

DEPARTMENT OF CIVIL ENGINEERING

**COURSE STRUCTURE AND SYLLABUS
(1ST – 4TH SEMESTER)**

FOR

M. TECH PROGRAMME

SPECIALISATION

IN

**STRUCTURAL ENGINEERING
(EFFECTIVE FROM 2016-17)**



**VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY
(FORMLY, UNIVERSITY COLLEGE OF ENGINEERING)
BURLA – 768 018, SAMBALPUR, ODISHA**

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA

DEPARTMENT OF CIVIL ENGINEERING

VISION

To emerge as an nationally acclaimed Civil Engineering Department for imparting futuristic technical education and creation of vibrant research enterprise to create quality civil engineers and researchers, truly world class leader and unleashes technological innovations to serve the global society and improve the quality of life.

MISSION

The Department of Civil Engineering, VSSUT Burla strives to create values and ethics in its products by inculcating depth and intensity in its education standards and need based research through

- Participative learning in a cross cultural environment that promotes the learning beyond the class room.
- Collaborative partnership with industries and academia within and outside the country in learning and research.
- Encouraging innovative research and consultancy through the active participation and involvement of all faculty members.
- Facilitating technology transfer, innovation and economic development to flow as natural results of research where ever appropriate.
- Expanding curricula to cater broader perspectives.
- Creation of service opportunities for upliftment of the society at large.

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA
DEPARTMENT OF CIVIL ENGINEERING
M.TECH IN STRUCTURAL ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. To ensure that graduates will have mastery of fundamental knowledge, problem solving skills, engineering experimental abilities, and design capabilities necessary for entering civil engineering career and/or graduate school.
2. To produce graduates that have the knowledge and skills necessary for identifying and assessing design alternatives and the related social, economic, environmental, and public safety impacts.
3. To produce graduates who have verbal and written communication skills necessary for successful professional practice
4. To prepare graduates to function effectively on teams
5. To prepare graduates to deal with ethical and professional issues, taking into account the broader societal implications of civil engineering
6. To prepare graduates for professional licensure, leadership roles and lifelong learning

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA
DEPARTMENT OF CIVIL ENGINEERING
M.TECH IN STRUCTURAL ENGINEERING

GRADUATE ATTRIBUTES

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs.

These Graduate Attributes are identified by National Board of Accreditation.

- a. Engineering Knowledge
- b. Problem Analysis
- c. Design & Development of Solutions
- d. Investigation of Complex Problem
- e. Modern Tools Usage
- f. Engineer and Society
- g. Environment & Sustainability
- h. Ethics
- i. Individual & Team work
- j. Communication
- k. Lifelong Learning
- l. Project management & Finance

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DEPARTMENT OF CIVIL ENGINEERING
M.TECH IN STRUCTURAL ENGINEERING

PROGRAMME OUTCOMES (POs)

- a. An ability to apply knowledge of mathematics, science and engineering
- b. An ability to design and conduct experiments as well as to analyze and interpret data
- c. An ability to design a system, component, or process to meet desired needs
- d. An ability to function on multidisciplinary teams
- e. An ability to identify, formulate and solve engineering problems
- f. An understanding of professional and ethical responsibility
- g. An ability to communicate effectively
- h. The broad education necessary to understand the impact of engineering solutions in a global and societal context
- i. A recognition of the need for, and an ability to engage in lifelong learning
- j. A knowledge of contemporary issues
- k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

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DEPARTMENT OF CIVIL ENGINEERING
M.TECH IN STRUCTURAL ENGINEERING

POs aligned to the Graduate Attributes prescribed by the NBA

GA (NBA) /PO	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
a	√										
b		√									
c			√		√						
d				√							
e					√						√
f						√		√			
g								√			
h						√					
i				√							
j							√				
k									√		√
l										√	

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY: BURLA
CIVIL ENGINEERING DEPARTMENT
Curriculum for M.TECH –STRUCTURAL ENGINEERING(REGULAR)

First (Autumn) Semester: -

Sub No.	Subjects	L	T	P	C	
	Advanced Structural Analysis (same as CE 15060)	4	0	0	4	
	Civil Engineering Materials	4	0	0	4	
	Finite Element Method (same as CE 15068)	4	0	0	4	
	Elective – I(Group – A)	4	0	0	4	
	Elective – II(Group – A)	4	0	0	4	
	CAD Lab.	0	0	6	4	
	Seminar – I	0	0	3	2	
	Comprehensive Viva Voce-I				2	
Total		=	20	0	9	28

Second (Spring) Semester: -

Sub No.	Subjects	L	T	P	C	
	Advanced Design of Steel Structures	4	0	0	4	
	Advanced Reinforced Concrete Design	4	0	0	4	
	Structural Dynamics (same as CE 15071)	4	0	0	4	
	Elective – III (Group – B)	4	0	0	4	
	Elective - IV(Group – B)	4	0	0	4	
	Structural Engineering Lab.	0	0	6	4	
	Seminar – II	0	0	3	2	
	Comprehensive Viva Voce-II				2	
Total		=	20	0	9	28

Third (Project) Semester :-

Sub No.	Subjects	L	T	P	C
	Dissertation interim evaluation				10
	Comprehensive Viva Voce- III				3
	Seminar on Dissertation				2
Total		=			15

Fourth (Project) Semester:-

Sub No.	Subjects	L	T	P	C
	Dissertation Open Defense				5
	Dissertation evaluation				20
Total		=			25

Grand Total = 96

Electives in Group – A

1. Theory of Elasticity and Plasticity (same as CE 15069)
2. Structural Connections and Composite Structures
3. Concrete Mechanics
4. Construction Management
5. Development of Human Resources
6. Construction Methods and Equipments
7. Structural Optimization
8. Project Engineering and Management.
9. Numerical Methods in Engineering (same as CE 15066)

Electives in Group- B:-

1. Bridge Engineering (same as CE 15049)
2. Theory of Elastic Stability
3. Theory of Plates and Shells
4. Prestressed Concrete (same as CE 15048)
5. Tall Structures
6. Recent Advances in Construction Materials
7. Earthquake Analysis and Design
8. Mechanics of Composite materials (same as CE 15051)
9. Optimization Techniques (same as M.Tech. - TE)
10. Continuum Mechanics

ADVANCED STRUCTURAL ANALYSIS (4-0-0)
(same as CE 15060 ADVANCED STRUCTURAL ANALYSIS)

Course Objectives:

- To develop an understanding of structural analysis theory necessary to be a judicious and effective user of computer analysis.
- To obtain some experience in the use of modern structural analysis programs.
- To write a computer program for the structural analysis of two-dimensional frames.

Module I

(10 Hours)

Matrix methods of structural analysis: Introduction, equilibrium, static and kinematic indeterminacy, kinematics, virtual work, concepts of stiffness and flexibility, analysis by displacement and force methods.

Module II

(10 Hours)

Application of flexibility method to beams and plane trusses

Module III

(10 Hours)

Application of stiffness method to beams, plane frames and plane trusses.

Module IV

(10 Hours)

Application of stiffness method to space truss, space frames and grids, basic concepts associated with computer implementation of stiffness method.

Substructure Analysis

Text Book:

1. G. Pandit & S. Gupta, "Structural Analysis, A Matrix Approach", Tata McGrawhill, New Delhi

References:

1. H.C.Martin," Introduction to Matrix Methods of Structural Analysis. McGraw-Hill
2. M.B.Kanchi, "Matrix Methods of Structural Analysis", New Age International Publishers, New Delhi
3. Bhavikatti, "Matrix Methods of Structural Analysis", IK International Pvt Ltd

Course Outcomes:

- Ability to analyze and evaluate systems in structural engineering using force and displacement methods.
- Ability to Perform analysis of various structures
- Ability to carry out stability analysis of various structural systems.
- Ability to write computer program for the structural analysis of two-dimensional frames.

CIVIL ENGINEERING MATERIALS (4-0-0)

Course Objectives:

- To apply the knowledge of concrete behavior at microstructure level to the design of different types of concrete.
- To be able to create a particular type of concrete of specific purpose
- To have the knowledge of advanced concrete technology.
- To have the knowledge of metal behaviour at varying environments

Module I

(10 Hours)

Cement: Portland cement, chemical composition, hydration of cement, structure of hydrated cement, mechanical strength of cement gel, water held in hydrated cement paste and heat of hydration, cements of different types.

Module II

(10 Hours)

Concrete: Factors affecting the strength of concrete, elasticity, shrinkage and creep of concrete; durability of concrete, permeability of concrete, chemical attack of concrete, air-entrained concrete and thermal properties of concrete, mechanical test of hardened concrete, light weight and high density concrete.

Module III

(10 Hours)

Mix design, statistical quality control, fibre reinforced concrete

Module IV

(10 Hours)

Metals: True stress-strain curve for mild steel in simple tension. Theories of failure and yield surfaces, Fatigue properties, Nature of fatigue failure, fatigue strength for completely reversed stresses, factors influencing fatigue strength, Temperature and Creep properties, Low temperature properties, high temperature properties, creep-stress-time-temperature relations for simple tension, and mechanics of creep in tension.

Text Books:

1. A.M. Neville, J.J. Brooks, Concrete Technology, Low Priced Edition, Pearson Education, 2004.
2. A J Martin, Mechanical behavior of engineering materials, Woodhead Publishing

Reference Books:

1. S P Timoshenko, Strength of materials- Part II , Krieger Pub Co
2. M. S. Shetty, Concrete technology- Theory & Practice, S.Chand & Company New Delhi, 2005

Course Outcomes:

- To have the knowledge of different aggregates of concrete
- To have the knowledge microstructure of concrete and its influence on the

strength and behaviour of concrete and effect of environmental agencies on the concrete.

- To have the ability to create different types of concrete for specific jobs
- To have the knowledge of advances that is taking place in the concrete technology.
- To have knowledge of behaviour of metals under varying environments

FINITE ELEMENT METHOD (4-0-0)

(same as CE 15068 FINITE ELEMENT METHOD)

Course Objectives:

- To provide basic knowledge of mathematics, science and engineering in the areas of element analysis applied to structural systems
- Enable the students to identify, formulate and solve engineering problems related to one, two and three Dimensional structures subjected to static loads.
- To give procedural knowledge of analysis of structural system, component or process as per needs and specifications when subjected to different loads
- To imbibe the culture of professional and ethical responsibilities by following code provisions in the analysis of structural systems subjected to static loads
- To show the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to wrong analysis.

Module I

(7 Hours)

Introduction: The Continuum, Equations of Equilibrium, Boundary Conditions, Strain displacement relations, Stress strain Relations, Plane stress and plane Strain problems, Different methods of structural analysis including numerical methods. Basics of finite element method (FEM), different steps involved in FEM, Different approaches of FEM, Direct method, Energy approach, Weighted residual Method.

Module II

(17 Hours)

One and Two Dimensional Problems: Detail formulation including shape functions, stress strain relations, strain displacement relations and derivation of stiffness matrices using energy approach, Assembling of element matrices, application of displacement boundary conditions, Numerical solution of one dimensional problems using bar, truss, beam elements and frames. Derivation of shape function using Lagrange's interpolation, Pascal's triangle, Convergence criteria, Finite Element modeling of two dimensional problems using Constant strain Triangle(CST) elements, Stress strain relations for isotropic and orthotropic materials, Four noded rectangular elements, axisymmetric solids subjected to axisymmetric loading.

Isoparametric Elements: Natural coordinates, isoparametric elements, four node, eight node elements. Numerical integration, order of integration

Module III

(8 Hours)

Plate Bending: Bending of plates, rectangular elements, triangular elements and quadrilateral elements, Concept of 3D modeling.

Module IV**(8 Hours)**

Dynamic Considerations: General Equation of motion, Lagrange's approach, mass matrix, lumped and consistent mass matrices, Evaluation of eigenvalue and eigenvectors, stability problems.

Text Books:

1. C.S. Desai and J.F. Abel, Introduction to the Finite Element Method: CBS Publishers
2. R. D. Cook., Concepts and Applications of Finite Element Analysis, Wiley.

Reference Books:

1. Logan, D. L., A First Course in the Finite Element Method, PWS Publishing, Boston,
2. O. C Zienkiewicz .and R. L. Taylor, Finite Element Method, Mc Graw Hill

Course Outcomes:

- Ability to reproduce the basic knowledge of mathematics, science and engineering in the areas of finite element analysis related to structural engineering.
- Ability to identify, formulate and solve engineering problems of structural engineering related to one, two and three dimensional structures subjected to static loads.
- Ability to demonstrate the procedural knowledge to design a system, component or process as per needs and specifications when subjected to different loads
- Ability to practice the culture of professional and ethical responsibilities by following code provisions in the analysis of structural systems subjected to static loads
- Ability to evaluate the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to wrong analysis.
- Ability to provide factual knowledge on analysis of structural systems subjected to static loads.

ADVANCED REINFORCED CONCRETE DESIGN (4-0-0)
(Relevant IS codes are permitted in Examination)

Course Objectives:

- To understand various structural design methods in concrete
- To understand design of deep beam, shear wall and building frames
- To understand ductility design in reinforced concrete frames against seismic forces

Module I**(10 Hours)**

Design of reinforced concrete structures: Methods of design, working stress design (WSD) and limit state design (LSD), Review in brief of LSD-flexure, axial-flexure, shear and torsion, Estimation of crack width and deflection of reinforced concrete beams.

Module II**(10 Hours)**

Analysis and design of building frames subjected to wind load; Earthquake forces and structural response.

Module III

(10 Hours)

Ductility of reinforced structures; material ductility-steel and concrete, section ductility, member ductility, structural ductility, ductile detailing of reinforced concrete frames for seismic forces.

Module IV

Design of deep beams, Design of concrete shear walls.

(10 Hours)

Text Book:

1. A.K. Jain, "Reinforced Concrete: Limit State Design", Nemchand and Bros, 1999

Reference Books:

- 1 R Park and T Paulay, " Reinforced Concrete Structures", John Wiley & Sons
- 2 P.C. Varghese, "Advanced Reinforced Concrete Design", PHI, 2nd Edition, 2002

Course Outcome:

- Ability to understand various design methods in concrete including design of several structural RC member components including ductility design

ADVANCED DESIGN OF STEEL STRUCTURES (4-0-0)
(Relevant IS codes are permitted in Examination)

Course Objectives:

- To provide basic knowledge of mathematics, science and engineering in the areas of plastic analysis of steel beams.
- To provide basic knowledge of mathematics, science and engineering in the formation of plastic hinges and plastic moment of steel beams.
- To provide basic knowledge of mathematics, science and engineering in the areas of design Of various components in industrial building
- To communicate effectively on design of steel structures and enable effectively in lifelong learning.

Module I

(10 Hours)

Limit States Design of Steel Members: Uncertainties in load and resistance; Limit States and Load and Resistance Factor Design methods

Module II

(10 Hours)

Stability criteria: stability of beams – local buckling of compression flange & web, lateral-torsional buckling, stability of columns -slenderness ratio of columns, local buckling of flanges and web, bracing of column about weak axis, method of design - allowable stress design, plastic design, load and resistance factor design;

Module III

(10 Hours)

Strength Criteria: beams –flexure, shear, torsion, columns – moment magnification factor, effective length, P-M interaction, bi-axial bending, joint panel zones;

Module IV

(10 Hours)

Drift criteria: P-Δ effect, deformation-based design; Connections: types – welded, bolted, location – beam column, column-foundation, splices.

Text Book:

1. N Subramanian, ‘Design of steel structures’, Oxford University Press

Reference Books:

2. M Bill Wong, ‘Plastic analysis and design of steel structures’,
3. M Bruneau, CM Uang and SER Sabelli, ‘Ductile design of steel structures’

Course Outcomes:

- Ability to reproduce the basic knowledge of mathematics, science and engineering in the areas of steel structures.
- Ability to identify, formulate and solve engineering problems of structural engineering related to plastic analysis, light gauge sections.
- Ability to demonstrate the procedural knowledge to design a system, component or process as per needs and specifications of structural engineering such as beams and frames.
- Ability to practice the culture of professional and ethical responsibilities by following the basics of steel structures.
Ability to evaluate the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of steel structures.
- Ability to provide factual knowledge on analysis and design of steel structural systems

STRUCTURAL DYNAMICS (4-0-0)

(same as CE 15071 STRUCTURAL DYNAMICS)

Course Objectives:

- To provide basic knowledge of mathematics, science and engineering in the areas of vibrations applied to structural systems
- To enable to identify, formulate and solve engineering problems related to single degree, multi degree and continuous systems subjected to dynamic loads.
- To give procedural knowledge to design a system, component or process as per needs and specifications when subjected to dynamic loads

- To imbibe the culture of professional and ethical responsibilities by following code provisions in the analysis and design of structural systems subjected to dynamic loads
- To show the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to wrong design, use of poor quality of materials and faulty construction methods.
- To provide factual knowledge on structural systems subjected to dynamic loads

Module I **(14 Hours)**

Oscillatory motion; harmonic motion, periodic motion, vibration terminology, Single degree of freedom system; equation of motion, damped and undamped free vibration, response to harmonic, periodic, impulse load and general dynamic load, Duhamel's integral, vibrating measuring instruments.

Module II **(12 Hours)**

Multi-degrees of freedom system: equation of motion, free vibration analysis, dynamic response and modal analysis.

Module III **(8 Hours)**

Normal mode vibration of continuous beams, vibrating beams, vibrating strings, longitudinal vibration of rods, torsional vibration of rods, Euler equation for beams, effect of rotary inertia and shear deformation

Module IV **(6 Hours)**

Random vibrations, random phenomena, time averaging and expected value, frequency response function.

Text Books:

1. WT Thomsen, 'Theory of vibration', CBS Publications
2. M. Paz, 'Structural Dynamics- Theory and Computation', Van Nostrand, 1985

Reference Books:

1. R.W. Clough and J. Penzien, 'Dynamics of Structures', McGraw-hill Inc
2. A.K. Chopra, 'Dynamics of Structures: Theory and Applications to Earthquake Engineering, Printice Hall of India
3. M. Mukhopadhyay, 'Structural Dynamics Vibrations & Systems, Ane Books India.

Course Outcomes:

- Ability to reproduce the basic knowledge of mathematics, science and engineering in the areas of vibration problems related to structural engineering.
- Ability to identify, formulate and solve engineering problems of structural engineering related to SDF, MDF and continuous systems.
- Ability to demonstrate the procedural knowledge to design a system, component or process as per needs and specifications of structural engineering such as beams and frames.

- Ability to practice the culture of professional and ethical responsibilities by following the basics of structural dynamics.
- Ability to evaluate the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to in ignoring dynamic loads.
- Ability to provide factual knowledge on analysis and design of structural systems subjected to dynamic loads

ELECTIVE GROUP- A

THEORY OF ELASTICITY AND PLASTICITY (4-0-0)

(same as CE 15069 THEORY OF ELASTICITY AND PLASTICITY)

Course Objectives:

- To provide the students with basic knowledge of Elasticity, Plasticity and application of the concepts of stress and strain in Cartesian Coordinates.
- Ability to apply the knowledge of mathematics, science and engineering with stress and strain to solve problems in two dimensional problems in Cartesian coordinate system.
- Ability to apply the knowledge of mathematics, science and engineering with Elasticity concept to solve problems in two Dimensional Problems in Polar Coordinates.
- Ability to apply the knowledge of mathematics, science and engineering with Elasticity concept to solve problems in Torsion of Prismatic Bars.
- To provide the students with basic knowledge of plasticity concept applicable in structural systems.

Module- I

(12 Hours)

Plane stress and plane strain problems. General stress and strain equations (Equilibrium and compatibility equations). Two dimensional problems in rectangular coordinates. Stress and strain components, differential equation, equilibrium equations and compatibility equations in polar coordinate. Stress distribution for axisymmetric problems. Pure bending of curved bars, thick walled cylinder. Concentrated force at a point of straight boundary. Force acting on the end of a wedge. Concentrated force acting on a beam. Effect of circular holes on stress distributions in plates.

Module- II

(9 Hours)

Stress and strain in three dimensions: Principles stresses, maximum shearing stress, principal axes of strain. Stretching of prismatic bar by its own axis. Elementary problems of elasticity in three dimensions

Module- III

(9 Hours)

Torsion of non-circular prismatic bars, Saint Venant's theory, Various analogies, Torsion of hollow and thin section, Application of energy methods

Module- IV

(10 Hours)

Introduction to the theory of plasticity, the yield criteria of metals, stress space representation of yield criteria, stress-strain relations plastic potential, flow rules and maximum work hypothesis.

Two dimensional plastic flow problems. Incompressible two dimensional flow, stresses in plastic materials in condition of plane strain, equation of equilibrium the simplest slip-line fields.

Text Book:

1. S P Timoshenko and J N Goodier, Theory of Elasticity, Mc Graw Hill
2. Hoffman and Sachs, Theory of plasticity

Reference Books:

1. N.Filonenko-Borodich, Theory of Elasticity, Mir Publishers, Moscow, 1965
2. W. Johnson and P B Meller, Plasticity of Mechanical Engineers
3. C.R. Calladine, 'Plasticity for Engineers', Ellis Herwood, Chichester, U.K., 1985

Course Outcomes:

- Ability to acquire the basic knowledge of elasticity and application of the concepts of stresses and strain.
- Ability to have the ability to identify, formulate and solve engineering problems with respect to stress and strain as applied to 2D and 3D elements in Cartesian and polar coordinates.
- Ability to have the ability to identify, formulate and solve engineering problems as applied to Torsion of Prismatic bars.
- Ability to have the ability to identify, formulate and solve engineering problems with respect to Plasticity and how exactly applied to the structural systems.

STRUCTURAL CONNECTIONS AND COMPOSITE STRUCTURES (4-0-0)

Course Objectives:

- To acquire the basic knowledge of steel-concrete composites in the civil engineering field. To have the ability to apply the knowledge of mathematics, science and engineering to identify, formulate and solve engineering problems with respect to design of composite beams, columns and trusses.
- To have the ability to analyze structural system with the design concepts of composite structures.
- To have the ability to communicate effectively in design of structural elements.
- To have the ability to engage in life-long learning with the advances in structural engineering fields

Module I

(10 Hours)

Joints in reinforced concrete frame works, portals and gables, beam-column and column-slab joints, connection between prefabricated units.

Module II

(10 Hours)

Analysis of framed, seated and continuous beam to column connections in steels structures, shear transfer in square knees, straight haunched knees.

Module III**(10 Hours)**

Steel-concrete composite structures: design philosophy, shear connection, simply supported composite beams and slabs. Continuous composite beams,

Module IV**(10 Hours)**

Elastic and inelastic design considerations, Composite column and frames, Design of beam-column joints and rigid joints jointed composite frames. Concrete infilled thin walled closed steel sections; FRP composites.

Text Books

1. CBRI, Building materials and components, India, 1990
2. Gerostiza C.Z., Hendrikson C. and Rehat D.R., Knowledge based process planning for construction and manufacturing, Academic Press Inc., 1994

References

1. Koncz T., Manual of precast concrete construction, Vols. I, II and III, Bauverlag, GMBH, 1971.
2. Structural design manual, Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland BetorVerlag, 1978.

Course Outcomes:

- Ability to acquire the basic knowledge of steel-concrete composites in the civil engineering field.
- Ability to apply the knowledge of mathematics, science and engineering to identify, formulate and solve engineering problems with respect to design of composite beams, columns and trusses.
- Ability to analyze structural system with the design concepts of structures.
- Ability to communicate effectively in design of structural elements.
- Ability to engage in life-long learning with the advances in structural engineering field.

CONCRETE MECHANICS (4-0-0)**Course Objectives:**

- To apply the knowledge of concrete behavior at microstructure level to the design of different types of concrete.
- To have the knowledge of advanced concrete technology.

Module I**(10 Hours)**

Introduction: Rheological modeling of fresh concrete, constitutive equations, nonlinear elasticity, plasticity, viscoelasticity and fracture mechanics of hardened concrete, confinement and ductility, moisture diffusion, drying shrinkage,

Module II**(10 Hours)**

Solid and structural mechanics of reinforced concrete

(10 Hours)

Module III

Skew bending, modified compression field and unified theories of RC beams under bending, shear and torsion, bond slip and phenomenon of cracking in reinforced concrete

Module IV

(10 Hours)

Static and dynamic analysis of RC structures, Trends.

Text Books:

1. P. Kumar Mehta and Paulo J. M. Monteiro, 2006. *Concrete - Microstructure, Properties, and Materials*, 3rd Edition, McGraw-Hill,
2. M L Gambhir, *Concrete Technology*, 2009, 4th Ed., McGraw-Hill

References:

1. Paul and Pama, 1978, Ferro Cement, AIT, Bangkok
2. Neville, A.M. 1995. *Properties of Concrete*, 4th ed. Addison Wesley Longman
3. Fafat Siddique, 2000, *Special Structural concrete*, Galgotia Publications

Course Outcomes:

- To have the knowledge microstructure of concrete and its influence on the strength and behavior of concrete and effect of environmental agencies on the concrete.
- To have the knowledge of advances that is taking place in the concrete technology

CONSTRUCTION MANAGEMENT (4-0-0)

Course objectives:

- To study and understand the latest construction techniques applied to engineering construction for sub structure, super structure and special structures
- To understand the principles of financial management and decision theory

Module- I

(10 Hours)

Introduction: Foundations of Project Management, Project Life Cycle, the Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure.

Module- II

(10 Hours)

Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT Modeling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations, PERT/COST Accounting

Module- III

(10 Hours)

Scheduling with limited resources, Resource Planning, Resource Allocation, Project Schedule Compression, Project Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT.

Module- IV

(10 Hours)

Estimation of Project Costs, Earned Value Analysis, Monitoring Project Progress, Project Appraisal and Selection, Recent Trends in Project Management.

Text Books:

1. R.L. Peurify, 'Construction planning, Equipments and Methods', Tata Mc Grawhill
2. B. Sengupta & H Guha, 'Construction management and planning', Tata Mc Grawhill

Reference Books:

1. M Verma, 'Construction planning and management'
2. L.S. Srinath, 'PERT & CPM', East-West Press
3. S.S. Rao, 'Optimization', Tata McGrawhill

Course outcomes:

- To understand the latest construction techniques applied to engineering construction for sub structure, super structure and special structures
- To understand the principles of financial management and decision theory

DEVELOPMENT OF HUMAN RESOURCES (4-0-0)

Course objectives:

- To study and understand the nature and scope of Human Resources Development
- To understand Human process Intervention
- To understand total quality management and business process reengineering

Module- I

(10 Hours)

Nature and scope of Human Resource Development, Training and Development,

Module- II

(10 Hours)

Human Process Intervention; T-Group, Team Building, Survey Feedback, Intergroup Relations, Quality of Work Life,

Module- III

(10 Hours)

HR Interventions: Goal Setting, Career Development, Stress Management, Time Management; Contemporary Issues in HRD: Quality Circle,

Module- IV

(10 Hours)

Total Quality Management, ISO 9000, empowerment, Business Process Reengineering.

Text Books:

1. Ghosh, Biswanath, Human Resource Development and Management, Vikas Publishers, 2000
2. Noe, A. Raymond (2010), Employee Training and Development, Irwin Mc Graw-Hill, U.S.A

Reference Books:

1. Harris, David. M and Desimone Rady L (2001), Human Resource Development, The Dryden Press, Orlando
2. Pace, R Wayne, Smith Philip.C and Mills Gordon E (1991), Human Resource Development; The Field., Prentice Hall, New Jersey
3. Steward, Jim and McGoldrick, Jim (1996), Human Resource Development Perspectives, Strategies and Practise. Pitman Publishing, U.K

Course outcomes:

- To understand the nature and scope of Human Resources Development
- To understand Human process Intervention
- To understand total quality management and business process reengineering

CONSTRUCTION METHODS AND EQUIPMENTS (4-0-0)

Course objectives:

- To study and understand the construction engineering fundamentals
- To analyse production outputs and costs
- To evaluate the performance of equipments for earth moving
- To understand the batching, mixing, transport and placement of concrete

Module I

(10 Hours)

Factors affecting selection of equipments-technical and economic, construction engineering fundamentals,

Module II

(10 Hours)

Analysis of production outputs and costs,

Module III

(10 Hours)

Characteristics and performances of equipments for earth moving, erection, material transport, pile driving, dewatering

Module IV

(10 Hours)

Concrete construction (including batching, mixing, transport and placement) and tunneling

Text Books:

1. Robert Wade Brown, Practical foundation engineering hand book, McGraw Hill Publications, 1995
2. Patrick Powers .J, Construction Dewatering: New Methods and Applications John Wiley & Sons, 1992

Reference Books:

1. Jerry Irvine, Advanced Construction Techniques CA Rockers, 1984
2. Peurifoy, R.L., Ledbetter, W.B. and Schexnayder.C, Construction Planning Equipment and Methods, McGraw Hill. Singapore 1995
3. Sharma S.C. Construction Equipment and Management, Khanna Publishers, Delhi, 1988
4. Deodhar, S.V. Construction Equipment and Job Planning Khanna Publishers Delhi, 1988
5. Dr. Mahesh Varma, Construction Equipment and its planning and application, Metropolitan Book Company, New Delhi 1983

Course outcomes:

- To understand the construction engineering fundamentals
- To analyse production outputs and costs
- To evaluate the performance of equipments for earth moving
- To understand the batching, mixing, transport and placement of concrete

STRUCTURAL OPTIMIZATION (4-0-0)

Course objectives:

- To identify real-world objectives and constraints based on actual problem descriptions.
- To create mathematical optimization models.
- To work through proper solution techniques.
- To make recommendations based on solutions, analyses, and limitations of models.

Module I

(10 Hours)

Basic concepts, Kuhn-Tucker conditions, linear and nonlinear programming

Module II

(10 Hours)

Integer programming, geometric programming, dynamic programming, stochastic programming

Module III

(10 Hours)

Genetic algorithms, simulated annealing, concepts of homogenization

Module IV

(10 Hours)

Applications in the design of reinforced concrete and steel- beams, columns, frames and plates, Treatment of shape and topology variables, Introduction to Structural Control

Text Books:

1. Arora, J.S., Introduction to Optimization, McGraw Hill, Intl Edn, 1989.
2. Rao, S.S., Optimization: Theory and Applications, Wiley Eastern, 1992.

Reference Books:

1. Haftka, R. T. and Gurdal, Z., "Elements of Structural Optimization," Kluwer Academic Publishers, 1992.
2. A. J. Morris Foundations of structural optimization: a unified approach Wiley, 1982
3. M. save and W Prager, Structural Optimization-Volume 2, Plenum Press, New York

Course outcomes:

- Ability to identify real-world objectives and constraints based on actual problem descriptions.
 - Ability to create mathematical optimization models.
 - Ability to work through proper solution techniques.
- Ability to make recommendations based on solutions, analyses, and limitations of models.

PROJECT ENGINEERING AND MANAGEMENT (4-0-0)

Course objectives:

- To study and understand the foundation of project management
- To analyse Network Scheduling
- To estimate the project costs

Module I

(10 Hours)

Introduction: Foundations of Project Management, Project Life Cycle, The Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure.

Module II

(10 Hours)

Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT Modeling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations, PERT/COST Accounting.

Module III

(10 Hours)

Scheduling with limited resources, Resource Planning, Resource Allocation, Project Schedule Compression, Project Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT.

Module IV

(10 Hours)

Estimation of Project Costs, Earned Value Analysis, Monitoring Project Progress, Project Appraisal and Selection, Recent Trends in Project Management.

Text Books:

1. Project Management, A Managerial Approach, 6th Edition by Jack R. Meredith and Samuel J. Mantel Jr. Publisher: John Wiley & Sons; ISBN: 13978-0471-715375.
2. PMI, A guide to the project management body of knowledge, 3rd ed., Project Management Institute, Pennsylvania, 1996.

Reference Books

1. M. Mawdesley, W. Askew and M. O'Reilly, Planning and controlling construction projects, Addison Wesley Longman Limited, Essex, 1997.
2. M. Levy, Project management in construction, 5th ed., McGraw Hill, New York, 2007

Course outcomes:

- To understand the foundation of project management
- To analyse Network Scheduling
- To estimate the project costs

NUMERICAL METHODS IN ENGINEERING (4-0-0)

(same as CE 15066 NUMERICAL METHODS IN ENGINEERING)

Course Objectives:

- To apply Computer- oriented methods for solving numerical problems in science and engineering
- To solve Numerically systems of simultaneous linear equations, nonlinear algebraic equations (root solving), differentiation and integration, ordinary differential equations, interpolation

Module 1

(10 Hours)

Introduction to digital computers and programming-an overview, Errors-polynomial approximation ,interpolation: finite differences, Newton's formula for interpolation ,central difference interpolation formulae, interpolation with unevenly spaced points, divided difference and their properties, inverse interpolation and double interpolation Numerical differentiation: errors in numerical differentiation, differentiation formula with function values. Numerical integration: Trapezoidal rule, Simpson's 1/3rd & 3/8th rule, Romberg integration, newton cote's integration formula, Euler-maclaurin formula, Gaussian integration, numerical double integration

Module 2**(10 Hours)**

Solution of linear system - Gaussian elimination and Gauss-Jordan methods , necessity for pivoting, LU decomposition methods , Jacobi and Gauss-Seidel iterative methods sufficient conditions for convergence , Power method to find the dominant Eigen value and eigenvector Diagonal dominance, condition number, ill conditioned matrices, singularity and singular value decomposition. Banded matrices, storage schemes for banded matrices, skyline solver. Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - NewtonRaphson method

Module 3**(10 Hours)**

Approximate solution technique, static condensation, Rayleigh-Ritz method, subspace iteration, Application of finite difference method, solution of equilibrium equations in dynamics, direct method, central difference method, Houbolts method, Wilson θ method, Newmarks method

Module 4**(10 Hours)**

Numerical Solution of Ordinary Differential Equations- Euler's method - Euler's modified method ,Taylor's method and Runge-Kutta method for simultaneous equations and 2nd order equations - Multistep methods - Milne's and Adams' methods

Text Book

Numerical methods for Scientists and Engineers by M.K. Jain, S.R. Iyengar & R.K. Jain, Wiley Eastern Ltd.

Numerical methods in engineering and science, Grewal, B.S., Khanna Publishers, Delhi.

Reference Books

Mathematical Numerical Analysis By S.C. Scarborough, Oxford and IBH Publishing Company.

Introductory methods in Numerical Analysis by S.S. Sastry, Prentice Hall of India.

Theory and problems in Numerical Methods by T. Veerajan and T. Ramachandran, Tata McGrawHill Publishing Company, New Delhi-2004.

Numerical Methods for Mathematics Sciences and Engineering 2nd ed. By John H. Mathews, Prentice Hall of India, New Delhi 2003.

Advanced Engineering Mathematics by R.K. Jain & S.R.K. Iyengar, Narosa-200

Computational engineering: introduction to numerical methods, Schafer, Michael, Springer Verlag, Berlin,

Numerical Methods in Science & Engg., Rajasekaran, S Chand Publication, 1983

Course Outcomes:

- Be aware of the use of numerical methods in modern scientific computing,
- Be familiar with finite precision computation,
- Be familiar with numerical solutions of nonlinear equations in a single variable,
- Be familiar with numerical interpolation and approximation of functions,
- Be familiar with numerical integration and differentiation
- Be familiar with numerical solution of ordinary differential equations
- Be familiar with calculation and interpretation of errors in numerical methods

ELECTIVE GROUP- B

BRIDGE ENGINEERING (4-0-0)

(same as CE 15049 BRIDGE ENGINEERING)

Course Objectives:

- To provide basic knowledge of mathematics, science and engineering in the design of bridges, using limit state design.
- To Enable to identify, formulate and solve engineering problems design of bridges.
- To give procedural knowledge to design a system, component or process as per needs and specifications of different variety of bridges like slab culvert, box culvert, T beam bridges, PSC bridges and balanced cantilever bridges slabs subjected to various load combinations with different boundary conditions.
- To imbibe the culture of professional and ethical responsibilities by following codal provisions in the analysis, design and detailing of bridges for strength and durability.
- To show the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to wrong design, use of poor quality of materials and faulty construction methods.
- To provide factual knowledge on analysis and design of various types of bridges

Module 1:

(10 Hours)

Introduction: classification and components of a standard bridge, Engineering and aesthetic requirements, introduction to bridge codes. Investigation for bridge: Site selection, data drawing, design discharge linear water way, economical span, location of piers and abutments, vertical clearance above HFL, scour depth and choice of bridge type. Standard Loadings for Road Bridges: Dead load, Live loads, Impact effect, Wind load, Longitudinal forces, Centrifugal forces, Horizontal forces due to water current, Buoyancy effect, Earth pressure, Deformation stresses, Erection stresses, Temperature effects, and Seismic force.

Module 2:

(10 Hours)

Foundation and substructures: Types of foundation (open, pile, well and caisson), design of piers, abutments, wing wall and bed blocks. Design of Culverts: Design of Pipe culverts (hydraulics and structural), Analysis and design of right, skew and curved slab culvert; design of single vent rectangular box culvert.

Module 3:

(10 Hours)

Design of Girders: Design and detailing T-beam bridge (without footpath), load distribution, design and orthographic plate analysis of bridge deck. Bearings: Bearings for slab bridges and girder bridges, design of elastomeric bearing. Joints: Design and construction of expansion joints.

Module 4:

(10 Hours)

Introduction to long span bridges: Cantilever bridges, Arch bridges, Cable stayed bridges, suspension bridges, Pre-stressed concrete bridge (pre-tensioned and post-tensioned) and steel bridges. Bridge Launching: Methods of erection of concrete, steel, pre-stressed and composite bridges Inspection and Maintenance of Bridges: Types of inspection (routine inspection, principal inspection and special inspection), Types of maintenance (Ordinary maintenance and specialized maintenance).

Text Book:

1. Essentials of Bridge Engineering, by DJ Victor, Oxford IBH.

Reference Books:

1. Design of Bridge Structures, by T. R. Jagadeesh, PHI.
2. Principles and Practice of Bridge Engineering, SP Bindra, Dhanpat Rai Publications

Course Outcomes:

- To reproduce the basic knowledge of mathematics, science and engineering in the design of various types of bridges.
- To identify, formulate and solve engineering problems in design of bridges subjected to flexure, shear and torsion.
- To demonstrate the procedural knowledge to design a system, component or process as per needs and specifications of slab culvert, box culvert, T beam bridges, PSC bridges and balanced cantilever bridges slabs subjected to various load combinations with different boundary conditions subjected to various load combinations with different boundary conditions.
- To practice the culture of professional and ethical responsibilities by following codal provisions in the analysis, design and detailing of advanced design of bridges for strength and durability.
- To evaluate the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to wrong design, use of poor quality of materials and faulty construction methods.
- To provide factual knowledge on analysis and design of various types of bridges.

THEORY OF ELASTIC STABILITY (4-0-0)**Course objectives:**

- To understand basic knowledge of stability analysis with static and dynamic and various factors involved in it.
- To model a structure against deformation, oscillation, vibration, uniform sways for stability analysis.
- To forecast safety against failure, through analytical modeling using software.
To demonstrate structural stability of individual elements and also at junctions bending elements

Module I**(10 Hours)**

Buckling of elastic columns and frames (bending theory, differential equation of beam-columns, critical load of perfect columns with various end restraints, imperfect columns and Southwell plot, prestressed columns, buckling of continuous beams and frames, stiffness and flexibility matrices for beam-columns, post critical behaviour of frames)

Module II**(10 Hours)**

Energy Methods (Potential energy for discrete elastic systems, bifurcation buckling at small deflections, Koiter's theory, imperfection sensitivity, indirect variation method and Euler equation,

Raleigh quotient), Thin walled beams, plates and shells (potential energy and differential equations, axial torsional buckling of columns, lateral buckling of beams and arches, buckling of beams with arbitrary open cross section, buckling of rectangular plates and axi-symmetric cylindrical shells)

Module III

(10 Hours)

Introduction to inelastic buckling (perfect columns/structures Shanley's bifurcation, imperfect columns, visco-elastic buckling)

Module IV

(10 Hours)

Dynamic analysis and stability (vibration of columns or frames and divergence, non-conservative loads-follower forces, theorems of Lagrange-Dirichlet and Liapunov, stability of dynamic system, thermodynamic criteria of stable state and path, Drucker's and Illushin's postulate for stable materials)

Text Book:

1. Timoshenko, S.P., and Gere, J.M., Theory of Elastic Stability, McGraw Hill Intl Edition.

Reference Books:

1. Simitses, G.J., and Hodges, D.H., Fundamentals of Structural Stability, Elsevier Inc.
2. Bazant, Z.P., and Cedolin, L., Stability of Structures, Dover Publications.

Course outcomes:

- Ability to understand basic knowledge of stability analysis with static and dynamic and various factors involved in it.
- Ability to model a structure against deformation, oscillation, and vibration, uniform sways for stability analysis.
- Ability to forecast safety against failure through analytical modelling using software.
- Ability to demonstrate structural stability of individual elements and also at junctions bending elements.

THEORY OF PLATES AND SHELLS (4-0-0)

Course Objectives:

- To provide basic knowledge of mathematics, science and engineering in the areas of analysis of components such as rectangular plates.
- Ability to identify, formulate and solve engineering problems of theory of plates and shells system subjected to uniformly distribution loads, sinusoidal load and point load.
- To give procedural knowledge to design a system, component or process as per needs and specifications of theory of plates and shells subjected to various load combinations with different boundary conditions.
To imbibe the culture of professional and ethical responsibilities by following codal provisions in the analysis, design and detailing plates and shells.
- To provide factual knowledge on theory of plates and shells

Module I**(10 Hours)**

Plates: Pure bending of plates, Slope and curvature of slightly bent plates, relationship between moment and curvature, strain energy in bending of plates

Module II**(10 Hours)**

Energy Differential equations for symmetrical bending of circular plates under lateral loads, Uniformly loaded, concentrically loaded and loaded at the center of simply supported and fixed circular plates. Differential equation of the deflection surface and boundary conditions of laterally loaded rectangular plates by classical theory, Solutions of simply supported rectangular plates due to sinusoidal loads, uniformly distributed loads and concentrated load by Navier's Solution, Levy approach

Module III**(10 Hours)**

Shells: Membrane theory of symmetrical loaded shells of revolution, Spherical shells, conical shells, Membrane theory of cylindrical shells and shells of Double curvature such as Hyperbolic paraboloids and elliptic paraboloids, conoids

Module IV**(10 Hours)**

Circular cylindrical shells loaded symmetrically with respect to its axis, particular cases of symmetrical deformation of circular cylindrical shells, cylindrical tanks of uniform wall thickness

Text Books:

1. SP Timoshenko and SW Krieger, Theory of Plates and Shells, McGraw-Hill
2. P.L. Gould, 'Analysis of shells and plates', Pearson Higher Education

Reference Books:

1. OP Billington, Thin shell structures, McGraw-Hill 1982
2. E Ventsel and T Krauthammer, 'Thin Plates and Shells: Theory, Analysis & Applications', CRC, 1st edition, 2001
3. M.H Jawad, 'Theory and design of plate and shell structures', Kluwer Academic Publications

Course Outcomes:

- Ability to reproduce basic knowledge of mathematics, science and engineering in the areas of analysis of components such as rectangular plates.
- Ability to identify, formulate and solve engineering problems of theory of plates and shells system subjected to uniformly distribution loads, sinusoidal load and point load.
Ability to have procedural knowledge to design a system, component or process as per needs and specifications of theory of plates and shells subjected to various load combinations with different boundary conditions.
- Ability to practice the culture of professional and ethical responsibilities by following codal provisions in the analysis, design and detailing plates and shells.

- Ability to gain factual knowledge on theory of plates and

PRESTRESSED CONCRETE (4-0-0)

(Relevant IS Codes are permitted in the examination)

(same as CE 15048 *PRESTRESSED CONCRETE*)

Course Objectives:

- To understand pre-stressing materials, system and various pre-stressing losses and deflections
- Analysis and design of various pre-stressed structural components
- To understand the stress distribution in end-block by various methods
- To understand the design of prismatic continuous beams

Module I

(10 Hours)

Different systems of prestressing, Characteristics of concrete and steel, Other suitable materials, Losses in prestress,

Analysis and design of section for flexure, shear and torsion, Design of flexural member, Limit state design as per IS code

Module II

(10 Hours)

Deflection of prestressed structures- short term as well as long term deflections of uncracked and cracked members

Module III

(10 Hours)

Stress distribution in end-block of post tensioned section, Magnel's method, Guyen's method, Rowe's method and IS code method

Module IV

(10 Hours)

Indeterminate structures- Principles of design of prismatic continuous beams of two equal, unequal spans with same and variable moments of inertia, Cap cable, Design concept of concordancy of cable, Secondary design consideration

Design of Pre-tensioned and post-tensioned beam

Text Books:

1. N Krishnaraju, 'Prestressed concrete', Tata Mc-Grawhill, New Delhi- 2004
2. SK Mallik & AP Gupta, 'Prestressed concrete', Oxford & IBH, New Delhi 1988

Reference Books:

1. EW Bennet, 'Prestressed concrete theory & design', Chapman & Hall, London-1962
2. TY Lin & H Burns Ned, 'Design of prestressed concrete structures', John Wiley & Sons, New York, 1982

Course Outcomes:

- Ability to determine the pre-stressing force required in beam for a prestressing systems.
- Ability to compute losses and deflections of pre-stressed concrete members
- Ability to compute flexural strength and torsional resistance of Prestressed Concrete members
- Ability to design End Blocks of a post tensioned pre-stressed concrete member.

TALL STRUCTURES (3-1-0)

Course objectives:

- To reproduce basic knowledge of mathematics, science and engineering in the areas of analysis of structural systems for Tall buildings.
- To identify, formulate and solve engineering problems of structural systems of tall structures subjected to gravity, wind and seismic loadings.
- To demonstrate the procedural knowledge to design a system, component or process as per needs and specifications of Steel, RC Frames, shear walls subjected to various load combinations with different boundary conditions.
- To practice the culture of professional and ethical responsibilities by following codal provisions in the analysis, design and detailing steel and concrete frames.
- To evaluate the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to wrong design, use of poor quality of materials and faulty construction methods.

Module I

(10 Hours)

Structural systems and concepts, Matrix and approximate methods, analysis of tall building frames, lateral load analysis, multi bay frames, gravity loads, settlement of foundation

Module II

(10 Hours)

Foundation-superstructure interaction, Earthquake effects and design for ductility. Analysis of shear walls - plane shear walls, in-filled frames, coupled frames, frames with shear walls.

Module III

(10 Hours)

Principle of three dimensional analysis of tall buildings; Perforated cores, pure torsion in thin tubes, bending and warping of perforated cores.

Module IV

(10 Hours)

Analysis of floor system in tall buildings, Vierendal girders, diagrid floors, elastic stability of frames and shear walls. Analysis of thermal stresses

Text Books:

1. Wolfgang Schueller, High - rise building Structures, John Wiley and Sons, New York 1976
2. Bryan Stafford Smith and Alex Coull, Tall Building Structures, Analysis and Design, John Wiley and Sons, Inc., 1991

Reference Books:

1. Coull, A. and Smith, Stafford, B. " Tall Buildings ", Pergamon Press, London, 1997
2. LinT.Y. and Burry D.Stotes, " Structural Concepts and Systems for Architects and Engineers ", John Wiley, 1994
3. Lynn S.Beedle, Advances in Tall Buildings, CBS Publishers and Distributors, Delhi, 1996
4. Taranath.B.S., Structural Analysis and Design of Tall Buildings, Mc Graw Hill,1998.

Course outcomes:

- Ability to reproduce basic knowledge of mathematics, science and engineering in the areas of analysis of structural systems for Tall buildings.
- Ability to identify, formulate and solve engineering problems of structural systems of tall structures subjected to gravity, wind and seismic loadings.
- Ability to demonstrate the procedural knowledge to design a system, component or process as per needs and specifications of Steel, RC Frames, shear walls subjected to various load combinations with different boundary conditions.
- Ability to practice the culture of professional and ethical responsibilities by following codal provisions in the analysis, design and detailing steel and concrete frames.
- Students will evaluate the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to wrong design, use of poor quality of faulty construction methods.

RECENT ADVANCES IN CONSTRUCTION MATERIALS (3-1-0)

Course Objectives:

- To study and understand various types of construction materials
- To study the corrosion of concrete in various environments
- To study the polymers in civil engineering construction

Module I

(10 Hours)

Foams and light weight materials, fibre reinforced concrete, types of fibres, workability, mechanical and physical properties of fibre reinforced concrete, Industrial waste materials in concrete, their influence on physical and mechanical properties and durability of concrete, concrete at high temperature, high strength concrete, changes in concrete with time

Module II

(10 Hours)

Corrosion of concrete in various environments, corrosion of reinforcing steel, electro chemical process, measures of protection, ferro cement, material and properties

Module III

(10 Hours)

Polymers in civil engineering, polymers, fibres and composites, fibre reinforced plastic in sandwich panels, modeling, architectural use and aesthetics of composites

Module IV

(10 Hours)

Adhesives and sealants, structural elastomeric bearings and resilient seating, moisture barriers, polymer foams and polymers in building physics, polymer concrete composites

Text Books:

1. Metha P.K and Monteiro. P.J.M, " CONCRETE", Microstructure, Properties and Materials, Third Edition, Tata McGraw- Hill Publishing company Limited, New Delhi, 2006
2. Shetty .M.S., " Concrete Technology, Theory and Practice", Revised Edition, S. Chand & company Ltd., New Delhi,2006

Reference Books:

1. Neville. A.M. , " Properties of Concrete", 4th Edition Longman,1995
2. Mindass and Young, " Concrete", Prentice Hall.1998

Course Outcomes:

- To understand various types of construction materials
- To understand the corrosion of concrete in various environments
- To understand the polymers in civil engineering construction

EARTHQUAKE ANALYSIS AND DESIGN (3-1-0)

Course Objectives:

- To study the earthquake characteristics and seismic inputs to structures
- To study the earthquake recording instruments and its characteristics
- To study various dynamic soil properties and their measurements
- To analysis and design the earthquake resistance buildings

Module I

(10 Hours)

Characteristics of earthquakes; Earthquake response of structures; Seismology, seismic risk and hazard, Soil dynamics and seismic inputs to structures, Characterization of ground motion; lateral load calculation, base shear

Module II**(10 Hours)**

Earthquake intensity and magnitude; Recording instruments and base line correction; Predominant period and amplification through soil; Response spectrum, analysis, Spectral analysis

Module III**(10 Hours)**

Idealization of structural systems for low, medium and high rise buildings; Nonlinear and push over analysis, Dynamic soil-structure interaction, Earthquake design philosophy

Module IV**(10 Hours)**

Concept of earthquake resistant design; Code provisions of design of buildings;

Reinforcement detailing for members and joints, retrofitting and strengthening of structures, concept of base isolation design and structural control

Text Books:

1. Clough R.W. and Penzien J., 'Dynamics of Structures', McGraw-Hill, 2nd edition, 1992
2. Earthquake Resistant Design: Shrikhandee & Agarwal-PHI Publ

Reference Books:

1. Newmark N.M. and Rosenblueth E., 'Fundamentals of Earthquake Engg.', Prentice Hall, 1971
2. David Key, 'Earthquake Design Practice for Buildings', Thomas Telford, London, 1988.
3. Wiegel R.L., 'Earthquake Engg.', Prentice Hall, 1970
4. Blume J.A., Newmark N.M., Corning L.H., 'Design of Multi-storied Buildings for Earthquake ground motions', Portland Cement Association, Chicago, 1961

Course Outcomes:

- Ability to characterize various ground motions
- Ability to study seismograph data and analysis
- Ability to analyse and design of earthquake resistance buildings
- Ability for reinforcement detailing of RC members and joints based on code provisions
- Ability to analyse soil-structure interaction problems

MECHANICS OF COMPOSITE MATERIALS (3-1-0)
(same as CE 15051 MECHANICS OF COMPOSITE MATERIALS)

Course Objectives:

- To study the basic concepts and characteristics of composite materials
- To study the elastic behavior of unidirectional lamina based on various theories
- To study the elastic behavior of multi-directional laminates
- To analysis the bending behavior of cross-ply and angle-ply laminates

Module I **(10 Hours)**

Classification and characteristics of Composite Materials, advantages and limitations, Basic Concepts and characteristics: Homogeneity and Heterogeneity, Isotropy, Orthotropy and Anisotropy; Characteristics and configurations of lamina, laminate, micromechanics and macromechanics, Constituent materials and properties.

Module II **(10 Hours)**

Elastic behavior of unidirectional lamina, Strength of unidirectional lamina, Macromechanical failure theories: Maximum stress theory, maximum strain theory, Deviatoric strain energy theory (Tsai-Hill), Interactive tensor polynomial theory (Tsai-Wu).

Module III **(10 Hours)**

Elastic Behaviour of multidirectional laminates: Basic assumptions, Stress-strain relations, load deformation relations, symmetric and balanced laminates, laminate engineering properties.

Module IV **(10 Hours)**

Bending of laminated plates: Governing equations, Deflection of simply supported rectangular symmetric angle-ply, specially orthotropic, antisymmetric cross-ply laminates.

Text Books:

1. RM Jones, 'Mechanics of Composite Materials', McGraw-Hill Book Company
2. IM Daniel and O Ishai, 'Engineering mechanics of composite materials,' Oxford university press

References

1. PK Mallick, 'Fiber-reinforced composites', Marcel Dekker inc

2. D Hull and TW Clyne, 'An introduction to composite materials', Cambridge University Press
3. JN Reddy, 'Mechanics of laminated composite plates and shells: theory and analysis', CRC Press.

Course Outcomes:

- To reproduce the basic knowledge of mathematics, science and engineering in the areas of Composite materials, classifications and applications.
- To analyze simple laminated structural elements ply-stress and strain, lamina failure theories first ply failure, vibration and buckling analysis.
- To evaluate the impact of engineering solutions on the society and also will be aware of contemporary issues regarding failure of structures due to wrong design, use of poor quality of materials.

OPTIMIZATION TECHNIQUES

(same as M.Tech. - TE - OPTIMIZATION TECHNIQUES)

Course Objectives:

- To study and understand the concepts of linear programming
- To study the methods of nonlinear programming
- To study the various search methods

Module-I

Linear Programming: Introduction and formulation of models; Convexity; simplex method; Two phase method; Degeneracy, non - existent and unbounded solutions; Duality in L.P.P. Dual simplex method, Sensitivity analysis; Revised simplex method; transportation and assignment problems.

Module-II

Non-Linear Programming: Classical optimisation methods; Equality and inequality constraints; Lagrange multipliers; & KuhnTucker conditions; Quadratic forms; Quadratic programming.

Module-III

Search Methods: One dimensional optimisation; Fibonacci search; multi dimensional search methods; Univariate search; gradient methods; steepest descent/ascent methods; Conjugate Gradient method; Penalty function approach.

Module-IV

Dynamic Programming: Principle of optimality; Recursive relations; solution of L.P.Problem; simple examples. Integer Linear Programming: travelling salesman problem

Text book:

1. Optimisation Theory and Applications - S.S.Rao; Wiley Eastern Ltd., New Delhi

Reference Books:

1. Introduction to Optimisation - J.C.Pant; Jain Brothers; New Delhi.
2. Optimisation Method - K.V.Mital; Wiley Eastern Ltd. New Delhi.

Course Outcomes:

- To understand the concepts of linear programming
- To understand the methods of nonlinear programming
- To understand the various search methods

CONTINUUM MECHANICS (4-0-0)**Course Objectives:**

- To study and understand the basic concepts of the theory of continuous media
- To study the kinematics of deformable bodies

Module -1

Basic concepts of the theory of continuous media

Tensor algebra: Points. Vectors. Tensors, Spectral Theorem. Cayley-Hamilton Theorem. Polar Decomposition Theorem

Tensor Analysis: Differentiation, Gradient, Divergence. Curl, the Divergence Theorem. Stokes' Theorem

Module -2

Kinematics: Bodies. Deformations, Strain, material and spatial description, deformation gradient, polar decomposition, volume change, distortional component of the deformation gradient, area change, linearized kinematics, velocity and material time derivative, rate of deformation, spin tensor, rate of change of volume, superimposed rigid body motions and objectivity.

Module- 3

Stress and Equilibrium: cauchy stress tensor, equilibrium, principle of virtual work, work conjugacy, and alternative stress representations, stress rates.

Introduction to hyperelasticity: the material or lagrangian elasticity tensor, the spatial or eulerian elasticity tensor, isotropic hyperelasticity.

Module- 4

Linearized equilibrium equations: linearization and newton–raphson process, lagrangian linearized internal virtual work; Eulerian linearized internal virtual work, linearized external virtual work, variational methods and incompressibility.

Discretization and solution: Discretized kinematics, Newton–Raphson iteration and solution procedure

Text Books:

- Gurtin M. , An Introduction to Continuum Mechanics, Academic Press

- Bonet J., and Wood R.D., Nonlinear continuum mechanics for finite element analysis, Cambridge University Press.

Reference Books:

- Reddy, J.N., An introduction to continuum mechanics with applications, Cambridge university press.

Course Outcomes:

- To understand the basic concepts of the theory of continuous media
- To understand the kinematics of deformable bodies

CAD LABORATORY (0-0-6)

Course Objectives:

- To understand computer models of civil engineering structures
- To understand procedures for analysis and design of civil engineering structures
- To understand the process of writing the codes for analysis of structures..

Introduction to computer aided design and drafting.

Applications to structural engineering problems using commercial software, Individual / group projects

Course Outcomes:

- To develop the Ability to use AutoCAD for drafting structural models.
- To develop the Ability to use StaadPro for analysis and design structures.
- To develop the Ability to use Matlab for writing codes for analysis of framed structures.

STRUCTURAL ENGINEERING LABORATORY-I (0-0-6)

Course Objectives:

- To provide the basic knowledge of science and engineering of concrete properties related to civil engineering problems.
- Ability to identify, formulate and solve problems in strength of concrete.
- Ability to effectively present research to professional and engage in lifelong learning with the advances in concrete technology.
- Ability to communicate effectively in the design of concrete structures

Instruments, Properties of fresh & hardened concrete - Concrete mix design Tests on RC beam, Prestressed beam, RC slabs, RC column, Steel beam, Steel column;

NDTS - Application of acoustic emission instrument, ultrasonic test.

Biaxial and multiaxial testing, Steel-concrete composite,

Tests on fibre reinforced concrete composites, Individual/group projects

Course outcomes:

- Understands the fresh and hardened properties of various types of concrete.
- Understands how modern instruments helpful for the experimenting the strength of concrete.
- Understands the importance of experiments in behavioral aspect of ingredients of concrete.
- Understands field application of properties of concrete and implementation of it at site

TITLE: Dissertation work I & II

Course outcomes:

- Ability to identify and focus on an emerging area of research in the field of structural engineering
- Ability to review the literature both at national and international levels
- Ability to define a specific program through gap analysis
- Ability to do a characterization of materials used in research
- Design a methodology for mix design, casting and testing of structural elements as specified by various codes
- Research analysis to interpret the experimental data generated.
- Draw conclusions and also suggest scope for further work.