Scheme of Teaching & Examination

And

Syllabus for I – IV Semester

(2016-2018 Batch)

M.Tech in Structural Engineering

(An Autonomous PG Programme under VTU)

Post Graduate Programme

Department of Civil Engineering

NITTE MEENAKSHI INSTITUTE OF TECHNOLOGY

(An Autonomous Institution under Visvesvaraya Technological University, Belgaum)

YELAHANKA, BANGALORE - 560 064

2016-17

Scheme for M Tech, Structural Engineering (Tentative)

SEMESTER: I

Sl No	Subject Code	Subject Name	Course Type	Teaching Dept.	Teaching Hours/week			Examination			Credits
					L#	T#	P#	CIE*	SEE**	Total	
1	16SEC101	ADVANCED MATHEMATICS	PC		4	0	0	50	50	100	4
2	16SEC102	MECHANICS OF DEFORMABLE BODIES	PC		4	0	2	50	50	100	5
3	16SEC103	ADVANCED DESIGN OF RCC STRCUTURES	PC		4	0	2	50	50	100	5
4	16SEC104	STRUCTURAL DYNAMICS	PC		4	0	2	50	50	100	5
5	16SEC105EX	PROGRAM ELECTIVE – GROUP A	PE		4	0	0	50	50	100	4
6	16SEC106L	SELF STUDY & LABORATORY	PC		0	0	4	50	50	100	3
7	16SEC107S	TECHNICAL SEMINAR	PC		0	0	0	50	50	100	2
							TOTAL	350	350	700	28

SEMESTER: II

Sl No	Subject Code	Subject Name	Course Type	Teaching Dept.	Teaching Hours/week			Examination			Credits
					L#	T#	P#	CIE*	SEE**	Total	
1	16SEC201	DESIGN CONCEPTS OF SUBSTRUCTURES	PC		4	0	0	50	50	100	4
2	16SEC202	MATRIX AND FINITE ELEMENT METHOD OF ANALYSIS	PC		4	0	2	50	50	100	5
3	16SEC203	DESIGN OF TALL STRUCTURES	PC		4	0	2	50	50	100	5
4	16SEC204	ADVANCED DESIGN OF STEEL STRUCTURES	PC		4	0	2	50	50	100	5
5	16SEC205EX	PROGRAM ELECTIVE – GROUP B	PE		4	0	0	50	50	100	4
7	16SEC206L	LABORATORY	PC		0	0	4	50	50	100	3
8	16SEC207S	TECHNICAL SEMINAR	PC		0	0	0	50	50	100	2
							TOTAL	350	350	700	28

SEMESTER: III

Sl No	Subject Code	Subject Name	Course Type	Teaching Dept.	Teaching Hours/week			Examination			Credits
					L#	T#	P#	CIE*	SEE**	Total	
1	14SEC301S	SEMINAR/FIELD WORK/PROFESSIONAL TRAINING/ SELF STUDY	PC		-	-	8	50	50	100	4
2	14SEC302P	PROJECT PHASE -1 Assessment	PC		-	-	22	50	50	100	16
							TOTAL	100	100	200	20

Note: 1.External examination should be combined for SEMINAR/FIELD WORK/PROFESSIONAL TRAINING/ SELF STUDY/TERM PAPER and PROJECT PHASE -1 (Viva Voce) but separate marks sheet should be submitted.
2. The Project will commence immediately after the II semester.

Group A – Elective Subjects of I Sem			Group B – Elective Subjects of II Sem		
Sl No	Subject Code	Subject Name	Sl No	Subject Code	Subject Name
1	16SEC105E1	OPTIMIZATION TECHNIQUE	1	16SEE205E1	DESIGN OF RC BRIDGES
2	16SEC105E2	RESTORATION AND REHABLITATION OF STRUCTURES	2	16SEE205E2	SUSTAINABLE STRUCTURES
3	16SEC105E3	DESIGN OF MASONARY STRUCTURES	3	16SEE205E3	DESIGN OF PLATES AND SHELLS
4	16SEC105E4	STABILITY OF STRUCTURES	4	16SEE205E4	CONSTRUCTION PROJECT MANAGEMENT
5	16SEC105E5	RELIABILITY ANALYSIS OF STRUCTURES	5	16SEE205E5	ADVANCED PSC STRUCTURES
6	16SEC105E6	PRE-CAST AND PRE-FABRICATED STRUCTURES	6	16SEE205E6	COMPOSITE AND SMART MATERIALS
7	16SEC105E7	SPECIAL CONCRETES			

SEMESTER: IV

Sl No	Subject Code	Subject Name	Course Type	Teaching Dept.	Teaching Hours/week			Examination			Credits
					L#	T#	P#	CIE*	SEE**	Total	
1	14SEC401P	PROJECT PHASE -2- Thesis Evaluation	PC		-	-	15	100$	100#	200	08
2	14SEC402P	PROJECT PHASE -2- Assessment & Viva Voce	pc		-	-	15	100	100	200	16
							TOTAL	200	200	400	24

* Continuous Internal Evaluation ** Semester End Exam

$ - Internal evaluation by the guide, # - External Examiner Evaluation (Thesis)

PROJECT PHASE -2- THESIS ASSESMENT* :-

The evaluation under this title involves two components

1. Thesis evaluation by the external examiner will be considered as SEE#
2. Thesis evaluation by the internal examiner will be considered as CIE$

PROJECT PHASE -2- INTERNAL EVALUATION AND VIVO VOCE**

The evaluation under this title involves two components

1. Final Viva Voce jointly conducted by the Internal and External examiner s will be considered as SEE
2. Continuous evaluation of the project throughout the semester by the Internal committee (at departmental level) will be considered as CIE

Subject Name : Advanced Mathematics			
Subject Code	: 16SEC101		CIE Marks : 50
No. of Lecture Hrs/Week	: 04		SEE Marks : 50
Total No. of Lecture Hrs	: 52		Exam Hours : 03

Course Outcomes (COs):

After successful completion of the course, students will be able to,

1. Compute solution of a system of algebraic equations.
2. Demonstrate an understanding to Fourier series and Fourier transforms.
3. Formulate boundary value problems involving one dimensional heat and wave equation.
4. Employ analytical techniques to solve partial differential equations with appropriate boundary conditions.
5. Obtain the extreme of a functional.

UNIT -1

Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling

Engineering problem solving: simple mathematical model, Conservation laws of Engineering.

Roots of Equations: Bisection method, False position method, Newton Raphson method, Secant method, Simple fixed point iteration

10Hrs

UNIT-2

Roots of Polynomials in Engineering and Science, Muller's method, Bairstow's method, Graffe's Roots squaring method. Numerical differentiation- Numerical Differentiation applied to engineering problems.

10Hrs

UNIT-3

Numerical Integration: Newton-Cotes (Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rule)and Gauss Quadrature Integration formulae, Integration of equations, Romberg Integration, Ordinary Differential Equations: Initial Value problems, Single step methods- Taylor's series method, Runge-Kutta method (4^{th} order method, R-K method for system of equations and higher order systems). Multistep methods- Milne Predictor-Corrector methods

10Hrs

UNIT-4

System of Linear Algebraic equations and Eigen Value problems: Triangularization method ,Cholesky method, Partition method., Eigen values and Eigen vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rautishauser method for arbitrary matrices, Power method, Inverse power method.

10Hrs

UNIT-5

Numerical solution of Partial Differential Equations: Classification of second order equations, Parabolic equations- solution of one dimensional heat equation, explicit method, Crank-Nicolson method and Du fort-Frankel method, hyperbolic equations- solution of one dimensional wave equation

09Hrs

Laboratory Component: Use of MATHEMATICA or Any other Software where ever applicable

Course Assessment Method:

CIE –50 Marks

1. Three internals tests (each 30 marks) are conducted, average of best two marks will be considered.
2. Case Studies /Assignment/seminar 20 marks.

SEE –50 Marks

1. Two questions to be set from each unit, carrying 20 mark each.
2. Students have to answer 5 questions selecting one full question from each unit

Text Book:

1. **Computational Methods for Partial Differential Equations**, M. K. Jain, S.R.K. iyengar, R.K. Jain, New Age International, 1994.-
2. **Numerical Methods for Engineers**, Steven C. Chapra, Raymond P. Canale,Tata Mcgraw Hill, ^{4th} Edition,2002.
3. **Numerical Methods for Scientific and Engineering Computation,** M. K. Jain, S.R.K. iyengar, R.K. Jain,New Age International, 2003

Reference Book:

1. Introductory methods of Numerical Analysis, S.S. Sastry,PHI, 2005
2. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publishers, 2003
3. Fundamentals of Engineering Numerical Analysis, Pervez Moin, Cambridge, 2010
4. Grewal B.S, Higher Engineering Mathematics, Khanna publishers, 1997.
5. Venkataraman, M.K., Higher Mathematics for Engineers, National Publishing Co.

Subject Name: Mechanics of Deformable Bodies				
Subject Code	: 16SEC102		CIE Marks	: 50
No. of Lecture Hrs/Week	: 04+02		SEE Marks	: 50
Total No. of Lecture Hrs	: 78		Exam Hours	: 03

Course Outcomes (COs):

After successful completion of the course, students will be able to,

1. Determine the equations of equilibrium for stress and strain at a point.
2. Solve axi symmetric problems, find deviatric strains
3. Find twist of circular shafts and membrane analogy
4. Apply the theories of plasticity

UNIT -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.

8hrs

UNIT -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 deviatoric strains, max. shear strain.

10hrs

UNIT -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.

10hrs

UNIT -4

Elementary problems of elasticity in three dimensions, stretching of a prismatical 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.

12hrs

UNIT -5

Theory of Plasticity: Stress – strain diagram in simple tension, 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.

12hrs

Laboratory Component: Use of MATHEMATICA or Any other Software where ever applicable

Course Assessment Method:
CIE –50 Marks

3. Three internals tests (each 30 marks) are conducted, average of best two marks will be considered.
4. Case Studies /Assignment/seminar 20 marks.

Scheme: Set question paper for 100 marks

3. Two questions to be set from each unit, carrying 20 mark each.
4. Students have to answer 5 questions selecting one full question from each unit

TEXT BOOKS:

1. Timoshenko & Goodier, "**Theory of Elasticity**", McGraw Hill, 2015.
2. Srinath L.S., **Advanced Mechanics of Solids**, 10th print, Tata McGraw Hill Publishing company, New Delhi, 1994

REFERENCE BOOKS:

1. Sadhu Singh, "**Theory of Elasticity**", Khanna Publishers, 2012.
2. Verma P.D.S, "**Theory of Elasticity**", Vikas Publishing Pvt. Ltd, 2000.
3. Chenn W.P and Hendry D.J, "**Plasticity for Structural Engineers**", Springer Verlag, 2002.
4. Valliappan C, "**Continuum Mechanics Fundamentals**", Oxford IBH Publishing Co. Ltd., 1998.
5. Xi Lu, "**Theory of Elasticity**", John Wiley, 1990.

Subject Name: Advanced Design of RCC Structures			
Subject Code	: 16SEC103		CIE Marks : 50
No. of Lecture Hrs/Week	: 04+02		SEE Marks : 50
Total No. of Lecture Hrs	: 78		Exam Hours : 03

Course Outcomes (COs)

After successful completion of the course, students will be able to,

1. Estimate the crack width and deflection with regard to the serviceability.
2. Analyse and design a grid floor system.
3. Analyse and design a flat slab system.
4. Discuss fire and seismic resistance of concrete structures.
5. Analyse and design bunkers, silos, chimneys and tanks.

UNIT 1

Design of continuous beams with redistribution of moments – Symmetric Loading, unsymmetrical loading, simply supported beam and continuous beams of two and three spans.

Ductile Detailing earthquake resistant structures – Typical Drawings using AUTOCADD and Specifications.

10Hr

UNIT 2

Design of grid floors and Flat Slab

Concept of Yield line failures of Slab - (Only Theory Questions, No Numerical Examples)

10Hr

UNIT 3

Design of Silos and Bunkers

06Hr

UNIT 4

Design Elevated water tanks -Intze Type of Water Tank on staging

12Hr

UNIT 5

Elevated water tanks funnel shaped water tanks on shaft 12Hr

Laboratory Component: Detailing of the Design covered in Unit 1 to 5 should be prepared using Autocadd in Laboratory and submitted as assignment report.

Scheme: Set question paper for 100 marks

a. Two questions to be set from each unit, carrying 20 mark each.
b. Students have to answer 5 questions selecting one full question from each unit

TEXT BOOKS:

1. Krishnaraju N., "**Advanced Reinforced Concrete Design**", CBI Publishers, New Delhi. 2014
2. Punmia B.C., "**Reinforced Concrete Structures**", Volume II, 5th Edition Lakshmi Publications Pvt. Ltd., New Delhi.2013

REFERENCE BOOKS:

1. A Park and Paulay, **“Reinforced and Prestressed Concrete**” 2000.
2. Lin TY and Burns N H, “**Reinforced Concrete Design**".
3. Kong KF and Evans T H “**Design of Prestressed Concrete Structures**
4. P.C.Varghese, "**Advanced Reinforced Concrete Design**”, Prentice-Hall of India, New Delhi, 2005.

Subject Name : Structural Dynamics			
Subject Code	: 16SEC104		CIE Marks : 50
No. of Lecture Hrs/Week	: 04+02		SEE Marks : 50
Total No. of Lecture Hrs	: 78		Exam Hours : 03

Course Outcomes (COs).

After successful completion of the course, students will be able to,

1. Carry out load calculation, analysis, design and detailing of flat slabs, grid floor, water tanks, bunker and silos, folded plate and domes as per relevant IS code of practice.,
2. Analysis and design of raft foundation, strip footing and pile caps,
3. Ensure serviceability criteria for reinforced concrete structural elements.

CO-PO,PSO Mapping

UNIT 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

10hrs

UNIT 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.

10hrs

UNIT 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.

10hrs

UNIT 4

Response of Shear buildings for harmonic loading without damping using normal mode approach. Response of Shearbuildings for forced vibration for harmonic loading with damping using normal mode approach, condition of damping uncoupling.

10hrs

UNIT 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 discredited beam in matrix form.

12hrs

Lab Component: Demonstration of SDOF System & MDOF System & estimation of vibration responses

Course Assessment Method:

CIE –50 Marks

5. Three internals tests (each 30 marks) are conducted, average of best two marks will be considered.
6. Case Studies /Assignment/seminar 20 marks.

SEE –50 Marks

5. Two questions to be set from each unit, carrying 20 mark each.
6. Students have to answer 5 questions selecting one full question from each unit

TEXT BOOKS:

1. Anil K. Chopra "**Dynamics of Structures – Theory and Application to Earthquake Engineering**"- 2nd edition.Pearson Education. 2012
2. Vinod Hosur "**Earthquake Resistant Design of Building Structures**" WILEY (India) 2000
3. M. Mukhopadhaya "**Vibrations, Structural dynamics**"-: Oxford IBH 1999
4. Mario Paz "**Structural Dynamics**" CBS publishers. 2011
5. Structural Dynamics,- Clough & Penzien : TMH 1996
6. Vibration Problems in Engineering Timoshenko, S, Van-Nostrand Co. 1992

REFERENC BOOKS:

1. Yuan ka vang, bayerian methods for structural dynamics and civil engineering, john wiley & sons, NY-2010.
2. Petyt Maurice, introduction to finite element vibration analysis, Cambridge university press, 2010-cambridge.
3. Rao S S, , Mechanical vibratory, pearson education, 4th edition 2004- new delhi

Subject Name : Optimization Technique			
Subject Code	: 16SEC105E1	CIE Marks	: 50
No. of Lecture Hrs/Week	: 04	SEE Marks	: 50
Total No. of Lecture Hrs	: 52	Exam Hours	: 03

Course Outcomes (COs)

After successful completion of the course, students will be able to,

1. Importance of optimization of industrial process management
2. Apply basic concepts of mathematics to formulate an optimization problem
3. Analyse and appreciate variety of performance measures for various optimization problems

UNIT 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.

12hrs

UNIT 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.

10hrs

UNIT 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. 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.

12hrs

UNIT 4

Geometric programming: Geometric programming, conversion of NLP as a sequence of LP/ geometric programming.

10hrs

UNIT 5

Dynamic programming: Dynamic programming conversion of NLP as a sequence of LP/ Dynamic programming. 8hrs

Course Assessment Method:

CIE –50 Marks

1. Three internals tests (each 30 marks) are conducted, average of best two marks will be considered.
2. Case Studies /Assignment/seminar 20 marks.

SEE –50 Marks

1. Two questions to be set from each unit, carrying 20 mark each.
2. Students have to answer 5 questions selecting one full question from each unit

TEXT BOOKS:

1. Bhavikatti S.S. - "**Structural optimization using sequential linear programming"**- Vikas publishing house. – 2011
2. Singiresu S. Rao **:-Engineering Optimization:** Theory and Practice**. 2013**
3. **A. Ravindran , K.M. Ragsdell , G.V. Reklaitis Engineering Optimization:** Methods and Applications.2006

REFERENCE BOOKS:

1. Spunt, "**Optimum Structural Design**"- Prentice Hall-2000
2. S.S. Rao, "**Optimization – Theory and Practice**"- Wiley Eastern Ltd. - 2001
3. Uri Krisch, "**Optimum Structural Design**"- McGraw Hill- 1999

Subject Name : Restoration and Rehabilitation of Structures			
Subject Code	:16SEC105E2	CIE Marks	: 50
No. of Lecture Hrs/Week	: 04	SEE Marks	: 50
Total No. of Lecture Hrs	: 52	Exam Hours	: 03

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. Acquiring in depth knowledge about structural rehabilitation of the historical buildings

2. Understanding the specific characteristics of structural rehabilitation when restoring the architectural monuments.

3. Understanding the typical strength and failure mechanisms of hysterical buildings. Learning about the structural evaluation and its specific methods, techniques and diagnosis for finding out the rehabilitation solution.

4. Learning about rehabilitation techniques used for structural rehabilitation in line with the national and world wide trends.

5. Acquiring knowledge and necessary skills for working in interdisciplinary teams with the aim of historical buildings restoration.

6. Learning about the structural rehabilitation technical development. Worldwide applied documents. Legislative elements.

UNIT 1

General Introduction to Restoration, Rehabilitation, Repair and Retrofitting of Structures, Durability of Concrete Structures—Factors affecting Durability, Codal provisions for Durability. Cause of deterioration of concrete structures, Role of Material deficiency , Constructional deficiency, lack of Maintenance and environmental effects on durability of structures, Design and construction errors. Cracks in concrete – Causes, effects and remedies.

Corrosion: Corrosion mechanism, Effects of cover thickness and cracking, methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coatings, cathodic protection. Quality assurance for concrete construction as built concrete properties strength, permeability, thermal properties, Influence on Serviceability and Durability: Deflection, Cracking, Effects due to climate, temperature, chemicals, wear and erosion.

12hrs

UNIT 2

Investigation of Structures in distress: stages of Investigation, Physical inspection, Field tests, Method of documentation, Preliminary investigation and final investigation, Assessment of condition of structures, Methods of assessment. Forensic Method of Evaluation of Structural Health conditions.

Investigation of Structures in distress: Physical inspection, Field tests, NDT methods

10hrs

UNIT 3

Maintenance and Structural Health Monitoring Techniques: Definitions: Maintenance, repair and rehabilitation, Facets of Maintenance importance of Maintenance Preventive measures on various aspects. Concept of structural health monitoring, sensor systems and hardware requirements, global and local techniques, computational aspects of global dynamic techniques, experimental mode shapes, piezo-electric materials and other smart materials, electro-mechanical impedance (EMI) technique, adaptations of EMI technique.

10hrs

UNIT 4

Repair Materials and Techniques – Epoxies, Polymers, Latex, Modified mortars and Concretes, Bonding agents, grouting agents, Corrosion inhibitors, Surface Coating. Repair & Restoration methods: Stitching, grouting, replacement, Jacketing, Electrochemical methods for Corrosion control, Fire resistance, Soil stabilization methods.

Repair Techniques - 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.

10hrs

UNIT 5

Case study of Restored Structures—Foundations, Framed Structures, Water tanks, Sewage and treatment plants, Industrial Buildings, Bridges and Aqueducts.

Assignment-Industrial visit to at least two structures which are under repair and restoration

. 10hrs

Course Assessment Method:

CIE –50 Marks

1. Three internals tests (each 30 marks) are conducted, average of best two marks will be considered.
2. Case Studies /Assignment/seminar 20 marks.

SEE –50 Marks

1. Two questions to be set from each unit, carrying 20 mark each.
2. Students have to answer 5 questions selecting one full question from each unit

TEXT BOOKS:

1) Denison Campbell, Allen and Harold Roper, "**Concrete Structures, Materials, Maintenance and Repair**", Longman Scientific and Technical UK, 1991.
2) Allen R.T. & Edwards S.C, **Repair of Concrete Structures**, Blakie and Sons, UK, 1987

REFERENCE BOOKS

1. Shetty M.S., "Concrete Technology - Theory and Practice", S.Chand and Company, 2008.
2. Dov Kominetzky.M.S., " Design and Construction Failures", Galgotia Publications Pvt. Ltd., 2001
3. Ravishankar.K., Krishnamoorthy.T.S, " Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures", Allied Publishers, 2004.
4. CPWD and Indian Buildings Congress, Hand book on Seismic Retrofit of Buildings, Narosa Publishers, 2008. 5. Gambhir.M.L., "Concrete Technology", McGraw Hill, 2013

Subject Name: Design of Masonry Structures			
Subject Code	:16SEC105E3	CIE Marks	: 50
No. of Lecture Hrs/Week	: 04	SEE Marks	: 50
Total No. of Lecture Hrs	: 52	Exam Hours	: 03

Course Outcomes (COs)

After successful completion of the course, students will be able to

1) On successful completion of this module, students will be able to formulate conceptual designs in masonry.
2) Apply Health and Safety legislation to masonry structures.
3) Identify appropriate materials for use in masonry structures
4) Design vertically, laterally and reinforced masonry walls
5) Design for concentrated and accidental loads on masonry and design masonry diaphragm walls.
6) Design masonry to perform well thermally and acoustically.

UNIT 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.

10hrs

UNIT 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.

10hrs

UNIT 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.

10hrs

UNIT 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.

12hrs

UNIT 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.

10hrs

Course Assessment Method:

CIE –50 Marks

1. Three internals tests (each 30 marks) are conducted, average of best two marks will be considered.
2. Case Studies /Assignment/seminar 20 marks.

SEE –50 Marks

1. Two questions to be set from each unit, carrying 20 mark each.
2. Students have to answer 5 questions selecting one full question from each unit

TEXT BOOKS:

1. **Clement Clarence Williams** ,.The Design of Masonry Structures and Foundations2010
2. Hendry A W, Sinha B P & Davis S R., "**Design of Masonry structures**"- 3rd edition, Taylor and Francis, 2004
3. Jagadish K S, Venkatarama Reddy B V and Nanjunda Rao K S, "**Alternative Building Materials and Technologies**"- 2014,New Age International, New Delhi & Bangalore

REFERENCE BOOKS:

1. Hendry A.W., **"Structural masonry**"- Macmillan Education Ltd., 2nd edition- 1998
2. Dayaratnam P, "**Brick and Reinforced Brick Structures**"- Oxford & IBH, 2015
3. Curtin, "**Design of Reinforced and Prestressed Masonry**"- Thomas Telford 2011
4. Sven Sahlin, "**Structural Masonry**"-Prentice Hall 1999
5. IS 1905, BIS, New Delhi.
6. SP20(S&T),New Delhi

Subject Name: Stability of Structures .		
Subject Code : 16SEC105E4		CIE Marks : 50
No. of Lecture Hrs/Week : 04		SEE Marks : 50
Total No. of Lecture Hrs : 52		Exam Hours : 03

Course Outcomes (COs)

After successful completion of the course, students will be able to

1) Achieve Knowledge of design and development of problem solving skills.
2) Understand the principles of strength and stability
3) Design and develop analytical skills.
4) Appraise the Stability analysis by finite element approach.
5) Understand the concepts of Lateral buckling of beams.

UNIT 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.

10hrs

UNIT 2

Buckling of frames and continuous beams, Elastica 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.

10hrs

UNIT 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 in). Buckling of pin jointed frames (maximum of two active DoF) – symmetrical single bay portal frame.

10hrs

UNIT 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.

10hrs

UNIT 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.

12hrs

Course Assessment Method:

CIE –50 Marks

1. Three internals tests (each 30 marks) are conducted, average of best two marks will be considered.
2. Case Studies /Assignment/seminar 20 marks.

SEE –50 Marks

1. Two questions to be set from each unit, carrying 20 mark each.
2. Students have to answer 5 questions selecting one full question from each unit

TEXT BOOKS:

1. Stephen P.Timoshenko, James M Gere, "**Theory of Elastic Stability**"-2nd Edition, McGraw – Hill, New Delhi. 2012
2. Robert D Cook et.al, "**Concepts and Applications of Finite Element Analysis**"-3rd Edition, John Wiley and Sons, New York. 1998
3. Selvam V K M "**Elements of Matrix and Stability Analysis of Structures"2012**
4. H.H.E. Leipholz" **Stability of Elastic Structures (CISM International Centre for Mechanical Sciences) 1980**

REFERENCE BOOKS:

1. S.Rajashekar, "**Computations and Structural Mechanics**"-Prentice – Hall, India. 2011
2. Ray W Clough and J Penzien, "**Dynamics of Structures**" - 2nd Edition, McGraw Hill, New Delhi 2000
3. H.Zeiglar, "**Principles of Structural Stability**"-Blaisdall Publications.
4. Murari Lal Gambhir **"Stability Analysis and Design of StructuresPaperback" – 2013**

.

Subject Name: Reliability Analysis of Structures				
Subject Code	: 16SEC105E5		CIE Marks	: 50
No. of Lecture Hrs/Week	: 04		SEE Marks	: 50
Total No. of Lecture Hrs	: 52		Exam Hours	: 03

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. Achieve Knowledge of design and development of problem solving skills.
2. Understand the principles of reliability.
3. Design and develop analytical skills.
4. Summarize the Probability distributions
5. Understands the concept of System reliability.

UNIT 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.

10hrs

UNIT 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.

10hrs

UNIT 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.

10hrs

UNIT 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)

10hrs

UNIT 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

12hrs

Course Assessment Method:

CIE –50 Marks

1 Three internals tests (each 30 marks) are conducted, average of best two marks will be considered.

2 Case Studies /Assignment/seminar 20 marks.

SEE –50 Marks

1 Two questions to be set from each unit, carrying 20 mark each.

2 Students have to answer 5 questions selecting one full question from each unit

TEXT BOOKS:

1. Ranganathan, R. "**Structural Reliability Analysis and design"-** Jaico publishing house, Mumbai, India. 1999
2. Nathabdndu, T., Kottegoda, and Renzo Rosso. Statistics, "**Probability and reliability for Civil and Environmental Engineers"**- Mc Graw Hill international edition, Singapore. 1998
3. Achintya Haldar, and Sankaran Mahadevan (2000). "**Probability, Reliability and Statistical methods in Engineering design"-** John Wiley and Sons. Inc. 2000

REFERENCE BOOKS:

1. 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. Year 2000

2. Milton, E. Harr (1987). "**Reliability based design in civil engineering"**- Mc Graw Hill book Co. 1987

3. Thoft-christensen, P., and Baker, M., J., (1982), "**Structural reliability theory and its applications**"- Springer-Verlag, Berlin, NewYork. 1982

Subject Name : Pre-Cast and Pre-Fabricated Structures			
Subject Code	: 16SEE105E6		CIE Marks : 50
No. of Lecture Hrs/Week	: 04		SEE Marks : 50
Total No. of Lecture Hrs	: 52		Exam Hours : 03

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. Achieve Knowledge of design and development of problem solving skills.
2. Understand the principles of Concrete mix design • Design and develop analytical skills.
3. Summerize the Light Weight concrete, Fibre reinforced concrete and High Performance concrete
4. Understand the concepts of high Performance concrete.

UNIT 1

Prefabricated Structures Necessity, Advantages, Disadvantages, Mass produced building Products, Industrial units.

Modular Construction --- Basic module, Planning and Design of modular grid system, National Building Code Specifications, Standardization, Dimensions of Products, Preferred Dimensions and Sizes, tolerances and Deviations, Layout and Process.

12hrs

UNIT 2

Classification of Prefabricates--- Foundations, Beams and Columns, Roof and Roof panels, Wall panels, Box fabricates Erection and assembly.

Pre-casting and Pre fabricating Techniques---- Planning, Production and erection of industrial Structures, Space structures and prestressed pre-cast elements.

10hrs

UNIT 3

Precast Concrete Production Techniques: Forms and moulds for various materials, manufacturing methods—Pressed casting extrusion method, Vacuum process, Spinning process, Hot concrete process, mix designs adopted, Large panel construction, Box systems, Lift slab systems.

10hrs

UNIT 4

Design of prefabricated elements - Lift points, joints in elements, Design of joints to transfer axial forces, moments, shear forces.

10hrs

UNIT 5

Site Infrastructure---Equipment, Horizontal and Vertical transportation, In-situ manufacture and preparation, Fabrication, Storage and Assembly, Curing methods of Prefabricates.

10hrs

Course Assessment Method:

CIE –50 Marks

1 Three internals tests (each 30 marks) are conducted, average of best two marks will be considered.

2 Case Studies /Assignment/seminar 20 marks.

SEE –50 Marks

1 Two questions to be set from each unit, carrying 20 mark each.

2 Students have to answer 5 questions selecting one full question from each unit

TEXT BOOKS:

1. Koncz Tihamer, “Manual of Precast Concrete Construction” Vol 1,2,3, Buverlag GMBH, Wiesbaden and Berlin. 2000
2. Lewiciki, Bohdan, “Building with large Prefabricates”, Elsevier Publishing Company, London 1966.
3. National Building Code {part –VI, Prefabrication and systems building}, Bureau of Indian Standards.

Subject Name : Self Study & Laboratory - Special Concretes			
Subject Code	: 16SEC106L		CIE Marks : 50
Seminar & Laboratory	: 04		SEE Marks : 50
Total No. of Lecture Hrs	: 52		Exam Hours : 03

Self Study – Guidelines

1. Individual Evaluation, even if the topic is selected by a group of 2-3 students.
2. Detailed report should be submitted.
3. CIE Component – Phase I & II - First & Final for CIE Component
4. SEE – Report submission & Viva-Voce is conducted along with Laboratory Exam.
5. CIE & SEE Component – 50% for the Self Study & 50% for Laboratory

Each Student / a group of 2-3 students should take up any one **type of Concretes** and prepare a detailed report which should contain the following. Individual performance Evaluation is to be carried out, through individual viva voca.

Types of Concrete – Conventional Concrete, Self Compacting Concrete, Geopolymer Concrete, High Strength Concrete, High Performance Concrete, High Density concrete, Fibre Reinforced Concrete, Ferrocement, No fine Concrete, Translucent Concrete, UHPC, Self Curing Concrete, Bacterial Concrete.

Report should contain the details on the following:

1. Components of modern concrete and developments in progress and constituent materials: Role of constituents, latest developments in cements and cement replacement materials, pozzolana, Fly Ash, Silica Fume, Rice Husk Ash, Recycled Aggregates, Admixtures, Properties of materials. Mix design principles, Methods & Procedures - BIS Method, EFNARC, ACI and other methods.

2. Assessment of Properties of Fresh Concrete – Slump Test, Vee-Bee Consistometer Test, Compaction Factor Test, Properties of fresh SCC – Slump Flow, J-Ring, L-Box, V-Funnel, U-Box Tests as per relevant codes of practice.

3. Assessment of properties of Hardened concrete (Laboratory Experiments)

a. Strength Properties – Compressive strength, Flexural Strength, Split Tensile strength, Modulus of Elasticity (Static and Dynamic) and Bond Strength. NDT methods (Laboratory Experiments)

b. Durability Parameters – Permeability (Sorption, Diffusion, RCP, Initial Surface Absorption, Water permeability), Resistance to Acid, Chloride, Sulphate Attach, Shrinkage and Creep (Demonstration of Experiments).

3 Detailed Literature Review on the selected topic.

I. Tests on Concrete

i. Compressive strength,
ii. Flexural Strength,
iii. Split Tensile strength,
iv. NDT methods – UPV Test, Rebound Hammer Test
v. Modulus of Elasticity (Static and Dynamic) - Demonstration
vi. Bond Strength – Demonstration

II. Behaviour of Structural Elements – Beams in Flexure & Shear – Demonstration
III. Structural Dynamic Experiments Analysis of SDOF and MDOF – Different frames

Course Assessment Method:

CIE – 50 Marks

1. Students in a group of 2 or 3 should take up one type of Concrete and prepare detailed report (in the standard format), covering all the aspects of concrete.
2. Individual Performance Evaluation – Assessment through detailed technical viva & Report.
3. One group of students will conduct the assessment procedure to the other group in the presence of Faculty in-charge & evaluation Committee, who will evaluate each & every group and award marks based on the performance.(Follow evaluation rubrics).

SEE –50 Marks – Laboratory Examination

1. One experiment should be conducted by each individual student – 60%
   i Laboratory Record – 05 marks
   ii. Writing Procedures & tabular Column – 10 Marks
   iii. Analysis of Results with graphs using excel – 10 Marks
   iv. Results & Discussions, Rational Conclusions – 5 marks
2. Self Study Component – Individual Assessment through Viva-Voce & report – 40%

REFERENCE BOOKS:

1. Neville A.M, "Properties of Concrete" Pearson Education Asis, 2000
2. P. Kumar Mehta, Paul J.N.Monterio, CONCRETE, "Microstructure, Properties and Materials"- Tata McGraw Hill year?
3. A.R.Santhakumar, (2007) "Concrete Technology"-Oxford University Press, New Delhi, 2007
4. Gambhir "Concrete Technology" TMH. year?
5. Short A and Kinniburgh.W, "Light Weight Concrete"- Asia Publishing House, 1963- too old
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 Wiehgt concrete"- Akademiaikiado, Budapest, 1963. Too old
9. M S Sheetty – "Concrete Technology

Subject Name: Technical Seminar			
Subject Code	: 16SEC107S		CIE Marks : 50
Seminar	: 02		SEE Marks : 50
			Exam Hours : 03

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. Outcomes Correlates to program outcome Proficiency assessed by H L M
2. An ability to work in actual working environment.
3. An ability to utilize technical resources
4. An ability to write technical documents and give oral presentations related to the work completed.

Course Assessment Method:

CIE –50 Marks – Internal Evaluation through Rubrics

Guidelines & Rubrics under preparation

SEE –50 Marks – External Examination

Guidelines & Rubrics under preparation

II Semester

SEMESTER: II										
Subject Code	Subject Name	Course Type	Teaching Dept.	Teaching Hours/week			Examination			Credits
				L#	T#	P#	CIE *	SEE **	Total	
16SEC201	DESIGN CONCEPTS OF SUBSTRUCTURES	PC		4	0	0	50	50	100	4
16SEC202	MATRIX AND FINITE ELEMENT METHOD OF ANALYSIS	PC		4	0	2	50	50	100	5
16SEC203	DESIGN OF TALL STRUCTURES	PC		4	0	2	50	50	100	5
16SEC204	ADVANCED DESIGN OF STEEL STRUCTURES	PC		4	0	2	50	50	100	5
16SEC205EX	PROGRAM ELECTIVE – GROUP B	PE		4	0	0	50	50	100	4
16SEC206L	LABORATORY	PC		0	0	4	50	50	100	3
16SEC207S	TECHNICAL SEMINAR	PC		0	0	0	50	50	100	2
			TOTAL				350	350	700	28

Group B – Elective Subjects of II sem		
Sl No	Subject Code	Subject Name
1	16SEC205E1	DESIGN OF RC BRIDGES
2	16 SEC205E2	SUSTAINABLE STRUCTURES
3	16 SEC205E3	DESIGN OF PLATES AND SHELLS
4	16 SEC205E4	CONSTRUCTION PROJECT MANAGEMENT
5	16 SEC205E5	ADVANCED PSC STRUCTURES
6	16 SEC205E6	COMPOSITE AND SMART MATERIALS

* Continuous Internal Evaluation ** Semester End Exam

$ - Internal evaluation by the guide, # - External Examiner Evaluation (Thesis)

PROJECT PHASE -2- THESIS ASSESMENT* :-

The evaluation under this title involves two components

1. Thesis evaluation by the external examiner will be considered as SEE#
2. Thesis evaluation by the internal examiner will be considered as CIE$

PROJECT PHASE -2- INTERNAL EVALUATION AND VIVO VOCE**

The evaluation under this title involves two components

1. Final Viva Voce jointly conducted by the Internal and External examiner s will be considered as SEE
2. Continuous evaluation of the project throughout the semester by the Internal committee (at departmental level) will be considered as CIE

Subject Name :Design Concepts of Substructures			
Subject Code	: 16SEC201	CIE Marks	: 50
No. of Lecture Hrs/Week	: 04	SEE Marks	: 50
Total No. of Lecture Hrs	: 52	Exam Hours	: 03

Course Outcomes (COs)

After successful completion of the course, students will be able to

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

UNIT 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.

10hrs

UNIT 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.

10hrs

UNIT 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.

10hrs

UNIT 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.

10hrs

UNIT 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.

12hrs

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 covered

Course Assessment Method

CIE –50 Marks

1. Three internal tests (each for 30 marks) are conducted, average of best two tests marks will be considered.
2. Case Studies /Assignment/seminar 20 marks.

SEE –Question paper to be set for 100 marks

3. Two questions to be set from each unit, carrying 20 mark each.
4. Students have to answer 5 full questions selecting one full question from each unit.

TEXT 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.

REFERENCE BOOKS:

1. R.B. Peck, W.E. Hanson & T.H. Thornburn – "**Foundation Engineering**"- Wiley Eastern Ltd.,Second Edition, 1984.
2. J.E. Bowles – "**Foundation Analysis and Design**"- McGraw-Hill Int. Editions, Fifth Ed., 1996.
3. W.C. Teng – "**Foundation Design**"- Prentice Hall of India Pvt. Ltd., 1983.
4. 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.

Subject : Matrix and Finite Element Method of Analysis		
Subject Code : 16SEC202		CIE Marks : 50
No. of Lecture Hrs/Week : 04+02		SEE Marks : 50
Total No. of Lecture Hrs : 78		Exam Hours : 03

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. To apply the fundamental concepts and basic principles of Flexibility matrix method by element approach. [L3]
2. To apply the fundamental concepts and basic principles of Stiffness matrix method by element approach. [L3]
3. To analyze continuous beams, plane frames and plane trusses by using Flexibility matrix method and Stiffness matrix method. [L4]
4. To apply the concept of Direct Stiffness method using matrix methods for the analysis of indeterminate structures. [L3]
5. To apply the various solution techniques to solve simultaneous equations. [L3]

UNIT 1

Fundamental concepts of Matrix Analysis:

a. Static and Kinematic indeterminacy, Concepts of stiffness and flexibility.

b. Development of element flexibility and element stiffness matrices for truss, beam and grid elements. Force-transformation matrix using Flexibility metho**d,** Development of global flexibility matrix for continuous beams, plane trusses and simple rigid plane frames.

c. Displacement-transformation matrix using Stiffness Method, Development of global stiffness matrix and of continuous beams, plane trusses and Simple rigid plane frames. Use of MATLAB for solving the problems.

12hrs

UNIT 2

Basic concepts of elasticity

a. Kinematic and Static variables for various types of structural problems – approximate method of structural analysis – Rayleigh – Ritz method – Finite difference method – Finite element method.

b. Variation method and minimization of Energy approach of element formulation. Principles of finite element method – advantages & disadvantages – Finite element procedure.

c. 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.

10hrs

UNIT 3

Nodal displacement parameters

a. 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.

10hrs

UNIT 4

Isoparametric elements

a.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.

b.Development of strain – displacement matrix and stiffness matrix, consistent load vector, numerical integration.

08hrs

UNIT 5

Application of Finite Element Method

a. 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.
   Application to Plates & Shells- Choice of displacement function (C0, C1 and C2 type)Techniques for Non – linear Analysis

12hrs

Laboratory Component: Use of ETABS or Any other Software where ever applicable

Course Assessment Method

CIE –50 Marks

1. Three internal tests (each for 30 marks) are conducted, average of best two tests marks will be considered.
2. Case Studies /Assignment/seminar 20 marks.

SEE –Question paper to be set for 100 marks

1. Two questions to be set from each unit, carrying 20 mark each.
2. Students have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. S.Rajasekaran, "**Computational Structural Mechanics**", PHI, New Dehi 2001.
2. W.Weaver and J.H.Gere, "**Matrix Analysis of Framed Structures**", Van Nastran, 1980
3. M.F.Rubinstein "**Matrix Computer Methods of Structural Analysis** "Prentice – Hall,1990
4. H.Karde Stuncer, "**Elementary Matrix Analysis of Structures**", McGraw Hill 1974.
5. Bathe K J, "**Finite Element Procedures in Engineering Analysis**"- Prentice Hall 2001
6. Rajasekaran. S, "**Finite Element Analysis in Engineering Design**"-Wheeler Publishing 2000

REFERENCE BOOKS:

1. F.W.Beaufait et al., "**Computer methods of Structural Analysis**", Prentice Hall, 1970.
2. A.K.Jain "**Advanced Structural Analysis with Computer Application**" Nemchand and Brothers, Roorkee, India. 1996
3. Krishnamoorthy C S, "**Finite Element Analysis**"- Tata McGraw Hill 2000
4. Desai C and Abel J F, "**Introduction to the Finite Element Method**"- East West Press Pvt. Ltd., 1972
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

Subject Name : Design of Tall Structures			
Subject Code	: 16SEC203		CIE Marks : 50
No. of Lecture Hrs/Week	: 04+02		SEE Marks : 50
Total No. of Lecture Hrs	: 78		Exam Hours : 03

Course Outcomes (COs)

After successful completion of the course, students will be able to

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

UNIT 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

10hrs

UNIT 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.

10hrs

UNIT 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.

10hrs

UNIT 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. .

10hrs

UNIT 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.

12hrs

Laboratory Component: Use of ANSIS , STADD Pro or Any other Software where ever applicable

Course Assessment Method
CIE –50 Marks

3. Three internal tests (each for 30 marks) are conducted, average of best two tests marks will be considered.
4. Case Studies /Assignment/seminar 20 marks.

SEE –Question paper to be set for 100 marks

3. Two questions to be set from each unit, carrying 20 mark each.
4. Students have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. Taranath B.S, "**Structural Analysis and Design of Tall Buildings**"- McGraw Hill, 2000
2. Bryan Stafford Smith & Alexcoull, "**Tall building structures Analysis and Design**"- John Wiley 1996

REFERENCE BOOKS:

1. Wilf gang Schuller, "**High rise building structures**"- John Wiley 1996
2. T.Y Lin & D.Stotes Burry, "**Structural concepts and system for Architects and Engineers**"- John Wiley 2001
3. Lynn S.Beedle, "**Advances in Tall Buildings**"- CBS Publishers and Distributors
4. Dr. Y.P. Gupta – Editor, "**Proceedings National Seminar on High Rise Structures**-Design and Construction

Subject Name :Advanced Design of Steel Structures			
Subject Code : 16SEC204		CIE Marks : 50	
No. of Lecture Hrs/Week : 04+02		SEE Marks : 50	
Total No. of Lecture Hrs :78		Exam Hours : 03	

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. To design beams subjected to biaxial bending and beam columns as per current code
2. To have an experience in the complete design of an Industrial building
3. To learn the concept of design of transmission towers
4. To learn the analysis and design of multistoried buildings
5. To learn the concepts of plastic analysis and design of steel structures

Structural steel design is as important as concrete design. The speed of construction in the case of steel structure is quite fast compared with concrete. Hence for industrial buildings steel is preferred to RCC.

INSTRUCTIONAL OBJECTIVES

1. General principle in the design of steel structures
2. Various types of connections
3. Steel transmission line towers
4. Plastic method of structural analysis
5. Analysis and design of industrial structures

UNIT 1

GENERAL: Beams subjected to biaxial bending - Built-up Purlins - Various types and design - Design of Wind girders-Beam-columns - With various support conditions-Designs of foundations-with lateral forces.

10hrs

UNIT 2

CONNECTIONS: Bearing type joints - Unstiffened and Stiffened seat connections resisting connection of brackets-bolted and welded-semi-rigid connections.

PRE-ENGINEERED BUILDINGS: Introduction – connection details – design of typical portal frame from Industrial shed using IS: 800-2007

10hrs

UNIT 3

INDUSTRIAL BUILDINGS: Industrial buildings-braced and unbraced - Gable frames with gantry industrial frames-Fire resistant design-Fatigue resistant design.

DESIGN OF INDUSTRIAL STRUCTURES: Introduction – analysis and design of knee braced truss members –Design of gable portal frame – analysis and design of Gantry girdercolumns.

10hrs

UNIT 4

TOWERS: Basic structural configurations - free standing and guyed towers - wind loads - foundation design - design criteria for different configurations and transmission line towers.

10hrs

UNIT 5

PLASTIC ANALYSIS: Theory of plastic bending - Plastic hinge concept -Mechanism method Application to continuous beams and portal frames-Plastic moment distribution - Analysis of Gable frames - instantaneous centre of rotation Connections.

12hrs

Laboratory Component: Use of STADD Pro, ETABS or Any other Software where ever applicable

Course Assessment Method

CIE –50 Marks

3. Three internal tests (each for 30 marks) are conducted, average of best two tests marks will be considered.
4. Case Studies /Assignment/seminar 20 marks.

SEE –Question paper to be set for 100 marks

5. Two questions to be set from each unit, carrying 20 mark each.
6. Students have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. N.Subramanian, "**Design of Steel Structures**: Theory and Practice",Oxford university Press, U.S.A, Third Edition, 2011
2. .Duggal.S.K, "**Design of Steel Structures**", McGraw Hill New Delhi, 2010
3. Dayaratnam P. "**Design of Steel Structures**,"S. Chand Limited, New Delhi. 2008

REFERENCE BOOKS:

1. John E. Lothers, "**Structural Design in Steel**",Prentice Hall, 1999
2. Neal. B.G.,"**Plastic Method of Structural Analysis**",Taylor& Francis, Third Edition, 1985
3. Edwin.H.Gaylord, Charles.N.Gaylord, James. E. Stallmeyer, "**Steel Structures**" , McGraw Hill, New Delhi, 1980.
4. Ramchandra, "**Design of Steel Structures**", Vol I & II Standard Book House, Delhi, 1975
5. Arya.S and Ajmani.J.L, "**Design of Steel Structures**", Nem Chand & Bros, Roorkee
6. Edmin H. Gaylord, J. Charles. N. Gaylord & James E. Stallmeyer,“ **Design of steel structures**”, 3rdEdition, McGraw – Hill International1992.
7. M.R. Sheyekar “**Limit state design in Structural Steel**”,1st Edition, PHI Publications, 2010.

Subject Name : Design of RC Bridges			
Subject Code : 16SEC205E1		CIE Marks : 50	
No. of Lecture Hrs/Week : 04		SEE Marks : 50	
Total No. of Lecture Hrs : 52		Exam Hours : 03	

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. Achieve Knowledge of design and development of problem solving skills.
2. Explain the Bridge substructures and superstructures
3. Design and develop analytical skills.
4. Summarize the principles of design and detailing of bridges
5. Understands the different types of bridges.

UNIT 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.

10hrs

UNIT 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.

10hrs

UNIT 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.

10hrs

UNIT 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 MORICELITTLE Method for IRC Class AA Tracked vehicle only, BM & SF for different loads, Structural Design of Main Girder With Reinforcement Details.

10hrs

UNIT 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.

12hrs

Course Assessment Method
CIE –50 Marks
5. Three internal tests (each for 30 marks) are conducted, average of best two tests marks will be considered.
6. Case Studies /Assignment/seminar 20 marks.
SEE –Question paper to be set for 100 marks
7. Two questions to be set from each unit, carrying 20 mark each.
8. Students have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. N Krishna Raju, "**Design of Bridges**"- Oxford & IBH Publishing Co New Delhi-2013
2. Ponnuswamy. S, "**Bridge Engineering**"- Tata McGraw Hill 2000
3. Raina V.K., "**Concrete Bridge Practice**"- Tata McGraw Hill 2000
4. D Johnson Victor "Essentials of Bridge Engineering"-, Oxford & IBH Publishing Co New Delhi 1999

REFERENCE BOOKS:

1. "Principles and Practice of Bridge Engineering"- S P Bindra Dhanpat Rai & Sons New Delhi- 2000
2. IRC 6 – 2000 "Standard Specifications and Code of Practice for Road Bridges"- Section II Loads and Stresses, the Indian Road Congress New Delhi
3. IRC 21 – 2000 "Standard Specifications and Code of Practice for Road Bridges"- Section III Cement Concrete (Plain and reinforced) The Indian Road Congress New Delhi
4. IRC 18-2000 "Standard Specifications and Code of Practice for Road Bridges"
4. IS 456 – 2000 "Indian Standard Plain and Reinforced Concrete Code of Practice"- (Fourth Revision) BIS New Delhi
5. IS 1343 Part(II and IV) – "Indian Standard Prestressed Concrete Code of Practice"- BIS New Delhi
6. Bakht B & Jaeggar, "Bridge Analysis Simplified"- McGraw Hill- year
11. Derrick Beckett, "An Introduction to Structural Design of Concrete Bridges"- Surrey University Press- 1996

Subject Name : Sustainable Structures				
Subject Code	: 16SEC205E2		CIE Marks	: 50
No. of Lecture Hrs/Week	: 04		SEE Marks	: 50
Total No. of Lecture Hrs	: 52		Exam Hours	: 03

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. Assess the impact of built environment on energy and material resources as well as its influence on health, comfort and productivity for occupants.
2. Understand the criteria followed by local, national, and international agencies to assess green initiatives for new construction and renovations.
3. Select materials and structures which optimize both embodied and operational energies and create an ambience of wellbeing of occupants

UNIT – I

Introduction to sustainability concept in construction industry, need, objectives, achieving sustainability at various stages of construction

Introduction to Built and Natural Environment and Climatic Condition in India, vis. a vis. World Scenario, What makes a building sustainable - Phases of sustainable development: site selection, site planning location of building on a site, design for sustainability-building design: orientation, components, systems, integrated design, scale, sustainability during construction, selection of sustainable materials, commissioning, and occupancy phases

10hrs

UNIT - II

Energy concept

Concept of Embodied Energy importance of embodied energy constituents of embodied energy. Operational energy, Life Cycle energy understanding with the case study of a typical building. How to reduce embodied energy, Typical Embodied energy values of few materials of construction. Concept of Net Zero Energy building

10hrs

UNIT – III

Sustainable Materials and Resources

Sustainable construction materials and methods,materials at various stages of construction, selection of materials, Recyclability , Use of marginal material in the construction of Civil Engineering structures.Use of processed demolished materials and construction waste Use of recycled materials viz., aluminium, steel, wood, flyash, GGBS, gypsum etc. Manufactured sand including slag sand and bottom ash sand.

10hrs

UNIT – IV

Sustainable Design and Construction

Architectural and functional planning concepts; Building systems: lighting – day lighting; ventilation – natural ventilation; indoor air quality – sick building syndrome, shell and core: vertical communication, building systems; roof: green roofs, white roofs, roof membranes;

interiors: interior architecture (partitions) interior decoration: finishes, walls, ceiling, floor Planning of plumbing and water supply systems. Water conservation – grey water reuse, water saving plumbing fixtures, Rain water harvesting methods.
solar lighting and heating facilities heating/cooling – geothermal; passive and active systems for energy production and conservation;

10hrs

UNIT – V

Assessment of Sustainability

Introduction and brief description of existing rating systems for sustainable building design and construction (both new construction and renovations) at local, national, and international level;

Rating Systems Introduction LEED Rating System Selection Guidance, Guide to the LEED Certification Process and considerations The LEED Rating Systems to assess sustainability of a new building or existing building Introduction to GRIHA concept and rating system for green buildings. Criteria for assessment under GRIHA

12hrs

Course Assessment Method
CIE –50 Marks

7. Three internal tests (each for 30 marks) are conducted, average of best two tests marks will be considered.
8. Case Studies /Assignment/seminar 20 marks.

SEE –Question paper to be set for 100 marks

9. Two questions to be set from each unit, carrying 20 mark each.
10. Students have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. Urvashi Dhamija**, "Sustainable Solid Waste Management: Issues Policies and Structures Hardcover" –** 2006
2. Poonam I. Modi, Chirag N. Patel" **Repair and Rehabilitation of Concrete Structures" Paperback –** Import, 30 Mar 2016

REFERENCE BOOKS:

1. Meg Calkins "**Materials For Sustainable Sites**"1990
2. Charles Kibert "**Sustainable Construction-Green Building Design And Delivery**" 2011
3. Michael Ash "**Material And Environment**" 1996
4. Jefferson W.T etal "Sustainable energy by choosing options" (2005), P H, learning pvt Ltd New Delhi

Subject: Design of Plates and Shells .		
Subject Code : 16SEC205E3		CIE Marks : 50
No. of Lecture Hrs/Week : 04		SEE Marks : 50
Total No. of Lecture Hrs : 53		Exam Hours : 03

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. Achieve Knowledge of design and development of problem solving skills.
2. Understand the principles of Analysis and Design
3. Design and develop analytical skills.
4. Summarize the performance of shells
5. Understand the concepts of energy principle.

UNIT 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.

12hrs

UNIT 2

Energy methods for rectangular and circular plates with clamped edges subjected to symmetric loadings.

10hrs

UNIT 3

Introduction to curved surfaces and classification of shells, Membrane theory of spherical shells, cylindrical shells, hyperbolic, paraboloids, elliptic paraboloid and conoids.

10hrs

UNIT 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.

10hrs

UNIT 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.

10hrs

Course Assessment Method

CIE –50 Marks

5. Three internal tests (each for 30 marks) are conducted, average of best two tests marks will be considered.
6. Case Studies /Assignment/seminar 20 marks.

SEE –Question paper to be set for 100 marks

5. Two questions to be set from each unit, carrying 20 mark each.
6. Students have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. Timosheko, S. and Woinowsky-Krieger, W., "**Theory of Plates and Shells**" 2nd Edition, McGraw-Hill Co., New York,2011
2. Varghese P.C" **Design of Reinforced Concrete Shells and Folded Plates**" Paperback – 2010
3. Maan H. Jawad" **Design of Plate and Shell Structures**"2004

REFERENCE BOOKS:

1. Ramaswamy G.S. – "**Design and Constructions of Concrete Shell Roofs**" – CBS Publishers and Distributors –Delhi – 1986.
2. Ugural, A. C. "**Stresses in Plates and Shells**", 2nd edition, McGraw-Hill, 1999.
3. R. Szilard, "**Theory and analysis of plates** - classical and numerical methods", PrenticeHall, 1994
4. Chatterjee.B.K. – "**Theory and Design of Concrete Shell**", – Chapman & Hall, Newyork- third edition, 1988
5. Lublira J, **Plasticity Theory**, Dover, 2008.
6. Chakrabanty, **Theory of Plasticity**, Buttawerth, 2006.

Subject : Construction Management			
Subject Code : 16SEC205E4		CIE Marks : 50	
No. of Lecture Hrs/Week : 04		SEE Marks : 50	
Total No. of Lecture Hrs : 52		Exam Hours : 03	

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. Techniques to achieve project goals. Possess organizational and leadership capabilities for effective management of construction projects.
2. Be able to apply knowledge and skills of modern construction practices and techniques.
3. Have necessary knowledge and skills in accounting, financing, risk analysis and contracting.
4. Be capable of using relevant software packages for planning, scheduling, executing and controlling of construction projects.

UNIT 1

Introduction

Nature and characteristics of management, scope and functional areas of management – management as a science, art or profession – management and administration – roles of management, levels of management, development of management thought – early management approaches – modern management approaches

10hrs

UNIT 2

Planning, Organising and Staffing, Directing & Controlling

Nature, importance and purpose of planning process – objectives – Types of plans (Meaning only) – Decision making – Importance of planning – steps in planning & planning premises – Hierarchy of plans. Definition of Project and resource allocation - Organizing, Nature, principles, Types of organization – Departmentation, Delegation of Authority and responsibility – Span of control – MBO and MBE (Meaning only) Staffing - Directing – Leadership styles, Motivation Theories, Communication – Role and importance – Coordination, Techniques of Co-ordination.

Specific methodologies for planning – Brief about each of the the following

- The critical path method (CPM) - Elaborate
- The program evaluation and review technique (PERT) - Elaborate
- The precedence diagramming method (PDM)
- The graphical evaluation and review technique (GERT)
- Queue – Graphical evaluation and review technique (GERT)
- Simulation language for alternative modeling (SLAM)
- Dynamic planning and control methodology (DPM)
- Critical chain planning
- Resource loading

10hrs

UNIT 3

Engineering Economics

Interest, equivalent worth, comparing alternatives, rate of return methods, depreciation and taxes, inflation, benefit-cost analysis, Time cost Trade-of Project management

10hrs

UNIT 4

Quality control and safety during construction

Quality and safety concerns in construction – organizing for quality and safety – work and material specifications – total quality control by statistical methods – statistical quality control with sampling attributes – statistical quality control with sampling by variables – safety

10hrs

UNIT - 5

Construction Equipment and Management

Introduction to mechanization of Construction industry, need, merits, demerits, Classification of equipments, and equipment inventory for various stages of work.

Planning Process for Equipment , Methods and Management.

Scheduling Equipment-Intensive Horizontal Construction Projects - Linear scheduling method, Scheduling Lifting Equipment for Vertical Construction,

Cost of Owning and Operating Construction Equipment , - Ownership cost, Depreciation, Operating cost, and Ownership and operating costs calculation methods, Estimation of Equipment Productivity, Equipment Financing Decision - Financing methods, Rental and lease contract considerations. optimal allocation of equipment across projects. Maintenance & breakdown of equipment

Assignment - Quantitative equipment management through Software Applications, queuing theory, and system simulation. (Optional)

12hrs

Many software tools, such as Microsoft Project, Primavera Project Planner, Primavera Monte Carlo, Crystal Ball and Prochain are available to the project manager for deterministic and probabilistic planning. In this course we will use the following.

- Primavera P3 – for deterministic time and resource scheduling.
- Primavera Monte Carlo – for probabilistic time and resource scheduling.
- Primavera Expedition – for documenting multiple and complex projects.
- Prochain – for scheduling with the critical chain method.
- Crystal Ball – for risk analysis
- Vensim – for system dynamics analysis
- System Dynamic simulation methodology.

10hrs

Course Assessment Method
CIE –50 Marks
7. Three internal tests (each for 30 marks) are conducted, average of best two tests marks will be considered.
8. Case Studies /Assignment/seminar 20 marks.
SEE –Question paper to be set for 100 marks
7. Two questions to be set from each unit, carrying 20 mark each.
8. Students have to answer 5 full questions selecting one full question from each unit.

TEXTS BOOKS

1. D. G. Gransberg, C. M. Popescu and R. C. Ryan, **Construction equipment management for engineers**, estimators, and owners, Taylor & Francis, New York, 2006.
2. R. L. Peurifoy, C. J. Schexnayder, A. Shapira and R. Schmitt**, Construction planning, equipment, and methods**, 8th ed., McGraw Hill, New York, 2010.

REFERENCE BOOKS

1 D. A. Day and N. B. H. Benjamin, **Construction equipment guide**, 2nd ed., Wiley, New Jersey, 1991.
2 F. Harris, **Modern construction and ground engineering equipment and methods**, 2nd ed., Longman, London, 1994.
3 J. Singh, **Heavy construction - planning, equipment and methods**, 3rd ed., CRC Press, 2009.

Subject Name :Advanced PSC Structures					
Subject Code	: 16SEC205E5		CIE Marks	:	50
No. of Lecture Hrs/Week	: 04		SEE Marks	:	50
Total No. of Lecture Hrs	: 52		Exam Hours	:	03

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. Understand the necessity of HSC and HST for making of PSC structures
2. Apply the fundamental principles to analyze a prestressed section for resultant flexural stresses.
3. Understand the concept of cracking moment, loss of prestress and calculate the deflection of a prestressed concrete beam under different support conditions as per codal provisions
4. Calculate the ultimate flexural resistance and shear strength as per provisions of IS1343-2000
5. Design PSC sections for given situations by limit state method , end block as per codal provisions

Unit - 1

Review of the concept of prestressing, flexure, shear, deflection in uncracked members and bond stresses in pre-tensioned and post tensioned members. Deflection in cracked prestressed concrete members and code provisions.

12hrs

Unit - 2

Design of prestressed concrete section: Design of sections for flexure-minimum section modulus, limitation of prestress in long span, limiting zone for prestressing force, Design of sections for axial tension, compression, bending, shear, torsion, bond stress and bearing.

10hrs

Unit - 3

Design of pretensioned – post-tensioned flexural members. Analysis and design of composite construction: Types of composite construction, analysis of stresses, differential shrinkage, deflection, flexural strength and shear strength of composite section. Design of composite section.

10hrs

Unit - 4

Statically Indeterminate Structures: Analysis of continuous members- advantages, effect of prestressing, Methods of analysis-Theorem of Three Moments, Tendon Reaction method or the methods of equivalent load, Ultimate load analysis of continuous prestressed members. Determination of concordant tendon profile.

10hrs

Unit - 5

Design of continuous prestressed concrete beams.

10hrs

Course Assessment Method

CIE –50 Marks

9. Three internal tests (each for 30 marks) are conducted, average of best two tests marks will be considered.
10. Case Studies /Assignment/seminar 20 marks.

SEE –Question paper to be set for 100 marks

4 Two questions to be set from each unit, carrying 20 mark each.

5 Students have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. N.Krishna Raju "**Prestressed Concrete**", publishers Tata Mc-Graw Hill, India. 2012
2. T.Y.Lin and N.H Burns, John Wiley and Sons" **Design of prestressed concrete Structures**" New York, 2006
3. Guyon" **Prestress Concrete**, Vol.I and Vol.II",1967

REFERENCE BOOKS:

1. Nilson A.H, Darwins.D and Dolar C.W, "**Design of concrete Structures**", MC Graw Hill, 2004
2. Agarwal and Shsikhande, "**Earthquake Resistant Design of Structures**", Practice-Hall of India Pvt. Ltd, New Delhi, 2006.

Subject Name : Composite and Smart Materials				
Subject Code	: 16SEC205E6		CIE Marks :	50
No. of Lecture Hrs/Week	: 04		SEE Marks :	50
Total No. of Lecture Hrs	: 52		Exam Hours :	03

Course Outcomes (COs)

After successful completion of the course, students will be able to

1. Achieve Knowledge of design and development of problem solving skills.
2. Understand the principles of Composite materials
3. Design and develop analytical skills.
4. Summarize the smart materials and structures
5. Understand the concepts of control systems.

UNIT 1

Introduction: Introduction to Composite materials, classifications and applications. Anisotropic elasticity – unidirectional and
anisotropic laminae, thermo – mechanical properties, micro – mechanical analysis, characterization tests.

10hrs

UNIT 2

Classical composite lamination theory, cross and angle – play laminaes, symmetric, antisymmetric and general symmetric laminates, mechanical coupling. Analysis of simple laminated structural elements ply-stress and strain, lamina failure theories – first fly failure, vibration and buckling analysis. Sandwich structure face and core materials, secondary failure modes environmental effects, manufacturing of composites.

10hrs

UNIT 3

Introduction to smart materials and structures – piezoelectric materials – coupled electromechanical constitutive relations –depoling and coercive field – field – strain relation – hysterics – creep – strain rate effects – manufacturing.

10hrs

UNIT 4

Actuators and sensors: single and dual actuators – pure extension, pure bending – bending extension relations – uniform strain beam model – symmetric induced strain actuators – bond shearing force – Bernoulli Euler (BE) beam model – embedded actuators.

10hrs

UNIT 5

Assymetric induced strain actuators in uniform strain and Euler – Bernoulli models. Uniform strain model – energy principle formulation – BE model – single and dual surface bonded actuators – Extension – bending and torsion model. Introductions to control systems: Open loop and close loop transfer functions – stability criteria – deflection control of beam like structures –using piezoelectric sensors and actuators – shape memory alloys.

10hrs

Course Assessment Method

CIE –50 Marks

11. Three internal tests (each for 30 marks) are conducted, average of best two tests marks will be considered.
12. Case Studies /Assignment/seminar 20 marks.

SEE –Question paper to be set for 100 marks

6 Two questions to be set from each unit, carrying 20 mark each.

7 Students have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. Robart M.Jones, "**Mechanical of Composite Materials**"- McGraw Hill Publishing Co. 2000
2. M. Mukhopadhya "**Mechanics of Composite Materials and Structures**" - Universities Press 2009
3. Bhagwan D Agarvalm, and Lawrence J Brutman, "**Analysis and Performance of Fiber Composites**"- John Willy and Sons 1999
4. R.M. Jones, **Mechanics of Composite materials,** Taylor and Francis, 1999
5. M. Daniel and O. Ishai, **Engineering mechanics of Composite materials**, Oxford university press, 1999
6.

REFERENCE BOOKS:

1.Crawley, E and de Luis, J., "Use of Piezoelectric actuators as elements of intelligent structures"- AIAA Journal, Vol.25, No.10, Oct 1987, PP 1373-1385.

2. Crawley, E and Anderson, E., "Detailed models of Piezoceramic actuation of beams" - Proc. of the 30th AIAA/ASME/ASME/ASCE/AHS/ASC – Structural dynamics and material conference, AIAA, Washington DC, April 1989.

3. P.K. Mallick, **Fiber-reinforced Composites**, Marcel Dekker Inc, 1988.

4. D. Hull and T. W. Clyne**, An introduction to composite materials**, Cambridge, university press, Second Edition, 1996.

5 J.N. Reddy, **Mechanics of laminated composite plates and shells-Theory and Analysis**, CRC Press, Boca Raton, Second Edition, 2003

SEMESTER: III											
Subject Code	Subject Name	Course Type	Teaching Dept.	Teaching Hours/week			Examination			Credits
				L#	T#	P#	CIE*	SEE**	Total	
14SEC301S	SEMINAR/FIELD WORK/PROFESSIONAL TRAINING/ SELF STUDY	PC		-	-	8	50	50	100	4
14SEC302P	PROJECT PHASE -1 Assessment	PC		-	-	22	50	50	100	16
			TOTAL				100	100	200	20

Note: 1. External examination should be combined for SEMINAR/FIELD WORK/PROFESSIONAL TRAINING/ SELF STUDY/TERM PAPER and PROJECT PHASE -1
(Viva Voce) but separate marks sheet should be submitted.
8 The Project will commence immediately after the II semester

SEMESTER: IV											
Sl No	Subject Code	Subject Name	Course Type	Teaching Dept.	Teaching Hours/week			Examination			Credits
					L#	T#	P#	CIE*	SEE**	Total	
1	14SEC401P	PROJECT PHASE -2- Thesis Evaluation	PC		-	-	15	100$	100#	200	08
2	14SEC402P	PROJECT PHASE -2- Assessment & Viva Voce	PC		-	-	15	100	100	200	16
				TOTAL				200	200	400	24

* Continuous Internal Evaluation ** Semester End Exam
$ - Internal evaluation by the guide, # - External Examiner Evaluation (Thesis)

PROJECT PHASE -2- THESIS ASSESMENT* :-
The evaluation under this title involves two components
1. Thesis evaluation by the external examiner will be considered as SEE#
2. Thesis evaluation by the internal examiner will be considered as CIE$

PROJECT PHASE -2- INTERNAL EVALUATION AND VIVO VOCE**
The evaluation under this title involves two components
1. Final Viva Voce jointly conducted by the Internal and External examiner s will be considered as SEE
2. Continuous evaluation of the project throughout the semester by the Internal committee (at departmental level) will be considered as CIE.