
III.	Proportioning of Concrete Mixes:	08

	Approach to Concrete Mix Design, Principals and Properties related to Mix (Durability, Workability and Strength), Physical Properties of materials required for mix design, Variability of test results.	02
	Methods for Mix Proportioning: Trial Mix, Nominal Mix, Mix Design by Bureau of Indian Standards Method 10262:2019 (With and without fly ash), Mix Design by American Concrete Institute Method, Mix Design by Department of Environment Method, Mix Design by Fineness modulus method. Mix design of high strength concrete by ACI method 211.4R-93.	05
	Acceptance Criteria for Concrete: Determining the laboratory Design strength of concrete, Quality Control of concrete.	01
IV.	Non & Semi destructive testing methods:	04
	Probe Penetration, Pull Out Test, Break Off Maturity Method, Stress Wave Propagation Method, Infrared Thermography, Carbonation Test, Dye penetration examination, Linear Variable Differential Transformer and Contact type strain gauge.	04
V.	Special Concrete:	08
	Light weight concrete – Types of lightweight aggregate, Physical and Mechanical Properties, Factors affecting strength and density of light weight aggregates, properties of light weight concrete.	01
	Fiber Reinforced Concrete - Historical development of fibre reinforced concrete, Physical and Mechanical properties of natural, metallic and synthetic fibers. Interaction between fibres and matrix (uncracked and cracked matrix), Properties of hardened Steel fibre reinforced concrete.	02
	High Strength and High-performance Concrete – Microstructure, Manufacturing considerations, Properties of high strength concrete, advantages, applications and cost implications.	02
	Ferrocement and Porous Concrete – Materials, behaviour of ferrocement in tension, construction methods, applications and case studies of ferrocement in structures. Introduction of porous concrete, Need for porous concrete, construction of pervious concrete pavement.	02
	Self-Compacting Concrete – Properties of fresh and hardened self-compacting concrete, introduction to mix designs of self-compacting concrete, peculiarities in mixing and transportation of self-compacted concrete.	01
VI.	Durability and Deterioration of concrete:	07
	Durability Concrete in Special Environments - Introduction to durability and permeability, cracking in concrete, Frost Attack, Aggressive environment, Marine environment, High temperature or Fire and Radiation Shielding.	02
	Design of Durability using performance specification – performance-based specification, durability index method, durability index tests.	02
	Deterioration and repair technology of concrete, Distress and type of repairs, crack sealing techniques.	03
	Total	39

On successful completion of the course, the learners shall have an in-depth knowledge of the advanced concrete technology and its application in the diverse spectrums of the Civil Engineering. The students will be able to

1. Study the materials science aspects of the properties and behavior of modern constituents of concrete.

2. Understand the various properties and teats performedon fresh and hardened concrete.

3. Design the concrete mix for field application by different methods and discuss the quality and acceptance criteria of concrete.

4. Understand the implementation of semi and non-destructive testing methods for inspection and testing of various structures.

5. Explain the various properties and behaviour of special concrete.

6. Describe the durability and deterioration of concrete and apply the knowledge of durability in extreme weather concreting.

#### **Internal Assessment**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for either the tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

#### **Theory Examination:**

End Semester Examination

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total **six** questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

#### **Recommended Books:**

- 1. Concrete Technology: Santhakumar, Oxford University Press.
- 2. Concrete Technology: A.M. Neville and Brooks
- 3. Properties of Concrete: Murdock.
- 4. Properties of Concrete: P. K. Mehta.
- 5. Concrete Technology: M. S. Shetty.
- 6. Fiber Reinforced Cement Composite: P.N. Balguru and P. N. Shah.
- 7. Concrete Technology: D.F. Orchard
- 8. Concrete Technology:Gambhir,3rd edition, Tata Mc Graw Hill

#### Semester- II

<b>Course Code</b>	Course Name	Credits

## 20 Marks

## 80 Marks

STRPE2034	Advanced Finite Element Analysis	03
	Program Elective III	

C	Contact Hours	5	Credits Assigned					
Theory	Practical	Tutorial	Theory	Total				
03			03			03		

Theory						Term Work/Practical/Or al			
Internal Assessment			End	Duration of				Total	
Test	Test-	Aver	Sem	End Sem	TW	PR	OR		
-I	II	age	Exam	Exam					
20	20	20	80	03	-	-	-	100	

#### Rationale

Advanced Finite Element analysis is a numerical technique for solving differential equations that describe many engineering problems. Main reason for its popularity is that the method results in computer codes which are versatile in nature that can solve many practical problems with minimum training. This course of advanced finite element analysis covers the fundamental concepts and its designed for students in civil engineering, researchers and design engineers in the structural engineering field. The course presents the FEM as a tool to find approximate solution of differential equations and thus can be used by students. Applications include analysis of structural frameworks, stress analysis and programs etc.

#### **Course Objectives**

- 1. To understand the basics, advantages, significance of finite element analysis and the various methods used in finite element formulation.
- 2. To understand geometric non-linearity, material non-linearity in two dimensional elements and general formulation of a physically non-linear problem..
- 3. To study Finite Element Analysis of Plate and Shell
- 4. To study the Analysis of Three Dimensional Problem
- 5. To understand terminology, Finite element Discretization, system of units, Stages in solution using ANSYS.
- To understand Analysis of Space Trusses ,plates subjected to in-plane loads using CST elements, Three –Dimensional Structures using CST element by MATLAB programs

## **Detailed Syllabus**

Module	Course Modules / Contents	Hrs				
	Basics of Finite Element Analysis	05hrs				
	Review of Variation methods- Calculus of variation- Variational					
	Principles of solid Mechanics. The Basic component- Concept of an					
	element- Various Element Shapes Displacement models-					
	Formulation of Finite Element Method. Derivation of Element					
т	Stiffness and loads for Pin Jointed Bar element, Beam element,					
I	Triangular and Rectangular Plate Element in Bending.					
	Isoparametric element- Local vs. Natural Co-ordinates system, Line,					
	Triangular, Quadrilateral and Tetrahedral Element Interpolation					
	Displacement Models Formulation of Isoparametric .General steps					
	involved in finite element analysis. Calculations of Element Stresses.					
	Non Linear analysis using Finite Element Analysis:	07 hrs				
	Introduction to Non Linear Analysis, Geometric Non-Linearity-					
	Geometric Stiffness of an Axial Element, Stability of Bar Spring					
	System. General Formulation of a Geometrically Nonlinear problem.					
	Geometric Stiffness of a Beam-Column of Triangular element. Non-					
II	linear material behaviour. Non-linear spring- Elastic Plastic Analysis					
	by FEM-Elasto-Plastic Analysis of Truss-Two Dimensional Element					
	Formulations- General Formulation of a Physically Non-linear					
	Problem Stiffness of Truss Members-Analysis of Truss-Stiffness of					
	Beam Members-Finite Element Analysis of Continuous Beam-Plane					
	Frame Analysis-Analysis of Grid and Space Frame					
	Plate and shell and applications of Finite Flement Analysis	08 hrs				
	Introduction to Plate Bending Problems - Finite Element Analysis of					
	Thin Plate - Finite Element Analysis of Thick Plate - Finite Element					
111	Analysis of Skew Plate -Introduction to Finite Strip Method - Finite					
	Element Analysis of Shell -Finite Elements for Elastic Stability -					
	Dynamic Analysis					
	Analysis of Three Dimensional Problem	07 hrs				
IV	Introduction, Tetrahedran Element, Hexahedron element, Analysis					
	of solids of Revolution.					
V	Finite Element Analysis using ANSYS	06 hrs				

	Introduction, GUI layout in ANSYS, terminology, Finite element	
	Discretization, system of units, Stages in solution.	
	MATLAB programs for Finite Element Analysis	06 hrs
	Solution of linear system of equations using Choleski Method,	
VI	Incorporation of boundry conditions, Analysis of Space Trusses,	
	Analysis of plates subjected to in-plane loads using CST elements.	
	Analysis of Three –Dimensional Structures using CST element.	

## **Contribution to Outcome**

On completion of this course, the students will be able to

- 1. Understand the basics, advantages, significance of finite element analysis and the various methods used in finite element formulation.
- 2. Understand geometric non -linearity, material non-linearity in two dimensional elements and general formulation of a physically non-linear problem.
- 3. Analyze Plate and Shell using Finite Element Analysis.
- 4. Analyze the Three Dimensional Problem using Finite Element Analysis.
- 5. Understand terminology, Finite element Discretization, system of units, Stages in solution using ANSYS.
- 6. Understand Analysis of Space Trusses, plates subjected to in-plane loads using CST elements, Three –Dimensional Structures using CST element by MATLAB programs.

#### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

#### **TheoryExamination:**

- 5. Question paper will comprise of **six** questions; each carrying 20marks.
- 6. There can be an **internal** choice in various sub-questions/questions in order to accommodate the questions on all the topics/ sub-topics.

- 7. The students will have to attempt any **four** questions out of **total six** questions.
- 8. The questions can be of mixed nature irrespective of modules

#### **RecommendedBooks:**

- 15. Zienkiewicz,O.C.: 'The Finite Element Method in Engineering Science',*McGraw Hill Book Co.*
- 16. J.N.Reddy :'Finite Element Analysis', McGraw Hill BookCo.
- 17. Chandragupta, T.R. and Belagundu, A.D.: 'Introduction to Finite Elements in Engineering', *Prent iceHallofIndiaPvt.Ltd*.
- 18. Rajshekaran, S.: 'Finite Element Analysis', Wheeler Publishing.
- 19. Krishnamoorthy C.S.:'Finite Element Analysis', McGrawHillBookCo.
- 20. Cook,R.D.,Malkus,D.S.andPlesha,M.E.: 'ConceptsandApplicationsofFiniteElementAnalysi s',*John Wiley andSons (Asia) Pvt. Ltd.*
- 21. Bickford, W.B.: 'AFirstCourseinFiniteElementMethod', IRWIN, Homewood, IL60430
- 22. Rao, S.S.: 'The Finite Element Method in Engineering', PergamonPress.
- 23. Weaver, W.and Johnston, P.R.: 'Finite Element for Structural Analysis', Prentice Hall.
- 24. M. Asghar Bhatti, "Fundamental Finite Element Analysis and Applications with Mathematical and MATLAB Computations", *Wiley India Pvt. Ltd.*
- 25. Chandrupatla and Belegundu, "Introduction to Finite Elements in Engineering" PHI /Pearson Education, 2003.
- 26. Logan. D.L. "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002.
- 27. S.S.Bhavikatti "Finite Element Analysis" New Age International Publication.
- 28. Y. M. Desai "Finite Element Method" Pearson.

|--|

Course Code	Course Name	Credits	
STDDE 2041	Design of Industrial Structures	02	
51KFE2041	Program Elective -4	03	

#### **Teaching Scheme**

(	Contact Hours		Credits Assigned					
Theory	Practical	Tutorial	Theory	Practical	Total			
03	-	-	03			03		

#### **Evaluation Scheme**

		Theo	Work/					
Inter Test- I	Internal AssessmentEndDurationSest-Test- IIAverageSemEnd SenExamExamExamExam		Duration of End Sem Exam	TW	PR	OR	Total	
20	20	20	80	03	-	-	-	100

#### Rationale

Good structural engineer requires efficient knowledge of design of an industrial structural who can design safe and cost-effective structure. An efficient structural designer can create structures that can last forever. These are different types of the industrial structures which are subjected to various types of loading and its combination. These structures are made of RCC, Steel or composite material. The structures are designed by working stress method and limit state method.

#### **Course Objectives**

On completion of this course, the learner will be able to

1 To be thorough with the design of industrial steel structures and connection viz. bolted and welded and detailing of reinforcement in Industrial RCC Structure.

- 2 To understand the design concept of lattice tower
- 3 To understand the analysis and design concept of round tubular structures.
- 4 To know the analysis and design of chimney.
- 5 To understand the design concept of gantry girder.

#### **Detailed Syllabus**

Module		<b>Course Module / Contents</b>	Contact hours					
1	INDU	JSTRIAL ROOF TRUSS						
	1.1	Introduction; Types; Loads-Dead loads, live loads and wind	9					
		loads						
	1.2	Design wind speed and pressure; wind pressure on roofs	-					
	1.3	Analysis and design of tubular trusses including purlins and	-					
		supports						
2	DESI	GN OF STEEL BUNKERS AND SILOS	7					
	2.1	Introduction of steel bunkers and silos						
	2.2	Janssen's Theory; Airy's Theory						
	2.3	Design of Parameters; Design Criteria; Analysis of Bins;	-					
		Hopper Bottom Design of Bins.						
3	STEI	EL CHIMNEY	7					
	3.1	Introduction; Behaviour of chimney						
	3.2	Design of self - supporting chimney - Design of base plates,						
		foundations and anchor bolts						
	3.3	Guyed steel chimney						
4	GAN	TRY GIRDER						
	4.1	Introduction; Loads acting on gantry girder	7					
	4.2	.2 Analysis and Design of gantry girder						
5	TRA							
	5.1	Introduction; Types; component parts	9					
	5.2	Types of bracing patterns; Sag and tension calculations						
	5.3	Analysis and design of lattice transmission line towers						

#### **Contribution to Outcome**

On completion of this course, the candidate will be able to

- 1 Independently design steel structures using relevant IS codes.
- 2 Design various components of industrial structure such as purlins, girts and tie runner etc.
- 3 Design Industrial structures subjected to wind load.
- 4 Analysis and design of gantry girder, lattice tower and tubular truss.
- 5 Analysis and design chimney.

#### **Internal Assessment**

# The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for either the tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

## **Theory Examination:**

## **End Semester Examination**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total **six** questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- 3 Remaining questions will be of mixed in nature.
- 4 The students will have to attempt **any four** questions out of **total six** questions.

#### **Recommended Books:**

1	Design of Steel Structures: P.Dayaratnam, S. Chand, Edition 2011-12.
2	Limit State Design of Steel Structures: S.K. Duggal, Mc Graw Hill Education Private Ltd., NewDelhi.
3	Design of Steel Structures: Galyord& Gaylord, Publisher, Tata Mc Graw Hill, Education. Edition 2012
4	Design of Steel Structures: Punamia, A. K. Jain and Arun Kumar Jain, Laxmi Publication
5	Design of Steel Structures : N Subramanian, Oxford- University Press

## **Reference Books and IS codes:**

1	Design of Steel Structures: Kazimi, S. M. and Jindal, R. S., Prentice Hall of India
2	Design of Steel Structures: Breslar, Lin and Scalzi, John Willey, New York.
3	Design in structural steel: John E. Lothers, Prentice Hall of India
4	IS:800-2007-General Construction in Steel - Code of Practice
5	IS: 1498-1970, "Classification and Identifications of soils for General Engineering
	Purposes".
6	IS:9178 (Part-I)-1979, General requirements and assessment of loads
7	IS:9178 (Part-II)-1979; Criteria for design of steel bins for storage of bulk materials
8	IS:9178 (Part-III)-1980: Bins Designed for Mass Flow and Funnel Flow
9	IS:3177-1999: Code of practice for electric overhead travelling cranes and gantry cranes
	other than steel work cranes
10	IS:806-1968: Code of practice for use of steel tubes in general building construction

20 Marks

80 Marks

11	IS:802-2015:	Use	of structural	steel	in	overhead	transmission	line	towers	- (	code	of
	practice											

Course Code	Course Name	Credits	
STRPE2042	Design of Green Buildings	0.2	
	Program Elective -4	03	

## **Teaching Scheme**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03			03

#### **Evaluation Scheme**

Theory				Term Work/Practical/Oral					
Inter Test-	mal Asses	sment End Sem		al Assessment End Duration Test- Sem of End		TW	PR	OR	Total
I	II	Average Exam	Exam	Sem Exam					
20	20	20	80	03 Hours	-	-	-	100	

## Rationale

Basics of Civil Engineering/Architecture/Infrastructure/Planning Knowledge, National Building Code-2016, Development Control Rules (DCR), Building Bye Laws, Model Building Development Control Rules, Building Planning, Design and Constructions.

#### **Course Objectives**

- 1. To acquire knowledge on various aspects of green buildings.
- 2. To learn practices Indian Green Building Council.
- 3. To introduce green building design.
- 4. To learn material conservation handling of non process non-recycled waste.
- 5. To study national as well international, green building assessment system.
- 6. To study various terminologies Embodied Energy, Life Cycle Assessment, Environmental Impact Assessment, Energy Audit and Energy Management

## **Detailed Syllabus**

Module	Course Module / Contents	Contact hours
1	Green Building Concepts: What is Green Building, Why to go for Green Building, Benefits of Green Buildings, Green Building Materials and Equipment in India, What are key Requisites for Constructing a Green Building? Principles of green building–Selection of site and Orientation of the building–usage of low energy materials– effective cooling and heating systems– effective electrical systems– effective water conservation systems.	5
2	Green Building Practices in India: . Practices of Indian Green Building Council, Green Building Movement in India, Benefits Experienced in Green Buildings, Launch of Green Building Rating Systems, Residential Sector, Market Transformation; Green Building Opportunities and Benefits: Opportunities of Green Building, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy Saving Approach in Buildings Introduction to Green Building Design	7
3	Green Building Design Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximize System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources. Eco-friendly captive power generation for factory, Building requirement.	7
4	Material Conservation Handling of Non Processed Waste: Material Conservation, Handling of non processed waste, waste reduction during construction, materials with recycled content, local materials, material reuse, certified wood, Rapidly renewable building materials and furniture; Indoor Environment Quality And Occupational Health: Air conditioning, Indore air quality, Sick building syndrome, Tobacco smoke control, Minimum fresh air requirements avoid use of asbestos in the building, improved fresh	7

	air ventilation, Measure of Indoor Air Quality (IAQ), Reasons for poor IAQ, Measures to achieve Acceptable IAQ levels.	
	Green building Rating Systems:	
5	Green building assessments system studying e.g. LEED US (Leadership in Energy and Environmental Design); Living Building Challenge, Green Globes (Green Building Initiative) (US), Green Globes (ECD-Canada; LEED-Canada, Built Green CANADA, BREEAM (Building Research Establishment Environmental Assessment Method) (UK), LEED India (Indian GBC); IGBC Green modules; TERI-GRIHA (Green Rating for Integrated Habitat Assessment) (India) Rating system various modules	7
	Embodied Energy, Life Cycle Assessment, Environmental	
	Introduction to the Concept: "Life Cycle assessment of materials"	
ć	EIA: Introduction to EIA. Process of EIA and its application through	(
0	a case study, EIA as a strategic tool for sustainable development.	0
l	Embodied energy of various construction materials-Energy	
	Management with respect to buildings, Clean Development	
	Mechanism, Kyoto Protocol, Energy Conservation Building Code	

## **Contribution to Outcome**

On completion of this course, the learner will be able to

- 1. Understand the concepts of green building.
- 2. Learn practices of Indian Green Building Council and GRIHA.
- 3. Learn material conservation and handling of non-recycled non processed waste.
- 4. Learn green building assessment systems national as well international.
- 5. Study various terminologies Embodied Energy, Life Cycle Assessment,

Environmental Impact Assessment, Energy Audit and Energy Management system.

## **Internal Assessment**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for either the tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

#### **Theory Examination:**

#### **End Semester Examination**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total **six** questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).

#### 20 Marks

## 80 Marks

4 Only Four questions need to be solved.

## **Recommended Books:**

- 1. Green Building Materials by Ross Spiegel and Dru Meadows
- 2. Sustainable Building Design Manual-Volume-I, II, III, IV, V by TERI Publications
- 3. Mechanical and Electrical Systems in Construction and Architecture by Frank R.Dagostino
- 4. Sustainable Building Design Manual-Volume-I, II, III, IV, V by CII-Godrej- IGBC Publications
- 5. Tom Woolley, Sam Kimmins, Paul Harrison and Rob Harrison "Green Building Handbook" Volume I, Spon Press, 2001

## **Reference Books**

- 1. Manual of Tropical housing and climate change by Koenigsberger
- 2. Climate responsive Architecture by Arvind Krishnan
- 3. Manual of solar passive Architecture by Nayak J.K., R. Hazzra J.Prajapati
- 4. Energy Efficient buildings in India by Mili Mujumdar
- 5. Publications from-CBRI-Roorkee, IDC-Mumbai, NID-Ahmedadbad, SERC, BMTPC
- 6. Solar Energy in Architecture and Urban Planning by Herzog Thomos
- 7. Solar Heating, Design Process by Kreider Jan F
- 8. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.
- 9. Green Building Hand Book by Tom woolley and Sam kimings, 2009.
- 10. Green building codes and standards
- 11. International Green Construction Code
- 12. Complete Guide to Green Buildings by Trish riley
- 13. Shahane, V. S, "Planning and Designing Building", Poona, Allies Book Stall, 2004.
- 14. Michael Bauer, Peter Mösle and Michael Schwarz "Green Building Guidebook for Sustainable Architecture" Springer, 2010.
- 15. Standard for the design for High Performance Green Buildings by Kent Peterson, 2009

Semester II					
Subject	Subject Name	Credits			
Code					
STRPE2043	Design Of Environmental And Hydraulics Structures	03			
	Program Elective -IV				

#### **Teaching Scheme**

Contact Hours			Credits assigned			
Theory	Practical	Tutorial	Theory Practical Tutorials T			
03			03			03

#### **Evaluation Scheme**

Theory					wor	Total		
Internal Assessment		End Som	Duration of End	TW	PR	OR		
Test 1	Test 2	Average	Exam	Sem Exam				
20	20	20	80	03				100

#### Rationale

Design Of Environmental And Hydraulics Structures provides necessary knowledge about design and constructions of important environmental-hydraulic structures like units of WTP, STP, dams, reservoirs, weirs, cross drainage woks and canal structures. This subject is taught to understand the concepts of pipe network and design. A student, who successfully completes the course, should be able to design various structures in the given field conditions.

#### **Course Objectives**

- 1. To impart necessary skill required for the design of water treatment units.
- 2. To study the basic principles used in designing sewage treatment plant.
- 3. To understand the design for water tank.
- 4. To design the section of spillway and energy dissipaters.
- 5. To study design of Aqueduct and design canal regulation works.
- 6. To study the concepts of pipe network and design.

	Detailed Syllabus				
Module	Course Modules / Contents	Period			
Ι	Design of water treatment plant	07 hrs			
	Flash mixer, Flocculator, settling tanks, Rapid sand filter. Ground				
	service reservoir and Elevated service reservoir, Jack Well, Pump				
	House				
II	Design of sewage treatment plant	07 hrs			
	Design of primary settling tank and other units of sewage/effluent				
	treatment plant, Design of grit chambers, Design criteria for digester				
	and UASB				
III	Design of water tanks	06 hrs			
	Design of underground water tanks, Design of water tanks resting				
	on ground: circular & rectangular tanks				
IV	Spillway	07 hrs			
	Spillway Necessity, components and classification, Design				
	consideration of overflow/ogee spillway, Design as per IS, Design				
	of hydraulic jump type energy dissipaters-stilling basin as per IS,				
	design of roller bucket type energy dissipaters				
V	Aqueducts	07 hrs			
	Types of aqueducts and syphon aqueducts, Design of aqueducts,				
	Design of weirs and barrages over permeable foundations, causes				
	of failure, Khosala's theory, Canal regulation works: alignment				
	of off-taking channels, distributoryhead regulator, cross regulator				
	and their design				
VI	Design of concrete pipes	05 hrs			
	Pipes-Pre-stressed concrete, steel and cast iron, Classification of				
	R.C.C and pre-stressed pipe, Design principles, Reinforcements				
	in pipes, Design of non-pressure R.C.C.pipes for culverts, laying				
	of concrete pipes.				

# **Contribution to Outcome**

On completion of this course the student shall be able to

- 1. Understand the basic principles used in the design of water treatment units.
- 2. Analyze and design the sewage treatment plant.
- 3. Design circular and rectangular water tank.
- 4. Design ogee spillway and energy dissipaters.

- 5. Design of aqueduct and understand concept of canal regulation works.
- 6. Understand the concepts of pipe network and design.

## **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. Thelearner/s shall beasked to appear for the either tests. However, at least one test is mandatoryand the learner/s may be asked to undertake the completion of assignment on live problems orcourse project instead of another test, solelyat the discretion of the course instructor.

## **Theory Examination:**

1. Question paper will comprise of six questions; each carrying 20 marks.

2. There can be an internal choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

3. The students will have to attempt any four questions out of total six questions.

4. The questions can be of mixed nature irrespective of modules

## **Recommended Books:-**

- 1. P.Dayaratnam, (2004), Reinforced Concrete, Oxford Publishing Private Limited.
- 2. Krishna Raju, (2004), Prestressed Concrete, Tata McGraw Hill Publishing Co, 2nd Edition.
- 3. N.C.Sinha&S.K.Roy, (2002), "Reinforced Concrete, S.Chand and Co.
- 4. Ramaswamy.G.S.,(1996), Design and Construction of Concrete Shell roofs CBS Publishers, India.
- 5. Jain , S.K., Jaiswal, O.R., "Guidelines for seismic design of liquid storage tanks", NICEE, IIT K, 2004
- 6. Anchor, R.D., "Design of liquid retaining concrete structure" Edward Arnold,
- BIS, IS-3370, "Indian standard code of Practice for Concrete Structure for the storage of Liquids", Part-I to IV
- 8. Ghali, A., "Circular storage tanks and Silos", E & F N Spon, London, 1979
- 9. Irrigation Water Resources and Water Power Engineering: *P.N. Modi*, Standard Book House, Delhi, ISBN 978-81-87401-29-0.
- 10. Irrigation Engineering and Hydraulic Structures: S. K. Ukarande, Ane's Books Pvt. Ltd. (Abridged Edition 2015), ISBN 9789383656899
- 11. Irrigation and Water Power Engineering: *B.C. Punmia, Pande, B.B. Lal, A.K Jain.* Laxmi Publications Pvt, Ltd. New Delhi.
- 12. Irrigation Engineering and Hydraulics Structures: S. K. Garg, Khanna Publishers. Delhi.
- 13. Design of Irrigation Structures: S. K. Sharma, S. Chand and Co.
- 14. Theory and Design of Irrigation Structures: *R. S. Varshney and R, C. Gupta*, Nem Chand and Bros., Roorkee
- 15. Engineering for Dams, Vol. I to III: Crager, Justin and Hinds, John Wiley
- 16. Design of Small Dams: USBR.
- 17. Water Supply Engineering, S.K.Garg, Khanna Publication.
- 18. Sewage disposal and Air Pollution Engineering, S.K.Garg, Khanna Publication.
- 19. CPHEEO Manual on Water Supply and Treatment
- 20. CPHEEO Manual on Sewage and Treatment

# Semester II

Course Code	Course Name	Credits	
STDDE2044	Design of Bridge Structures	03	
S1 KPE2044	<b>Program Elective -IV</b>		

#### **Teaching Scheme**

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03	-	-	03			03

#### **Evaluation Scheme**

Theory				Work/				
Inte Test-	nternal Assessment End Sem		Duration of End Sem	TW	PR	OR	Total	
I	II	Average	Exam	Exam				
20	20	20	80	3	-	-		100

#### Rationale

Bridge engineering is a field of engineering (particularly a significant branch of structural engineering) dealing with the surveying, plan, design, analysis, construction, management, and maintenance of bridges that support or resist loads. A bridge is a construction made for carrying the road traffic or other moving loads in order to pass through an obstacle or other constructions. The required passage may be for pedestrians, a road, a railway, a canal, a pipeline, etc. Obstacle can be rivers, valleys, sea channels, and other constructions, such as bridges themselves, buildings, railways, or roads. The mission of a bridge design may be defined as "to design a safe, functional, and beautiful bridge within the given budget."

#### **Course Objectives**

- 1. To study the aspect of survey methodology, hydraulics and waterways study, bridge analysis, design and its philosophy.
- 2. To study the type of bridge selection.
- 3. To study the design theories.
- 4. To study the different code provisions and requirements in analysis and design of bridges.
- 5. To study the design of superstructure and substructure.
- 6. To study different software available for analysis and design. (Like MIDAS etc.)
- 7. To study inspection, maintenance, monitoring, testing and rehabilitation methodology for bridges.

# **Detailed Syllabus**

Module	Course Module / Contents		Contact Hrs.
1	Introduction to Bridge Structures and Fundamentals of Bridge		
	Desig	n Uistoriaal raview of bridges	-
	1.1	Historical feview of bridges	4
	1.2	arrangement, selection type of bridges, different materials used and advanced material used for bridge construction.	
	1.3	Hydraulics and water ways of bridges	
	1.4	General design requirements, GAD preparation.	
2	Loads and Load distributions		
	2.1	I.R.C. and BIS specifications for loads and material for bridges.	5
	2.2	Different types of loadings including environmental loadings and their combinations for design. Load path.	
	2.3	Load distribution theories: Courbon's Method, Hendry Jaeger Method, Grillage analogy, Pigeaud's curves etc Bridge modelling for analysis and modelling in software.	
3	Design of Bridge Superstructure		
	3.1	Design of RCC and Prestressed slab/girder/box Bridges.	11
	3.2	Design of steel bridges like plate girder, truss bridge and composite bridge.	
	3.3	Analysis and design concept of cable stayed, extradosed, arch, bowstring and other types of bridges, their load path, component and proportion of element.	
4	Design of Bridge Substructure		
	4.1	Various parts of substructures, Various types of substructures, Loads acting on substructures,	10
	4.2	Design of pier and pier cap	
	4.3	Design of Abutment, returns, RE wall design and other component.	
	4.4	Introduction to bridge foundation, different types of foundation and their selection.	
5	Bridge Bearings & expansion joints		
	5.1	Bearings: General features, types design and replacement.	6
	5.2	Expansion joints: Requirement, types and selection. Bridge centering design, different erection techniques, launching girder bridge construction machinery	
6	Inspection, maintenance, monitoring, load testing and		
	rehabilitation of Bridges		
	6.1	Inspection methods, maintenance strategy, different types of monitoring and instrumentation, load testing and rating of bridges, different rehabilitation techniques.	3

## **Contribution to Outcome**

On completion of this course, the learner will be able to

- Understand the bridge structures & their types and make capable to select appropriate
- <sup>1</sup> bridge type and able to prepare bridge GAD
- 2 Understand the design theories and loadings.
- 3 Understand the codal provisions and requirements
- 4 Understand the design of superstructure
- 5 Understand the design of substructure
- 6 Understand the bridge inspection procedures.

#### **Internal Assessment**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for either the tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

#### **Theory Examination:**

#### End Semester Examination

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1 Question paper will comprise of total **six** questions, each carrying 20 marks.
- 2 Question 1 will be compulsory and should cover maximum contents of the curriculum.
- Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
- 4 Only Four questions need to be solved.

## **Recommended Books:**

- 1. Design of Bridges", N.Krishna Raju, Oxford & IBH Publishing Co.Pvt.Ltd, New Delhi Bridge Deck Behaviour by E.C. Hambly.
- 2. Design of Bridges by V.V. Sastry, Dhanpat Rai & Co
- 3. Concrete Bridge Design and Practice by V.K. Raina.
- 4. Design of Bridge Structures by Jagadeesh & Jayaram, PHI learning Pvt. ltd.
- 5. All IRC, BIS codes.
- 6. Essentials of Bridge Engineering by Victor D J & Johnson, Oxford & IBH publishers.
- 7. Bridge Engineering Bindra S P D publisher DhanpatRai& Co.

## **Reference Books:**

- 1. R. Rajagopalan, "Bridge Superstructure", Tata McGraw- Hills Publishing Company Limited.
- 2. Chen Wai-Fah, Duan Lian, Bridge Engineering Handbook Fundamentals, CRC Press.
- 3. Chen Wai-Fah, Duan Lian, Bridge Engineering Handbook Superstructure Design,CRC Press.
- 4. Chen Wai-Fah, Duan Lian, Bridge Engineering Handbook Construction & Maintenance, CRC Press.
- 5. Chen Wai-Fah, Duan Lian, Bridge Engineering Handbook Seismic Design, CRC Press.
- 6. Chung C. Fu, Wang Shuqing, Computational Analysis & Design of Bridge Structures,

# 20 Marks

#### 80 Marks
# CRC Press.

7. NPTEL

Semester II				
Course Code	Subject Name	Credits		
STRILE2011	Institute Level Elective-II	03		
	Project Management			

		Credits	Assigned			
Theory	ory Practical Tuto		Theor yPracticalTutorialTo			Total
03			03			03

### **Evaluation Scheme**

Theory					Term w	<b>T</b> -4-1		
Intern Test 1	nal Assess Test 2	ment Avg	End Sem Exam	Duration of End Sem Exam	TW	PR	OR	l otal Marks
20	20	20	80	03 Hrs.				100

- To familiarize the students with the use of a structured methodology/approach for eachand every unique project undertaken, including utilizing project management concepts, tools and techniques.
- To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

	Detailed Syllabus	
Module	Course Module / Contents	Hrs
Ι	<b>Project Management Foundation:</b> Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
Π	<b>Initiating Projects:</b> How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6

TTT	During A Discursion and Cale during					
111	Project Planning and Scheduling:					
	Work Breakdown structure (WBS) and linear responsibility chart,					
	Interface					
	Co-ordination and concurrent engineering, Project cost estimation and	8				
	budgeting, Top down and bottoms up budgeting, Networking and	Ū				
	Scheduling techniques. PERT, CPM, GANTT chart. Introduction to					
	Project Management Information System (PMIS).					
IV	Planning Projects:					
	Crashing project time, Resource loading and leveling, Goldratt's critical					
	chain, Project Stakeholders and Communication plan.					
	Risk Management in projects: Risk management planning, Risk	6				
	identification and risk register. Qualitative and quantitative risk					
	assessment, Probability and impact matrix. Risk response strategies for					
	positive and negative risks					
V	Executing Projects:					
	Planning monitoring and controlling cycle. Information needs and					
	reporting, engaging with all stakeholders of the projects.					
	Team management, communication and project meetings.					
	Monitoring and Controlling Projects:	0				
	Earned Value Management techniques for measuring value of work	ð				
	completed; Using milestones for measurement; change requests and scope					
	creep. Project audit.					
	Project Contracting					
	Project procurement management, contracting and outsourcing,					
VI	Project Leadership and Ethics:					
	Introduction to project leadership, ethics in projects.					
	Multicultural and virtual projects.					
	Closing the Project:					
	Customer acceptance; Reasons of project termination, Various types of	6				
	project terminations (Extinction, Addition, Integration, Starvation),	U				
	Process of project termination, completing a final report; doing a lessons					
	learned analysis; acknowledging successes and failures; Project					
	management templates and other resources; Managing without authority;					
	Areas of further study.					

## **Contribution to Outcomes**

Students will be able to:

- Apply selection criteria and select an appropriate project from different options.
- Write work break down structure for a project and develop a schedule based on it.
- Identify opportunities and threats to the project and decide an approach to deal with them strategically.
- Use Earned value technique and determine & predict status of the project.
- Capture lessons learned during project phases and document them for future reference

### Internal Assessment:

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

## **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 9. Question paper will comprise of **six** questions; each carrying 20 marks.
- 10. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 11. The students will have to attempt any **four** questions out of **total six** questions.

The questions can be of mixed nature irrespective of modules

- 1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7<sup>th</sup>Ed.
- 2. A Guide to the Project Management Body of Knowledge (PMBOK<sup>®</sup> Guide), 5<sup>th</sup> Ed, Project Management Institute PA, USA
- 3. Gido Clements, Project Management, Cengage Learning.
- 4. Gopalan, Project Management, , Wiley India
- 5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Semester II					
Course Code	Course Name	Credits			
STRILE2012	Institute Level Elective-II	03			
	Finance Management				

	Credits Assigned						
Theory	Practical	Tutorial	Theor y	Practical	Tutorial	Total	
03			03			03	

## **Evaluation Scheme**

Theory				Term work / Practical / Oral				
Internal Assessment			End Duration					Total
			Som	of End	тм	DD	OP	Total Morke
Test 1	Test 2 A	2 Avg	Avg Exam	Sem	1 **	IK	UK	
				Exam				
20	20	20	80	03 Hrs.				100

- Overview of Indian financial system, instruments and market
- Basic concepts of value of money, returns and risks, corporate finance, working capitaland its management
- Knowledge about sources of finance, capital structure, dividend policy

	Detailed Syllabus	
Module	Course Module / Contents	Hrs
Ι	<ul> <li>Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.</li> <li>Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</li> <li>Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</li> <li>Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</li> </ul>	06
Π	Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two- security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
III	<b>Overview of Corporate Finance:</b> Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.	09

	Financial Ratio Analysis: Overview of Financial Statements—	
	Balance Sheet, Profit and Loss Account, and Cash Flow	
	Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios;	
	Efficiency or Activity Ratios; Profitability Ratios; Capital	
	Structure Ratios; Stock Market Ratios; Limitations of Ratio	
	Analysis.	
IV	Capital Budgeting: Meaning and Importance of Capital	
	Budgeting; Inputs for Capital Budgeting Decisions; Investment	
	Appraisal Criterion—Accounting Rate of Return, Payback Period,	
	Discounted Payback Period, Net Present Value(NPV),	
	Profitability Index, Internal Rate of Return (IRR), and Modified	
	Internal Rate of Return (MIRR)	10
	Working Capital Management: Concepts of Meaning Working	10
	Capital; Importance of Working Capital Management; Factors	
	Affecting an Entity's Working Capital Needs; Estimation of	
	Working Capital Requirements; Management of Inventories;	
	Management of Receivables; and Management of Cash and	
	Marketable Securities.	
V	Sources of Finance: Long Term Sources-Equity, Debt, and	
	Hybrids; Mezzanine Finance; Sources of Short Term Finance-	
	Trade Credit, Bank Finance, Commercial Paper; Project Finance.	
	Capital Structure: Factors Affecting an Entity's Capital	
	Structure; Overview of Capital Structure Theories and	05
	Approaches- Net Income Approach, Net Operating Income	
	Approach; Traditional Approach, and Modigliani-Miller	
	Approach. Relation between Capital Structure and Corporate	
	Value; Concept of Optimal Capital Structure	
VI	Dividend Policy: Meaning and Importance of Dividend Policy;	
	Factors Affecting an Entity's Dividend Decision; Overview of	02
	Dividend Policy Theories and Approaches—Gordon's Approach,	03
	Walter's Approach, and Modigliani-Miller Approach	

### **Contribution to Outcomes**

Students will be able to...

- Understand Indian finance system and corporate finance
- Take investment, finance as well as dividend decisions

### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

### **Theory Examination:**

- 1. Question paper will comprise of six questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.

3. The students will have to attempt any **four** questions out of **total six** questions.

The questions can be of mixed nature irrespective of modules

- 1. Fundamentals of Financial Management, 13<sup>th</sup> Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
- 2. Analysis for Financial Management, 10<sup>th</sup> Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
- 3. Indian Financial System, 9<sup>th</sup> Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.

	Semester II	
Course Code	Course Name	Credits
STRIL201	Institute level Elective-II	03
3	Entrepreneurship	
	<b>Development and Management</b>	
	Teaching Scheme	÷

Teaching Scheme							
Contact Hours			Credits Assigned				
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total	
03			03			03	

### **Evaluation Scheme**

Theory				Term v	work / Prac	tical / Oral			
Inte	Internal Assessment		<b>End</b> Duration					Total	
Test	Test Test		Sem Exam Sem	тw	PR	OR	Marks		
1	2	Avg		Exam	Exam	am Sem			011
-	-			Exam					
20	20	20	80	03 Hrs.				100	

- To acquaint with entrepreneurship and management of business
- Understand Indian environment for entrepreneurship
- Idea of EDP, MSME

Detailed Syllabus					
Module	Course Module / Contents	Hrs			
Ι	<b>Overview Of Entrepreneurship:</b> Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04			
Π	<ul> <li>Business Plans And Importance Of Capital To Entrepreneurship:</li> <li>Preliminary and Marketing Plans, Management and Personnel, Start-up</li> <li>Costs and Financing as well as Projected Financial Statements, Legal</li> <li>Section, Insurance, Suppliers and Risks, Assumptions and Conclusion,</li> <li>Capital and its Importance to the Entrepreneur</li> <li>Entrepreneurship And Business Development: Starting a New</li> <li>Business, Buying an Existing Business, New Product Development,</li> <li>Business Growth and the Entrepreneur Law and its Relevance to Business</li> <li>Operations</li> </ul>	09			
III	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises.	05			

IV	Indian Environment for Entrepreneurship: key regulations and legal	
	aspects, MSMED Act 2006 and its implications, schemes and policies of	
	the Ministry of MSME, role and responsibilities of various government	
	organisations, departments, banks etc., Role of State governments in terms	08
	of infrastructure developments and support etc., Public private	
	partnerships, National Skill development Mission, Credit Guarantee Fund,	
	PMEGP, discussions, group exercises etc	
V	Effective Management of Business: Issues and problems faced by micro	
	and small enterprises and effective management of M and S enterprises	00
	(risk management, credit availability, technology innovation, supply chain	Vð
	management, linkage with large industries), exercises, e-Marketing	
VI	Achieving Success In The Small Business: Stages of the small business	
	life cycle, four types of firm-level growth strategies, Options – harvesting	05
	or closing small business Critical Success factors of small business	

### **Contribution to Outcomes:**

Students will be able to...

- Understand the concept of business plan and ownerships
- Interpret key regulations and legal aspects of entrepreneurship in India
- Understand government policies for entrepreneurs

### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

## **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of six questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of **mixed nature** irrespective of modules

- 1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
- 2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
- 3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
- 4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
- 5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
- 6. MaddhurimaLall, ShikahSahai, Entrepreneurship, Excel Books
- 7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad

- 8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
- 9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
- 10. Laghu Udyog Samachar
- 11. www.msme.gov.in
- 12. www.dcmesme.gov.in
- 13. www.msmetraining.gov.in

Semester II					
Course Code	Course Name	Credits			
STRIL2014	Institute level Elective -II	03			
	Human Resource Management				

C	ontact Hours		(	Credits Assign	ed		
Theory	Practical	Tutoria l	Theory	Practical	Tutoria l	Total	
03			03			03	
Evaluation Scheme							

Theory					Term work / Practical / Oral			Tradi
Inter Test 1	nal Asser Test 2	ssment Averag e	End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Marks
20	20	20	80	03 Hrs.				100

- To introduce the students with basic concepts, techniques and practices of the human resource management.
- To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
- To familiarize the students about the latest developments, trends & different aspects of HRM.
- To acquaint the student with the importance of inter-personal & inter-group behavioralskills in an organizational setting required for future stable engineers, leaders and managers.

	Detailed Syllabus				
Module	Course Module / Contents	Hrs			
Ι	Introduction to HR Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5			
Π	Organizational Behavior (OB) Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);	7			

	Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team.	
III	Organizational Structure &Design Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
IV	Human resource Planning Recruitment and Selection process, Job-enrichment, Empowerment - Job- Satisfaction, employee morale. Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. Training & Development: Identification of Training Needs, Training Methods	5
V	<b>Emerging Trends in HR</b> Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
VI	<ul> <li>HR &amp; MIS</li> <li>Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&amp;D, Public Transport, Hospitals, Hotels and service industries</li> <li>Strategic HRM</li> <li>Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals</li> <li>Labour Laws &amp; Industrial Relations</li> <li>Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</li> </ul>	10

## **Contribution to Outcomes:**

Students will be able to:

- Understand the concepts, aspects, techniques and practices of the human resourcemanagement.
- Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
- Gain knowledge about the latest developments and trends in HRM.
- Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

#### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

### **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of six questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of **mixed nature** irrespective of modules

- 1. Stephen Robbins, Organizational Behavior, 16<sup>th</sup> Ed, 2013
- 2. V S P Rao, Human Resource Management, 3<sup>rd</sup> Ed, 2010, Excel publishing
- 3. Aswathapa, Human resource management: Text & cases, 6<sup>th</sup> edition, 2011
- 4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15<sup>th</sup> Ed, 2015, Himalaya Publishing, 15<sup>th</sup>edition, 2015
- 5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5<sup>th</sup> Ed, 2013, Himalaya Publishing
- 6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Semester II					
Course Code	Course Name	Credits			
STRILE2015	Institute level Elective - II	03			
	Professional Ethics and CSR				

Co	Credits Assigned						
Theory	Practical	Tutorial	Theory	Practica l	Tutorial	Total	
03			03			03	
Evaluation Scheme							

Theory					Term wo				
Internal Assessment		<b>Duration of</b>					Total		
Test 1	Test	Average	End Sem Exam	End Sem	TW	PR	OR	Marks	
	2			Exam					
20	20	20	80	03 Hrs.				100	

## **Objectives:**

- To understand professional ethics in business ٠
- To recognized corporate social responsibility •

	Detailed Syllabus	
Module	Course Module / Contents	Hrs
I	<b>Professional Ethics and Business:</b> The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
п	<ul> <li>Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy</li> <li>Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources</li> </ul>	08
III	<ul> <li>Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy</li> <li>Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.</li> </ul>	06
IV	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
V	<b>Corporate Social Responsibility:</b> Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP)	08
VI	<b>Corporate Social Responsibility in Globalizing India:</b> Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry	08

of Corporate Affairs, Government of India, Legal Aspects of Corporate	
Social Responsibility—Companies Act, 2013.	

#### **Contribution to outcomes**

Students will be able to...

- Understand rights and duties of business
- Distinguish different aspects of corporate social responsibility
- Demonstrate professional ethics
- Understand legal aspects of corporate social responsibility

#### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

### **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of six questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of mixed nature irrespective of modules

- 1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
- 2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
- 3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
- 4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Semester II				
Course Code	Course Name	Credits		
STRILE2016	Institute level Elective - II	03		
	Research Methodology			

<b>Contact Hours</b>				Credits A	ssigned	
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
03			03			03

### **Evaluation Scheme**

Theory				Term v	vork / Pract	ical / Oral		
Intern	ernal Assessment		E J C	<b>Duration</b> of				Total
Test 1	Test 2	Average	End Sem Exam	End Sem Exam	TW	PR	OR	Marks
20	20	20	80	03 Hrs.				100

- To understand Research and Research Process
- To acquaint students with identifying problems for research and develop research strategies
- To familiarize students with the techniques of data collection, analysis of data and interpretation

	Detailed Syllabus	
Module	Course Module / Contents	Hrs
	Introduction and Basic Research Concepts	
	Research – Definition; Concept of Construct, Postulate, Proposition, Thesis,	
	Hypothesis, Law, Principle. Research methods vs Methodology	
т	Need of Research in Business and Social Sciences	00
L	Objectives of Research	09
	<b>Issues</b> and Problems in Research	
	Characteristics of Research: Systematic, Valid, Verifiable, Empirical and	
	Critical	
	Types of Research	
	Basic Research	
	Applied Research	
II	Descriptive Research	07
	Analytical Research	
	Empirical Research	
	<b>2.6</b> Qualitative and Quantitative Approaches	
	Research Design and Sample Design	
TTT	Research Design – Meaning, Types and Significance	07
	Sample Design – Meaning and Significance Essentials of a good sampling	07
	Stages in Sample Design Sampling methods/techniques Sampling Errors	

	Research Methodology	
	4.1 Meaning of Research Methodology	
117	<b>4.2</b> . Stages in Scientific Research Process:	00
1 V	a. Identification and Selection of Research Problem	Võ
	<b>b.</b> Formulation of Research Problem	
	<b>c.</b> Review of Literature	
	<b>d.</b> Formulation of Hypothesis	
	e. Formulation of research Design	
	f. Sample Design	
	g. Data Collection	
	h. Data Analysis	
	i. Hypothesis testing and Interpretation of Data	
	j. Preparation of Research Report	
	Formulating Research Problem	
V	<b>5.1</b> Considerations: Relevance, Interest, Data Availability, Choice of data,	04
	Analysis of data, Generalization and Interpretation of analysis	
	Outcome of Research	
VI	Preparation of the report on conclusion reached	04
	Validity Testing & Ethical Issues	••
	Suggestions and Recommendation	

### Outcomes

Students will be able to:

- Prepare a preliminary research design for projects in their subject matter areas
- Accurately collect, analyze and report data
- Present complex data or situations clearly
- Review and analyze research findings

### Internal Assessment:

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

## **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of **six** questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of **mixed nature** irrespective of modules

## **References:**

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.

- 2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
- 3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2<sup>nd</sup>ed), Singapore, Pearson Education

Semester II				
Course Code	Course Code Course Name			
STRILE2017	STRILE2017 Institute level Elective-II			
	IPR & Patenting			

Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutoria l	Total
03			03			03
Evaluation Scheme						

Theory					Tern	n work / P Oral	Practical /	T-4-1
Internal	Assessm	ent	ntEndDuration ofSemEnd SemTW		OR	l otal Marks		
1 est 1	1 est 2	t 2 Avg Exam Exam						
20	20	20	80	03 Hrs.				100

- To understand intellectual property rights protection system
- To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
- To get acquaintance with Patent search and patent filing procedure and applications

Detailed Syllabus				
Module	Course Module / Contents	Hrs		
Ι	<ul> <li>Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc.</li> <li>Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development</li> </ul>	05		
II	<ul> <li>Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement</li> <li>Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.</li> </ul>	07		
III	<b>Emerging Issues in IPR:</b> Challenges for IP in digital economy, e- commerce, human genome, biodiversity and traditional knowledge etc.	05		
IV	<b>Basics of Patents:</b> Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while	07		

	patenting, Patent specification Patent claims, Disclosures and non-				
	disclosures, Patent rights and infringement, Method of getting a patent				
	Patent Rules: Indian patent act, European scenario, US scenario, Australia				
V	scenario, Japan scenario, Chinese scenario, Multilateral treaties where India				
	is a member (TRIPS agreement, Paris convention etc.)				
	Procedure for Filing a Patent (National and International): Legislation				
	and Salient Features, Patent Search, Drafting and Filing Patent Applications,				
VI Processing of patent, Patent Litigation, Patent Publication etc, Time frame					
	and cost, Patent Licensing, Patent Infringement				
	Patent databases: Important websites, Searching international databases				

### **Contributions to Outcomes:**

Students will be able to ...

- understand Intellectual Property assets
- assist individuals and organizations in capacity building
- work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

### Internal Assessment:

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

## **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of six questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of **mixed nature** irrespective of modules

## **Reference Books:**

- 1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
- 2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
- 3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
- 4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
- Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7<sup>th</sup> Edition, Sweet & Maxwell
- LousHarns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3<sup>rd</sup> Edition, WIPO

- 7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
- 8. R Radha Krishnan & S Balasubramanian,2012,Intellectual Property Rights, 1st Edition,Excel Books
- 9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
- 10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
- 11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
- 12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
- 13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
- 14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
- 15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Semester II				
Course Code Course Name Credits				
STRILE2018	STRILE2018 Institute Level Elective - II			
	Digital Business Management			

	Credits Assigned					
Theory Practical Tutorial		Theory	Practical	Tutorial	Total	
03			03			03

### **Evaluation Scheme**

Theory					Term work / Practical / Oral			
Internal Assessment		Fnd	Duration				Total Marks	
Test 1	Test 2	Avg	Sem Exam	of End Sem Exam	TW	PR	OR	i otar ivrarks
20	20	20	80	03 Hrs.				100

- To familiarize with digital business concept
- To acquaint with E-commerce
- To give insights into E-business and its strategies

Detailed Syllabus						
Module	Course Module / Contents	Hrs				
I	<ul> <li>Introduction to Digital Business- Introduction, Background and current status, E-market places, structures mechanisms, economics and impacts</li> <li>Difference between physical economy and digital economy,</li> <li>Drivers of digital business- Big Data &amp; Analytics, Mobile, Cloud Computing Social media, BYOD, and Internet of Things(digitally intelligen machines/services)</li> <li>Opportunities and Challenges in Digital Business,</li> </ul>	5, 9, 09				
II	<ul> <li>Overview of E-Commerce</li> <li>E-Commerce- Meaning, Retailing in e-commerce-products and services consumer behavior, market research and advertisement</li> <li>B2B-E-commerce-selling and buying in private e-markets, public B2I exchanges and support services, e-supply chains, Collaborative Commerce Intra business EC and Corporate portals</li> <li>Other E-C models and applications, innovative EC System-From E government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethic and Societal impacts of EC</li> </ul>	S, B S, <b>06</b> g d e s				
Ш	<b>Digital Business Support services</b> : ERP as e –business backbone, knowledge Tope Apps, Information and referral system <b>Application Development:</b> Building Digital business Applications and Infrastructure	06				

IV	Managing E-Business-Managing Knowledge, Management skills for e- business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
V	<b>E-Business Strategy</b> -E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
VI	Materializinge-business:FromIdeatoRealization-Businessplanpreparationcase Studies and presentations </th <th>08</th>	08

### **Contributions to Outcomes:**

Students will be able to:

- Identify drivers of digital business
- Illustrate various approaches and techniques for E-business and management
- Prepare E-business plan

### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

## **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of six questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of mixed nature irrespective of modules

- 1. A textbook on E-commerce, Er. Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
- 2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
- 3. Digital Business and E-Commerce Management, 6<sup>th</sup> Ed, Dave Chaffey, Pearson, August 2014
- 4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
- 5. Digital Business Concepts and Strategy, Eloise Coupey, 2<sup>nd</sup> Edition, Pearson
- 6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
- 7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
- 8. E-Governance-Challenges and Opportunities in : Proceedings in 2<sup>nd</sup> International Conference theory and practice of Electronic Governance

- 9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
- 10. Measuring Digital Economy-A new perspective -OECDPublishing

Semester II					
<b>Course Code</b>	Course Name	Credits			
STRILE2019	Institute level Elective-II	03			
	Environmental Management				

Teaching	Scheme
Tracinne	Schund

T cuching benefite									
	<b>Contact Hours</b>	Credits Assigned							
Theory Practical		Tutorial	Theory	Practical Tutorial		Total			
03			03			03			

### **Evaluation Scheme**

Theory					Term			
Internal Assessment End Duration		Duration				Total		
Test 1	Test 2	Avg	Sem Exam	of End Sem Exam	TW	PR	OR	Marks
20	20	20	80	03 Hrs.				100

- Understand and identify environmental issues relevant to India and global concerns
- Learn concepts of ecology
- Familiarise environment related legislations

Detailed Syllabus						
Module	Course Module / Contents	Hrs				
I	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10				
П	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06				
III	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05				
IV	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10				
V	Total Quality Environmental Management, ISO-14000, EMS certification.	05				
VI	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03				

### **Contribution to Outcomes**

Students will be able to...

- Understand the concept of environmental management
- Understand ecosystem and interdependence, food chain etc.
- Understand and interpret environment related legislations

### **Internal Assessment:**

The internal assessment consists of two tests, i.e., mid-semester and end semester. The learner/s shall be asked to appear for the either tests. However, at least one test is mandatory and the learner/s may be asked to undertake the completion of assignment on live problems or course project instead of another test, solely at the discretion of the course instructor.

### **End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

- 1. Question paper will comprise of six questions; each carrying 20 marks.
- 2. There can be an **internal** choice in various sub-questions/ questions in order to accommodate the questions on all the topics/ sub-topics.
- 3. The students will have to attempt any **four** questions out of **total six** questions.
- 4. The questions can be of **mixed nature** irrespective of modules

- 1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
- 2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
- 3. Environmental Management, T V Ramachandra and Vijay Kulkarni, TERI Press
- 4. Indian Standard Environmental Management Systems Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
- 5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
- 6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
- 7. Environment and Ecology, Majid Hussain, 3<sup>rd</sup> Ed. Access Publishing.2015

Semester II						
Course Code	Course Name	Credits				
STRL201	Program Lab-II	01				

Teaching Scheme							
Contact Hours			Credits Assigned			d	
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total	
-	2	-	-	1	-	01	

Evaluation Scheme								
Theory Term Work/ Practical/Oral								
In Test 1	ternal As Test 2	ssessment Average	End Sem Exam	Duration of End Sem Exam	TW	PR	OR	Total
-	-	-	-	-	25	-	25	50

## Objectives

- Apply spreadsheet (excel or other) tools to simplify complex civil engineering problems
- Study of the Software used for analysis and design of structures
- Write technical papers in reputed journals
- Summarizes technical articles

Detailed Syllabus					
Module	Course Module / Contents	Hrs			
I	<b>Material testing laboratory</b> : Revision of Tests on Cement, Aggregates, Fresh concrete, Destructive / Non-destructive Tests related with determination of various material properties related with construction.	04			
п	<b>Computer applications</b> Basic fundamentals of coding, Application of EXCEL spreadsheets in analysis of structural members. Use of various software available for Analysis and Design of Structures. (SAP/ ANSYS/ ETABS/ STAAD Pro) is recommended.	04			
III	The analysis and design of the structures containing anyone of building (G+2) or bridges or industrial truss or transmission tower. The comprehensive report of the analysis and design of the selected structure.	08			
IV	Summarizing two articles related to Structural engineering from reputed technical journals	04			

### **Contribution to Outcomes**

Students will be able to:

- understand the physics of the problem
- understand codal provisions and its applications.
- learn various software in Analysis and design of structures.
- be familiar with hands on practice.
- apply spreadsheet (excel or other) tools to simplify complex civil engineering problems

Semester II						
Course Code	Course Name	Credits				
STRSBL201	Skill Based Lab-II	02				

Teaching Scheme						
Contact Hours			Credits Assigned			
Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
-	4	-	-	2	-	02

Evaluation Scheme								
Theory				Term Work/				
Internal Assessment			End Sem	Duration of	<b>F</b> I3			Total
Test 1	Test 2	Average	Exam	End Sem Exam	TW	PR	OR	
-	-	-	-	-	50	-	50	100

### **Course Objectives**

- Understand the Concept of coding algorithm.
- Study the Various Structural Analysis and Design Software used in Construction Industry

Detailed Syllabus					
Module	Course Module / Contents	Hrs			
Ι	Learners should be asked to develop the Finite Element program for analyzing structural members like beams, columns, slabs, trusses, frames etc	09			
II	Learners should be asked to analyze and design some of the structures involved in the courses they studied and submit the report.	11			
<b>Term Work:</b> At least one Project Assignment must be prepared in mention software of each module required to Submit for Term work Assessment & Viva Exam.					

## **Contribution to Outcomes**

Students will be able to:

- Basic concepts of developing the coding algorithm.
- Use the analysis and design software.

## **Recommended Books & Journal**

1) All reputed National/international Structural Engineering Journals

2) Available analysis and design software