VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELAGAVI

Scheme of Teaching and Examinations and Syllabus

M.Tech Structural Engineering (CSE)

(Effective from Academic year 2020 - 21)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2020 - 21
M. Tech. STRUCTURAL ENGINEERING (CSE)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical	Skill Development Activities (SDA)	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20CSE11	Advanced structural analysis	03	--	02	03	40	60	100	4
2	PCC	20CSE12	Matrix methods of Structural Analysis	03	--	02	03	40	60	100	4
3	PCC	20CSE13	Advanced Design of RC Structures	03	--	02	03	40	60	100	4
4	PCC	20CSE14	Mechanics of Deformable Bodies	03	--	02	03	40	60	100	4
5	PCC	20CSE15	Structural Dynamics	03	--	02	03	40	60	100	4
6	PCC	20CSEL16	Structural Engineering Lab -1	--	04	--	03	40	60	100	2
7	PCC	20RMI17	Research Methodology and IPR	02	--	--	03	40	60	100	2
			TOTAL	**17**	**04**	**10**	**21**	**280**	**420**	**700**	**24**

Note: PCC: Professional core.

Skill development activities:
Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.
The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.
The students shall
(1) Gain confidence in modelling of systems and algorithms.
(2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
(3) Handle advanced instruments to enhance technical talent.
(4) Involve in case studies and field visits/ field work.
(5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.
All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.
(ii) Three credit courses are designed for 40 hours Teaching – Learning process.

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M. Tech. STRUCTURAL ENGINEERING (CSE)
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II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Cr
				Theory	Practical/ seminar	Skill Development Activities (SDA)	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20CSE21	Advanced Design of Steel Structures	03	--	02	03	40	60	100	4
2	PCC	20CSE22	Finite Element Method of Analysis	03	--	02	03	40	60	100	4
3	PCC	20CSE23	Earthquake resistant Structures	03	--	02	03	40	60	100	4
4	PEC	20CSE24X	Professional elective 1	04	--	--	03	40	60	100	4
5	PEC	20CSE25X	Professional elective 2	04	--	--	03	40	60	100	4
6	PCC	20CSEL26	Structural Engineering Lab-2	--	04	--	03	40	60	100	2
7	PCC	20CSE27	Technical Seminar	--	02	--	--	100	--	100	2
TOTAL				**17**	**06**	**06**	**18**	**340**	**360**	**700**	**24**

Note: PCC: Professional core, PEC: Professional Elective.

Professional Elective 1		**Professional Elective 2**	
Course Code under 20CSE24X	**Course title**	**Course Code under 20CSE25X**	**Course title**
20CSE241	Analysis and Design of Plates and Shells	20CSE251	Design of Industrial Structures
20CSE242	Design of Precast & Composite Structures	20CSE252	Advances in Artificial Intelligence
20CSE243	Advanced Concrete Technology	20CSE253	Structural Health Monitoring
20CSE244	Advanced Design of Pre-stressed Concrete Structures	20CSE254	Design of Tall structures

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. A University examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

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III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ Mini –Project/ Internship	Skill Development activities (SDA)	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PCC	20CSE31	Design of Bridges	03	--	02	03	40	60	100	4
2	PEC	20CSE32X	Professional elective 3	03	--	--	03	40	60	100	3
3	PEC	20CSE33X	Professional elective 4	03	--	--	03	40	60	100	3
4	Project	20CSE34	Project Work phase -1	--	02	--	--	100	--	100	2
5	PCC	20CSE35	Mini-Project	--	02	--	--	100	--	100	2
6	Internship	20CSEI36	Internship	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)			03	40	60	100	6
TOTAL				**09**	**04**	**02**	**12**	**360**	**240**	**600**	**20**

Note: **PCC: Professional core, PEC: Professional Elective.**

Professional elective 3		**Professional elective 4**	
Course Code under 20CSE32X	**Course title**	**Course Code under 20CSE33X**	**Course title**
20CSE321	Design Concepts of Substructures	20CSE331	Fracture Mechanics for Structural Engineering
20CSE322	Optimization Techniques	20CSE332	Design of Masonry Structures
20CSE323	Stability of Structures	20CSE333	Retrofitting And Rehabilitation Of Structures
20CSE324	Reliability Analysis of Structures	20CSE334	Green Building Technology

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (University examination) shall be as per the University norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI Scheme of Teaching and Examinations – 2020 - 21 M. Tech. STRUCTURAL ENGINEERING (CSE) Choice Based Credit System (CBCS) and Outcome Based Education(OBE)										
IV SEMESTER										
Sl. No	**Course**	**Course Code**	**Course Title**	**Teaching Hours /Week**		**Examination**				**Credits**
				Theory	**Practical/ Field work**	**Duration in hours**	**CIE Marks**	**SEE Marks Viva voce**	**Total Marks**	
1	Project	20CSE41	Project work phase -2	--	04	03	40	60	100	20
			TOTAL	--	**04**	**03**	**40**	**60**	**100**	**20**

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HOD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

<table>
<tr><td colspan="4" align="center">ADVANCED STRUCTURAL ANALYSIS
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II</td></tr>
<tr><td>Subject Code</td><td>20CSE11</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Teaching Hours/Week (L:P:SDA)</td><td>4:0:0</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>50</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 04</td></tr>
</table>

Prerequisites:

- Strength of Materials
- Structural Analysis

Course objectives:

Students will be given provided with the knowledge of mathematics, science, and engineering in the in the analysis of following structural systems curved beams, Beams on elastic foundation, shear centre and unsymmetrical bending and buckling of non-prismatic columns and beam column.

Modules	Teaching Hours	RBT Level
Module-1		
Curved Beams Curved beams, Introduction, assumptions, derivation of WINKLER BACH equation, Radius to the neutral surface of simple geometric figures, Limitation, Stress distribution in open curved members such as Hooks and chain links, Stress distribution in closed rings and chain links. Deformations of open and closed rings.	**10 Hours**	
Module-2		
Beams on Elastic Foundations Governing differential equation for elastic line, Interpretation of constants, Infinite beam with point load, moment & UDL with problems. Semi-infinite beams with point load and moment UDL with problems over fixed and hinged support conditions.	**10 Hours**	

Module -3		
Shear Centre Concept of shear center in torsion induced bending of beams, expression to the Shear Centre for Symmetrical and Unsymmetrical Sections, Derivation of shear centre for angles, channel, semicircular and built-up sections with numerical problems	**10 Hours**	
Module -4		
Unsymmetrical Bending (Asymmetrical Bending) Theory behind unsymmetrical bending, Assumptions, obtaining the stresses in beams, simply supported and cantilever unsymmetrical beams subjected to inclined loading, Deflections of unsymmetrical simply supported and cantilever beams with numerical problems.	**10 Hours**	
Module -5		
Buckling of Non Prismatic Columns and Beam-Column Principle behind Euler's theory of buckling, Governing differential equation applied to buckling of columns and evaluation of constants for various boundary conditions, Obtaining the characteristic equation for the buckling load of non-prismatic compound columns, Analysis of Beam-column, conceptual theory of magnification stresses and deformations subjected to axial and different types of lateral loads with numerical problems.	**10 Hours**	

Course Outcomes: Students will be able to

- Apply Winkler Bach and Strain Energy principles to obtain stresses and deformation in curved members
- Derive the expressions to Foundation pressure, Deflection, Slope, BM and SF of infinite and semi-infinite Beams resting on Elastic Foundation
- Obtain the equations for the shear centre for symmetrical and unsymmetrical from fundamental.
- Extrapolate the bending theory to calculate the stresses and deformations in unsymmetrical bending.
- Develop the characteristic equation for the buckling load of compound column and stresses and deformations in beam-column

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Text Books

1) Krishna Raju N & Gururaj D R "Advanced mechanics of solids and structures", NAROSA Publishers Company Delhi.
2) Srinath L.S. "Advanced Mechanics of Solids", Tenth Print, Tata McGraw Hill publishing company. New Delhi, 1994.

Reference Books

1) Vazirani V N and Ratwani M M "Advanced theory of structures and Matrix Method". 5th Edition, Khanna publishers, Delhi 1995.
2) HetenyiM."Beams on elastic foundation" 3rd printing, University of Michigan, USA, 1952.
3) Alexander Chatjes "Principles of Structural stability theory", Prentice – Hall of India, New Delhi, 1974.
4) Sterling Kinney "Indeterminate Structural Analysis", Oxford & IBH publishers

<table>
<tr><td colspan="4" align="center">Matrix methods of Structural Analysis
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I</td></tr>
<tr><td>Subject Code</td><td align="center">20CSE12</td><td>CIE Marks</td><td align="center">40</td></tr>
<tr><td>Teaching Hours/Week (L:P:SDA)</td><td align="center">3:0:2</td><td>SEE Marks</td><td align="center">60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td align="center">40</td><td>Exam Hours</td><td align="center">03</td></tr>
<tr><td colspan="4" align="center">CREDITS – 04</td></tr>
</table>

Prerequisites:

- Engineering Mechanics
- Strength of Materials
- Structural Analysis
- Matrix Algebra

Course objectives:

- To understand basic concepts of Matrix Methods of Structural Analysis
- To analyse the behavior of plane trusses, continuous beams, and portal frames

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Basic concepts of structural analysis and methods of solving simultaneous equations: Introduction, Types of framed structures, Static and Kinematic Indeterminacy, Equilibrium equations, Compatibility conditions, Principle of superposition, Energy principles, Equivalent joint loads, Methods of solving linear simultaneous equations- Gauss elimination method, Cholesky method and Gauss-Siedal method.	**8 Hours**	**L1,L2, L3,L4**
Module-2		
Fundamentals of Flexibility and Stiffness Methods: Concepts of stiffness and flexibility, Local and Global coordinates, Development of element flexibility and element stiffness matrices for truss, beam and grid elements, Force-transformation matrix, Development of global flexibility matrix for continuous beams, plane trusses and 1rigid plane frames, Displacement-transformation matrix, Development of global stiffness matrix for continuous	**8 Hours**	**L1,L2, L3,L4**

beams, plane trusses and rigid plane frames.		
Module-3		
Analysis using Flexibility Method: Continuous beams, plane trusses and rigid plane frames	**8 Hours**	**L2,L3, L4,L5**
Module-4		
Analysis using Stiffness Method: Continuous beams, plane trusses and rigid plane frames	**8 Hours**	**L2,L3, L4,L5**
Module-5		
Direct Stiffness Method: Stiffness matrix for truss element in local and global coordinates, Analysis of plane trusses, Stiffness matrix for beam element, Analysis of continuous beams and orthogonal frames.	**8 Hours**	**L2,L3, L4,L5**

Course outcomes:

Upon completing this course, the students will be able to:

- Formulate force displacement relation by flexibility and stiffness method
- Analyze the plane trusses, continuous beams and portal frames by transformation approach
- Analyse the structures by direct stiffness method

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Weaver, W., and Gere, J.M., ***Matrix Analysis of Framed Structures***, CBS Publishers and distributors Pvt. Ltd., 2004.
2. Rajasekaran, S., and Sankarasubramanian, G., ***Computational Structural Mechanics***, PHI, New Delhi, 2001.
3. Martin, H, C., ***Introduction to Matrix Methods of Structural Analysis***, McGraw-Hill, New York, 1966.
4. Rubinstein, M.F., ***Matrix Computer Analysis of Structures,*** Prentice-Hall, Englewood Cliffs, New Jersey, 1966.
5. Beaufait, F.W., Rowan, W. H., Jr., Hoadely, P. G., and Hackett, R. M., ***Computer Methods of Structural Analysis***, Prentice-Hall, Englewood Cliffs, New Jersey, 1970.
6. Kardestuncer, H., ***Elementary Matrix Analysis of Structures***, McGraw-Hill, New York, 1974.

ADVANCED DESIGN OF RC STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	**20CSE13**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 04

Prerequisites: An undergraduate course on reinforced concrete.

Course objectives:

The objective of this course is to make students to learn principles of Structural Design, to design different types of structures and to detail the structures. To evaluate performance of the structures

Modules	**Teaching Hours**	**RBT Level**
Module-1		
• Design of R C slabs by yield line method • Design of flat slabs	**8 Hours**	**L1, L2, L3, L4, L5**
Module-2		
• Design of grid or coffered floors • Design of continuous beams with redistribution of moments	**8 Hours**	**L1, L2, L3, L4, L5**
Module -3		
• Design of R C Chimneys	**8 Hours**	**L1, L2, L3, L4,**
Module -4		
• Design of R C silos • Design of R C bunkers	**8 Hours**	**L1, L2, L4, L5**
Module -5		
Formwork: Introduction, Requirements of good formwork, Materials for forms, choice of formwork, Loads on formwork, Permissible stresses for timber, Design of formwork, Shuttering for columns, Shuttering for slabs and beams, Erection of Formwork, Action prior to and during concreting, Striking of forms. Recent developments in form work.	**8 Hours**	**L1, L2**

Course outcomes:

On completion of this course, students are able to:

1. Achieve Knowledge of design and development of problem solving skills
2. Understand the principles of Structural Design.
3. Design and develop analytical skills.
4. Summarize the principles of Structural Design and detailing
5. Understands the structural performance.

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Hsu T. T. C. and Mo Y. L., "Unified Theory of Concrete Structures", John Wiley & Sons, 2010
2. Krishnamurthy, K.T., Gharpure S.C. and A.B. Kulkarni – "Limit design of reinforced concrete structures",Khanna Publishers, 1985
3. Lin T Y and Burns N H., "Reinforced Concrete Design". Wiley, 2004
4. Park & Paunlay.,"Reinforced Concrete Structures". Wiley, 2004
5. Punmia B.C, Ashok Kumar Jain and Arun Kumar Jain, "Comprehensive RCC Design", Laxmi Publications, New Delhi
6. Purushothaman. P., "Reinforced Concrete Structural Elements : Behaviour Analysis and Design", TataMc Graw Hill, 1986
7. Sinha. N.C. and Roy S.K., "Fundamentals of Reinforced Concrete", S. Chand and Company Limited, NewDelhi, 2003
8. Unnikrishna Pillai and Devdas Menon., "Reinforced concrete Design', Tata McGraw Hill PublishersCompany Ltd., New Delhi, 2006
9. Varghese, P.C., "Limit State Design of Reinforced Concrete", Prentice Hall of India, 2007
10. Varghese. P. C., "Advanced Reinforced Concrete Design", Prentice-Hall of India, New Delhi, 2000

Recommended Reading:

1. Krishna Raju. N., "Advanced Reinforced Concrete Design", CBS Publishers & Distributors
2. Pillai S. U. and Menon D., "Reinforced Concrete Design", Tata McGraw-Hill, 3rd Ed, 1999
3. Relevant IS Code Books
4. Shah.H.J, "Reinforced Concrete", Vol-1 and Vol-2, Charotar, 8th Edition – 2009 and 6th Edition – 2012 respectively.
5. Gambhir.M.L, "Design of Reinforced Concrete Structures", PHI Pvt. Ltd, New Delhi, 2008

MECHANICS OF DEFORMABLE BODIES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	**20CSE14**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 04

Prerequisites:

Basics of Mathematics, Strength of Materials

Course objectives:

Course objectives: The objective of this course is to make students to learn principles of Analysis of Stress and Strain, To predict the stress-strain behaviour of continuum. To evaluate the stress and strain parameters and their inter relations of the continuum

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Theory of Elasticity: Introduction: Definition of stress and strain and strain at a point, components of stress and strain at appoint of Cartesian and polar coordinates. Constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases.	**8 Hours**	**L1, L2**
Module-2		
Transformation of stress and strain at a point,Principal stresses and principal strains, invariants ofstress and strain, hydrostatic and deviatric stress,spherical and deviatric strains max. shear strain.	**8 Hours**	**L2, L3**
Module -3		
Plane stress and plane strain: Airy's stress function approach to 2-D problems of elasticity, simple problems of bending of beams. Solution of axisymmetric problems, stress concentration due to the presence of a circular hole in plates.	**8 Hours**	**L2, L3**
Module -4		

Elementary problems of elasticity in three dimensions, stretching of a prismatic bar by its own weight, twist of circular shafts, torsion of non-circular sections, membrane analogy, Propagation of waves in solid media. Applications of finite difference equations in elasticity.	**8 Hours**	**L2, L3, L4**
Module -5		
Theory of Plasticity: Stress – strain diagram in simpletension, perfectly elastic, Rigid – Perfectly plastic, Linear work – hardening, Elastic Perfectly plastic, Elastic Linear work hardening materials, Failure theories, yield conditions, stress – space representation of yield criteria through Westergard stress space, Tresca and Von-Mises criteria of yielding	**8 Hours**	**L1, L2**

Course outcomes:

On completion of this course, students are able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of stress-strain behaviour of continuum
- Design and develop analytical skills.
- Describe the continuum in 2 and 3- dimensions
- Understand the concepts of elasticity and plasticity

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Timoshenko &Goodier, "Theory of Elasticity", McGraw Hill
2. Srinath L.S., Advanced Mechanics of Solids, 10th print, Tata McGraw Hill Publishing company, New Delhi, 1994.
3. Sadhu Singh, "Theory of Elasticity", Khanna Publishers
4. Verma P.D.S, "Theory of Elasticity", Vikas Publishing Pvt. Ltd
5. Chenn W.P and Hendry D.J, "Plasticity for Structural Engineers", Springer Verlag
6. Valliappan C, "Continuum Mechanics Fundamentals", Oxford IBH Publishing Co.Ltd.
7. Sadhu Singh, "Applied Stress Analysis", Khanna Publishers
8. Xi Lu, "Theory of Elasticity", John Wiley.

STRUCTURAL DYNAMICS

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – I

Subject Code	**20CSE15**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 04

Course objectives:

The objective of this course is to make students to learn principles ofStructural Dynamics, To implement these principles through different methods and to apply the same for free and forced vibration of structures. To evaluate the dynamic characteristics of thestructures

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Introduction: Introduction to Dynamic problems in Civil Engineering, Concept of degrees of freedom, D'Alembert's principle, principleof virtual displacement and energy principles . Dynamics of Single degree-of-freedom systems: Mathematical models of Single-degree-of-freedom systems system, Free vibration response of damped and undamped systems including methods for evaluation of damping.	**8 Hours**	**L_1, L_2, L_5**
Module-2		
Response of Single-degree-of-freedom systems to harmonic loading including support motion, vibration isolation, transmissibility. Numerical methods applied to Single-degree-of-freedom systems – Duhamel integral. Principle of vibration measuring instruments– seismometer and accelerometer.	**8 Hours**	**L_3, L_4, L_5**
Module -3		
Dynamics of Multi-degree freedom systems: Mathematical models of multi-degree-of-freedom systems, Shear building concept, free vibration of undamped multi-degree-of-freedom systems – Natural frequencies and mode shapes – Orthogonality of modes.	**8 Hours**	**L_1, L_2, L_4, L_5**

<table>
<tr><td>Module -4</td><td></td><td></td></tr>
<tr><td>Response of Shear buildings for harmonic loading without damping using normal mode approach. Response of Shear buildings for forced vibration for harmonic loading with damping using normal mode approach.</td><td>8 Hours</td><td>L_3, L_4, L_5</td></tr>
<tr><td>Module -5</td><td></td><td></td></tr>
<tr><td>Approximate methods: Rayleigh’s method, Dunkarley’s method, Stodola’s method.
Dynamics of Continuous systems: Flexural vibration of beams with different end conditions.
Stiffness matrix, mass matrix (lumped and consistent).</td><td>8 Hours</td><td>L_2, L_4</td></tr>
</table>

Course outcomes:

On completion of this course, students are ableto:

- AchieveKnowledgeofdesignanddevelopmentofproblemsolvingskills.
- Understand the principles of StructuralDynamics
- Design and develop analyticalskills.
- Summarize the Solution techniques for dynamics of Multi-degree freedom systems
- Understand the concepts of damping instructures.

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Dynamics of Structures – “Theory and Application toEarthquakeEngineering”- 2nd ed., Anil K. Chopra, Pearson Education.
2. Earthquake Resistant Design ofBuildingStructures,Vinod Hosur, WILEY (India)
3. Vibrations, structural dynamics- M. Mukhopadhaya : Oxford IBH
4. Structural Dynamics- Mario Paz: CBS publishers.
5. Structural Dynamics- Clough & Penzien: TMH
6. Vibration Problems in Engineering Timoshenko, S, Van-Nostrand Co.

STRUCTURAL ENGINEERING LAB-1 [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	**20CSEL16**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:3:0	SEE Marks	60
Total Number of Lecture Hours	42	Exam Hours	03
CREDITS – 02			

Prerequisites: Concrete Technology, Special Concrete, Structural Analysis, Structural Dynamics

Course objectives:
The objective of this course is to make students to learn principles of design of experiments, To investigate the performance of structural elements. To evaluate the different testing methods and equipments.

Modules	**Teaching Hours**	**RBT Level**
1. Experiments on Concrete, including Mix design	**12 Hrs**	**L1, L2, L3, L4, L5, L6**
2. Testing of beams for deflection, flexure and shear	**12 Hrs**	
3. Experiments on vibration of multi storey frame models for Natural frequency and modes.	**12 Hrs**	
4. Use of Non destructive testing (NDT) equipments – Rebound hammer, Ultra sonic pulse velocity meter and Profometer	**06Hrs**	

Course outcomes: On complete of this course the students will able to

- Achieve Knowledge of design and development of experimenting skills.
- Understand the principles of design of experiments
- Design and develop analytical skills.
- Summarize the testing methods and equipment's.

RESEARCH METHODOLOGY AND IPR

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	**20RMI17**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	2:0:0	SEE Marks	60
Total Number of Lecture Hours	25	Exam Hours	03

CREDITS – 02

Course objectives: At the end of this course, students will be able to:

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

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	**5 Hours**	
Module-2		
Effective literature studies approaches, analysis, Plagiarism, Research ethics.	**5 Hours**	
Module -3		
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	**5 Hours**	

Module -4		
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	**5 Hours**	
Module -5		
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. **New Developments in IPR:** Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	**5 Hours**	

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

References:

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction" Model Curriculum of Engineering & Technology PG Courses [Volume -II] [15]
- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007
- Mayall , "Industrial Design", McGraw Hill, 1992
- Niebel , "Product Design", McGraw Hill, 1974
- Asimov , "Introduction to Design", Prentice Hall, 1962
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

ADVANCED DESIGN OF STEEL STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	**20CSE21**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 04

Prerequisites:

- Engineering Mechanics
- Strength of Materials
- Structural Analysis
- Design of Steel structures

Course objectives: This course will enable students to

1. Understand the background to the design provisions for hot-rolled and cold-formed steel structures, including the main differences between them.
2. Proficiency in applying the provisions for design of columns, beams, beam-columns
3. Design structural sections for adequate fire resistance

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Laterally Unrestrained Beams: Lateral Buckling of Beams, Factors affecting lateral stability, IS 800 code provisions, Design Approach. Lateral buckling strength of Cantilever beams, continuous beams, beams with continuous and discrete lateral restraints ,Mono-symmetric and non-uniform beams – Design Examples. Concepts of -Shear Center, Warping, Uniform and Non-Uniform torsion.	**8 Hours**	
Module-2		
Beam- Columns in Frames: Behaviour of Short and Long Beam - Columns, Effects of Slenderness Ratio and Axial Force on Modes of Failure, Biaxial bending, Strength of Beam Columns, Sway and Non-Sway Frames, Strength and Stability of rigid jointed frames, Effective Length of Columns-, Methods in IS 800 - Examples	**8 Hours**	

Module -3		
Steel Beams with Web Openings: Shape of the web openings, practical guide lines, and Force distribution and failure patterns. Analysis of beams with perforated thin and thick webs, Design of laterally restrained castellated beams for given sectional properties. Vierendeel girders (design for given analysis results)	**8 Hours**	
Module -4		
Cold formed steel sections: Techniques and properties, Advantages, Typical profiles, Stiffened and unstiffened elements, Local buckling effects, effective section properties, IS 801& 811 code provisions-numerical examples, beam design, column design.	**8 Hours**	
Module -5		
Fire resistance: Fire resistance level, Period of Structural Adequacy, Properties of steel with temperature, Limiting Steel temperature, Protected and unprotected members, Methods of fire protection, Fire resistance Ratings. Numerical Examples.	**8 Hours**	

Course outcomes:

After studying this course, students will be able to:

- Able to understand behavior of Light gauge steel members
- Able to understand design concepts of cold formed/unrestrained beams
- Able to understand Fire resistance concept required for present days.
- Able to analyze beam column behavior

Question paper pattern:

IS 800: 2007, IS 801-2010, IS811-1987 and BS5950 – part 8 to be allowed along with Steel Tables in Exam.
The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. N. Subramanian, “Design of Steel Structures”, Oxford, IBH
2. Duggal,S.K. Design of Steel Structures, Tata McGraw-Hill
3. IS 800: 2007, IS 801-2010 , IS 811-1987
4. BS5950 Part- 8,
5. INSDAG Teaching Resource Chapter 11 to 20:www.steel-insdag.org
6. SP 6 (5)-1980

FINITE ELEMENT METHOD OF ANALYSIS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	**20CSE22**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 04

Prerequisites:

- Computational structural Mechanics
- Theory of Elasticity

Course objectives:

- To provide the fundamental concepts of the theory of the finite element method
- To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of softwares

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Basic concepts of elasticity, Kinematic and Static variables for various types of structural problems, approximate methods of structural analysis–Rayleigh–Ritz method, Finite difference method, Finite element method. Variation method and minimization of Energy approach of element formulation, Principles of finite element method, advantages and disadvantages, Finite element procedure, Finite elements used for one, two and three dimensional problems, C0, C1 and C2 type elements, Element aspect ratio, Mesh refinement vs. higher order elements, Numbering of nodes to minimize bandwidth.	**8 Hours**	**L1, L2**
Module-2		
Nodal displacement parameters, Convergence criterion, Compatibility requirements, Geometric invariance, Shape function, Polynomial form of displacement function, Generalized and Natural coordinates, Lagrangian interpolation function, shape functions for one, two &three	**8 Hours**	**L1, L2, L4, L5**

dimensional elements.		
Module -3		
Isoparametric elements, Internal nodes and higher order elements, Serendipity and Lagrangian family of Finite Elements, Sub-parametric and Super- parametric elements, Condensation of internal nodes, Jacobian transformation Matrix, Development of strain-displacement matrix and stiffness matrix, consistent load vector, numerical integration.	**8 Hours**	**L1, L2, L4, L5**
Module -4		
Application of Finite Element Method for the analysis of one & two dimensional problems: Analysis of plane trusses and beams, Application to plane stress/strain, Axisymmetric problems using CST and Quadrilateral Elements	**8 Hours**	**L1, L2, L3, L4, L5**
Module -5		
Application to Plates and Shells, Non-linearity: material, geometric and combined non- linearity, Techniques for Non-linear Analysis.	**8 Hours**	**L1, L2**

Course Outcome:

After successful completion of this the course, students shall be able to:

- Explain the basic theory behind the finite element method.
- Formulate force-displacements relations for 2-D elements
- Use the finite element method to analyze real structures.
- Use a Finite Element based program for structural analysis

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

- Zeinkeiwich, O.C. and Tayler, R.L., The Finite Element Method for Solid and Structural Mechanics, Butterworth-Heinemann,2013
- Krishnamoorthy,C.S., Finite Element Analysis: Theory and programming, Tata McGraw Hill Publishing Co. Ltd., 2017
- Desai, C., and Abel, J. F., Introduction to the Finite Element Method: A Numerical method for Engineering Analysis, East West Press Pvt. Ltd.,1972
- Cook, R.D., Malkas, D.S. and Plesha., M.E., Concepts and applications of Finite Element Analysis, John Wiley and Sons., 2007
- Reddy, J., An Introduction to Finite Element Methods, McGraw Hill Co., 2013
- Bathe K J, Finite Element Procedures in Engineering Analysis, Prentice Hall
- Shames,I.H. and Dym,C.J., Energy and Finite Element Methods in Structural Mechanics, McGraw Hill, New York,1985

EARTHQUAKE RESISTANT STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	**20CSE23**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 04

Prerequisites:

- Structural Dynamics

Course objectives:

The objective of this course is to make students to learn principles of engineering seismology, To design the reinforced concrete buildings for earthquake resistance. To evaluate the seismic response of the structures

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Introduction to engineering seismology, Geological and tectonic features of India, Origin and propagation of seismic waves, characteristics of earthquake and its quantification – Magnitude and Intensity scales, seismic instruments. Earthquake Hazards in India, Earthquake Risk Evaluation and Mitigation. Structural behavior under gravity and seismic loads, Lateral load resisting structural systems, Requirements of efficient earthquake resistant structural system, damping devises, base isolation systems.	**8 Hours**	**L1, L2**
Module-2		
The Response history and strong motion characteristics. Response Spectrum – elastic and inelastic response spectra, tripartite (D-V-A) response spectrum, use of response spectrum in earthquake resistant design. Computation of seismic forces in multi-storied buildings – using procedures (Equivalent lateral force and dynamic analysis) as per IS-1893.	**8 Hours**	**L2, L3, L4, L5**
Module -3		

Structural Configuration for earthquake resistant design, Concept of plan irregularities and vertical irregularities, Soft storey, Torsion in buildings. Design provisions for these in IS-1893. Effect of infill masonry walls on frames, modeling concepts of infill masonry walls. Behaviour of masonry buildings during earthquakes, failure patterns, strength of masonry in shear and flexure, Slenderness concept of masonry walls, concepts for earthquake resistant masonry buildings – codal provisions.	**8 Hours**	**L2, L4, L5**
Module -4		
Design of Reinforced concrete buildings for earthquake resistance-Load combinations, Ductility and energy absorption in buildings. Confinement of concrete for ductility, design of columns and beams for ductility, ductile detailing provisions as per IS1893. Structural behavior, design and ductile detailing of shear walls.	**8 Hours**	**L2, L4, L5**
Module -5		
Seismic response control concepts – Seismic demand, seismic capacity, Overview of linear and nonlinear procedures of seismic analysis. Performance Based Seismic Engineering methodology, Seismic evaluation and retrofitting of structures.	**8 Hours**	**L2, L5, L6**

Course Outcome: On completion of this course, students are able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of engineering seismology
- Design and develop analytical skills.
- Summarize the Seismic evaluation and retrofitting of structures.
- Understand the concepts of earthquake resistance of reinforced concrete buildings.

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Dynamics of Structures – Theory and Application to Earthquake Engineering-2nd ed. – Anil K. Chopra, Pearson Education.

2. Earthquake Resistant Design of Building Structures, Vinod Hosur, WILEY (india)

3. Earthquake Resistant Design of Structures, Duggal, Oxford University Press.

4. Earthquake resistant design of structures - Pankaj Agarwal, Manish Shrikande - PHI India.

5. IS – 1893 (Part I): 2002, IS – 13920: 1993, IS – 4326: 1993, IS-13828: 1993

6. Design of Earthquake Resistant Buildings, Minoru Wakabayashi, McGraw Hill Pub.

7. Seismic Design of Reinforced Concrete and Masonry Buildings, T Paulay and M J N Priestley, John Wiley and Sons.

ANALYSIS AND DESIGN OF PLATES AND SHELLS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	**20CSE241**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites:

Course objectives:

The objective of this course is to make students to learn different methods of analysis and design of plates and shells, To critically detail the plates, folded plates and shells. To evaluate the performance of spatial structures.

Modules	Teaching Hours	RBT Level
Module-1		
Introduction to plate theory, Small deflection of laterally loaded thin rectangular plates for pure bending. Navier's and Levy's solution for various lateral loading and boundary conditions (No derivation), Numerical examples	**10 Hours**	**L1, L2**
Module-2		
Energy methods for rectangular and circular plates with clamped edges subjected to symmetric loadings.	**10 Hours**	**L2, L3**
Module -3		
Introduction to curved surfaces and classification of shells, Membrane theory of spherical shells, cylindrical shells, hyperbolic paraboloids, elliptic paraboloid and conoids	**10 Hours**	**L2, L3**
Module -4		
Axially symmetric bending of shells of revolution, Closed cylindrical shells, water tanks, spherical shells and Geckler's approximation. Bending theory of doubly curved shallow shells.	**10 Hours**	**L2, L3**
Module -5		

Design and detailing of folded plates with numerical examples Design and Detailing of simple shell problems – spherical domes, water tanks, barrel vaults and hyperbolic paraboloid roofs	**10 Hours**	**L2, L3, L4**

Course outcomes:

On completion of this course, students are able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of Analysis and Design
- Design and develop analytical skills.
- Summarize the performance of shells
- Understand the concepts of energy principle.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. Timoshenko, S. and Woinowsky-Krieger, W., "Theory of Plates and Shells" 2nd Edition, McGraw-Hill Co., New York, 1959

2. Ramaswamy G.S. – "Design and Constructions of Concrete Shell Roofs" – CBS Publishers and Distributors – New Delhi – 1986.

3. Ugural, A. C. "Stresses in Plates and Shells", 2nd edition, McGraw-Hill, 1999.

4. R. Szilard, "Theory and analysis of plates - classical and numerical methods", Prentice Hall,1994.

5. Chatterjee. B.K. – "Theory and Design of Concrete Shell", – Chapman & Hall, New York-third edition, 1988.

Design of Precast & Composite Structures

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – I

Subject Code	**20CSE242**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 04

Prerequisites:

Basics of Strength of materials, Structural Analysis

Course objectives:

1. Understand the concepts and techniques of precast construction and Select or design precast elements suitable for project specific requirements
2. Design precast systems to ensure integrity and safety of the structure and to avoid progressive collapse and Design composite floors and beam elements

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Concepts , components, Structural Systems and Design of precast concrete floors Need and types of precast construction, Modular coordination, Precast elements- Floor, Beams, Columns and walls. Structural Systems and connections. **Design of precast Concrete Floors:** Theoretical and Design Examples of Hollow core slabs,. Precast Concrete Planks, floor with composite toppings with and without props.	**8 Hours**	**L1,L2**
Module-2		
Design of precast reinforced and prestressed Concrete beams Theoretical and Design Examples of ITB – Full section precast, Semi Precast, propped and unpropped conditions. Design of RC Nibs	**8 Hours**	**L3,L4**
Module -3		
Design of precast concrete columns and walls	**8 Hours**	**L3,L4**

Design of braced and unbraced columns with corbels subjected to pattern and full loading. Design of Corbels Design of RC walls subjected to Vertical, Horizontal loads and moments, Design of vertical ties and horizontal joints.		
Module -4		
Design of Precast Connections and Structural Integrity Beam bearing, Beam half Joint, Steel Inserts, Socket Connection, Structural integrity, Avoidance of progressive collapse, Design of Structural Ties.	**8 Hours**	**L3,L4**
Module -5		
Design of Steel Concrete Composite Floors and Beams **Composite Floors:** Profiled Sheeting with concrete topping, Design method, Bending and Shear Resistance of Composite Slabs, Serviceability Criteria, Design Example **Composite Beams:** Elastic Behaviour, Ultimate Load behavior of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams.	**8 Hours**	**L3,L4**
Course Outcomes:		

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Hass A.M. – Precast Concrete – Design and applications Applied Science, 1983.
2. David Sheppard – "Plant cast, Precast and Prestressed concrete – McGraw Hill; 1989
3. NBC – 2005 (Part I to Part VII) BIS Publications, New Delhi, IS 15916- 2011,IS 11447,IS6061 – I and III
4. R.P. Johnson: Composite Structure of Steel and Concrete (Volume 1), Blackwell Scientific Publication (Second Edition), U.K., 1994.
5. IS: 11384-1985, Code of Practice for Composite Construction in Structural Steel and Concrete.
6. INSDAG Teaching Resource Chapter 21 to 27: www.steel-insdag.org

ADVANCED CONCRETE TECHNOLOGY [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Subject Code	**20CSE243**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			

Prerequisites: Knowledge of Material Science and Concrete Technology

Course objectives: The objective of the course is to provide students to obtain an in-depth knowledge of a wide variety of advanced topics in concrete technology and practice. Concrete, being the popular materials for the construction material for civil infrastructure building, is undergoing significant changes in the recent times, in relation to the constituent materials used, production technology, testing methods and performance requirements.

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Fibre reinforced concrete: History, mechanism, different types of fibres, Aspect ratio, Volume of fibres, orientation of fibres, balling effect, properties of fibre reinforced concrete, applications of fibre reinforced concrete. Types of Fibre reinforced concrete. **Ferro cement:** Definition, different materials used, casting techniques, properties of Ferro cement, applications.	**10 Hours**	
Module-2		
Light Weight Concrete: Introduction, classification, properties, strength and durability, mix proportioning and problems **High Density Concrete:** Radiation shielding ability of concrete, materials for high density concrete, mix proportioning, properties in fresh and hardened state, placement methods.	**10 Hours**	

<table>
<tr><td>Module -3</td><td></td><td></td></tr>
<tr><td>Ready mix concrete:
Concept, ready mix concrete plants, difficulties faced and their solution , use of admixtures in ready mix concrete, economics and quality control aspects of ready mix concrete.
High Performance Concrete:
Constituents, mix proportioning, properties in fresh and hardened states, applications & limitations</td><td>10 Hours</td><td></td></tr>
<tr><td>Module -4</td><td></td><td></td></tr>
<tr><td>Polymer concrete:
Polymers, resins, polymerization, different types of polymer concrete like polymer impregnated concrete, polymer concrete (Resin concrete) and polymer modified concrete, their properties and applications.
Self-compacting concrete:
Development of SCC, basic principles and requirements , workability tests for SCC, mix design of SCC, acceptance criteria for SCC, adoption of SCC in the precast industry, present status of SCC</td><td>10 Hours</td><td></td></tr>
<tr><td>Module -5</td><td></td><td></td></tr>
<tr><td>Concrete from Industrial wastes:
a. Blast furnace slag cement concrete
b. Fly-ash concrete
c. Silica fume concrete
d. Recycled aggregate Concrete</td><td>10 Hours</td><td></td></tr>
<tr><td colspan="3">Course outcomes:
a. On complete of this course the students will able to understand the construction material, meeting the demanding performance requirements based on men, machines and materials.
b. Innovative special concrete with mixes, applications and limitations
c. Testing methods developed to increase the scope of concrete usage as an advanced material</td></tr>
<tr><td colspan="3">Question paper pattern:
The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.</td></tr>
</table>

Reference Books:

1. Aitcin P.C. “High performance concrete”, E and FN, Spon London 1998
2. Kumar Mehta.P, Paul J.N.Monterio, CONCRETE, “Microstructure, Properties and Materials”- TataMcGraw Hill
3. Rixom.R. and Mailvaganam.N., “Chemical admixtures in concrete”, E and FN, Spon London 1999
4. Rudnai.G., “Light Wiehgt concrete”, Akademiaikiado, Budapest, 1963.
5. Short A and Kinniburgh.W, “Light Weight Concrete”, Asia Publishing House, 1963
6. Aitcin P C “High Performance Concrete”, E and FN, London.
7. Andrew short and William Kinnibargh- ''light weight Concrete''-applied science publishers ltd London.
8. GyulaRudani- by "Light weight concretes "Publishing house of the Hungarian academy of sciences, Budapest (Hungary).
9. Kong, Evans, Cohen and Roll- "Hand book of structural concrete" Pitman pub.Inc., 1020,Plain street, Marsh field, Massachusetts.
10. Sidney Mindness and Francis young_- ''Concrete" Printice Hall inc. Englewood cliffs. New Jersey.

Recommended Reading:

1. Krishnaraju.N-"Design of concrete mixes" CBS Publication and distributors, Delhi.
2. Mehta P K & P J M Monteiro, “Concrete”, Prentice Hall, New Jersey (Special Student Edition by Indian Concrete Institute Chennai)
3. Neville. A. M “Properties of Concrete”, ELBS Edition, Longman Ltd., London
4. Rafat Siddique “Special Structural Concretes”, Galgotia publications, New Delhi
5. Santhakumar A R, “Concrete Technology”, Oxford University Press.
6. Shetty M S “Concrete Technology”, S. Chand publishing House Ltd., New Delhi

ADVANCED DESIGN OF PRE-STRESSED CONCRETE STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	**20CSE244**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites:

Course objectives:

This course will enable students to

- Design pre-stressed elements
- Understand the behavior of pre-stressed elements.
- Understand the behavior of pre-stressed sections

Modules	Teaching Hours	RBT Level
Module-1		
Shear and Torsional Resistance: Shear and principal stresses, ultimate shear resistance, design of shear reinforcement, Torsion, Design of reinforcement for torsion. **Anchorage Zone Stresses in Post-Tensioned Members:** Introduction, stress distribution in end block, investigations on Anchorage zone stresses, Magnel and Guyon's Methods, Comparative Analysis, Anchorage zone reinforcement.	**10 Hours**	**L1, L2**
Module-2		
Tension Members: Introduction, Ties, Pressure pipes – fabrication process, analysis, design and specifications. Cylindrical containers construction techniques, analysis, design and specifications. **Compression Members:** Introduction, Columns, short columns, long columns, biaxially loaded columns, Design specifications.	**10 Hours**	**L2, L3**

Module -3		
Statically indeterminate Structures: Introduction, Advantages of continuous members, effect of prestressing in indeterminate structures, methods of analysis for secondary moments, concordant cable profile, Guyon's theorem, Ultimate load analysis, Design of continuous beams and portal frames.	**10 Hours**	**L2, L3, L4**
Module -4		
Slab and Grid Floors: Types of floor slabs, Design of one way, two way and flat slabs. Distribution of prestressing tendons, Analysis and design of grid floors.	**10 Hours**	**L1, L2, L3**
Module -5		
Composite Beams: Introduction, types of composite beams, analysis for stresses, differential shrinkage, serviceability limit state. Design for flexural and shear strength. **Precast Elements:** Introduction, Prestressed concrete poles-manufacturing techniques, shapes and cross sectional properties, design loads, designs principles. Railway sleepers-classification and Manufacturing techniques, design loads, analysis and design principles. Prestressed concrete pavements, slab and wall panels.	**10 Hours**	**L1, L2, L3**

Course Outcomes:

After studying this course, students will be able to:

- Analyse , Design and detail PSC elements

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Srinath. L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Delhi Co ltd., New
2. Krishna Raju, "Prestressed concrete", Tata Mc Graw Hill Book – Co., New Delhi.
3. T.Y. Lin and Burn, "Design of prestress concrete structures", John Wiley, New York.
4. S. Ramamrutham, "Prestressed concrete", Dhanpat Rai & Sons, Delhi.

DESIGN OF INDUSTRIAL STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	**20CSE251**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites:

Course objectives:

The objective of this course is to make students to learn principles of Design of industrial building, To design different components of industrial structures and to detail the structures. To evaluate the performance of the Pre-engineered buildings

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Analysis of industrial building for Gravity and Wind load. Analysis and design of framing components namely, girders, trusses, gable frames	**10 Hours**	**L2, L3, L4**
Module-2		
Analysis and design of gantry column (stepped column / column with bracket), purlins, girts, bracings including all connections.	**10 Hours**	**L2, L3, L4**
Module -3		
Analysis of transmission line towers for wind load and design of towers including all connections.	**10 Hours**	**L2, L3, L4**
Module -4		
Forms of light gauge sections, Effective width computation of unstiffened, stiffened, multiple stiffened compression elements of cold formed light gauge sections. Concept of local buckling of thin elements. Limiting width to thickness ratio. Post buckling strength.	**10 Hours**	**L1, L2, L4**
Module -5		
Concept of Pre- engineered buildings, Design of compression and tension members of cold formed light gauge sections, Design of	**10 Hours**	**L2, L3, L4**

flexural members (Laterally restrained / laterally unrestrained).		

Course outcomes: On completion of this course, students are able to

- Achieve Knowledge of design and development of problem solving skills.
- Understand the industrial building and the components.
- Design and develop analytical skills.
- Summarize the principles of Structural Design and detailing
- Understands the concept of Pre- engineered buildings.

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Bureau of Indian Standards, IS800-2007, IS875-1987, IS-801-1975. Steel Tables, SP 6 (1) – 1984
2. N Subramanian- "Design of Steel Structure" oxford University Press
3. B.C. Punmia, A.K. Jain "Design of Steel Structures", Laxmi Publications, New Delhi.
4. Ramchandra and Virendra Gehlot " Design of Steel Structures " Vol 1 and Vol.2, Scientific Publishers, Jodhpur
5. Duggal "Limit State Design of Steel Structures" TMH

Advances in Artificial Intelligence [As per Choice Based Credit System (CBCS) scheme] **SEMESTER – II**			
Subject Code	**20CSE252**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			

Prerequisites:

Course objectives:

- To learn the difference between optimal reasoning Vs human like reasoning • To understand the notions of state space representation, exhaustive search, heuristic search along with the time and space complexities
- To learn different knowledge representation techniques
- To understand the applications of AI: namely Game Playing, Theorem Proving, Expert Systems, Machine Learning and Natural Language Processing

Modules	**Teaching Hours**	**RBT Level**
Module-1 Introduction: What is AI? Foundations of AI, History of AI, Agents and environments, The nature of the Environment, Problem solving Agents, Problem Formulation, Search Strategies	**10 Hours**	**L2, L3**
Module-2		
Knowledge and Reasoning: Knowledge-based Agents, Representation, Reasoning and Logic, Prepositional logic, First-order logic, Using First-order logic, Inference in First-order logic, forward and Backward Chaining	**10 Hours**	**L2, L3**
Module -3		
Learning: Learning from observations, Forms of Learning, Inductive Learning, Learning decision trees, why learning works, Learning in Neural and Belief networks	**10 Hours**	**L2, L3**
Module -4		
Practical Natural Language Processing: Practical applications, Efficient parsing, Scaling up the lexicon, Scaling up the Grammar, Ambiguity, Perception, Image	**10 Hours**	**L3, L4**

formation, Image processing operations for Early vision, Speech recognition and Speech Synthesis		
Module -5		
Robotics: Introduction, Tasks, parts, effectors, Sensors, Architectures, Configuration spaces, Navigation and motion planning, Introduction to AI based programming Tools	**10 Hours**	**L3, L4**

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Stuart Russell, Peter Norvig: “Artificial Intelligence: A Modern Approach”,2nd Edition, Pearson Education, 2007
2. Artificial Neural Networks B. Yagna Narayana, PHI
3. Artificial Intelligence , 2nd Edition, E.Rich and K.Knight (TMH).
4. Artificial Intelligence and Expert Systems – Patterson PHI.
5. Expert Systems: Principles and Programming- Fourth Edn, Giarrantana/ Riley, Thomson.
6. PROLOG Programming for Artificial Intelligence. Ivan Bratka- Third Edition – Pearson Education.
7. Neural Networks Simon Haykin PHI

STRUCTURAL HEALTH MONITORING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – II

Subject Code	**20CSE253**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Prerequisites:

Course objectives:

1. Learn the fundamentals of structural health monitoring.
2. Study the various vibration-based techniques for structural health monitoring.
3. Learn the structural health monitoring using fiber-optic and Piezoelectric sensors.
4. Study the structural health monitoring using electrical resistance and electromagnetic techniques.

Modules	Teaching Hours	RBT Level
Module-1 Introduction to Structural Health Monitoring Definition of structural health monitoring (SHM), Motivation for SHM, SHM as a way of making materials and structures smart, SHM and biomimetics, Process and pre-usage monitoring as a part of SHM, SHM as a part of system management, Passive and active SHM,NDE, SHM and NDECS, Variety and multidisciplinarity: the most remarkable characters of SHM, Birth of the SHM Community.	**10 Hours**	**L2, L3**
Module-2		
Vibration-Based Techniques for SHM Basic vibration concepts for SHM, Local and global methods, Damage diagnosis as an inverse problem, Model-based damage assessment, Mathematical description of structural systems with damage, General dynamic behavior, Statespace description of mechanical systems, Modeling of damaged structural elements, Linking experimental and analytical data, Modal Assurance Criterion (MAC) for mode pairing, Modal Scaling Factor (MSF), Co-ordinate Modal Assurance Criterion (COMAC), Damping, Expansion and reduction, Updating of the initial model, Damage	**10 Hours**	

localization and quantification, Change of the flexibility matrix, Change of the stiffness matrix, Strain-energy-based indicator methods and curvature modes, MECE error localization technique, Static displacement method, Inverse eigen sensitivity method, Modal force residual method, Kinetic and strain energy-based sensitivity methods, Forced vibrations and frequency response functions, Solution of the equation system, Regularization, Parameter subset selection, Other solution methods, Variances of the parameters, Neural network approach to SHM, The basic idea of neural networks, Neural networks in damage detection, localization and quantification, Multi-layer Perceptron (MLP), A simulation example, Description of the structure, Application of damage indicator methods, Application of the modal force residual method and inverse eigen sensitivity method, Application of the kinetic and modal strain energy methods, Application of the Multi-Layer Perceptron neural network, Time-domain damage detection methods for linear systems, Parity equation method, Kalman filters, AR and ARX models, Damage identification in non-linear systems, Extended Kalman filter, Localization of damage using filter banks, A simulation study on a beam with opening and closing crack, Applications, I-40 bridge,,Steelquake structure, Application of the Z24 bridge, Detection of delamination in a CFRP plate with stiffeners.		
Module -3		
Fiber-Optic Sensors Classification of fiber-optic sensors, Intensity-based sensors, Phasemodulated optical fiber sensors, or interferometers, Wavelength based sensors, or Fiber Bragg Gratings (FBG), The fiber Bragg grating as a strain and temperature sensor, Response of the FBG to uniaxial uniform strain fields, Sensitivity of the FBG to temperature, Response of the FBG to a non-uniform uniaxial strain field, Response of the FBG to transverse stresses, Photoelasticity in a plane stress state, Structures with embedded fiber Bragg gratings, Orientation of the optical fiber optic with respect to the reinforcement fibers, Ingress/egress from the laminate, Fiber Bragg gratings as	**10 Hours**	**L2, L3**

damage sensors for composites, Measurement of strain and stress variations, Measurement of spectral perturbations associated with internal stress release resulting from damage spread, Examples of applications in aeronautics and civil engineering, Stiffened panels with embedded fiber Bragg gratings, Concrete beam repair		
Module -4		
SHM with Piezoelectric Sensors The use of embedded sensors as acoustic emission (AE) detectors, Experimental results and conventional analysis of acoustic emission signals, Algorithms for damage localization, Algorithms for damage characterization, Available industrial AE systems, New concepts in acoustic emission, State-the-art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research, Lamb wave structure interrogation, Sensor technology, Tested structures (mainly metallic or composite parts), Acousto-ultrasonic signal and data reduction methods, The full implementation of SHM of localized damage with guided waves in composite materials, Available industrial acoustoultrasonic systems with piezoelectric sensors, Electromechanical impedance, E/M impedance for defect detection in metallic and composite parts, The piezoelectric implant method applied to the evaluation and monitoring of viscoelastic properties.	**10 Hours**	**L2, L3**
Module -5		
SHM Using Electrical Resistance Composite damage, Electrical resistance of unloaded composite, Percolation concept, Anisotropic conduction properties in continuous fiber reinforced polymer, Influence of temperature, Composite strain and damage monitoring by electrical resistance, 0° unidirectional laminates, Multidirectional laminates, Randomly distributed fiber reinforced polymers, Damage localization. Low Frequency Electromagnetic Techniques Theoretical considerations on electromagnetic theory, Maxwell‘s equations, Dipole radiation, Surface impedance, Diffraction by a circular aperture, Eddy currents, Polarization of dielectrics, Applications to the NDE/NDT domain, Dielectric materials, Conductive	**10 Hours**	**L3, L4**

materials, Hybrid method, Signal processing, Time-frequency transforms, The continuous wavelet transform, The discrete wavelet transform, Multiresolution, Denoising, Application to the SHM domain, General principles, Magnetic method, Electric method, Hybrid method.		

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, WileyISTE, 2006.
2. Douglas E Adams, Health Monitoring of Structural Materials and Components-Methods with Applications, John Wiley and Sons, 2007.
3. J.P. Ou, H.Li and Z.D. Duan, Structural Health Monitoring and Intelligent Infrastructure, Vol-1, Taylor and Francis Group, London, U.K, 2006.
4. Victor Giurglutiu, Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc, 2007.
5. Smart Materials and Structures, Gandhi and Thompson
6. Structural Health Monitoring: Current Status and Perspectives, Fu Ko Chang

DESIGN OF TALL STRUCTURES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Subject Code	**20CSE254**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	4:0:0	SEE Marks	60
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			

Prerequisites:

- Special Concrete
- Structural Dynamics

Course objectives:

The objective of this course is to make students to learn principles of stability of tall buildings, To design the tall buildings for earthquake and wind resistance. To evaluate the performance of tall structures for strength and stability

Modules	Teaching Hours	RBT Level
Module-1		
Design Criteria: Design philosophy, loading, sequential loading, and materials – high performance concrete, fiber reinforced concrete, lightweight concrete, design mixes. Loading and Movement: Gravity loading: Dead and live load, methods of live load reduction, Impact, Gravity loading, Construction loads	**10 Hours**	**L1, L2**
Module-2		
Wind loading: static and dynamic approach, Analytical and wind tunnel experimentation method. Earthquake loading: Equivalent lateral force, modal analysis, combinations of loading, working stress design, Limit state design, Plastic design.	**10 Hours**	**L1, L3, L4, L5**
Module -3		
Behavior of Various Structural Systems: Factors affecting growth, Height and structural form; High rise behavior, Rigid frames, braced frames, in-filled frames, shear walls, coupled shear walls, wall-frames, tubular, cores, Futigger – braced and hybrid mega system.	**10 Hours**	**L2, L3**
Module -4		

Analysis and Design: Modeling for approximate analysis, accurate analysis and reduction techniques, analysis of building as total structural system considering overall integrity and major subsystem interaction, analysis for member forces; drift and twist, computerized general three dimensional analyses.	**10 Hours**	**L2, L3, L4**
Module -5		
Stability of Tall Buildings: Overall buckling analysis of frames, wall frames, approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first order and P-Delta analysis, Transnational, Torsional instability, out of plum effects, stiffness of member in stability, effect of foundation rotation. Structural elements: sectional shapes, properties and resisting capacities, design, deflection, cracking, pre-stressing, shear flow. Design for differential movement, creep and shrinkage effects, temperature effects and fire	**10 Hours**	**L2, L3, L4, L5**

Course outcomes: On completion of this course, students are able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of strength and stability
- Design and develop analytical skills.
- Summarize the behavior of various structural systems.
- Understand the concepts of P-Delta analysis

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Taranath B.S, “Structural Analysis and Design of Tall Buildings”- McGraw Hill
2. Wilf gang Schuller, “High rise building structures”- John Wiley
3. Bryan Stafford Smith & Alexcoull, “Tall building structures Analysis and Design”- John Wiley
4. T.Y Lin & D.Stotes Burry, “Structural concepts and system for Architects and Engineers”- John Wiley
5. Lynn S.Beedle, “Advances in Tall Buildings”- CBS Publishers and Distributors.
6. Dr. Y.P. Gupta – Editor, “Proceedings National Seminar on High Rise Structures- Design and Construction practices for middle level cities”- New Age International Limited

STRUCTURAL ENGINEERING LAB-2
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – II

Subject Code	**20CSEL26**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	1:3:0	SEE Marks	60
Total Number of Lecture Hours	42	Exam Hours	03

CREDITS – 02

Prerequisites:

Course objectives:

The objective of this course is to make students
To analyze the structure using FE based Software
To learn principles of design
To investigate the performance of structural elements.
To design the structural components using excel sheets

Modules	Teaching Hours	RBT Level
1. Static and Dynamic analysis and design of Multistory Building structures using any FE based software	**12 Hrs**	**L1, L2, L3, L4, L5, L6**
2. Design of RCC and Steel Tall structures using any FE based software	**12 Hrs**	
3. Analysis of folded plates and shells using any FE software.	**06 Hrs**	
4. Preparation of EXCEL sheets for structural design	**12 Hrs**	

Course outcomes: On complete of this course the students will able to

- Achieve Knowledge of design and development of programming skills.
- Understand the principles of structural analysis and design
- Design and develop analytical skills.
- Summarize the performance of structures for static and dynamic forces.

DESIGN OF BRIDGES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Subject Code	**20CSE31**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 04			

Prerequisites:

- Structural Analysis
- Highway Engineering
- Design of RC Structures

Course objectives:

- The students will be exposed to the Engineering aspects of concrete bridges
- Various loads that act on the bridges as per IRC.
- Analysis for the maximum BM and SF at critical section using load distributing theories.
- Design of various components using limit state method with reinforcement details.

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Introduction & Design of Slab Culvert Bridge Engineering and its development in past, Ideal site selection for Bridges, Bridge classifications, Forces acting on Bridge. Analysis for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles. Structural design of slab culvert using limit state method with reinforcement details.	**8 Hours**	**L2, L3**
Module-2		
Box Culvert Introduction to box culvert, advantage of structural continuity, Analysis for maximum BM and SF at critical sections using moment distribution method for various load combinations such as Dead, Surcharge, Soil, Water and Live load as per IRC class A, B, AA tracked and wheeled vehicles. Structural design of box culvert using limit state method with reinforcement details.	**8 Hours**	**L2, L3**

Module -3		
T Beam Bridge Components of T Beam Bridge, Load transfer mechanism, Proportioning the of Components, Analysis of **Slab** using **Pigeauds Method** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of **Slab** using limit state method with reinforcement details. Analysis of **Cross Girder** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of slab using limit state method with reinforcement details. Analysis of **Main Girder** using **Courbon's Method** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of **Main Girder** using limit state method with reinforcement details.	**8 Hours**	**L3, l4**
Module -4		
PSC Bridge Introduction to Pre & Post Tensioning, Proportioning of Components, Analysis & Structural Design of Slab, Analysis of Main Girder Using **Courbon's Method** for IRC Class AA, Tracked vehicle, Calculations of Prestressing Force, Calculations of Stresses, Cable profile, Design of End Block, Detailing of Main Girder.	**8 Hours**	**L3, L4**
Module -5		
Balanced Cantilever Bridge Introduction & Proportioning of Components, Analysis of Main Girder Using **Courbon's Method** for IRC Class AA, Tracked vehicle Design of Simply Supported Portion, Cantilever Portion, Articulation, using limit state method with reinforcement details.	**8 Hours**	**L3, L4**

Course outcomes:

After studying this course, students will be able to:

- Describe historical growth, select ideal site and bridge, calculate values of design parameters of slab culvert at critical section as per IRC, design and detailing required for the execution of the project.
- Carry out analysis of box culvert as per IRC to obtain the values of design parameters and to design and detail the components following IS code procedure.

- Demonstrate the use of **Pigeauds Method** and **Courbon's Method** in the analysis of T beam bridge as per IRC, design to obtain the safe dimensions various components, optimum reinforcement required following IS code procedure.
- Display the use of **Courbon's Method** in the analysis of PSC bridge as per IRC, design to obtain the safe value of prestressing force, obtain the dimensions of various components to keep the stresses within codal provisions following IS code procedure.
- Analysis a balanced cantilever bridge as per IRC and to obtain the safe values of design parameters and to design and detail the components as per IS code procedure

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Essentials of Bridge Engineering by Dr D Johnson Victor, Oxford & IBH Publishing Co New Delhi

2. Design of Bridges by Dr N Krishna Raju, Oxford & IBH Publishing Co New Delhi

References:

1. Principles and Practice of Bridge Engineering by S P Bindra, Dhanpat Rai & Sons New Delhi
2. IRC 6 -1966 Standard Specifications And Course Code Of Practice For Road Bridges Section II Loads and Stresses, The Indian Road Congress New Delhi
3. IRC 21 - 1966 Standard Specifications And Course Code Of Practice For Road Bridges Section III Cement Concrete (Plain and reinforced) The Indian Road Congress New Delhi
4. IS 456 - 2000 Indian Standard Plain and Reinforced Concrete Course Code of Practice (Fourth Revision) BIS New Delhi
5. IS 1343 - Indian Standard Prestressed Concrete Course Code of Practice BIS New Delhi

DESIGN CONCEPTS OF SUBSTRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	**20CSE321**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Prerequisites:

Course objectives:

The objective of this course is to make students to learn principles of subsoil exploration, To design the sub structures. To evaluate the soil shear strength parameters.

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Introduction, Site investigation, In-situ testing of soils, Subsoil exploration, Classification of foundations systems. General requirement of foundations, Selection of foundations, Computations of Loads, Design concepts.	**8 Hours**	**L2, L4, L5**
Module-2		
Concept of soil shear strength parameters, Settlement analysis of footings, Shallow foundations in clay, Shallow foundation in sand & C-Φ soils, Footings on layered soils and sloping ground, Design for Eccentric or Moment Loads	**8 Hours**	**L2, L4, L5**
Module -3		
Types of rafts, bearing capacity & settlements of raft foundation, Rigid methods, Flexible methods, soil structure interaction, different methods of modeling the soil. Combined footings (rectangular & trapezoidal), strap footings & wall footings, Raft – super structure interaction effects & general concepts of structural design, Basement slabs	**8 Hours**	**L2, L4, L5**
Module -4		
Deep Foundations: Load Transfer in Deep Foundations, Types of Deep Foundations, Ultimate bearing capacity of different	**8 Hours**	**L2, L3, L4, L5**

types of piles in different soil conditions, Laterally loaded piles, tension piles & batter piles, Pile groups: Bearing capacity, settlement, uplift capacity, load distribution between piles, Proportioning and design concepts of piles.		
Module -5		
Types of caissons, Analysis of well foundations, Design principles, Well construction and sinking. Foundations for tower structures: Introduction, Forces on tower foundations, Selection of foundation type, Stability and design considerations, Ring foundations – general concepts.	**8 Hours**	**L2, L3, L4, L5**

Course outcomes:

On completion of this course, students are able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of subsoil exploration
- Design and develop analytical skills.
- Identify and evaluate the soil shear strength parameters.
- Understand the concepts of Settlement analysis.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. Swami Saran – "Analysis & Design of Substructures"- Oxford & IBH Pub. Co. Pvt. Ltd., 1998.
2. Nainan P Kurian – "Design of Foundation Systems"- Narosa Publishing House, 1992.
3. R.B. Peck, W.E. Hanson & T.H. Thornburn – "Foundation Engineering"- Wiley Eastern Ltd.,Second Edition, 1984.
4. J.E. Bowles – "Foundation Analysis and Design"- McGraw-Hill Int. Editions, Fifth Ed., 1996.
5. W.C. Teng – "Foundation Design"- Prentice Hall of India Pvt. Ltd., 1983.
6. Bureau of Indian Standards:IS-1498, IS-1892, IS-1904, IS-6403, IS-8009, IS-2950, IS-11089, IS-11233, IS-2911 and all other relevant codes

OPTIMIZATION TECHNIQUES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Subject Code	**20CSE322**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			
Prerequisites:			
Course objectives: The objective of this course is to make students to learn principles of optimization, To implement the optimization Concepts for the structural engineering problems. To evaluate different methods of optimization.			

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Introduction: Introduction to optimization, engineering applications of optimization, Formulation of structural optimization problems as programming problems. Optimization Techniques: Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.	**8 Hours**	**L1, L2, L4**
Module-2		
Linear Programming: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.	**8 Hours**	**L2, L4, L5**
Module -3		
Non-linear programming: Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods	**8 Hours**	**L2, L3, L4, L5**

Module -4		
Constrained optimization techniques such as direct methods, the complex methods, cutting plane method, exterior penalty function methods for structural engineering problems. Formulation and solution of structural optimization problems by different technique	**8 Hours**	**L2, L3, L4, L5**
Module -5		
Geometric programming: Geometric programming, conversion of NLP as a sequence of LP/ geometric programming. **Dynamic programming:** Dynamic programming conversion of NLP as a sequence of LP/ Dynamic programming	**8 Hours**	**L4, L5**

Course outcomes:

On completion of this course, students are able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of optimization.
- Design and develop analytical skills.
- Summarize the Linear, Non-linear and Geometric Programming
- Understands the concept of Dynamic programming

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. Spunt, “Optimum Structural Design”- Prentice Hall
2. S.S. Rao, “Optimization – Theory and Practice”- Wiley Eastern Ltd.
3. Uri Krisch, “Optimum Structural Design”- McGraw Hill
4. Richard Bronson, “Operation Research”- Schaum’s Outline Series
5. Bhavikatti S.S.- “Structural optimization using sequential linear programming”- Vikas publishing house

STABILITY OF STRUCTURES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Subject Code	**20CSE323**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Prerequisites:

- Strength of Materials
- Finite Element Analysis
- Theory of Elasticity

Course objectives:

The objective of this course is to make students to learn principles of stability of structures, To analyse the structural elements for stability. To evaluate the use of strain energy in plate bending and stability.

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Beam – Column Differential equation. Beam column subjected to (i) lateral concentrated load, (ii) several concentrated loads, (iii) continuous lateral load. Application of trigonometric series, Euler's formulation using fourth order differential equation for pined – pined, fixed – fixed, fixed – free and fixed – pinned column.	**8 Hours**	**L1, L2**
Module-2		
Buckling of frames and continuous beams. Elastic Energy method: Approximate calculation of critical loads for a cantilever. Exact critical load for hinged – hinged column using energy approach. Buckling of bar on elastic foundation. Buckling of cantilever column under distributed loads. Determination of critical loads by successive approximation. Bars with varying cross section. Effect of	**8 Hours**	**L2, L3**

shear force on critical load. Column subjected to pulsating forces.		
Module -3		
Stability analysis by finite element approach Derivation of shape function for a two nodded Bernoulli–Euler beam element (lateral and translation of) – element stiffness and element geometric stiffness matrices – assembled stiffness and geometric stiffness matrices for a discretised column with different boundary condition – calculation of critical loads for a discretised (two elements) column (both ends built in). Buckling of pin jointed frames (maximum of two active DOF) – symmetrical single bay portal frame.	**8 Hours**	**L2, L3, L4**
Module -4		
Lateral buckling of beams Differential equation –pure bending – cantilever beam with tip load – simply supported beam of I section subjected to central concentrated load. Pure Torsion of thin – walled bars of open cross section. Non – uniform Torsion of thin – walled bars of open cross section.	**8 Hours**	**L1, L2, L3**
Module -5		
Expression for strain energy in plate bending with in plate forces (linear and non – linear). Buckling of simply supported rectangular plate– uniaxial load and biaxial load. Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge condition along the other two sides.	**8 Hours**	**L1, L2, L3**
Course Outcomes: On completion of this course, students are able to: • Achieve Knowledge of design and development of problem solving skills. • Understand the principles of strength and stability • Design and develop analytical skills. • Appraise the Stability analysis by finite element approach. • Understand the concepts of lateral buckling of beams.		

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Stephen P. Timoshenko, James M Gere, "Theory of Elastic Stability"-2nd Edition, McGraw – Hill, New Delhi.
2. Robert D Cook et.al, "Concepts and Applications of Finite Element Analysis"-3rd Edition, John Wiley and Sons, New York.
3. S. Rajashekar, "Computations and Structural Mechanics"-Prentice – Hall, India.
4. Ray W Clough and J Penzien, "Dynamics of Structures" - 2nd Edition, McGraw Hill, New Delhi
5. H.Zeiglar, "Principles of Structural Stability"-Blaisdall Publications

RELIABILITY ANALYSIS OF STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

Subject Code	**20CSE324**	CIE Marks	40
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Prerequisites:

Course objectives:

1. To impart the concept knowledge on data analysis and probability in the context of structural engineering.
2. To demonstrate uncertainty in structural engineering with respect to randomness of variables and knowledge of probability distributions.
3. To demonstrate principles of structural reliability in order to assess safety due to randomness of variables.
4. To perform computations of structural reliability using various methods at component and system level.

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Preliminary Data Analysis: Graphical representation- Histogram, frequency polygon, Measures of central tendency- grouped and ungrouped data, measures of dispersion, measures of asymmetry. Curve fitting and Correlation: Fitting a straight line, curve of the form $y = ab^x$, and parabola, Coefficient of correlation.	**8 Hours**	**L2, L3,L4**
Module-2		
Probability Concepts: Random events-Sample space and events, Venn diagram and event space, Measures of probability interpretation, probability axioms, addition rule, multiplication rule, conditional probability, probability tree diagram, statistical independence, total probability theorem and Baye's	**8 Hours**	**L2, L4**

theorem..		
Module -3		
Random variables: Probability mass function, probability density function, Mathematical expectation, Chebyshev's theorem. Probability distributions: Discrete distributions- Binomial and Poison distributions, Continuous distributions- Normal, Log normal distributions.	**8 Hours**	**L2, L4**
Module -4		
Reliability Analysis: Measures of reliability-factor of safety, safety margin, reliability index, performance function and limiting state. Reliability Methods-First Order Second Moment Method (FOSM), Point Estimate Method (PEM), and Advanced First Order Second Moment Method (Hasofer-Lind's method).	**8 Hours**	**L2, L3,L4,L5**
Module -5		
Simulation Techniques: Monte Carlo simulation- Statistical experiments, Confidence limits ,sample size and accuracy, Generation of random numbers- random numbers with standard uniform distribution, continuous random variables (normal and lognormal), discrete random variables. System reliability: series, parallel and combined systems.	**8 Hours**	**L2,L3,L4 L5**

Course Outcomes: Students will be able to

1. Understand the concepts of statistics for probabilistic analysis and importance of uncertainty (randomness) in structural analysis and design.
2. Apply the theoretical principles of randomness of variables in structural engineering through density functions.
3. Analyze components of structure to assess safety using concepts related to structural reliability by various methods.
4. Evaluate the safety reliability index at system level.

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Ranganathan, R. (1999). “Structural Reliability Analysis and design”- Jaico publishing house, Mumbai, India.
2. Devaraj.V & Ravindra.R,(2017),’Reliability based Analysis and Design for Civil Engineers’, I.K. International Publishing House Pvt. Ltd, India
3. Ang, A. H. S., and Tang, W. H. (1984). “Probability concepts in engineering planning and design”- Volume –I, John Wiley and sons, Inc, New York.
4. Ang, A. H. S., and Tang, W. H. (1984). “Probability concepts in engineering planning and design”-Volume –II, John Wiley and sons, Inc, New York.
5. Milton, E. Harr (1987). “Reliability based design in civil engineering”- Mc Graw Hill book Co.
6. Nathabandu, T., Kottegoda, and Renzo Rosso (1998). Statistics, “Probability and reliability for Civil and Environmental Engineers”- Mc Graw Hill international edition, Singapore.
7. Achintya Haldar and Sankaran Mahadevan (2000). “Probability, Reliability and Statistical methods in Engineering design”- John Wiley and Sons. Inc.

<table>
<tr><td colspan="4">FRACTURE MECHANICS APPLIED TO STRUCTURAL ENGINEERING
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III</td></tr>
<tr><td>Subject Code</td><td>20CSE331</td><td>CIE Marks</td><td>40</td></tr>
<tr><td>Teaching Hours/Week (L:P:SDA)</td><td>3:0:0</td><td>SEE Marks</td><td>60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40</td><td>Exam Hours</td><td>03</td></tr>
<tr><td colspan="4">CREDITS – 03</td></tr>
<tr><td colspan="4">Prerequisites: Concrete Technology and Mechanics of Deformable Bodies</td></tr>
<tr><td colspan="4">Course objectives: This course will enable students to
1. To compute the stress intensity factor, strain energy release rate and the stress and strain fields around a crack tip for linear and nonlinear materials.
2. Know experimental methods to determine the fracture toughness.
3. Use the design principles of materials and structures using fracture mechanics approach.</td></tr>
</table>

Modules	Teaching Hours	RBT Level
Module-1		
Stress concentration in elastic materials Theory of stress concentration in elastic materials, stress concentration factors around circular and elliptic holes. Influence of ratio of radii on stress concentration factor in elliptic hole.	**8 Hours**	**L1,L2**
Module-2		
Linear Elastic Fracture mechanics Modeling a crack as a flat elliptic hole by Inglis and the limitations of the model, Griffith theory of brittle fracture Theories of linear elastic fracture mechanics, stress intensity factors, Irwin's definition. Fracture toughness KIc, KIIc, KIIIc & corresponding values of GC.	**8 Hours**	**L2,L3**
Module -3		
Elasto-plastic fracture mechanics Crack-tip plasticity in metals. Irwin's modification for elasto-plastic material. J integral, CMOD, CTOD. Mixed mode problems and evaluation of critical fracture parameters.	**8 Hours**	**L2,L3,L4**

Module -4		
Fracture of Concrete Limitations of theories of linear elastic fracture mechanics in concrete, Review of concrete behaviour in tension and compression. Kaplan's experiments, concept of fracture energy, definition of a quasi-brittle material, concept of softening.	**8 Hours**	**L2,L3,L4**
Module -5		
Advanced concepts in fracture behavior of concrete Definition of fracture energy by RILEM, Influence of size on fracture behavior, Bazant's size effect law. Size dependent & independent fracture energies. Application of fracture mechanics in design of concrete structures.	**8 Hours**	**L2,L3,L4**

Course outcomes:

After studying this course, students will be able to:

- Apply principles of fracture mechanics.
- Design concrete structures using fracture mechanics approach.
- Explain the importance of fracture mechanics.
- Take special care of very large sized structures.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Reference Books:

1. Timoshenko & Goodier, "Theory of Elasticity", McGrawHill
2. Valliappan S. "Continuum Mechanics Fundamentals" (1982), Oxford IBH, ND. New Delhi.
3. Broek, D., "Elementary Engineering Fracture Mechanics", 4th edition, Martinus Nijhoff (1987).
4. T. L. Anderson, "Fracture Mechanics- Fundamentals and Applications", CRC press
5. Srinath L.S., Advanced Mechanics of Solids, 10th print, Tata McGraw Hill Publishing company, New Delhi,1994
6. Bhushan L Karihaloo "Fracture mechanics and structural concrete ",John Wiley&Sons Inc,
7. Zdenek P. Bazant, Jaime Planas, "Fracture and Size Effect in Concrete and Other Quasibrittle Materials" CRC press

<table>
<tr><td colspan="6">DESIGN OF MASONRY STRUCTURES
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III</td></tr>
<tr><td>Subject Code</td><td>20CSE332</td><td>CIE Marks</td><td colspan="3">40</td></tr>
<tr><td>Number of Lecture Hours/Week</td><td>03</td><td>SEE Marks</td><td colspan="3">60</td></tr>
<tr><td>Total Number of Lecture Hours</td><td>40</td><td>Exam Hours</td><td colspan="3">03</td></tr>
<tr><td colspan="6">CREDITS – 03</td></tr>
<tr><td colspan="6">Prerequisites: Construction Technology and Strength of Materials</td></tr>
<tr><td colspan="6">Course objectives:
The objective of this course is to make students
• To learn performance of masonry structures,
• To design the masonry structures for earthquake resistance.
• To evaluate the strength and stability of the masonry structures</td></tr>
<tr><td colspan="4">Modules</td><td>Teaching Hours</td><td>RBT Level</td></tr>
<tr><td colspan="4">Module-1</td><td></td><td></td></tr>
<tr><td colspan="4">Introduction, Masonry units, materials and types:
History of masonry, Masonry units – Brick- Types of bricks, Tests conducted on bricks. Other masonry units - stone, clay block, concrete block, laterite block, stabilized mud block masonry units Masonry materials – Classification and properties of mortars, selection of mortars. Cracks - Cracks in masonry structures, Type of crack, causes and prevention of crack.</td><td>8 Hours</td><td>L1,L2</td></tr>
<tr><td colspan="4">Module-2</td><td></td><td></td></tr>
<tr><td colspan="4">Strength of Masonry in Compression:
Behaviour of Masonry under compression, strength and elastic properties, influence of masonry unit and mortar Characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength, prediction of strength of masonry in Indian context, Failure theories of masonry under Compression. Effects of slenderness and eccentricity, effect of rate of absorption, effect of curing, effect of ageing, workmanship on compressive strength

Masonry Bond Strength and Masonry in Shear and Flexure
Bond between masonry unit and mortar, tests for determining flexural and shear bond strengths, factors affecting bond</td><td>8 Hours</td><td>L2,L3</td></tr>
</table>

strength, effect of bond strength on compressive strength, orthotropic strength properties of masonry in flexure, shear strength of masonry, test procedures for evaluating flexural and shear strength		
Module-3		
Design of load bearing masonry wall Permissible stresses: Types of walls, permissible compressive stress, stress reduction and shape modification factors, increase in permissible stresses for eccentric vertical and lateral load, permissible tensile stress and shear stresses. Design Considerations: Effective height of walls and columns, openings in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action in lintels. Problems on design considerations for solid walls, cavity walls, wall with pillars. **Load considerations and design of Masonry subjected to axial loads**: Design criteria, design examples of walls under UDL, solid walls, cavity walls, solid wall supported at the ends by cross wall, walls with piers.	**8 Hours**	**L2,L3, L4,L5**
Module-4		
Design of walls subjected to concentrated axial loads: Solid walls, cavity walls, solid wall supported at the ends by cross wall, walls with piers, design of wall with openings. Design of walls subjected to eccentric loads: Design criteria – stress distribution under eccentric loads – problems on eccentrically loaded solid walls, cavity walls, walls with piers. **Design of Laterally and transversely loaded walls:** Design criteria, design of solid wall under wind loading, design of shear wall – design of compound walls.	**8 Hours**	**L2,L3, L4,L5**
Module-5		
Earthquake resistant masonry buildings: Behaviour of masonry during earthquakes, concepts and design procedure for earthquake resistant masonry, BIS codal provisions. In-filled frames: Types – modes of failures **Reinforced brick masonry** Methods of reinforcing Masonry, Analysis of reinforced Masonry under axial, flexural and shear loading	**8 Hours**	**L2,L3, L4,L5**

On completion of this course, students are able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the principles of design and construction of masonry structures
- Design and develop analytical skills.
- Summarize the masonry Characteristics.
- · Evaluate the strength and stability of the masonry structures.

Reference book

- Henry, A.W., “Structural Masonry”, Macmillan Education Ltd., 1990.
- K.S. Jagadish, “Structural masonry”, I.K. International Publishing House Pvt. Ltd
- Dayaratnam P, “Brick and Reinforced Brick Structures”, Oxford & IBH, 1987.
- M. L. Gambhir, “Building and Construction Materials”, Mc Graw Hill education Pvt. Ltd.

Guidelines

- IS 1905–1987 “Code of practice for structural use of un-reinforced masonry- (3rd revision) BIS, New Delhi.
- SP 20 (S&T) – 1991, “Hand book on masonry design and construction (1st revision) BIS, New Delhi.

Question paper pattern:

- The question paper will have ten questions.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

RETROFITTING AND REHABILITATION OF STRUCTURES [As per Choice Based Credit System (CBCS) scheme] **SEMESTER – III**			
Subject Code	**20CSE333**	CIE Marks	40
Number of Lecture Hours/Week	03	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Prerequisites:

Course objectives:

1. Learn the fundamentals of maintenance and repair strategies.
2. Study the quality assurance, serviceability and durability of concrete.
3. Know the various materials and techniques used for repair of structures.
4. Educate the different repair, strengthening, rehabilitation and retrofitting techniques.
5. Instruct the various health monitoring and demolition techniques.

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Maintenance: Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating damaged structure, causes of deterioration. Repair Strategies: Causes of distress in concrete structures, Construction and design failures, Condition assessment and distress-diagnostic techniques, Assessment procedure for Inspection and evaluating a damaged structure,	**8 Hours**	**L2, L3**
Module-2		
Serviceability and Durability of Concrete: Quality assurance for concrete construction, concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.	**8 Hours**	**L2, L3**
Module -3		
Materials and Techniques for Repair: Special concretes and	**8 Hours**	**L2, L3**

mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, Sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. Bacterial concrete, Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coating and cathodic protection		
Module -4		
Repair, Rehabilitation and Retrofitting Techniques: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure, Repair of Structure – Common Types of Repairs – Repair in Concrete Structures – Repairs in Under Water Structures – Guniting – Shot Create – Underpinning. Strengthening of Structures – Strengthening Methods – Retrofitting – Jacketing.	**8 Hours**	**L2, L3**
Module -5		
Health Monitoring and Demolition Techniques: Long term health monitoring techniques, Engineered demolition techniques for dilapidated structures, Use of Sensors – Building Instrumentation.	**8 Hours**	**L3, L4**

Question paper pattern: The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Concrete Technology by A.R. Santakumar, Oxford University press
2. Defects and Deterioration in Buildingts, E F & N Spon, London
3. Non-Destructive Evaluation of Concrete Structures by Bungey - Surrey University
4. Maintenance and Repair of Civil Structures, B.L. Gupta and Amit Gupta, Standard Publications.
5. Concrete Repair and Maintenance Illustrated, RS Means Company Inc W. H. Ranso, (1981)
6. Building Failures : Diagnosis and Avoidance, EF & N Spon, London, B
7. Mehta, P.K and Montevic. P.J., Concrete- Microstructure, Properties and Materials, ICI, 1997.
8. Jackson, N., Civil Engineering Materials, ELBS, 1983.

GREEN BUILDING TECHONOLOGY [As per Choice Based Credit System (CBCS) scheme] **SEMESTER – III**			
Subject Code	**20CSE334**	CIE Marks	40
Number of Lecture Hours/Week	03	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Prerequisites:

Course objectives:

1. Exposure to the green building technologies and their significance.
2. Understand the judicial use of energy and its management.
3. Educate about the Sun-earth relationship and its effect on climate.
4. Enhance awareness of end-use energy requirements in the society.
5. Develop suitable technologies for energy management.

Modules	**Teaching Hours**	**RBT Level**
Module-1		
Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.	**8 Hours**	**L2, L3**
Module-2		
Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.	**8 Hours**	**L2, L3**
Module -3		
Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.	**8 Hours**	**L3, L4**

Module -4		
End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer	**8 Hours**	**L3, L4**
Module -5		
Energy management options - Energy audit and energy targeting - Technological options for energy management.	**8 Hours**	**L3, L4**

Question paper pattern:

The question paper will have ten questions; each question carries equal marks, there will be two full questions or with a maximum of four sub questions from each module, students will have to attend five full questions from each module.

Reference Books:

1. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.
3. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.
4. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.