SYLLABUS
M.Tech- STRUCTURAL ENGINEERING

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

Subject Code	16CSE11	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:
The objective of this course is to make students to learn principles of Structural Analysis, To implement these principles through different methods and to analyse various types of structures. To evaluate the force and displacement parameters of the structures.

Modules	Teaching Hours	RBT Level
Module -1		
Fundamental concepts: Static and Kinematic indeterminacy, Concepts of stiffness and flexibility. Energy concepts. Principle of minimum potential energy and minimum complementary energy. Development of element flexibility and element stiffness matrices for truss, beam and grid elements.	**10 Hours**	**L_1, L_2, L_4, L_5**
Module -2		
Analysis using Flexibility method: Force-transformation matrix using Flexibility method, Development of global flexibility matrix for continuous beams, plane trusses and rigid plane frames (having not more than six co-ordinates – 6x6flexibility matrix) Analysis of continuous beams, plane trusses and rigid plane frames by flexibility method (having not more than 3 coordinates – 3x3 flexibility matrix)	**10 Hours**	**L_1, L_2, L_3 L_4, L_5**
Module -3		
Analysis using Stiffness Method: Displacement-transformation matrix using Stiffness Method, Development of global stiffness matrix for continuous beams, plane trusses and rigid plane frames (having not more than six co-ordinates – 6x6 stiffness matrix) Analysis of continuous beams, plane trusses and rigid plane frames by stiffness method (having not more than 3 coordinates – 3x3 stiffness matrix)	**10 Hours**	**L_1, L_2, L_3 L_4, L_5**
Module -4		
Effects of temperature change and lack of fit: Related numerical problems by flexibility and stiffness method as in Module 2 and 3	**10 Hours**	**L_1, L_2, L_3 L_4, L_5**

Module -5		
Solution techniques: Solution techniques including numerical problems for simultaneous equations, Gauss elimination and Cholesky method. Bandwidth consideration.	**10 Hours**	**L_1, L_2, L_4, L_5**

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 Structural Analysis
- Design and develop analytical skills
- Summarize the Solution techniques
- Understand the concepts of structural behaviour

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- 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. Rajasekaran, "**Computational Structural Mechanics**", PHI, New Delhi 2001.
2. F.W.Beaufait et al., "**Computer methods of Structural Analysis"**, Prentice Hall, 1970.
3. W.Weaver and J.H.Gere, "**Matrix Analysis of Framed Structures"**, Van Nastran, 1980.
4. H.Karde Stuncer, "**Elementary Matrix Analysis of Structures"**, McGraw Hill 1974.
5. A.K.Jain "**Advanced Structural Analysis with Computer Application"** Nemchand and Brothers, Roorkee, India.
6. M.F.Rubinstein "**Matrix Computer Methods of Structural Analysis** "Prentice – Hall.

ADVANCED DESIGN OF RC STRUCTURES

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

SEMESTER – I

Subject Code	16CSE12	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

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		
Yield line method of design of slabs. Design of flat slabs.	**10 Hours**	**L_1, L_2, L_3, L_4, L_5**
Module -2		
Design of grid floors, Design of Chimneys	**10 Hours**	**L_1, L_2, L_3, L_4, L_5**
Module -3		
Design of continuous beams with redistribution of moments	**10 Hours**	**L_1, L_2, L_3, L_4, L_5**
Module -4		
Design of silos and bunkers	**10 Hours**	**L_1, L_2, L_4, L_5**
Module -5		
Art of detailing earthquake resistant structures, expansion and contraction joints	**10 Hours**	**L_1, L_2**

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 Structural Design
- Design and develop analytical skills.
- Summarize the principles of Structural Design and detailing
- Understands the structural performance.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- 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. A Park and Paulay, “Reinforced and Prestressed Concrete”, John Wiley & sons.
2. Kong K F and Evans T H, “Reinforced and Prestressed Concrete”, CRC Press.
3. P.C.Varghese, "Advanced Reinforced Concrete Design”, Prentice-Hall of India, New Delhi, 2005.
4. B.C.Punmia, Ashok Kumar Jain and Arun Kumar Jain, “Comprehensive RCC Design”, Laxmi Publications.
5. Bungey and Mosley, “Reinforced Concrete”, Palgrave Macmillan.

MECHANICS OF DEFORMABLE BODIES

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

Subject Code	16CSE13	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

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 co ordinates. Constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases.	**10 Hours**	**L_1, L_2**
Module -2		
Transformation of stress and strain at a point, Principal stresses and principal strains, invariants of stress and strain, hydrostatic and deviatric stress, spherical and deviatric strains, max. shear strain.	**10 Hours**	**L_2, L_3**
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 axi-symmetric problems, stress concentration due to the presence of a circular hole in plates.	**10 Hours**	**L_2, L_3**
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.	**10 Hours**	**L_2, L_3, L_4**
Module -5		
Theory of Plasticity: Stress – strain diagram in simple tension, perfectly elastic, Rigid – Perfectly plastic, Linear work – hardening, Elastic Perfectly	**10 Hours**	**L_1, L_2**

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		

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 full question consists of 16 marks.
- 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", 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	16CSE14	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:
The objective of this course is to make students to learn principles of Structural 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 the structures

Modules	Teaching Hours	RBT Level
Module -1		
Introduction: Introduction to Dynamic problems in Civil Engineering, Concept of degrees of freedom, D'Alembert's principle, principle of 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. Methods of evaluation of damping.	**10 Hours**	**L_1, L_2, L_5**
Module -2		
Response of Single-degree-of-freedom systems to harmonic loading (rotation unbalance, reciprocating unbalance) 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.	**10 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 property of modes.	**10 Hours**	**L_1, L_2, L_4, L_5**
Module -4		
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, condition of damping uncoupling	**10 Hours**	**L_3, L_4, L_5**

Module -5		
Approximate methods: Rayleigh's method Dunkarley's method, Stodola's method. Dynamics of Continuous systems: Free longitudinal vibration of bars, flexural vibration of beams with different end conditions, Stiffness matrix, mass matrix (lumped and consistent); equations of motion for the discretised beam in matrix form.	**10 Hours**	**L_2, L_4**

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 Structural Dynamics
- Design and develop analytical skills.
- Summarize the Solution techniques for dynamics of Multi-degree freedom systems
- Understand the concepts of damping in structures.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- 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:

- Dynamics of Structures – Theory and Application to Earthquake Engineering"- 2nd ed., Anil K. Chopra, Pearson Education.
- Earthquake Resistant Design of Building Structures, Vinod Hosur, WILEY (india)
- Vibrations, structural dynamics- M. Mukhopadhaya : Oxford IBH
- Structural Dynamics- Mario Paz: CBS publishers.
- Structural Dynamics- Clough & Penzien: TMH
- Vibration Problems in Engineering Timoshenko, S, Van-Nostrand Co

ADVANCED DESIGN OF PRE-STRESSED CONCRETE STRUCTURES

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

Subject Code	**16CSE151**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives: This course will enable students to

1. Design pre-stressed elements
2. Understand the behavior of pre-stressed elements.
3. Understand the behavior of pre-stressed sections

Modules	Teaching Hours
Module -1	
Losses of Prestress : Loss of prestress in pre-tensioned and post-tensioned members due to various causes like elastic shortening of concrete, shrinkage of concrete, creep of concrete, relaxation of steel, slip in anchorage, bending of member and frictional loss – Analysis of sections for flexure.	**8 Hours**
Module -2	
Design of Section for Flexure: Allowable stresses, Elastic design of simple beams having rectangular and I-section for flexure, kern lines, cable profile and cable layout. **Design of Sections for Shear**: Shear and Principal stresses, Improving shear resistance by different prestressing techniques-horizontal, sloping and vertical prestressing, Analysis of rectangular and I–beam, Design of shear reinforcement, Indian code provisions.	**8 Hours**
Module -3	
Deflections of Prestressed Concrete Beams: Short term deflections of uncracked members, Prediction of long-term deflections, load–deflection curve for a PSC beam, IS code requirements for maximum deflections.	**8 Hours**
Module -4	
Transfer of Prestress in Pretensioned Members : Transmission of prestressing force by bond, Transmission length, Flexural bond stresses, IS code provisions, Anchorage zone stresses in post tensioned members, stress distribution in End block, Anchorage zone reinforcements.	**8 Hours**
Module -5	
Statically Indeterminate Structures: Advantages and disadvantages of continuous PSC beams, Primary and secondary moments, P and C lines, Linear transformation, concordant and non-concordant cable profiles, Analysis of continuous beams.	**8 Hours**

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 full question carrying 16 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

REFERENCE BOOKS:

Srinath. L.S., Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co ltd., New Delhi

1. Krishna Raju, “Prestressed concrete”, Tata Mc Graw Hill Book – Co ., New Delhi.
2. T.Y. Lin and Burn, “Design of prestress concrete structures”, John Wiley, New York.
3. S. Ramamrutham, “Prestressed concrete”, Dhanpat Rai & Sons, Delhi.

SPECIAL CONCRETE

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

SEMESTER – I

Subject Code	16CSE152	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to learn principles of Concrete mix design, To differentiate between different types of concrete. To characterize the high Performance concrete.

Modules	Teaching Hours	RBT Level
Module -1		
Components of modern concrete and developments in the process and constituent materials: Role of constituents, Development in cements and cement replacement materials, pozzolona, fly ash, silica fume, rice husk ash, recycled aggregates, chemical admixtures. Mix proportioning of Concrete: Principles and methods.	**8 Hours**	**L_1, L_2, L_5**
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.	**8 Hours**	**L_1, L_2**
Module -3		
Ferro cement: Ferrocement materials, mechanical properties, cracking of ferrocement, strength and behaviour in tension, compression and flexure, Design of ferrocement in tension, ferrocement constructions, durability, and applications.	**8 Hours**	**L_1, L_2, L_5**
Module -4		
Fibre reinforced concrete: Fibre materials, mix proportioning, distribution and orientation, interfacial bond, properties in fresh state, strength and behavior in tension, compression and flexure of steel fibre reinforced concrete, mechanical properties, crack arrest and toughening mechanism, applications.	**8 Hours**	**L_1, L_2, L_5**
Module -5		
High Performance concrete: constituents, mix	**8 Hours**	**L_1, L_2**

proportioning, properties in fresh and hardened states, applications and limitations. Ready Mixed Concrete-QCI-RMCPC scheme requirements, Self Compacting Concrete, Reactive powder concrete, and bacterial concrete.		

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 Concrete mix design
- Design and develop analytical skills.
- Summarize the Light Weight concrete, Fibre reinforced concrete and High Performance concrete
- Understand the concepts of high Performance concrete

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- 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.

REFERENCES:

1. Neville A.M, "Properties of Concrete" Pearson Education Asia, 2000
2. P. Kumar Mehta, Paul J.N. Monterio, CONCRETE:Microstructure, Properties and Materials", Tata McGraw Hill
3. A.R.Santhakumar, (2007) "Concrete Technology"-Oxford University Press, New Delhi, 2007
4. Gambhir "Concrete Technology" TMH.
5. Short A and Kinniburgh.W, "Light Weight Concrete"- Asia Publishing House, 1963
6. Aitcin P.C. "High Performance Concrete"-E and FN, Spon London 1998
7. Rixom.R. and Mailvaganam.N., "Chemical admixtures in concrete"- E and FN, Spon London 1999
8. Rudnai.G., "Light Weight concrete"- Akademiaikiado, Budapest, 1963
9. http://qcin.org/CAS/RMCPC/

DESIGN OF PRECAST AND COMPOSITE STRUCTURES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – I			
Subject Code	**16 CSE153**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

Course objectives: This course will enable students to

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
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**
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**
Module -3	
Design of precast concrete columns and walls 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.	**8 Hours**
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**
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	**8 Hours**

Composite Beams: Elastic Behaviour, Ultimate Load behavior of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams.	

Course outcomes:

After studying this course, students will be able to:

Graduate Attributes (as per NBA)

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 16 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

REFERENCES:

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

RELIABILITY ANALYSIS OF STRUCTURES

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

SEMESTER – I

Subject Code	16CSE154	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives:
The objective of this course is to make students to learn principles of reliability, To implement the Probability Concepts for the Reliability Analysis. To evaluate different methods of reliability analysis.

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**	**L_1, L_2, L_3, L_4**
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 theorem	**8 Hours**	**L_1, L_2, L_4**
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**	**L_1, L_2, L_4**
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**	**L_1, L_2, L_3, L_4**

Module -5		
System reliability: Influence of correlation coefficient, redundant and non-redundant systems-series, parallel and combined systems, Uncertainty in reliability assessments- Confidence limits, Bayesian revision of reliability. Simulation Techniques: Monte Carlo simulation- Statistical experiments, sample size and accuracy, Generation of random numbers-random numbers with standard uniform distribution, continuous random variables, discrete random variables	**8 Hours**	**L_1, L_2, L_4**

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 reliability.
- Design and develop analytical skills.
- Summarize the Probability distributions
- Understands the concept of System reliability.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- 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. Ranganathan, R. (1999). "Structural Reliability Analysis and design"- Jaico publishing house, Mumbai, India.
2. 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.
3. 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.
4. Milton, E. Harr (1987). "Reliability based design in civil engineering"- Mc Graw Hill book Co.
5. Nathabdndu, T., Kottegoda, and Renzo Rosso (1998). Statistics, "Probability and reliability for Civil and Environmental Engineers"- Mc Graw Hill international edition, Singapore.
6. Achintya Haldar and Sankaran Mahadevan (2000). "Probability, Reliability and Statistical methods in Engineering design"- John Wiley and Sons. Inc.
7. Thoft-christensen, P., and Baker, M., J., (1982), "Structural reliability theory and its applications"- Springer-Verlag, Berlin, NewYork.
8. Thoft-christensen, P., and Murotsu, Y. (1986). "Application of structural systems reliability theory"- Springer-Verlag, Berlin, NewYork

STRUCTURAL ENGINEERING LAB-1

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

SEMESTER – I

Subject Code	**16CSEL16**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	42	Exam Hours	03

CREDITS – 02

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. Testing of beams for deflection, flexure and shear *-12 Hrs* 2. Experiments on Concrete, including Mix design *-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 *-06 Hrs*	**42**	**L_1, L_2, L_3, L_4, L_5, L_6**

Course outcomes:

On completion of this course, students are 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 equipments.

ADVANCED DESIGN OF STEEL STRUCTURES [As per Choice Based Credit System (CBCS) scheme] SEMESTER – II			
Subject Code	**16CSE21**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03
CREDITS – 04			

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
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.	**10 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	**10 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)	**10 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.	**10 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.	**10 Hours**

Course outcomes:

After studying this course, students will be able to:

Graduate Attributes (as per NBA)

Question paper pattern:

- The question paper will have Ten questions, each full question carrying 16 marks.
- There will be two full questions (with a maximum Three sub divisions, if necessary) from each module.
- Each full question shall cover the topics under a module.
- The students shall answer Five full questions selecting one full question from each module.
- If more than one question is answered in modules, best answer will be considered for the award of marks limiting one full question answer in each module.

REFERENCE BOOKS:

1. N. Subramanian, "Design of Steel Structures", Oxford,IBH
2. Duggal S.K, Design of Steel structures
3. Srinath L.S, Advanced Mechanics of Solids, Tata McGraw-Hill
3. IS 1641, 1642,1643
4. IS 800: 2007, IS 811
5. INSDAG Teaching Resource Chapter 11 to 20: www.steel-insdag.org

EARTHQUAKE RESISTANT STRUCTURES

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

SEMESTER – II

Subject Code	16CSE22	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

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.	**10 Hours**	**L_1, L_2**
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.	**10 Hours**	**L_2, L_3, L_4, L_5**
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	**10 Hours**	**L_2, L_4, L_5**

earthquakes, failure patterns, strength of masonry in shear and flexure, Slenderness concept of masonry walls, concepts for earthquake resistant masonry buildings – codal provisions.		
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 IS-1893. Structural behavior, design and ductile detailing of shear walls.	**10 Hours**	**L_2, L_4, L_5**
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.	**10 Hours**	**L_2, L_5, L_6**

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 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 full question consists of 16 marks.
- 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. 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

FINITE ELEMENT METHOD OF ANALYSIS

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

SEMESTER – II

Subject Code	16CSE23	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

Course objectives:
The objective of this course is to make students to learn principles of Analysis of Stress and Strain, To apply the Finite Element Method for the analysis of one and two dimensional problems. To evaluate the stress and strain parameters and their inter relations of the continuum.

Modules	Teaching Hours	RBT Level
Module -1		
Basic concepts of elasticity – Kinematic and Static variables for various types of structural problems – approximate method 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 & disadvantages – Finite element procedure. Finite elements used for one, two & three dimensional problems – Element aspect ratio – mesh refinement vs. higher order elements – Numbering of nodes to minimize band width.	**10 Hours**	**L_1, L_2**
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 dimensional elements.	**10 Hours**	**L_1, L_2, L_4, L_5**
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.	**10 Hours**	**L_1, L_2, L_4, L_5**

Module -4		
Application of Finite Element Method for the analysis of one & two dimensional problems, Analysis of simple beams and plane trusses, Application to plane stress / strain / axisymmetric problems using CST & Quadrilateral Elements	**10 Hours**	**L_1, L_2, L_3, L_4, L_5**
Module -5		
Application to Plates & Shells, Choice of displacement function (C^0, C^1 and C^2 type), Techniques for Non – linear Analysis.	**10 Hours**	**L_1, L_2**

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 state of stress in a continuum
- Understand the concepts of elasticity and plasticity.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- 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. Krishnamoorthy C S, “Finite Element Analysis”- Tata McGraw Hill
2. Desai C and Abel J F, “Introduction to the Finite Element Method”- East West Press Pvt. Ltd., 1972
3. Bathe K J, “Finite Element Procedures in Engineering Analysis”- Prentice Hall
4. Rajasekaran. S, “Finite Element Analysis in Engineering Design”-Wheeler Publishing
5. Cook R D, Malkan D S & Plesta M.E, “Concepts and Application of Finite Element Analysis” - 3rd Edition, John Wiley and Sons Inc., 1989
6. Shames I H and Dym C J, “Energy and Finite Element Methods in Structural Mechanics”- McGraw Hill, New York, 1985

DESIGN CONCEPTS OF SUBSTRUCTURES

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

SEMESTER – II

Subject Code	16CSE24	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

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.	**10 Hours**	**L_2, L_4, L_5**
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.	**10 Hours**	**L_2, L_4, L_5**
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	**10 Hours**	**L_2, L_4, L_5**
Module -4		
Deep Foundations: Load Transfer in Deep Foundations, Types of Deep Foundations, Ultimate bearing capacity of different 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.	**10 Hours**	**L_2, L_3, L_4, L_5**
Module -5		
Types of caissons, Analysis of well foundations,	**10 Hours**	**L_2, L_3, L_4,**

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.		**L_5**

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.

IMPORTANT NOTE:

Only design principles of all type footings as per relevant BIS codes are to be covered, design of RC elements need not be

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- 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

DESIGN OF TALL STRUCTURES

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

SEMESTER – II

Subject Code	16CSE251	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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	**8 Hours**	**L_1, L_2**
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.	**8 Hours**	**L_1, L_3, L_4, L_5**
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.	**8 Hours**	**L_2, L_3**
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	**8 Hours**	**L_2, L_3, L_4**

twist, computerized general three dimensional analyses.		
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	**8 Hours**	**L_2, L_3, L_4, L_5**

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 full question consists of 16 marks.
- 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. 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

REPAIR AND REHABILITATION OF STRUCTURES

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

SEMESTER – II

Subject Code	16CSE 252	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

Course objectives:

The objective of this course is to make students to investigate the cause of deterioration of concrete structures, To strategize different repair and rehabilitation of structures. To evaluate the performance of the materials for repair

Modules	Teaching Hours	RBT Level
Module -1		
General: Introduction, Cause of deterioration of concrete structures, Diagnostic methods & analysis, preliminary investigations, experimental investigations using NDT, load testing, corrosion mapping, core drilling and other instrumental methods, Quality assurance for concrete construction, as built concrete properties strength, permeability, thermal properties and cracking.	**8 Hours**	**L_3, L_5**
Module -2		
Influence on Serviceability and Durability: Effects due to climate, temperature, chemicals, wear and erosion, Design and construction errors, corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, and cathodic protection.	**8 Hours**	**L_3, L_4, L_5**
Module -3		
Maintenance and Repair Strategies: Definitions: Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance, Preventive measures on various aspects. Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration, testing techniques	**8 Hours**	**L_2, L_3, L_5**
Module -4		
Materials for Repair: Special concretes and mortars, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferro cement, Fiber	**8 Hours**	**L_2**

reinforced concrete. Techniques for Repair: Rust eliminators and polymers coating for rebar during repair foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shot Crete Epoxy injection, Mortar repair for cracks, shoring and underpinning.		
Module -5		
Examples of Repair to Structures: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering wear, fire, leakage, marine exposure, engineered demolition techniques for dilapidated structures - case studies	**8 Hours**	**L_2, L_5**

Course outcomes:

On completion of this course, students are able to:

- Achieve Knowledge of design and development of problem solving skills.
- Understand the cause of deterioration of concrete structures.
- Design and develop analytical skills.
- Summarize the principles of repair and rehabilitation of structures
- Understands the concept of Serviceability and Durability.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- 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. Sidney, M. Johnson “Deterioration, Maintenance and Repair of Structures”.
2. Denison Campbell, Allen & Harold Roper, “Concrete Structures – Materials, Maintenance and Repair”- Longman Scientific and Technical
3. R.T.Allen and S.C. Edwards, “Repair of Concrete Structures”-Blakie and Sons
4. Raiker R.N., “Learning for failure from Deficiencies in Design, Construction and Service”- R&D Center (SDCPL

STABILITY ANALYSIS OF STRUCTURES

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

SEMESTER – II

Subject Code	16CSE 253	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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**	**L_1, L_2**
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 shear force on critical load. Column subjected to non – conservative follower and pulsating forces.	**8 Hours**	**L_2, L_3**
Module -3		
Stability analysis by finite element approach – deviation 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	**8 Hours**	**L_2, L_3, L_4**

in). Buckling of pin jointed frames (maximum of two active DOF) – symmetrical single bay portal frame.		
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**	**L_1, L_2, L_3**
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**	**L_1, L_2, L_3**

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 full question consists of 16 marks.
- 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. 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

THEORY OF PLATES AND SHELLS

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

SEMESTER – II

Subject Code	16CSE 254	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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.	**8 Hours**	**L_1, L_2**
Module -2		
Energy methods for rectangular and circular plates with clamped edges subjected to symmetric loadings.	**8 Hours**	**L_2, L_3**
Module -3		
Introduction to curved surfaces and classification of shells, Membrane theory of spherical shells, cylindrical shells, hyperbolic paraboloids, elliptic paraboloid and conoids	**8 Hours**	**L_2, L_3**
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.	**8 Hours**	**L_2, L_3**
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	**8 Hours**	**L_2, L_3, L_4**

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.
- Each full question consists of 16 marks.
- 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

STRUCTURAL ENGINEERING LAB-II

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

Subject Code	16CSEL26	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	42	Exam Hours	03

CREDITS – 02

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. Static and Dynamic analysis and design of Multistory Building structures using software (ETABS / STAADPRO) 2. Design of RCC and Steel Tall structures using software (ETABS / STAADPRO) 3. Analysis of folded plates and shells using software. 4. Preparation of EXCEL sheets for structural design.	**42 Hours**	**L_1, L_2, L_3, L_4, L_5, L_6**

Course outcomes:

On completion of this course, students are 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 CONCRETE BRIDGES

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

Subject Code	16CSE 41	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS – 04

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		
Introduction: Historical Developments, Site Selection for Bridges, Classification of Bridges Forces on Bridges. Bridge substructures: Abutments, piers and wing walls Balanced Cantilever Bridge: Introduction and proportioning of components, Design of simply supported portion and design of cantilever portion, design of articulation	**10 Hours**	**L_1, L_2, L_3, L_4**
Module -2		
Box Culvert: Different Loading Cases IRC Class AA Tracked, Wheeled and Class A Loading, working out the worst combination of loading, Moment Distribution, Calculation of BM & SF, Structural Design of Slab Culvert, with Reinforcement Details.	**10 Hours**	**L_2, L_3, L_4**
Module -3		
T Beam Bridge Slab Design: Proportioning of Components Analysis of interior Slab & Cantilever Slab Using IRC Class AA Tracked, Wheeled Class A Loading, Structural Design of Slab, with Reinforcement Detail. T Beam Bridge Cross Girder Design: Analysis of Cross Girder for Dead Load & Live Load Using IRC Class AA Tracked, Wheeled Class A Loading A Loads, Structural Design of Beam, with Reinforcement Detail.	**10 Hours**	**L_2, L_3, L_4**
Module -4		
T Beam Bridge Main Girder Design: Analysis of Main Girder for Dead Load & Live Load Using IRC Class AA Tracked, Wheeled Class A Loading Using COURBON'S Method, Analysis of Main Girder Using HENDRY-JAEGER and MORICE-LITTLE Method for IRC Class AA Tracked vehicle only, BM & SF for	**10 Hours**	**L_2, L_3, L_4**

different loads, Structural Design of Main Girder With Reinforcement Details		
Module -5		
PSC Bridges: Introduction to Pre and Post Tensioning, Proportioning of Components, Analysis and Structural Design of Slab, Analysis of Main Girder using COURBON's Method for IRC Class AA tracked vehicle, Calculation of pre-stressing force, cable profile and calculation of stresses, Design of End block and detailing of main girder	**10 Hours**	**L_1, L_2, L_3, L_4**

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.
- Each full question consists of 16 marks.
- 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. "Essentials of Bridge Engineering"- D Johnson Victor, Oxford & IBH Publishing Co New Delhi
2. "Design of Bridges"- N Krishna Raju, Oxford & IBH Publishing Co New Delhi
3. "Principles and Practice of Bridge Engineering"- S P Bindra Dhanpat Rai & Sons New Delhi
4. IRC 6 – 1966 "Standard Specifications And Code Of Practice For Road Bridges"- Section II Loads and Stresses, The Indian Road Congress New Delhi
5. IRC 21 – 1966 "Standard Specifications And Code Of Practice For Road Bridges"-Section III Cement Concrete (Plain and reinforced) The Indian Road Congress New Delhi
6. IS 456 – 2000 "Indian Standard Plain and Reinforced Concrete Code of Practice"- (Fourth Revision) BIS New Delhi
7. IS 1343 – "Indian Standard Prestressed Concrete Code of Practice"- BIS New Delhi
8. Raina V.K., "Concrete Bridge Practice"- Tata McGraw Hill
9. Bakht B & Jaeggar, "Bridge Analysis Simplified"- McGraw Hill
10. Ponnuswamy. S, "Bridge Engineering"- Tata McGraw Hill.
11. Derrick Beckett, "An Introduction to Structural Design of Concrete Bridges"- Surrey University Press

OPTIMIZATION TECHNIQUES

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

SEMESTER – IV

Subject Code	16CSE 421	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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**	**L_1, L_2, L_4**
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**	**L_2, L_4, L_5**
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**	**L_2, L_3, L_4, L_5**

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 techniques	**8 Hours**	**L_2, L_3, L_4, L_5**
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**	**L_4, L_5**

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.
- Each full question consists of 16 marks.
- 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

DESIGN OF INDUSTRIAL STRUCTURES

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

Subject Code	16CSE 422	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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	**8 Hours**	**L_2, L_3, L_4**
Module -2		
Analysis and design of gantry column (stepped column / column with bracket), purlins, girts, bracings including all connections.	**8 Hours**	**L_2, L_3, L_4**
Module -3		
Analysis of transmission line towers for wind load and design of towers including all connections.	**8 Hours**	**L_2, L_3, L_4**
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.	**8 Hours**	**L_1, L_2, L_4**
Module -5		
Concept of Pre- engineered buildings, Design of compression and tension members of cold formed light gauge sections, Design of flexural members (Laterally restrained / laterally unrestrained).	**8 Hours**	**L_2, L_3, L_4**

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 full question consists of 16 marks.
- 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. 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

THEORY OF PLASTICITY AND FRACTURE MECHANICS [As per Choice Based Credit System (CBCS) scheme] SEMESTER – IV			
Subject Code	**16CSE423**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03
CREDITS – 03			

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 non linear materials.
2. Know experimental methods to determine the fracture toughness
3. Use the design principle of materials and structures using fracture mechanics approaches

Modules	Teaching Hours
Module -1	
Plasticity General concept, yield criteria, flow rules for perfectly plastic and strain hardening materials - simple applications, Theories of failure. Plasticity models for concrete	**8 Hours**
Module -2	
Linear Elastic Fracture mechanics Basic modes of fracture, Griffith theory of brittle fracture, Irwin's modifications for elastic-plastic materials, theories of linear elastic fracture mechanics, stress intensity factors, fracture toughness testing.	**8 Hours**
Module -3	
Elasto-plastic fracture mechanics Crack-tip plasticity and in metals. Mixed mode problems and evaluation of critical fracture parameters	**8 Hours**
Module -4	
Fatigue damage theories, Fatigue test, endurance limit, fatigue fracture under combined loading, fatigue controlling factors, cumulative fatigue damage concepts.	**8 Hours**
Module -5	
Fracture of Concrete Review of concrete behaviour in tension and compression, Basic frameworks for modeling of quasi-brittle materials, discrete crack concept/Smeared crack concept. FE Concepts and applications.	**8 Hours**

Course outcomes:

After studying this course, students will be able to:

- Explain and apply yield criteria & flow-rules
- Design structures using fracture mechanics approaches
- Apply principles of fracture mechanics
- Solve problems related to plastic fracture mechanics

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- 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. Valliappan S. "Continuum Mechanics Fundamentals" (1982), Oxford IBH, N D. New Delhi.
2. Broek, D., "Elementary Engineering Fracture Mechanics", 4th edition, MartinusNijhoff (1987).
3. Venkataraman and Patel “Structural Mechanics with introduction to Elasticity and Plasticity” – Mcgraw Hill, 1990.
4. T. L. Anderson, Fracture Mechanics- Fundamentals and Applications, 1nd, New Delhi, Advanced Mechanics of Solids, Tata McGraw-Hill Publishing Co Ltd, New Delhi

DESIGN OF MASONRY STRUCTURES

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

Subject Code	16CSE 424	IA Marks	20
Number of Lecture Hours/Week	03	Exam Marks	80
Total Number of Lecture Hours	40	Exam Hours	03

CREDITS – 03

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.

Modules	Teaching Hours	RBT Level
Module -1		
Introduction, Masonry units, materials and types: History of masonry Characteristics of Brick, stone, clay block, concrete block, stabilized mud block masonry units – strength, modulus of elasticity and water absorption. Masonry materials – Classification and properties of mortars, selection of mortars.	**8 Hours**	**L_1, L_2**
Module -2		
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	**8 Hours**	**L_1, L_2, L_4**
Module -3		
Flexural and shear bond, flexural strength and shear strength: Bond between masonry unit and mortar, tests for determining flexural and shear bond strengths, factors affecting bond 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	**8 Hours**	**L_1, L_2, L_4**

Module -4		
Design of load bearing masonry buildings: Permissible compressive stress, stress reduction and shape reduction factors, increase in permissible stresses for eccentric vertical and lateral loads, permissible tensile and shear stresses, Effective height of walls and columns, opening in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action, lintels; Wall carrying axial load, eccentric load with different eccentricity ratios, wall with openings, freestanding wall; Design of load bearing masonry for buildings up to 3 to 8 storeys using BIS codal provisions	**8 Hours**	**L_1, L_2, L_3, L_4**
Module -5		
Earthquake resistant masonry buildings: Behaviour of masonry during earthquakes, concepts and design procedure for earthquake resistant masonry, BIS codal provisions. Masonry arches, domes and vaults: Components and classification of masonry arches, domes and vaults, historical buildings, construction procedure	**8 Hours**	**L_1, L_2, L_4**

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 design and construction of masonry structures
- Design and develop analytical skills.
- Summarize the masonry Characteristics.
- Evaluate the strength and stability of the masonry structures.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- 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. Hendry A.W., "Structural masonry"- Macmillan Education Ltd., 2nd edition
2. Sinha B.P & Davis S.R., "Design of Masonry structures"- E & FN Spon
3. Dayaratnam P, "Brick and Reinforced Brick Structures"- Oxford & IBH
4. Curtin, "Design of Reinforced and Prestressed Masonry"- Thomas Telford
5. Sven Sahlin, "Structural Masonry"-Prentice Hall
6. Jagadish K S, Venkatarama Reddy B V and Nanjunda Rao K S, "Alternative Building Materials and Technologies"-New Age International, New Delhi & Bangalore
7. IS 1905, BIS, New Delhi.
8. SP20(S&T),New Delhi