**DEPARTMENT OF CIVIL ENGINEERING**

***Scheme of Instruction***
***and***
***Syllabus of***

# M.E. (CIVIL ENGG)
# Structural Engineering
# Full Time & PTPG

## AICTE Model Curriculum
## 2021-22

**UNIVERSITY COLLEGE OF ENGINEERING**
**(Autonomous)**
**Osmania University**
**Hyderabad – 500 007, TS, INDIA**

## INSTITUTE

### Vision

The Vision of the institute is to generate and disseminate knowledge through harmonious blending of science, engineering and technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

### Mission

- To achieve excellence in Teaching and Research
- To generate , disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services to the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programmes
- Technology transfer and incubation

## DEPARTMENT

### Vision

To be as a leading academic department on pace with global standards and contribute to the development of economic, technically viable and useful to societal problems and challenges of civil engineering profession and also contribute to the regional and country's developmental activities.

### Mission

- To train the human resources with knowledge base in the field of Civil Engineering so that they can face the challenges of civil and infrastructural engineering problems to provide viable solutions.
- To integrate their understanding and attainable knowledge on the specializations for effective functioning in their profession and useful to the welfare and safety of mankind.
- To enhance the technical knowledge and research aptitude in the domains of various Civil Engineering specializations to serve the society in highly professional manner.
- Produce highly competent and capable professionals and motivated young academicians to provide solutions to real life problems of Engineering and Technology and has apt for continuous learning and dedication towards societal issues.

**Programme Educational Objectives (PEO):**

The graduating students of the structural engineering program will be able to:

| | |
|---|---|
| **PEO1** | Apply basic principles of structural mechanics to comprehensively analyse the structure and apply design philosophies for design of structural elements. |
| **PEO2** | Understand characterization of material and its application together with construction technologies. |
| **PEO3** | Motivate themselves to carryout innovative research in core and multidisciplinary areas and disseminate the same through publications. |
| **PEO4** | Use computational techniques and tools and engage them in lifelong learning to solve real world engineering problems. |
| **PEO5** | Communicate effectively with their team mates, manage projects efficiently and practice their profession with regard to societal needs, with ethical responsibilities for sustainable development. |

**Programme Outcomes (PO):**

| | |
|---|---|
| **PO1** | Applying the core knowledge in Structural Engineering to address and solve the Civil engineering problems. |
| **PO2** | Identify appropriate materials and construction technologies so as to arrive at feasible solutions maintaining ecological balance. |
| **PO3** | Recognizing the need for continuous updating of his skills and knowledge to meet the challenges in the field of structural engineering. |
| **PO4** | Utilizing modern equipments and tools together with software packages necessary to solve structural engineering problems. |
| **PO5** | .Preparing the technical report and presenting the seminar in domain area to disseminate knowledge among professional peers |
| **PO6** | Communicate effectively, demonstrate leadership skills, work in inter-disciplinary engineering teams with social responsibility and ethical values |

**Mapping of PEOs with POs**

| PROGRAMME EDUCATIONAL OBJECTIVES | PO-1 | PO-2 | PO-3 | PO-4 | PO-5 | PO-6 |
|---|---|---|---|---|---|---|
| PEO-1 | 3 | 2 | -- | 1 | 1 | - |
| PEO-2 | - | 3 | 2 | -- | -- | -- |
| PEO-3 | -- | -- | 3 | 2 | 3 | 2 |
| PEO-4 | 1 | -- | 1 | 3 | - | -- |
| PEO-5 | 1 | - | 2 | -- | 2 | 3 |

## DEPARTMENT OF CIVIL ENGINEERING, U.C.E., O.U
## M. E. CIVIL (STRUCTURAL ENGINEERING) AICTE Model

| Type of course | Course Code | Course Name | Contact hours per week | | | Scheme of Examination | | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | CIE | SEE | |
| **SEMESTER-I** | | | | | | | | |
| Core-I | CE101 | Advanced Structural Analysis | 3 | | | 30 | 70 | 3 |
| Core-II | CE102 | Theory of Elasticity | 3 | | | 30 | 70 | 3 |
| Program Elective-I | CE111 | Fracture Mechanism in Concrete Structures | 3 | | | 30 | 70 | 3 |
| | CE112 | Advanced Reinforced Concrete Design | | | | | | |
| | CE113 | Theory of Structural Stability | | | | | | |
| Program Elective-II | CE114 | Advanced Steel Design | 3 | | | 30 | 70 | 3 |
| | CE115 | Structural Health Monitoring | | | | | | |
| | CE116 | Theory of Plates | | | | | | |
| | CE117 | Green Building Technology | | | | | | |
| Audit - I | AC031 | English for Research Paper Writing | 2 | | | 30 | 70 | 0 |
| | AC 131 | Disaster Mitigation & Management | | | | | | |
| | AC033 | Sanskrit for Technical Knowledge | | | | | | |
| | AC034 | Value Education | | | | | | |
| Lab-I | CE151 | Structural Design Lab | | | 3 | 50 | - | 1.5 |
| Seminar | CE161 | Seminar | | | 3 | 50 | - | 1.5 |
| MC | CE 100 | Research Methodology in Civil Engg. | 3 | - | | 30 | 70 | 3 |
| **TOTAL** | | | **17** | **-** | **6** | **280** | **420** | **18** |
| **SEMESTER-II** | | | | | | | | |
| Core-III | CE103 | FEM in Structural Engineering | 3 | | | 30 | 70 | 3 |
| Core-IV | CE104 | Structural Dynamics | 3 | | | 30 | 70 | 3 |
| Program Elective-III | CE118 | Earth Quake resistant design of structures | 3 | | | 30 | 70 | 3 |
| | CE119 | Bridge Engineering | | | | | | |
| | CE120 | Retrofitting and Rehabilitation of Structures | | | | | | |
| Program Elective-IV | CE121 | Advanced Concrete Technology | 3 | | | 30 | 70 | 3 |
| | CE122 | Analytical and Numerical methods for Structural Engineering | | | | | | |
| | CE123 | Structural Optimization | | | | | | |
| Audit-II | AC035 | Stress Management by Yoga | 3 | | | 30 | 70 | 0 |
| | AC036 | Personality Development through Life Enhancement Skills | | | | | | |
| | AC 037 | Constitution of India | | | | | | |
| | AC 038 | Pedagogy Studies | | | | | | |
| MC | CE 070 | Mini Project | | | 6 | 50 | | 3 |
| Lab-III | CE153 | Model Testing Lab | | | 3 | 50 | - | 1.5 |
| Lab-II | CE152 | Advanced Concrete Lab | | | 3 | 50 | - | 1.5 |
| **TOTAL** | | | **15** | | **12** | **300** | **350** | **18** |
| **SEMESTER-III** | | | | | | | | |
| Program Elective-V | CE124 | Design of Prestressed Concrete Structures | 3 | | | 30 | 70 | 3 |
| | CE125 | Design of High Rise Buildings | | | | | | |
| | CE126 | Theory of plates and shells | | | | | | |
| Open Elective | OE941 | Business Analytics | 3 | | | 30 | 70 | 3 |
| | OE942 | Industrial Safety | | | | | | |
| | OE943 | Operational Research | | | | | | |
| | OE944 | Cost Management of Engineering Projects | | | | | | |
| | OE945 | Composite Materials | | | | | | |
| | OE946 | Waste to Energy | | | | | | |
| | OE 947 | Internet of Things | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | OE 948 | Cyber Security | | | | | | |
| | CE181 | Major Project Phase-I | 6 | | 20 | 100 | | 10 |
| **TOTAL** | | | **12** | | **20** | **160** | **140** | **16** |
| **SEMESTER-IV** | | | | | | | | |
| | CE182 | Major Project Phase-II | | | 32 | | 200 | 16 |
| **GRAND TOTAL** | | | | | | | | **68** |

CIE: Continuous Internal Evaluation SEE : Semester End Examination

H E A D &
CHAIRPERSON BoS

## SEMESTER-I

**CE 101**

## ADVANCED STRUCTURAL ANALYSIS

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *Understand the concepts of matrix methods of analysis and equip them with the knowledge to independently handle the problems of structural analysis.*
- *Enhance the competency level in analysis of continuous beam, portal frames, pin jointed structures by flexibility and stiffness matrix methods.*
- *Understand the formation of global stiffness matrix from local stiffness matrix and equation solving techniques using direct stiffness method.*
- *Gain an insight into the nonlinear analysis of structures.*
- *Learn the concepts of beams on elastic foundation.*

**Outcomes:**

1. *Analyse the continuous beams, rigid jointed frames and pin jointed structures by stiffness method.*
2. *Analyse the continuous beams, rigid jointed frames and pin jointed structures by flexibility method.*
3. *Formulate the element and global stiffness matrices by direct stiffness method and learn equation solution techniques.*
4. *Understand and differentiate between the linear and nonlinear analyses.*
5. *Solve the problems pertaining to beams on elastic foundation.*

**UNIT-I**

**Introduction to Matrix Methods of Analysis:** Static indeterminacy and kinematic indeterminacy, Coordinate systems, displacement and force transformation matrices, element and structure stiffness matrices, equivalent joint loads and fixed end forces.

**Stiffness Method:** Stiffness of prismatic member, Analysis of bar element, plane truss, continuous beams, plane frames and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports.

**UNIT-II**

**Flexibility Method:** Flexibility of prismatic member, Analysis of bar element, plane truss, continuous beams, plane frames and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports.

**UNIT-III**

**Direct Stiffness Method:** Assemblage of global stiffness matrix, Analysis of plane truss, continuous beams, plane frame and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports. Exposure to softwares-MSC NASTRAN & E-TABS.

**UNIT-IV**

Introduction to Nonlinear Analysis: Geometric and material nonlinearity, P- effect, Effects of axial force on flexural stiffness – buckling of ideal columns, buckling behaviour of real columns, flexural behaviour of beam columns, flexural stiffness measures for braced prismatic beam columns, effect of axial tension, flexural stiffness measures for unbraced prismatic beam columns.

**UNIT-V**

**Beams on Elastic Foundations:** Introduction-Modulus of foundation & Basic equation. Beams of infinite length under concentrated & uniformly distributed loads, Analysis of semi-infinite beams making use of functions for infinite beams.

**References:**

1. Advanced Structural Analysis by Ashok.K. Jain, New Channel Brothers.
2. Devdas Menon, "Advanced Structural Analysis", Narosa Publishing House, 2009.
3. Asslam Kassimali, "Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA, 1999.
4. Amin Ghali, Adam M Neville and Tom G Brown, "Structural Analysis: A Unified Classical and Matrix Approach", Sixth Edition, 2007, Chapman & Hall.
5. William Weaver, Jr & James M. Gere, Matrix Analysis of Framed Structures, CBS Publishers &
6. Distributors, Delhi. 2. Wang C.K., Matrix methods of Structural Analysis Mc Graw Hill book Company, New Delhi. 3.
7. Advanced mechanics of solids & structures, N. Krishna Raju, D.R Gururaja Narosa publishing house New Delhi.
8. Advanced Mechanics of Materials, Seely and Smith.

**CE 102**

## THEORY OF ELASTICITY

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *Understand the concepts of elasticity and equip them with the knowledge to independently handle the problems of elasticity.*
- *Enhance the competency level and develop the self-confidence through quality assignments in theory of elasticity.*
- *Inculcate the habit of researching and practicing in the field of elasticity.*

**Outcomes:** *After completing this course, the student will be able to:*

1. *Solve the problems of 3-D elasticity with confidence.*
2. *Work independently with the problems of 2-D elasticity in Cartesian/polar coordinates.*
3. *Familiarize with the use of Airy's stress function in 2-D problems of elasticity in Cartesian/polar coordinates.*
4. *Equip with the knowledge of various theories of torsion of prismatic bars of various cross sections and can solve the problems of torsion.*
5. *Interpret and apply the theory of elasticity to practical problems of structural engineering*

**UNIT – I**

**Introduction:** Definition and notation for forces and stresses, components of stress and strain, Generalized Hooke's law, Stress-strain relations in three directions, Plane stress and plane strain, Equations of equilibrium and compatibility in two and three dimensions, Stress components on an oblique plane, Transformation of stress components under change of co-ordinate system.

**UNIT – II**

**Principal stresses and principal planes:** Stress invariants, Mean and Deviator stress, Strain energy per unit volume, Distortion strain energy per unit volume, Octahedral shear stress, Strain of a line element. Principal strains, Strain invariants, Volume strain, Principle of superposition, reciprocal theorem.

**UNIT – III**

**Two dimensional problems in Cartesian co-ordinates:** Solution by polynomials, St. Venant's Principle, Uniqueness of solution, Stress components in terms of Airy's stress function. Applications to Cantilever, simply supported and fixed beams with simple loading.

**UNIT – IV**

**Two dimensional problems in Polar co-ordinates:** Stress-strain components, Equilibrium equations, Compatibility equations, Applications using Airy's strain functions in polar co-ordinates for stress distributions symmetric about an axis, Effect of hole on stress distribution in a plate in tension, Stress due to load at a point on a semi-infinite straight boundary, Stresses in a circular disc under diametrical loading.

**UNIT – V**

**Torsion:** Torsion of various shapes of bars, Stress function method of solution applied to circular and elliptical bars, Torsion of rectangular bars, Solution of Torsional problems by energy method,

use of soap films in solving torsion problems, Prandtl's membrane analogy. Solution of torsion of rectangular bars by (i) Raleigh Ritz method and (ii) Finite difference method.

***Suggested Readings:***

1. Theory of Elasticity, S. Timoshenko & N. Goodier, Mc Graw Hill.
2. Theory of Elasticity, Valiappan, Mc Graw Hill.
3. Theory of Elasticity, Sadhu Singh, Khanna publishers

**CE 111**

## FRACTURE MECHANISM IN CONCRETE STRUCTURES (PROGRAM SPECIFIC ELECTIVE – I)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *Identify and classify cracking of concrete structures based on fracture mechanics*
- *Implement stress intensity factor for notched members*
- *Apply fracture mechanics models to high strength concrete and FRC structures.*
- *Compute J-integral for various sections understanding the concepts of LEFM*

**Outcomes:** *After completing this course, the student will be able to*

1. *To recognize cracks in concrete structures based on fracture mechanics*
2. *To recognize type of failures in concrete structures*
3. *To determine Stress intensity factors*
4. *To develop different material models*
5. *To develop numerical models*

**UNIT - I**

Introduction**:** Basic fracture mechanics, crack in a structure, mechanisms of fracture and crack growth.

**UNIT - II**

Cleavage fracture, ductile fracture, fatigue cracking, environment assisted cracking, service failure analysis

**UNIT - III**

Linear elastic fracture mechanics, Griffith's Criteria, Stress intensity factors, Stress at crack tip, Concept of R curve, Review of concrete behavior in tension and compression- Fracture Process Zone-Basic frameworks for modeling of quasibrittle materials.

**UNIT - IV**

Concept of CTOD and CMD, Fracture Models for Concrete Materials-Fictitious crack model- Crack band model-Two parameter fracture model-Size effect model.

**UNIT - V**

Concrete Fracture Properties- Direct method-indirect method- Flexural tests on notched beams-Fracture energy & Fracture parameters using three-point bend test.

Introduction to Damage Mechanics.

**References:**

1. Fracture Mechanics, Suri C. T. and Jin Z.H., 1st Edition, Elsevier Academic Press, 2012.
2. Elementary Engineering Fracture Mechanics, Broek David, 3rd Rev. Ed. Springer, 1982.
3. Fracture Mechanics of Concrete Structures – Theory and Applications, Elf green L., RILEM Report, Chapman and Hall, 1989.

**CE 112**

## ADVANCED REINFORCED CONCRETE DESIGN
## (PROGRAM SPECIFIC ELECTIVE – I)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives :**

- *Learn the analysis and design of beams curved in plan and deep beams.*
- *Design and detail the deep beams.*
- *Analyse, design and detail the domes, water tanks, bunkers and silos.*
- *Analyse and design the raft, pile and machine foundations.*

**Outcomes :**

*After completing this course, the student will be able to:*

1. *Design the beams curved in plan and deep beams.*
2. *Propose and design the deep beams*
3. *Design domes and various type water tanks.*
4. *Differentiate and design the bunkers and silos.*
5. *Design the raft, pile and machine foundations.*

**UNIT-I**

**Beams Curved in Plan:** Introduction - design principles – Terminologies, structural design of beams curved in plan of circular and rectangular type.

**UNIT-II**

**Deep Beams:** Introduction to deep beams, Flexural and Shear stresses in deep beams, IS Code provisions - design of deep beams.

**UNIT-III**

**Domes:** Introduction - Stresses and forces in domes - design of spherical and conical domes. **Water Tanks**: Types, Codal specifications, Design of circular, rectangular and Intze type water tanks.

**UNIT-IV**

**Bunkers and Silos:** Introduction - Design principles and theories Code provisions - design of square and circular bunkers - design of cylindrical silos. IS specifications.

**UNIT-V**

**Raft and Pile Foundations:** Introduction, need for the design, Design principles - Structural design of raft and pile foundations including the design of pile caps.

**Machine Foundations:** Introduction, Types, Design Principles, Case studies, detailed designs.

***Suggested Reading:***

1. "Advanced Reinforced Concrete Design", by N. Krishna Raju, CBS Pub. 1986.
2. "Reinforced Concrete", by H.J. Shah, Charotar Pub. 2000. Vol. II.
3. "R.C.C. Designs" by B.C. Punmia, Laxmi Pub. 1998

**CE 113**

## THEORY OF STRUCTURAL STABILITY
## (PROGRAM SPECIFIC ELECTIVE – I)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *Learn the buckling of columns, analysis using equilibrium, energy and approximate methods.*
- *Know the stability analysis of beam-columns and frames with different loads.*
- *Analyse for torsional, flexural and lateral bucklingof beams.*
- *Perform the buckling analysis of thin plates using different approaches.*
- *Study the inelastic buckling analysis of plates.*

**Outcomes:**

1. *Understand the analysis of buckling of columns using appropriate method.*
2. *Analyse the practical problems of beam-columns and frames.*
3. *Analyse the beams for torsional, flexural and lateral buckling.*
4. *Perform buckling analysis of thin plates.*
5. *Analyse the plates for inelastic buckling and understand the post-buckling behaviour of plates.*

**UNIT-I**

**Buckling of columns:** States of equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem. Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy methods. Approximate methods - Rayleigh Ritz, Galerkin's approach - Numerical Techniques - Finite difference method - Effect of shear on buckling.

**UNIT-II**

**Buckling of beam-columns and frames:** Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributed load and end couples Analysis of rigid jointed frames with and without sway - Moment distribution - Slope deflection and stiffness method.

**UNIT-III**

**Torsional and lateral buckling:** Torsional buckling - Torsional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions. Lateral buckling of beams, pure bending of simply supported beam and cantilever beam.

**UNIT-IV**

**Buckling of plates:** Governing differential equation - Buckling of thin plates, various edge conditions - Analysis by equilibrium and energy approach - Approximate and Numerical techniques.

**UNIT-V**

**Inelastic buckling:** Double modulus theory - Tangent modulus theory – Shanley's model – Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behavior of plates

***Suggested Readings:***

1. Timoshenko, S., and Gere., ―Theory of Elastic Stability‖, McGraw Hill Book Company, 1963.
2. Chajes, A. ―Principles of Structures Stability Theory‖, Prentice Hall, 1974.
3. Ashwini Kumar, ―Stability Theory of Structures‖, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1995.
4. Iyenger.N.G.R., ―Structural stability of columns and plates‖, Affiliated East West Press,1986.
5. Gambhir, ―Stability Analysis and Design of Structures‖, springer, New York

**CE 114**

## ADVANCED STEEL DESIGN
## (PROGRAM SPECIFIC ELECTIVE – II)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *The objectives of this course is to impart knowledge of and problem solving skills in*
- *Learn the fundamentals of design of steel tanks and grillage foundations.*
- *Solve the practical problems pertaining to steel tanks and grillage foundations.*
- *Study the concepts of analysis and design of various members of tubular structures.*
- *Gain knowledge of the design of bunkers and silos using appropriate method and solve the practical problems pertaining to it.*
- *Study the fundamentals of design of transmission line towers and solve the practical problems pertaining to it.*
- *Learn the concepts of analysis and design of various members of light-gauge steel structures.*

**Outcomes:** *After completing this course, the student will be able to:*

1. *Design and detail the rectangular plated and pressed steel tanks.*
2. *Propose the grillage foundations for structures.*
3. *Design and detail the hollow rectangular, square and circular tubular members in a truss including its joints.*
4. *Formulate the rectangular and square bunkers and silos using appropriate method.*
5. *Propose the geometry and analyse and design the transmission towers subjected to various loads.*

**UNIT-I**

**Steel Tanks:** Introduction, Types, Loads, Permissible stresses, Detailed design of elevated rectangular and pressed steel tanks including columns.

**UNIT-II**

**Grillage Foundations:** Introduction, Necessity of grillage foundation, Various types, Grillage foundations for single and double columns.

**Tubular Structures:** Introduction, Permissible stresses, Design considerations, Design of tension members, compression members and flexural members, Design of tubular trusses including joints.

**UNIT-III**

**Bunkers and Silos:** Introduction, General design principles, Design theories for bunkers and silos, detailed design of bunkers and silos.

**UNIT-IV**

**Transmission Line Towers:** Classification, Economical spacing, Design loads, IS codal provisions, Calculation of wind loads, Permissible stresses, Overall arrangement and design procedure, detailed design including foundations.

**UNIT-V**

**Design of Light Gauge Steel Structures:** Introduction, Forms of light-gauge sections, Behaviour of compression elements, Effective width for load and deflection calculation, Behaviour of

unstiffened and stiffened elements, Design of compression members, Design of laterally supported beams and laterally unsupported beams, Connections.

***Suggested Reading:***

1. S.K. Duggal, ―Design of Steel Structures‖, Tata McGraw Hill, 2009.
2. B.C Punmia, ―Design of Steel Structures‖, Laxmi Publications, 2001.
3. Ram Chandra, ―Design of Steel Structures‖, Vol. I & II, Standard Book House, 1989.
4. P. Dayaratnam, ―Design of Steel Structures‖, Orient Longman Publications, 1987.
5. I.C. Syal and S. Singh, ―Design of Steel Structures‖, Standard Book House, 2000

**CE115**

## STRUCTURAL HEALTH MONITORING
## (PROGRAM SPECIFIC ELECTIVE – II)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

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

**Outcomes:**

1 *Understand the fundamentals of maintenance and repair strategies.*
2 *Diagnose for serviceability and durability aspects of concrete.*
3 *Know the materials and techniques used for repair of structures.*
4 *Decide the appropriate repair, strengthening, rehabilitation and retrofitting technique required for a case study building.*
5 *Use an appropriate health monitoring technique and demolition technique.*

**UNIT-I**

Introduction to structural health monitoring: Definition of structural health monitoring (SHM) – Objectives- Need –Steps involved in SHM-Motivation for SHM - SHM as a way of making materials and structures smart - SHM and biomimetics - Process and pre usage monitoring as a part of SHM - SHM as a part of system management - The most remarkable characters of SHM Birth of the SHM community.

**UNIT-II**

Vibration-based techniques for SHM: Basic vibration concepts for SHM -Local and global methods - Damage diagnosis as an inverse problem -Model-based damage assessment - General dynamic behavior-State- space description of mechanical systems - Neural network approach to SHM - The basic idea of neural networks - Detection of delamination in a CFRP plate with stiffeners.

**UNIT-III**

Fiber-optic sensors: Classification of fiber-optic sensors - Intensity-based sensors - Phase-modulated optical fiber sensors - or interferometers -Wavelength based sensors - or Fiber Bragg Gratings (FBG) - The fiberBragg grating as a strain and temperature sensor - Orientation of the optical fiber optic with respect to the reinforcement fibers - Fiber Bragg gratings as damage sensors for composites - Measurement of strain and stress variations

**UNIT-IV**

SHM with piezoelectric sensors: The use of embedded sensors as Acoustic Emission (AE) detectors - Available industrial AE systems- New concepts in acoustic emission - State-the-art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research –The full implementation

of SHM of localized damage with guided waves in composite materials - Available industrial acousto ultrasonic systems with piezoelectric sensors

**UNIT-V**

SHM using electrical resistance: Composite damage - Electrical resistance of unloaded composite - Percolation concept - Anisotropic conduction properties in continuous fiber reinforced polymer - Influence of temperature - Composite strain and damage monitoring by electrical resistance - Randomly distributed fiber reinforced polymers - Damage localization. Low frequency electromagnetic techniques: Theoretical considerations on electromagnetic

**Suggested Reading:**

1. Daniel Balageas, Claus-Peter Fritzen and Alfredo Güemes "Structural Health Monitoring", John Wiley-ISTE, London, 2006.
2. Douglas E Adams, "Health Monitoring of Structural Materials and Components - Methods with Applications", John Wiley & Sons, New York, 2007.
3. J.P. Ou, H. Li and Z. D. Duan, "Structural Health Monitoring and Intelligent Infrastructure", Vol.-1, Taylor & Francis, London, 2006.
4. Victor Giurglutiu, "Structural Health Monitoring with Wafer Active Sensors", Academic Press Inc., 2007.
5. M.V. Gandhi and B.D. Thompson, "Smart Materials and Structures," Springer, 1992.
6. Fu Ko Chang, "Structural Health Monitoring: Current Status and Perspectives", Technomic, Lancaster, 1997.

**CE116**

## THEORY OF PLATES
## (PROGRAM SPECIFIC ELECTIVE – II)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *Learn the analysis of rectangular and circular plates subjected to various loading conditions with different boundary conditions.*
- *Understand fundamentals of buckling of plates.*
- *Know the concepts of small deflection theory of laterally loaded plates.*
- *Study the approximate methods of analysis of rectangular plates.*
- *Derive the governing differential equations for orthotropic plates and apply them to practical problems.*

**Outcomes:**

*After completing this course, the student will be able to:*

1. *Analyse the rectangular and circular plates subjected to various loading conditions*
2. *Decipher the problems of buckling of plates with different edge conditions*
3. *Work out the problems of small deflection theory of laterally loaded plates with different edge conditions.*
4. *Understand the various numerical and approximate methods for analysis of plate problems.*
5. *Apply the concepts of orthotropic plates to simply supported structures*

**UNIT-I**

**Bending of Rectangular Plates:** Pure and Cylindrical bending, differential equation, cylindrical bending of uniformly loaded rectangular plates with simply supported and built -in edges. Relations between slope and curvature of slightly bent plates, Moment-curvature relations in pure bending. Strain energy in pure bending.

**Bending of circular plates:** Symmetrical bending, differential equation of equilibrium, uniformly loaded plates at center, Circular plates with circular holes at the center.

**UNIT-II**

**Buckling of Plates:** Differential equation for bending of plate under the combined action of in-plane loading and lateral loading, Calculation of critical loads, buckling of simply supported rectangular plates uniformly compressed in one and two directions with different edge conditions.

**UNIT-III**

**Small deflections of laterally loaded plates:** Differential equation of equilibrium, Boundary conditions, Solution of simply supported rectangular plates under various loading conditions viz. uniformly distributed load (full or partial), concentrated load by Navier‘s approach, Levy type solution for rectangular plates under U.D.L with all four edges simply supported or two opposite edges simply supported and other two fixed.

**UNIT-IV**

**Approximate methods for Rectangular Plates:** Finite difference method for simply supported or fixed rectangular plates carrying UDL (full or partial) or central point load, Strain energy approaches Rayleigh-Ritz method.

**UNIT-V**

**Bending of Orthotropic Plates:** Differential equation of the bent plate. Application of the theory to simply supported rectangular (i) laminates; (ii) RC slabs (iii) grids.

***Suggested Reading:***

1. Theory of plates and shells, S. Timoshenko and W.Krienger, Mc Graw Hill.
2. Theory of plates and shells, R.H. Wood.
3. Theory of plates and shells, Zienkiwicz, Mc Graw Hill Co.

**CE117**

# GREEN BUILDING TECHNOLOGY
## (PROGRAM SPECIFIC ELECTIVE – II)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

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

**Outcomes:** *After completing this course, the student will*

1. *Understand the fundamentals of energy use and energy processes in building.*
2. *Identify the energy requirement and its management.*
3. *Know the Sun-earth relationship vis-a-vis its effect on climate.*
4. *Be acquainted with the end-use energy requirements.*
5. *Be familiar with the audit procedures of energy*

**UNIT-I**

Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

**UNIT-II**

Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

**UNIT-III**

Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

**UNIT-IV**

End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer.

**UNIT-V**

Energy management options - Energy audit and energy targeting - Technological options for energy management.

***Suggested Readings:***

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

**AC 031**

## ENGLISH FOR RESEARCH PAPER WRITING
## (AUDIT COURSE-I)

*Instruction: 2 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 00*

**Objectives:**

- *Understand that how to improve your writing skills and level of readability*
- *Learn about what to write in each section*
- *Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission*

**Outcomes:**

1. *Able to plan and prepare paragraphs, avoiding ambiguity*
2. *Writing of abstracts, paraphrasing and plagiarism*
3. *Providing of critical and thorough review of literature, discussions and conclusions*
4. *Able to exhibit key skills for writing titles, introduction, abstract.*
5. *Able to show key and necessary skills for paper writing, phrases, results.*

**Unit I**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

**Unit II**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

**Unit III**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

**Unit IV**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

**Unit V**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions -Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

**Suggested Studies:**

1. Goldbort R, *Writing for Science*, Yale University Press (available on Google Books), 2006.
2. Day R, *How to Write and Publish a Scientific Paper*, Cambridge University Press, 2006.
3. Highman N *Handbook of Writing for the Mathematical Sciences*, SIAM. Highman'sbook. 1998
4. Adrian Wallwork English *for Writing Research Papers*, Springer New York Dordrecht Heidelberg London. 2011.

**AC131**

## DISASTER MITIGATION & MANAGEMENT
## (AUDIT COURSE-I)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 00*

**Objectives:**

- *Introduction of various types of disasters and its effect on structures.*
- *Learning of quality assurance and damage assessment of structures*
- *Educate different types of repair, strengthening, rehabilitation and retrofitting techniques.*
- *Awareness about flood characteristics and flood forecasting systems*
- *Description of Flood mitigation, adjustment, and regulation*

**Outcomes:**

1. *Understand the fundamentals of disaster and seismic performance of buildings*
2. *Able to assess various damages in structures and give assurance of quality of concrete*
3. *Decide the appropriate repair, strengthening, rehabilitation and technique required for a case study of building.*
4. *Applications of flood routing, flood forecasting and space time characteristics of rainfall.*
5. *Advanced understanding of flood plain adjustments and employment of appropriate technologies for flood mitigation.*

**UNIT – I**

**Disaster:** Classifications - Causes - Impacts including social, economical, political, environmental, health, psychosocial, etc.

**Seismic performance of buildings:** case studies of major earthquakes in the country, damage to buildings, damage patterns, performance of non-engineered buildings-Introduction to repair and rehabilitation of structures.

**UNIT – II**

**Quality assurance for concrete** – Strength, Durability and Thermal properties of concrete.

Damage Assessment**:** - Condition assessment and distress, Purpose of assessment, Rapid assessment - diagnostic techniques, Investigation of damage, , Evaluation of surface and structural cracks, Damage assessment procedure, destructive, non-destructive and semi destructive testing systems, Procedure for evaluating damaged of structure.

**UNIT III**

**Repair, Rehabilitation And Retrofitting Techniques** : Repair materials, Common types of repairs – Repair in concrete structures – Repairs in under water structures – Guniting – Shot create – Underpinning, Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake, Retrofitting techniques.

**UNIT – IV**

Introduction to Disasters: **Hazard, Vulnerability, Resilience, Risks.-Disaster- Different types of cold wave-heat wave- droughts- floods-Effect of climate change on Processes.**

**Flood characteristics and forecasting**: Measureable features of a flood (Elevation, discharge, volume, and duration), flood forecasting (unit hydrograph method, meteorological and snow data, and snow field air temperatures), operation of flood forecasting systems.

**Space-time characteristics of rainfall**: Policy criteria for design flood of a major and minor reservoir, spillways, diversion dams and barrages, design flood criteria for dams and other hydraulic structures (CWC recommendations).

**UNIT - V**

**Flood Routing**: Mathematics of flood routing, various methods of flood routing, Hydrologic and Hydraulic routing.
**Flood mitigation:** flood ways, channel improvement, evacuation and flood proofing, land management, flood plain management, estimating benefits of flood mitigation.
**Flood plain adjustments and regulations**: Results of controlling floods, alternatives to controlling floods, range of possible adjustments, practical range of choice, critical characteristics of flood hazards.

**Suggested Reading:**

1. Barry A. Richardson, "Defects and Deterioration in Buildings", E &FN Spon Press, London, 1991.
2. J. H. Bungey, "Testing of Concrete in Structures", Chapman and Hall,New York, 1989.
3. A.R. Santakumar, "Concrete Technology", Oxford University Press,New Delhi, 2006.
4. Pankaj Agarwal and Manish Shrihkande (2006). "Earthquake Resistance Design of Structures." Prentice Hall of India.
5. Ravishankar.K., Krishnamoorthy.T.S, "Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures", Allied Publishers, 2004.
6. CPWD and Indian Buildings Congress, Hand book on Seismic Retrofit of Buildings, Narosa Publishers, 2008.
7. Chow, Ven Te 'Hand Book of Applied Hydrology', McGraw-Hill Publishers, New York. (1964),
8. Linsley, R. K. and Franzini A. W. 'Water Resource Engineering', McGraw-Hill Publishers, New York. 1992
9. Varshney, R. S. , 'Engineering Hydrology', Nem Chand Publishers, Roorkee.1979
10. Jaya Rami Reddy, P. , 'A. Text Book of Hydrology', Lakshmi Publishers, New Delhi.1987
11. Daniel H. Hoggan 'Computer Assisted Flood Plain Hydrology and Hydraulics', McGraw-Hill Publishers, New York.1989

**AC 033**

## SANSKRIT FOR TECHNICAL KNOWLEDGE
## (AUDIT COURSE-I)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 0*

**Objectives:**

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

**Outcomes:**

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

**UNIT-I:**

- Alphabets in Sanskrit.
- Past/Present/Future Tense.
- Simple Sentences.

**UNIT-II:**

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

**UNIT-III:**

- Technical concepts of Engineering-Electrical,
- Mechanical,
- Architecture,
- Mathematics

**References:**

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

**AC034**

## VALUE EDUCATION
## (AUDIT COURSE-I)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 0*

**Course Objectives :**

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

**Course outcomes :**

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

**UNIT I:**

- Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.
- Moral and non- moral valuation. Standards and principles.
- Value judgements.

**UNIT II:**

- Importance of cultivation of values.
- Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.
- Honesty, Humanity. Power of faith, National Unity.
- Patriotism. Love for nature, Discipline.

**UNIT III:**

- Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline.
- Punctuality, Love and Kindness.
- Avoid fault Thinking.
- Free from anger, Dignity of labour.
- Universal brotherhood and religious tolerance.
- True friendship.
- Happiness Vs suffering, love for truth.
- Aware of self-destructive habits.
- Association and Cooperation.
- Doing best for saving nature

**UNIT IV:**

- Character and Competence –Holy books vs Blind faith.
- Self-management and Good health.
- Science of reincarnation.
- Equality, Nonviolence,Humility, Role of Women.
- All religions and same message.
- Mind your Mind, Self-control.
- Honesty, Studying effectively

**References :**

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

**CE 151**

# STRUCTURAL DESIGN LABORATORY

*Instruction: 3 periods per week* *Duration of SEE: -- hours*
*CIE: 50 marks* *SEE: -- marks*
*Credits: 1.5*

**Objectives:**

- *To learn and Design and detail all the structural components of frame buildings for seismic and wind force*
- *Study to calculate wind load and seismic load on Multi storied building*
- *To learn and Design and detail complete multi-storey building Manually and using design software*

**Outcomes:**

*After completing this course, the student will be able to:*

1. *To analyse various forces on structures as per IS codes*
2. *Design and detail all the structural components of frame buildings for seismic and wind force.*
3. *Analyse complete multi-storey building for different load and load combination*
4. *Manual design of multi storied building*
5. *Design of multi storied buildings by using softwares*

**Syllabus Content:**

Design and detailed drawings by individual student using latest software like STAAD Pro, ETABS, and using relevant IS codes.

**Seismic Analysis and Design:**

1. Calculation of design seismic force by static and dynamic methods of IS 1893.
2. Calculation of lateral force distribution as per Torsion provisions of IS 1893.
3. Beam design of an RC frame building as per IS 13920.
4. Column design of an RC frame building as per IS 13920.
5. Beam-column joint design of an RC frame building as per IS 13920.
6. Complete manual seismic analysis, design and detailing of a simple G+3 storied building and its comparison with any structural analysis and design software.

**Wind Analysis and Design:**

1. Calculation of wind pressures and design forces on walls and roof of a rectangular building.
2. Calculation of design wind forces on a RC building using force coefficient method.
3. Calculation of design wind forces on a RC building using Gust Factor Approach.
4. Complete manual wind analysis and design of a simple G+3 storied structure using any structural analysis and design software and its comparison with any structural analysis and design software.

**CE 161**

# SEMINAR

*Instruction: 3 periods per week* *Duration of SEE: --*
*CIE: 50 marks* *SEE: --*
*Credits: 1.5*

**Objectives:**

- *Identify appropriate topic of relevance.*
- *Update literature on technical articles of selected topic and develop comprehension.*
- *Prepare a technical report.*
- *Deliver presentation on specified technical topic.*

**Outcomes:**

1. *Review literature on technical articles and develop comprehension.*
2. *Recognize appropriate topic of relevance*
3. *Prepare review repot of literature studied*
4. *Write a technical report.*
5. *Give presentation on specified technical topic*

At least two faculty members will be associated with the seminar presentation to evaluate and award marks.

**CE 100**

## RESEARCH METHODOLOGY IN CIVIL ENG.

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Course Objectives:**

- Learn the research types, methodology and formulation.
- Know the sources of literature, survey, review and quality journals.
- Understand the research design for collection of research data.
- Understand the research data analysis, writing of research report and grant proposal.

**Course Outcomes:**

1. Differentiate the research types and methodology.
2. Able to do literature survey using quality journals.
3. Able to collect research data.
4. Process research data to write research report for grant proposal.

**UNIT – I**

Scientific Research: Definition, Characteristics, Types, Need of research. Research methods vs Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.

Defining and formulating the research problem-Meaning of a research problem, Sources of research problems, Criteria of a good research problem, Importance of literature review in defining a problem, Errors in selecting a research problem, Scope and objectives of the research problem. Approaches of investigation of solutions for the research problem.

**UNIT – II**

Literature review-Source of literature, Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

Research design – Basic Principles, Need of research design, Features of good design, Important concepts relating to research design.

Developing a research plan - Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs.

**UNIT – III**

Execution of the research - Necessary instrumentations, Various data collection methods in Civil Engineering. Data processing and data interpretation. Data presentation and illustration.

Types of the reports–Technical reports and thesis; Different steps in the preparation – Layout, structure and language of technical writing; Writing research papers; Developing a Research Proposal, Common formats of the research proposals;

Oral presentation–Planning, Preparation, Practice, Making a presentation, Importance of effective communication

**UNIT – IV**

Ethical issues - Research ethics, Plagiarism, Citation and acknowledgement

Patenting and development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT Patent Rights. Problems encountered by researchers in India.

**UNIT – V**

Basics of statistics. Sampling and its types. Determination of sampling size. Sampling and non-sampling errors in statistics. Data: handling of data-significant figures & rounding. quality of data-precision & accuracy. Types of data.

Descriptive statistics: Summarization of Data- Measure of central tendency, Measure of central dispersion, Measure of symmetry.

Inferential statistics: Hypothesis of testing, Parametric (t-test & Analysis of variance) and Non-Parametric Tests. Univariate and Bivariate analysis; Correlational analysis.

Introduction to linear regression model and multi-linear regression models.

mathematical basis and introduction to SPSS

**Suggested Reading:**


1. C.R Kothari, "Research Methodology, Methods & Technique", New Age International Publishers, New Delhi, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, Chennai, 2011.
3. Ratan Khananabis and SuvasisSaha, "Research Methodology", Universities Press, Hyderabad, 2015.
4. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & Engineering students"
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
6. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008
8. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publishing Pvt. Ltd., New Delhi, 2004.
9. Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.
10. G. Nageswara Rao, "Research Methodology and Quantitative methods", BS Publications, Hyderabad, 2012.

## SEMESTER - II

**CE 103**

## FINITE ELEMENT METHODS in Structural Engineering

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:** *The objectives of this course is to impart knowledge of*

- *Learn the rudiments of finite element analysis.*
- *Study the fundamentals of domain discretization, interpolation, application of boundary conditions, assembly of global matrices, and solution of the resulting algebraic systems.*
- *Explain the core concepts of variational and weighted residual methods in FEM.*
- *Derive the element stiffness matrix for 1-D, 2-D and 3-D problems.*
- *Formulate the simple structural problems in to finite elements.*

**Outcomes:** *At the end of this course, students will be able to*

1. *Build and analyse the FEA models for various engineering problems.*
2. *Identify the information requirements and sources for analysis, design and evaluation.*
3. *Use the standard finite element software to solve the structural engineering problems.*
4. *Interpret the results obtained from FEA software, not only in terms of conclusions but also awareness of limitations.*
5. *To solve problems of non linear finite element*

### UNIT – I

**Introduction to FEM:** Types of Problems – Types of Materials – Elastic / Inelastic situations – Types of forces: Body forces / Surface Traction / Point loads – Deformable bodies – Types of Deformations – Homogeneous / Non homogeneous Problems – Equations of equilibrium for elastic 2-D / 3-D continua - Equilibrium equations for 2-D / 3-D boundary elements – Boundary conditions – Strain-displacement relation for 2-D / 3-D – Stress-strain relation for 2-D / 3-D – Plane stress / Plane strain problems.

**Virtual Work Formulation:** Application to problems of plane trusses with static indeterminacy not exceeding three.

**Finite Difference Method with Central Differences:** Solving ODE's and PDE's with central differences. Application to beam and plate bending problems of simple geometry.

### UNIT – II

**Variational Formulation:** Finite Element Formulation - Stationarity of Functional – Given the Functional or Differential equation – Number of elements limited to two.

**1-D Elements:** Strain-displacement relation matrix / stiffness matrix / Minimum Potential Energy Approach / Rayleigh-Ritz Method / introduction to natural coordinates / stiffness matrix of second order bar element / Axial bar subjected to point loads, body forces and surface traction forces / Problems with kinematic indeterminacy not exceeding two.

**2-D Triangular Elements:** Displacement models / criterion for convergence / geometric invariance / conforming and non-conforming elements - 3-node triangular elements (CST) / determination of strain-displacement matrix / area coordinates-shape functions / determination of element stiffness and load matrices, assembling global stiffness and load matrices / Problems with kinematic indeterminacy not exceeding three.

**2nd Order triangular elements:** Shape functions – degradation technique / strain-displacement matrix / Expression for stiffness matrix / Load matrices due to body forces and surface traction.

**UNIT – III**

**Iso-parametric elements:**

**Quadrilateral elements:** Construction of shape functions using natural coordinates/Strain-displacement matrices/Load matrices for body force and surface traction/ Expressions for stiffness matrix, load matrices for 4-noded quadrilateral elements/ Gauss Quadrature of numerical integration / Problems with rectangular elements, kinematic indeterminacy not exceeding three.

**2nd Order Quadrilateral elements: -** Determination of shape functions for 2nd order quadrilateral elements and for elements of with serendipity / Strain-displacement matrices / Load matrices for body force and surface traction.

**UNIT – IV**

**Method of Weighted Residuals:**

**Galerkin's Method of Weighted Residuals** – Application to problems of mathematics / structural engineering, number of trial functions not exceeding two.

**Galerkin's Finite Element Method** – Weak form of Trial Function - Application to problems of mathematics / structural engineering, number of elements limited to two.

**Axi-symmetric Problems:** Strain-displacement relationship/stress-strain relationship / determination of stiffness matrix for 3-noded ring element and load matrices for body force and surface traction/ Problems with kinematic indeterminacy not exceeding three for 3-noded ring elements only.

**UNIT – V**

**Tetrahedron elements:** Volume coordinates, Strain-displacement matrix, stiffness matrix, load matrices due to body force and surface traction/ introduction to Hexahedron (brick) elements.

**Non-linear Finite element analysis:** Introduction – problems with material non-linearity – problems with geometric non-linearity – problems with both material and geometric non-linearity.

**Introduction to MSC Nastran:** Illustration on different modules of Nastran / Structural engineering applications of the package/Creation of a simple 1-D model, 2-D model and a 3-D model/ analysis and post processing of the results.

***Suggested Reading:***

1.
2. Cook, R. D. (1981). ―Concepts and Application of Finite Element Analysis‖, John Wiley andSons.
3. Zienkiewicz, O. C. And Taylor, R. L, (1989). ―The Finite Element Method‖, Vol.1, McGraw Hill Company Limited, London.
4. Reddy, J. N, (1993). ―An Introduction to the Finite Element Method‖, McGraw Hill, NewYork.
5. Chandrupatla, T. R. And Belegundu, A. D, (2001). ―Introduction to Finite Elements in Engineering‖, Prentice Hall of India, New Delhi.
6. Seshu. P, (2003). ―Finite Element Analysis‖, Prentice Hall of India Private Limited, NewDelhi.
7. David V. Hutton, (2005). ―Fundamentals of Finite Element Analysis‖, Tata McGraw-Hill Publishing Company Limited, New Delhi.
8. Bathe, K. J, (2006). ―Finite Element Procedures‖, Prentice Hall of India, New Delhi

**CE 104**

## STRUCTURAL DYNAMICS

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

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

**Outcomes:** *At the end of this course, students will be able to*

1. *formulate dynamic equation of motions for given conditions and analysis methods for dynamic systems.*
2. *Understand the modelling approach of dynamic response in civil engineering applications.*
3. *Create the simple computer models for engineering structures using knowledge of structural dynamics.*
4. *Evaluate the dynamic response analysis results and understand the possible error sources. Interpret the dynamic analysis results for design, analysis and research purposes.*
5. *Apply the structural dynamics theory to earthquake analysis, response, and design of structures.*

**UNIT – I**

**Introduction to Structural Dynamics:** Objectives of dynamic analysis – Types of prescribed dynamic loading – Characteristics of a dynamic problem – Methods of discretization: Lumped mass Procedure / Consistent mass procedure/generalised displacements – Single Degree Freedom Systems – Formulation of Equation of Motion: D'Alemberts's Principle / Method of Virtual Work / Hamilton's Principle – Influence of Gravity Forces and Ground Motion on equation of motion – Generalised SDOF systems: Rigid Body Assemblage/Distributed Flexibility.

**UNIT – II**

**Single Degree of Freedom Systems:** Response of Un-damped/Damped free vibrations of SDOF systems – Un-damped/Damped vibrations of SDOF systems subjected to Harmonic loading: Dynamic equilibrium / Accelero Meters / Displacement Meters / Resonant Response / Vibration Isolation – Un-damped / Damped vibrations of SDOF systems subjected Periodic loading – Response of SDOF systems subjected Impulse loads: Half-sine pulse/Rectangular pulse/Triangular Pulse/ Shock spectra / Approximate method of impulse load analysis – Un-damped / Damped vibrations of SDOF systems subjected General dynamic loading / Duhamel Integral - Un-damped / Damped vibrations of SDOF systems subjected arbitrary dynamic loading.

**UNIT – III**

**Multi Degree Freedom Systems:** Formulation of Equations of Motion / Evaluation of Lumped Mass Matrix and consistent mass matrix/ Evaluation of Stiffness Matrix.

**Un-damped Free Vibrations:** Analysis of Frequency matrix and mode shape matrices using detrimental equation/Flexibility Formulation/Orthogonality Conditions/ Normalizing Mode

shapes/Analysis of Dynamic Response/Normal Coordinates/ Uncoupled Equations of Motion for un-damped systems/Conditions for damping orthogonality – Mode super position procedure for damped forced vibrations – Time History Analysis – Direct Integration Methods due to New Mark(average acceleration, linear acceleration), Wilson theta correction.

**UNIT – IV**

**Practical Vibration Analysis:** Stodola Method, Holtzer Method – Fundamental mode only, Reduction of degrees of freedom, basic concepts in matrix iteration.

Variational Formulation of Equations of Motion: Generalized coordinates, Lagrange's Equations of Motion, Application to simple un-damped and damped problems of 2-DOF systems.

**UNIT – V**

**Distributed Parameter Systems:** Partial Differential Equation of Motion – Beam Flexure (Elementary case) – Undamped free vibrations (Elementary case) – Analysis of dynamic response – normal coordinates.

Earthquake Resistant Design: Brief exposure to relevant IS Codes of Practice, Response Spectra method.

**Suggested Readings:**

1. Walter C. Hurty & Moshe F. Rubinstein, (1964). ―Dynamics of Structures‖, Prentice Hall India.
2. Clough, Ray. W, and Penzien, Joseph (1982). ―Dynamics of Structures‖, McGraw Hill Company Limited, New Delhi.
3. Mario Paz, (1987). ―Structural Dynamics‖, CBS Publishers.
4. Chopra, A. K, (1996). ―Dynamics of Structures‖, Prentice Hall India.

**CE 118**

## EARTH QUAKE RESISTANT DESIGN OF STRUCTURES
## (PROGRAM SPECIFIC ELECTIVE – III)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives**

- *Learn the causes of earthquake and effects of ground motion and modelling of structures.*
- *Study the response spectra and structural dynamics of MDOF systems.*
- *Discover the different analysis and design approaches like equivalent lateral force method and inelastic time history analysis.*
- *Be trained in the ductile detailing of reinforced concrete structures as per IS 4326 and IS 13920.*
- *Learn the seismic analysis of masonry buildings.*

**Outcomes:** *At the end of this course, students will be able to*

1. *Apply the knowledge of Earthquake ground motion and the concepts of structural dynamics for analysis of structures.*
2. *Model and analyse the structures to resist earthquake forces by different methods.*
3. *Design the various structural elements resisting earthquake forces as per IS Codes.*
4. *Able to design and ductile detailing of reinforced concrete structures as per codal provisions.*
5. *Able to analyse and design of masonry structures foe seismic loading*

**UNIT-I**

**Earthquake Ground Motion:** Engineering seismology, Seismic zoning map of India, Strong motion studies in India, Strong motion characteristics, Evaluation of seismic design parameters.

**Structural Dynamics:** Initiation into structural dynamics, Dynamics of SDOF systems, Theory of seismic pickup, Numerical evaluation of dynamic response, Response spectra, Dynamics of MDOF systems.

**UNIT-II**

**Concepts of Earthquake Resistant Design of RCC Structures:** Basic elements of earthquake resistant design, Identification of seismic damages in RCC buildings, Effect of structural irregularities on performance of RCC buildings during earthquakes, earthquake resistant building architecture.

**UNIT-III**

**Seismic Analysis and Modelling of RCC Structures:** Code based procedure for determination of design lateral loads, Infill walls, Seismic analysis procedure as per IS 1893 code, Equivalent static force method, Response spectrum method, Time history analysis, Mathematical modelling of multi-storey RCC buildings.

**UNIT-IV**

**Earthquake Resistant Design of RCC Structures:** Ductility considerations, Earthquake resistant design of multi-storey RCC buildings and shear walls based on IS 13920 code, Capacity based design.

**UNIT-V**

**Earthquake Resistant Design of Masonry Structures:** Identification of damages and non-damages in masonry buildings, Elastic properties of structural masonry, Lateral load analysis of masonry buildings, Seismic analysis and design of one-storey and two-storey masonry buildings.

***Suggested Reading:***

1. Bruce A Bolt, Earthquakes, W H Freeman and Company, New York, 2004.
2. C. A. Brebbia, Earthquake Resistant Engineering Structures, WIT Press, 2011.
3. Mohiuddin Ali Khan, Earthquake-Resistant Structures: Design, Build and Retrofit‖, Elsevier Science & Technology, 2012.
4. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures‖, Prentice Hall of India, 2009.
5. Paulay, T and Priestley, M.J.N., Seismic Design of Reinforced Concrete and Masonry buildings, John Wiley and Sons, 1992.
6. S K Duggal, ―Earthquake Resistant Design of Structures‖, Oxford University Press, 2007.

**CE 119**

## BRIDGE ENGINEERING
## (PROGRAM SPECIFIC ELECTIVE – III)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *Learn the hydraulic, geological and geo-technical aspects in bridge design.*
- *Analyse, design and detail the bridge deck and box girder systems, steel and composite bridges.*
- *Analyse and design the sub-structures, bridge bearings and various long span bridges.*

**Outcomes:** *After completing the course, the students will able to*

1. *Understand the fundamentals and codes of practice of bridge design.*
2. *Design the bridge deck and box girder systems using appropriate method.*
3. *Design the steel truss and composite steel-concrete bridges.*
4. *Propose the sub-structure components such as pier, abutments, etc. and bridge bearings.*
5. *Design the various types of long span bridges, curved and skew bridges.*

**UNIT – I**

**Introduction:**

Types of bridges, materials of construction, codes of practice (Railway and Highway Bridges), aesthetics, loading standards (IRC, RDSO, AASHTO), recent developments box girder bridges, historical bridges (in India and overseas). Planning and layout of bridges, hydraulic design, geological and geo-technical considerations; Design aids, computer software, expert systems.

**UNIT – II**

**Concrete Bridges:** Bridge deck and approach slabs, Slab design methods, design of bridge deck systems, slab-beam systems (Guyon-Massonet and Hendry Jaeger Methods), box girder systems, analysis and design. Detailing of box girder systems.

**UNIT – III**

**Steel and Composite Bridges:** Introduction to composite bridges, Advantages and disadvantages, Orthotropic decks, box girders, composite steel-concrete bridges, analysis and design, truss bridges.

**UNIT – IV**

**Sub-Structure:** Piers, columns and towers, analysis and design, shallow and deep foundations, caissons,abutments and retaining walls.

**Bridge appurtenances:** Expansion joints, design of joints, types and functions of bearings, design of elastomeric bearings, railings, drainage system, lighting.

**UNIT – V**

**Long span bridges:** Design principles of continuous box girders, curved and skew bridges, cable stayed and suspension bridges, seismic resistant design, seismic isolation and damping devices. Construction techniques (cast in-situ, prefabricated, incremental launching, free cantilever construction), inspection, maintenance and rehabilitation, current design and construction practices.

***Suggested Reading:***

1. "Bridge Engineering Handbook", Wai-Fah Chen Lian Duan, CRC Press, USA, 2000.
2. "Design of Highway Bridges", Barker, P.M. and Puckett, J.A., John Wiley & Sons, New York, 1997.
3. "Theory and Design of Bridges", Xanthakos, P.P., John Wiley & Sons, New York, 1994.

**CE 120**

## RETROFITTING AND REHABILITATION OF STRUCTURES (PROGRAM SPECIFIC ELECTIVE – III)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

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

**Outcomes:** *After completing the course, the students will able to*

1 *Understand the fundamentals of maintenance and repair strategies.*
2 *Diagnose for serviceability and durability aspects of concrete.*
3 *Know the materials and techniques used for repair of structures.*
4 *Decide the appropriate repair, strengthening, rehabilitation and retrofitting technique required for a case study building.*
5 *Use an appropriate health monitoring and demolition techniques*

**UNIT - I**

**Maintenance:** Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating damaged structure, causes of deterioration. **Repair Strategies:** Causes of distress in concrete structures, Construction and design failures, Condition assessment and distress-diagnostic techniques, Assessment procedure for Inspection and evaluating a damaged structure.

**UNIT - II**

**Serviceability and Durability of Concrete:** Quality assurance for concrete construction, concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.

**UNIT - III**

**Materials and Techniques for Repair:** Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. Bacterial concrete, Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coating and cathodic protection

**UNIT - IV**

**Repair, Rehabilitation and Retrofitting Techniques:** Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure, Repair of Structure – Common Types of Repairs – Repair in Concrete Structures – Repairs inUnder Water Structures – Guniting – Shot Create – Underpinning. Strengthening of Structures – Strengthening Methods – Retrofitting – Jacketing.

**UNIT – V**

**Health Monitoring and Demolition Techniques:** Long term health monitoring techniques, engineered demolition techniques for dilapidated structures, Use of Sensors – Building Instrumentation.

***Suggested Reading:***

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

. **CE 121**

## ADVANCED CONCRETE TECHNOLOGY
## (PROGRAM SPECIFIC ELECTIVE – IV)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:** *The objectives of this course is to impart knowledge of*

- *Learn the microstructure and material science aspect of concrete.*
- *Comprehend the long term and durability properties of concrete.*
- *Design high strength and high performance concrete mix by standard guidelines.*
- *Study the role of admixtures in concrete.*
- *Identify the mix proportion and properties of special concrete*

**Outcomes:** *After completing this course, the student will be able to:*

1. *Assessment of the hydrated structure and microstructure of concrete.*
2. *Acquire the knowledge of dimensional stability and durability properties of concrete.*
3. *Design concrete mixes by various methods of mix design*
4. *Familiarize with the types of admixtures added to concrete.*
5. *Carryout the mix design and properties of special concretes.*

**UNIT - I**

Concrete as a composite material; advantages-limitations; Materials science aspects of the properties and behavior of Cement Concrete: physical and chemical aspects of cement hydration, type and morphology of hydrates; Structure of concrete-Transition zone-Micro structural engineering.

Modern trends in concrete manufacture and placement techniques-methods of transportation-placing and curing-extreme whether concreting-special concreting methods-vaccum dewatering of concrete-under water concreting.

**UNIT – II**

Strength of Hardened concrete-NDT; Stress-strain relations; Dimensional stability-shrinkage and creep; Durability of concrete -Durability concept- pore structure and transport processes-reinforcement corrosion-chloride attack-carbonation- fire resistance- frost damage- sulphate attack-alkali aggregate reaction- delayed ettringite formation- methods of providing durable concrete-short-term tests to assess long-term behavior.

**UNIT - III**

Mix design of concrete –Quality control – Principles of concrete mix design-Various methods of mix design - IS code method - British and ACI methods-Mix design of special concrete- Design of high strength and high performance concrete-Design of pumpable concrete

**UNIT – IV**

Mineral Admixtures – Hydration of Admixtures - Slags – Pozzolanas and Fillers – Dispersing admixtures-Retarding admixtures-Accelerating admixtures-Air entraining admixtures-Water resisting admixtures-Corrosion inhibiting admixtures-Shrinkage reducing admixtures-Under water admixtures-Sprayed concrete admixtures- Compatibility issues with Chemical Admixtures.

**UNIT - V**

Special concrete- Fly ash concrete -Silica fume concrete -Fiber reinforced concrete- Sprayed concrete - Geopolymer concrete-Self compacting concrete- Roller compacted concrete- Ferro

cement-Recycled aggregate concrete-Slurry Infiltrated Concrete-Mix design-properties and their applications; Engineered cementitious composites

**Suggested Reading:**


1. A.M. Neville, "Properties of Concrete", English Language Book Society-Longman Publications, 1988.
2. A.M. Neville & J.J.Brooks, "Concrete Technology", Pearson Education Limited, 2010.
3. P.K. Mehta and J.M.M. Paulo, "Concrete – Microstructure – Properties and Material", McGraw-Hill, New York, 1997.
4. Zongji Li "Advanced Concrete Technology", John Wiley & sons, inc, 2011.
5. John Newman, Ban Seng Choo, "Advanced Concrete Technology", Elsevier publisher, 2003.
6. Thomas Dyer, " Concrete Durability", CRC Press, Taylor & Francis group,2014
7. N. Krishna Raju, "Design of Concrete Mix", CBS Publications, New Delhi, 1985.

**CE 122**

## ANALYTICAL AND NUMERICAL METHODS FOR STRUCTURAL ENGINEERING (PROGRAM SPECIFIC ELECTIVE – IV)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *Learn the Fundamentals of Numerical Methods.*
- *Study the non-linear Algebraic and Transcendental Equations.*
- *Understand the Finite Difference scheme and Numerical Differentiation & Integration.*
- *To write computer algorithms.*

**Outcomes:** *After completing this course, the student will be able to:*

1. *Solve ordinary and partial differential equations in structural mechanics using numerical methods.*
2. *Write a program to solve a mathematical problem*
3. *To write the algorithms for given problems*
4. *To solve integration and differential problems using numerical method*
5. *To solve the explicit and implicit problems using finite difference method*

**Unit I**

Fundamentals of Numerical Methods: Error Analysis, Polynomial Approximations and Interpolations, Curve Fitting**;** Interpolation and extrapolation.

**Unit-II**

Solution of Nonlinear Algebraic and Transcendental Equations, Elements of Matrix Algebra: Solution of Systems of Linear Equations, Eigen Value Problems.

**Unit-III**

Numerical Differentiation & Integration: Solution ofOrdinary and Partial DifferentialEquations.

**Unit IV**

Finite Difference scheme: Implicit & Explicit scheme.

**Unit-V**

Computer Algorithms: Numerical Solutions for Different Structural Problems, Fuzzy Logic and Neural Network.

**References:**

1. An Introduction to Numerical Analysis, AtkinsonK.E., J. Wiley and Sons, 1989.
2. Theory and Problems of Numerical Analysis, Scheid F, McGraw Hill Book Company, (Shaum Series), 1988.
3. Introductory Methods of Numerical Analysis, Sastry S. S, Prentice Hall of India

**CE 123**

## STRUCTURAL OPTIMIZATION
## (PROGRAM SPECIFIC ELECTIVE – IV)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *To study the optimization techniques and application to structural elements.*
- *Study to solve the linear and non-linear, transportation and assignment optimization problems.*
- *Understand the dynamic programming, decision theory and simulations.*
- *Apply optimization techniques for simple structures.*

**Outcomes:** *After completing this course, the student will be able to*

1. *Able to understand the basic concepts of optimization and linear programming model.*
2. *Ability to solve application based Linear Programming problem, transportation and assignment problem, modify and improve network flow problems to optimize the objective.*
3. *Able to formulate and solve nonlinear optimization models.*
4. *Understand the concept and application of dynamic programming, simulation and decision theory.*
5. *Use the optimization techniques for simple structural elements*

**UNIT – I**

**Introduction to optimization:** Introduction, basic theory and elements of Optimization, Terminology and definitions, Basic principles and procedure of optimization, Engineering applications of Optimization.

**Classical Methods of Optimization:** Trial and error method, Monte-Carlo method, Lagrangian multiplier method, illustrative examples

**Linear Programming:** Introduction, terminology, formulation of LPP, graphical and algebraic methods of solving LPP, standard form and canonical form of linear programming, geometrical interpretation, illustrative examples.

**UNIT – II**

**Linear Programming:** Simplex methods, Artificial variable techniques, solution of simultaneous equations, Dual formulations - illustrative examples.

**Network analysis:** Modifications and improvements on CPM/PERT

**Transportation and Assignment problem:** Introduction, terminology, formulation and solution of mathematical models, illustrative examples.

**UNIT – III**

**Non-Linear Programming:** local and global optimum, problem formulation, Unconstrained and constrained methods of Optimization-Kuhn Tucker conditions,LagrangianMultipliermethods,graphicalmethodUnivarialsearchmethod,SteepestDescent Methods,quadraticprogrammingproblem, Wolfs modified simplex method, illustrative examples.

**UNIT – IV**

**Dynamic programming:** Introduction, terminology, need and characteristics of dynamic programming, formulation, solution of LPP, applications, illustrative examples **Decision theory:** Introduction, types, decision trees.

**Simulation:** Introduction, advantages, limitations, types, applications.

**UNIT – V**

**Structural Optimization:** Optimum structural design of rectangular timber beam, reinforced concrete rectangular, T and L beams, concrete mix proportioning, reinforced concrete deep beams, planner trusses, Procedure of optimization for structural grid and slab.

**Suggested Reading:**

1. Engineering Optimization‖, S.S. Rao, New Age Internationals (1999).
2. Systems Analysis for Civil Engineers‖, Paul, J.O., john Wiley & Sons (1988)
3. Fundamentals of Optimum Design in Engineering‖ S.S. Bhavikatti, New Age International Publishers.
4. Operation Research‖, S. Kalavathy, Vikas publishing house Pvt Ltd. Second edition

**AC 035**

## STRESS MANAGEMENT BY YOGA
## (AUDIT COURSE-II)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 00*

**Objectives:**

- *Creating awareness about different types of stress and the role of yoga in the management of stress.*
- *Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
- *Prevention of stress related health problems by yoga practice.*

**Outcomes:** *Students will be able to*

1. *To understand yoga and its benefits.*
2. *Enhance Physical strength and flexibility.*
3. *Learn to relax and focus.*
4. *Relieve physical and mental tension through Asanas*
5. *Improve work performance and efficiency.*

**UNIT-I**

Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

**UNIT–II**

Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

**UNIT-III**

Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

**UNIT-IV**

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar

**UNIT-V**

**Pranayama-** Anulom and Vilom Pranayama - Nadishudhi Pranayama – Kapalabhati- Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

**Meditation techniques:** Om Meditation - Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique ( QRT), Deep Relaxation Technique (DRT).

**Suggested Reading:**

1. "Yogic Asanas for Group Training - Part-I": Janardhan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or Conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
3. Nagendra H.R nad Nagaratna R, "Yoga Perspective in Stress Management", Bangalore, Swami Vivekananda Yoga Prakashan

**Online Resources:**

https://onlinecourses.nptel.ac.in/noc16_ge04/preview
https://freevideolectures.com/course/3539/indian-philosophy/11

**AC 036**

## PERSONALITY DEVELOPMENT THROUGH LIFE ENHANCEMENT SKILLS (AUDIT COURSE-II)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 00*

**Objectives :**

- *To learn to achieve the highest goal happily*
- *To become a person with stable mind, pleasing personality and determination*
- *To awaken wisdom in students*

**Outcomes:** *Upon completing this course, students will be able to:*

1. *Develop their personality and achieve their highest goal of life.*
2. *Lead the nation and mankind to peace and prosperity.*
3. *To practice emotional self regulation.*
4. *Develop a positive approach to work and duties.*
5. *Develop a versatile personality.*

**UNIT-I**

Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

**UNIT-II**

Neetisatakam – Holistic development of personality (cont'd) - Verses 52, 53, 59 (dont's) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

**UNIT-III**

Introduction to Bhagavad Geetha for Personality Development - Shrimad Bhagawad Geeta: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 – Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

**UNIT-IV**

Statements of basic knowledge - Shrimad Bhagawad Geeta: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

**UNIT-V**

Role of Bahgavadgeeta in the present scenario - Chapter 2 – Verses 17 – Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

**Suggested Reading:**

1.. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata.

2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi

**Web resource:**

1. NTPEL:http://nptel.ac.in/downloads/109104115/

**AC 037**

## CONSTITUTION OF INDIA
## (AUDIT COURSE-II)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 00*

**Objectives:**

- *The history of Indian Constitution and its role in the Indian democracy.*
- *Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*
- *Have knowledge of the various Organs of Governance and Local Administration.*

**Outcomes:** *Upon completing this course, students will be able to:*

1. *Understand the making of the Indian Constitution and its features.*
2. *Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.*
3. *Have an insight into various Organs of Governance - composition and functions.*
4. *Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.*
5. *Understand Electoral Process, special provisions.*

**UNIT-I**

**History of making of the Indian constitutions:** History, Drafting Committee (Composition & Working). **Philosophy of the Indian Constitution**: Preamble, Salient Features.

**UNIT-II**

**Contours of Constitutional Rights and Duties** Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

**UNIT-III**

**Organs of Governance":** Parliament: Composition, Qualifications, Powers and Functions, Union executives : President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions.

**UNIT-IV**

**Local Administration -** District's Administration head: Role and importance. Municipalities: Introduction, ayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role. Block level: Organizational Hierarchy (Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

**UNIT-V**

**Election commission:** Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission :Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women**.**

**Suggested Reading:**

1. "The Constitution of India", 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1st Edition, 2015.
3. M. P. Jain, "Indian Constitution Law", 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.

**Web Resource:**

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

**AC038**

## PEDAGOGY STUDIES

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 0*

**Course Objectives:**

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

**Course Outcomes:**

1. What pedagogical practices are being used by teachers in formal and informal classrooms in Developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

**UNIT-I**

**Introduction and Methodology:**

- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions.
- Overview of methodology and Searching.

**UNIT-II**

- Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
- Curriculum, Teacher education.

**UNIT-III**

- Evidence on the effectiveness of pedagogical practices
  Methodology for the in depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school
- Curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.

**UNIT-IV**

- Professional development: alignment with classroom practices and followup support
- Peer support
- Support from the head teacher and the community.
- Curriculum and assessment
- Barriers to learning: limited resources and large class sizes

**UNIT-V**

- Research gaps and future directions
- Research design
- Contexts

- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact

**Suggested reading:**

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. ww.pratham.org/images/resource%20working%20paper%202.pdf.

**CE 070**

## MINI PROJECT

*Instruction: 6 periods per week* *Duration of SEE: -- hours*
*CIE: 50 marks* *SEE: 00 marks*
*Credits: 3*

**Objectives:**

- *To review available literature and formulate structural engineering problems*
- *To learn the technique of writing reports and prepare presentation*

**Outcomes:**

1. *Identify structural engineering problems reviewing available literature*
2. *Study different techniques used to analyse complex structural systems.*
3. *Able to work on the solutions given problem*
4. *present solution by using his/her technique applying engineering principles.*
5. *Prepare technical report and presentation*

**Syllabus Contents:**

Mini Project will have mid semester presentation and end semester presentation. Mid semester Presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution. Continuous assessment of Mini Project at Mid Sem and End Sem will be monitored by the departmental committee

**CE 152**

# ADVANCED CONCRETE TECHNOLOGY LABORATORY

*Instruction: 3 periods per week* *Duration of SEE: -- hours*
*CIE: 50 marks* *SEE: -- marks*
*Credits: 1.5*

**Objectives:**

- *Mix Proportioning for high strength concrete.*
- *Co relates different mechanical properties.*
- *To perform NDT on existing structures.*

**Outcomes:** *After completing this course, the student will be able to*

1. *Design high grade concrete*
2. *Study the parameters affecting the performance .*
3. *Conduct and prepare a report Non destructive test on existing structures*
4. *Understand behavior of structural/elements*
5. *Determine property of reinforcing material*

**List of Experiments**

**List of Experiments**

1 To investigate basic properties of ingredients used in proportioning of concrete

2 To design the mix for High Strength Concrete

3 To determine fresh properties of High Strength Concrete

4 Study of stress-strain curve of high strength concrete, correlation between cube strength, cylinder strength, split tensile strength and modulus of rupture

5 Tests on HYSD bars

6 Effect of cyclic loading on steel

7 Non Destructive tests on existing concrete structures

8 Behaviour of beam under flexure and shear

**CE153**

# MODEL TESTING VIRTUAL LAB

*Instruction: 3 periods per week* *Duration of SEE: -- hours*
*CIE: 50 marks* *SEE: -- marks*
*Credits: 1.5*

**Objectives:**

- *To study behaviour of SDOF system under different vibration modes.*
- *To study dynamic behaviouer of beams.*
- *To study the damage assesement of structures Using Electro-Mechanical Impedence (EMI) Techniqe.*

**Outcomes:**

1. *To visualize mode shapes for different types of vibrations*
2. *Visualize damage patterns in structures due to dynamic loads*
3. *Visualize shear lag effect and Rebar Corrosion*
4. *Draw response spectrum curve for given condition*
5. *Measure displacements using Photogrammetry*

**List of Experiments:**

**Simulation based experiments:**

1. Free Vibration of S.D.O.F System
2. Forced Vibration of S.D.O.F System
3. Impulse Response of S.D.O.F System
4. Concept of Response Spectrum
5. Vibration of M.D.O.F System
6. Behaviour of Rigid Blocks
7. Torsional Response of Building
8. Continuous Systems
9. Vibration Control
10. Modes of Vibration of Simply Supported Beam Under Flexure
11. Modes of Vibration of Simply Supported Plate
12. Damage Detection and Qualitative Quantification Using Electro-Mechanical Impedence (EMI) Technique
13. Dynamics of Bandra Worli Sea Link Bridge
14. Piezoelectric Energy Harvesting and Structural Health Monitoring Using Thin Surface Bonded PZT Patches.
14. Shear Lag Effect in Electro-Mechanical Impedance (EMI) Technique
15. Rebar Corrosion Detection and Assessment Using Electro-Mechanical Impedance (EMI) Technique.

## Trigger based experiments:

17. Vibration Characteristics of Aluminium Cantilever Beam Using Piezoelectric Sensors
18. Identification of High Frequency Axial Modes of Beam in "Free-Free" Condition Using Electro-Mechanical Impedance (EMI) Technique
19. Forced Excitation of Steel Beam Using Portable Shaker
20. Photogrammetry for Displacement Measurement

**Resources:**

1. http://sd-iiith.vlabs.ac.in/Introduction.html (For Experiments 1 to 9)
2. http://vssd-iitd.vlabs.ac.in/home.html (For Experiments 10 to 20)

**SEMISTER - III**

**CE 124**

**DESIGN OF PRESTRESSED CONCRETE STRUCTURES**
**(PROGRAM ELECTIVE – V)**

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:** The objectives of this course is to impart knowledge of

- Learn the concept of pre-stressed concrete, methods and systems of pre-stressing, losses of pre-stress.
- Analyse and design the sections for flexure, torsion and shear using different methods.
- Learn the design of sections for bond and anchorage and deflections of pre-stressed concrete beams.
- Study the analysis and design of statically indeterminate beams.

**Outcomes:** Upon completing this course, students will be able to:

1. Familiarize with fundamentals of pre-stressed concrete, methods and systems of pre-stressing and losses of pre-stress.
2. Analyse and design the sections for flexure, shear bond and anchorages.
3. Estimate the deflections of pre-stressed concrete elements
4. Know the circular pre-stressing, analysis and design of statically indeterminate beams.
5. Solve the problems pertaining to axial members, slabs and grid floors

**UNIT-I**

**Introduction:** Basic concepts, materials, permissible stress – Advantages and types of prestressing, Systems and devices of pre-stressing and post-tensioning, Prestressing steel

**Losses in pre-stress:** Loss of prestress in pre-tensioned and post-tensioned members – Analysis of sections for flexure

**UNIT-II**

**Deflections:** Importance of deflections, factors influencing deflections, codal provisions, short term and long term deflections.

**Shear:** Shear in principal stresses – cracked and un-cracked sections - codal provisions – Design of shear reinforcement.

**Torsion:** Torsion for cracked and un-cracked sections, codal provisions and design.

**UNIT-III**

**End Blocks:** Nature of stresses, Stress distribution – IS Code Method -codal provisions - Design.

**Continuous beams:** Advantages of Continuous members – Code provisions – Design of two span Continuous beams – concordant cable profiles.

**UNIT-IV**

**Tension Members:** Introduction, Ties, Circular pre-stressing – Design of PSC pipes.

**Compression Members:** Introduction – Design of PSC columns.

**UNIT-V**

**Slabs:** Introduction – Types – rectangular and flat slabs – Codal provisions – Design of PSC floor slabs- one way and two way slabs, and simple flat slabs. Grid Floors: Introduction.

**Readings:**

1. Prestressed Concrete‖ by N. Krishna Raju, Tata Mc Graw Hill, 2001.
2. Prestressed Concrete‖ by G.S. Pandit and S.P. Gupta, CBS Pub., 1995.
3. Design of prestressed Concrete‖ by Arthur H. Nilson, John Wiley, 1987

**CE 125**

## DESIGN OF HIGH RISED BUILDINGS
## (PROGRAM ELECTIVE – V)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:** *The objectives of this course is to impart knowledge of*

- *The differences between the regular buildings and tall buildings*
- *Various structural systems usually considered for the functional design of the tall buildings*
- *Various methods of calculation lateral forces (both wind forces and seismic/ earth quake forces) on the tall buildings*
- *The provisions of relevant IS codes (IS:875 - Part-3, IS:1893 - Part-1) in calculating the lateral forces mentioned above, on tall buildings*
- *The importance of shear wall in resisting the lateral forces on the tall buildings*
- *The importance of ductility of various structural members in resisting the seismic loads on tall buildings and the relevant provisions of the IS code (IS: 13920) regarding the reinforcement detailing in achieving this ductility in RCC members.*
- *The concept of capacity based design in resisting seismic forces on tall buildings.*

**Outcomes:** *After completing this course, the student will be able to:*

1. *the differences between the regular buildings and tall buildings*
2. *various structural systems usually considered for the functional design of the tall buildings*
3. *the provisions of relevant IS codes (IS:875 - Part-3, IS:1893 - Part-1) in calculating the lateral forces mentioned above, on tall buildings*
4. *the importance of shear wall in resisting the lateral forces on the tall buildings*
5. *the importance of ductility of various structural members in resisting the seismic loads on tall buildings and the relevant provisions of the IS code (IS: 13920) regarding the reinforcement detailing in achieving this ductility in RCC members.*

**UNIT-I Introduction**
Design Principles for Lateral Load resistance, ductility considerations in earthquake resistant design of concrete buildings, construction methods, choice of materials, cladding systems and their design principles, types of foundations for tall buildings.

**UNIT-II Wind Loads:**
Introduction to wind, characteristics of wind, Computation of wind loads on buildings as per IS code methods, Wind Tunnel testing, Introduction to Computational Fluid Dynamics.

**UNIT-III Seismic Loads:**
Introduction to Earthquakes, Characteristics of Earthquake, Computation of seismic loads on tall buildings – Response Spectrum Method, , Vibration Control – active control & passive control, Liquefaction effects of earthquake, Introduction to Time history Analysis and Pushover analysis.

**UNIT – IV Structural systems:**
Necessity of special structural systems for tall buildings, Structural Systems for **Steel Buildings -** Braced frames, Staggered Truss System, Eccentric Bracing System, Outtrigger& Belt truss system, Tube Systems**;** Structural Systems for **Concrete Buildings -** shear walls, frame tube structures, bundled tube structures**;** Design of shear wall as per IS code

**UNIT- V Special Topics:**
Second order effects of gravity loading, Creep and shrinkage in columns, Differential shortening of columns, Floor levelling problems, Panel zone effects, P-Delta analysis

**Text Books:**

1. Taranath B. S., "*Structural Analysis and Design of Tall Buildings*", McGraw-Hill Book Company, 1988.
2. Simlu E, "*Wind Effect on Structures: An Introduction to Wind Engineering*",Wile& Sons, 1978.

**Suggested Reading:**

1. Fintel, M, "*Hand Book of Concrete Engineering*", Von Nostrand, 1974.
2. Emilio Rosenblueth, "*Design of Earthquake Resistant Structures*", Pentech Press Ltd., 1990.
3. Schuellar, W, "*High Rise Building Structures*" , John Wiley & Sons Inc, 1977.
4. Bryan Stafford Smith & Alex Coull, "*Tall Building Structures: Analysis & Design*", Wiley India
   Pvt Ltd, 1991.
5. Lynn S. Beedle, "*Advances in Tall Buildings*", CBS Publishers and Distributors Delhi, 1996.

**CE 126**

## THEORY OF PLATES AND SHELLS
## (PROGRAM ELECTIVE – V)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *Learn the analysis and design of cylindrical shells, short and long shells.*
- *Study the concepts of bending theory using D.K.J. equations and Schorer theory.*
- *Understand the beam theory and beam arch analysis.*
- *Gain knowledge of the analysis and design of different shells of double curvature and axi-symmetrical shells by membrane theory.*
- *Analyse different types of folded plates using Simpson's and Whitney's methods.*

**Outcomes:** *After completing this course, the student will be able to:*

1. *Analyse the cylindrical shells and design the short and long shells*
2. *Solve the problems of bending theory using appropriate equations*
3. *Evaluate and design the cylindrical shells using beam theory .*
4. *Anlyse double curvature shells using membrane theory*
5. *Analyse the numerous types of folded plates using pertinent method.*

**UNIT-I**

**Introduction:** definition and classification of shells.

**Cylindrical Shells:** Membrane Theory – Equilibrium equations for differential shell elements – Calculation of stresses and displacement due to dead loads and snow loads for circular cylindrical shell.

**UNIT-II**

**Bending Theory:** Necessity of bending theory (i) D.K.J theory Assumption – Equilibrium equations for a differential element - stress strain relations - Moment curvature relations – Derivation of D.K.J. Differential and characteristics equations – Roots of the Characteristic equation – Expression for defection. (ii) Schorer theory – assumptions – Equilibrium equations for a differential shell element – stress strain relations – Moment curvature relations – Derivation of Schorer differential and characteristic equation – Roots of the characteristic equation – Expression of defection.

**UNIT-III**

**Beam Theory of cylindrical shells:** Assumptions and range of their validity – Outline of the beam arch analysis – Advantages of beams theory over other theories.

**UNIT-IV**

**Shells of Doubles Curvature:** Membrane theory of shells of revolution- Equilibrium equations for a differential shell element – Calculation of stresses in a spherical dome due to uniform load over the surface and due to concentrated load around a skylight opening. Shells of translation equilibrium equations for a differential shell element. Pucher's stress function, derivation of a differential equation from equations of equilibrium using Pucher's stress function calculation of stresses in hyperbolic parabolids with straight edges under uniform load over the surface.

**UNIT-V**

**Folded Plates:** Assumptions – Structural behavior – Resolutions of ridge loads – Edge shears – Stress distribution – Plate deflections and rotations. Effect of joint moments – Analysis of V shaped folded plates using (i) Simpson and (ii) Whitney methods.

**Suggested Readings:**

1. Theory of plates and shells, S. Timoshenko and W. Krienger, Mc Graw Hill.1959
2. Design and construction of concrete shell roofs, G.S. Ramaswamy, CBS Pub 1986
3. Thin Shells Theory and Problems, J. Ramchandran, Universities press, 1993.

**OE 941**

## BUSINESS ANALYTICS
## (Open Elective)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *Understanding the basic concepts of business analytics and applications*
- *Study various business analytics methods including predictive, prescriptive and prescriptive analytics*
- *Prepare the students to model business data using various data mining, decision making methods*

**Outcomes:** *Upon completing this course, students will be able to:*

1. *To understand the basic concepts of business analytics*
2. *Identify the application of business analytics and use tools to analyze business data*
3. *Become familiar with various metrics, measures used in business analytics*
4. *Illustrate various descriptive, predictive and prescriptive methods and techniques*
5. *Model the business data using various business analytical methods and techniques*

**UNIT-I**

**Introduction to Business Analytics:** Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

**UNIT-II**

**Descriptive Analytics:** Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization

**UNIT-III**

**Forecasting Techniques**: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

**UNIT-IV**

**Decision Trees**: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. **Clustering**: Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, **Prescriptive Analytics**- Linear Programming(LP) and LP model building,

**UNIT-V**

**Six Sigma**: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox

**Suggested Reading:**

1. U Dinesh Kumar, "Data Analytics", Wiley Publications, 1st Edition, 2017
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015
3. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015

**Web Resources:**

1. https://onlinecourses.nptel.ac.in/noc18-mg11/preview
2. https://nptel.ac.in/courses/110105089/

**OE942**

## INDUSTRIAL SAFETY
## (OPEN ELECTIVE)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Course Objectives:**

- *Causes for industrial accidents and preventive steps to be taken.*
- *Fundamental concepts of Maintenance Engineering.*
- *About wear and corrosion along with preventive steps to be taken*
- *The basic concepts and importance of fault tracing.*
- *The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry*

**Course Outcomes:**

1. *Identify the causes for industrial accidents and suggest preventive measures.*
2. *Identify the basic tools and requirements of different maintenance procedures.*
3. *Apply different techniques to reduce and prevent Wear and corrosion in Industry.*
4. *Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.*
5. *Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc*

**UNIT-I**

Industrial safety: Accident, causes, types, results and control, mechanical andelectrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

**UNIT–II**

Fundamentals of Maintenance Engineering: Definition and aim of maintenanceengineering, Primary and secondary functions and responsibility of maintenancedepartment, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

**UNIT–III**

Wear and Corrosion and their Prevention: Wear- types, causes, effects, wearreduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition of corrosion, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

**UNIT–IV**

Fault Tracing: Fault tracing-concept and importance, decision tree concept,need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, any one machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

**UNIT–V**

Periodic and Preventive Maintenance: Periodic inspection-concept and need,degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

**Suggested Reading:**

1. H. P. Garg, "Maintenance Engineering", S. Chand and Company
2. Audels, "Pump-hydraulic Compressors", Mcgraw Hill Publication
3. Higgins & Morrow, "Maintenance Engineering Handbook", Da Information Services.
4. Winterkorn, Hans, "Foundation Engineering Handbook", Chapman & Hall London

**OE 943**

# OPERATION RESEARCH
# (OPEN ELECTIVE)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *Introduce the concepts of optimization techniques*
- *Formulation of LPP models*
- *Basic concepts of Non-linear programming, Dynamic programming, Game theory are introduced.*

**Outcomes:**

1. *Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.*
2. *Students should able to apply the concept of non-linear programming*
3. *Students should able to carry out sensitivity analysis*
4. *Student should able to model the real world problem and simulate it.*
5. *Student should able to apply graph theory, competitive models, and game theory simulations.*

**UNIT I**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

**UNIT II**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

**UNIT III:**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

**UNIT IV**

Scheduling and sequencing - single server and multiple server models deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

**UNIT V**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

**Suggested Reading::**

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010.

**OE 944**

# COST MANAGEMENT OF ENGINEERING PROJECTS (OPEN ELECTIVE-I)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- Introduce the concepts of cost management, inventory valuation , decision making
- Fundamentals of cost overruns, project execution and technical activities
- Introduce the concepts of Quantitative techniques for cost management, Linear Programming, PERT/CPM

**Outcomes:**

1. Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.
2. Ability to appreciative detailed engineering activities of the project and execution of projects
3. Preparation of project report and network diagram
4. Able to plan Cost Behavior , Profit Planning , Enterprise Resource Planning, Total Quality Management.
5. Applications of various quantitative techniques for cost management

**UNIT I**

Introduction and Overview of the Strategic Cost Management Process-Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System- Inventory valuation- Creation of a Database for operational control; Provision of data for Decision-Making.

**UNIT II**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning- Project execution as conglomeration of technical and non- technical activities- Detailed Engineering activities.

**UNIT III**

Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

**UNIT IV**

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems- Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector- Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints- Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets-Performance budgets- Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

**UNIT V**

Quantitative techniques for cost management, Linear Programming, PERT/CPM,- Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

**Suggested Reading :**

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

**OE 945**

## COMPOSITE MATERIALS
## (OPEN ELECTIVE-I)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *Study the concepts of composite construction.*
- *Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.*
- *Apply the concepts for design of multi-storey composite buildings.*
- *Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.*

**Outcomes :**

1. *Understand the fundamentals of composite construction, and analysis and designs of composite beams.*
2. *Analyse and design the composite floors*
3. *Select suitable materials for composite columns,*
4. *Analyse composite trusses and understand connection details.*
5. *Analyse and design the multi-storey composite buildings*

**UNIT-I**

Introduction of composite constructions: Benefits of composite construction - Introduction to IS - BS and Euro codal provisions.

Composite beams: Elastic behaviour of composite beams - No and full interaction cases - Shear connectors - Ultimate load behaviour - Serviceability limits - Effective breadth of flange - Interaction between shear and moment - Basic design consideration and design of composite beams.

**UNIT-II**

Composite floors: Structural elements - Profiled sheet decking - Bending resistance - Shear resistance - Serviceability criterion - Analysis for internal forces and moments - Design of composite floors.

**UNIT-III**

Composite columns: Materials - Concrete filled circular tubular sections - Non-dimensional slenderness - Local buckling of steel sections - Effective elastic flexural stiffness - Resistance of members to axial compressions - Composite column design - Fire resistance.

**UNIT-IV**

Composite trusses: Design of truss - Configuration - Truss members - Analysis and design of composite trusses and connection details.

**UNIT-V**

Design of multi-storey composite buildings: Design basis - Load calculations - Design of composite slabs with profile decks - Composite beam design - Design for compression members - Vertical cross bracings - Design of foundation.

**Suggested Reading:**

1. R.P. Johnson, "Composite Structures of Steel and Concrete - Beams, Slabs, Columns and Frames in Buildings", Blackwell Publishing, Malden, USA, 2004.
2. "INSDAG Teaching Resources for Structural Steel Design", Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, India.
3. "INSDAG Handbook on Composite Construction – Multi-Storey Buildings", Institute for Steel Development and Growth Publishers, Calcutta, India.
4. "INSDAG Design of Composite Truss for Building", Institute for Steel Development and Growth Publishers, Calcutta, India.
5. "INSDAG Handbook on Composite Construction – Bridges and Flyovers", Institute for Steel Development and Growth Publishers, Calcutta, India.
6. IS: 11384-1985, "Code of Practice for Composite Construction in Structural Steel and Concrete", Bureau of Indian Standards, New Delhi, 1985.

**OE 946**

## WASTE TO ENERGY
## (OPEN ELECTIVE)

*Instruction: 3 periods per week* *Duration of SEE: 3 hours*
*CIE: 30 marks* *SEE: 70 marks*
*Credits: 3*

**Objectives:**

- *To know the various forms of waste*
- *To understand the processes of Biomass Pyrolysis.*
- *To learn the technique of Biomass Combustion*.

**Outcomes:** *Upon completing this course, students will be able to:*

1. *Understand the concept of conservation of waste.*
2. *Identify the different forms of wastage.*
3. *Chose the best way for conservation to produce energy from waste.*
4. *Explore the ways and means of combustion of biomass.*
5. *Develop a healthy environment for the mankind.*

**UNIT-I:**
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

**UNIT-II:**
Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

**UNIT-III:**
Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

**UNIT-IV:**
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

**UNIT-V:**
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

**Suggested Reading:**

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

**OE947**

## INTERNET OF THINGS
## (Open Elective)

Instruction: 3periods per week — Duration of SEE: 3 hours
CIE: 30 marks — SEE: 70 marks
Credits: 3

**Course Objectives:**

- To understand the concepts of Internet of Things and able to build IoT applications
- To learn the programming and use of Arduino and Raspberry Pi boards.
- To know about data handling and analytics in SDN.

**Course Outcomes:**

After Completion of the course Student will be able to:

1. Known basic protocols in sensor networks.
2. Program and configure Arduino boards for various designs.
3. Python programming and interfacing for Raspberry Pi.
4. Design IoT applications in different domains.

**UNIT – I**

Introduction to Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks.

**UNIT – II**

Machine-to-Machine Communications, Difference between IoT and M2M, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino,

**UNIT – III**

Introduction to Python programming, Introduction to Raspberry Pi, Interfacing Raspberry Pi with basic peripherals, Implementation of IoT with Raspberry Pi

**UNIT - IV**

Implementation of IoT with Raspberry Pi, Introduction to Software defined Network (SDN), SDN for IoT, Data Handling and Analytics,

**UNIT - V**

Cloud Computing, Sensor-Cloud, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring

**Suggested Readings:**

1. "The Internet 'of Things: Enabling Technologies, Platforms, and Use Cases", by PethuruRaj and Anupama C. Raman (CRC Press).
2. “Make sensors”: Terokarvinen, kemo, karvinen and villeyvaltokari, 1st edition, maker media, 2014.
3. "Internet of Things: A Hands-on Approach", by ArshdeepBahga and Vijay Madisetti Vijay Madisetti,
4. ArshdeepBahga, “Internet of Things: A Hands-On Approach”
5. WaltenegusDargie,ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice"
6. Beginning Sensor networks with Arduino and Raspberry Pi – Charles Bell, Apress, 2013

**OE948**

## CYBER SECURITY

(Open Elective)

Instruction: 3periods per week | Duration of SEE: 3 hours
CIE: 30 marks | SEE: 70 marks
Credits: 3

**Course Objectives**

- Learn the various threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and IT laws and policies

**Course Outcomes:**

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

1. Understand the various network threats.
2. Analyze the forensic tools for evidence collection.
3. Apply the firewalls for threat analysis.

**UNIT-I**

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

**UNIT-II**

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

**UNIT-III**

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, searc and seizure of computer systems, password cracking.

**UNIT-IV**

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrival, Email analysis from mobile phones.

**UNIT-V**

Ethics, Policies and IT Act Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

**Suggested Readings**

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

**CE 181**

## MAJOR PROJECT PHASE-I

*Instruction: 6 periods per week* *Duration of SEE: --*
*CIE: 100 marks* *SEE: --*
*Credits: 10*

**Objectives:**

- *Identification of the research problem*
- *Discussion of literature survey.*

**Outcomes:**

1. *Identification of the objectives of the Research Problem.*
2. *Ability to update the latest literature in chosen area of research & establishment of the scope of work.*
3. *Development of the methodology for the chosen research problem and perform basic theoretical /experiment studies.*

Each student will be attached to a faculty member/guide for project. The student will carry out the project which may be development of Software / Hardware / Simulation studies / Design analysis / Experimental related to his/her specialization. The work will be monitored regularly by the guide. At the end of the semester student will write the report on the work done and submit to the guide. Student has to present his/her work before two faculty members (one guide and other to be appointed by chairman BOS) on a fixed day during last week of the semester in which project is offered. The sessional marks will be awarded jointly by these examiners based on the report, presentation and viva voice

**SEMISTER - IV**

**CE 182**

**MAJOR PROJECT PHASE-II**

*Instruction: 32 periods per week* *Duration of SEE: --*
*CIE: --* *SEE: 200 marks*
*Credits: 16*

**Objectives:**

- *Identification of the research problem*
- *Discussion of literature survey.*

**Outcomes:**

1. *Expand the defined Research Problem for the dissertation work.*
2. *Conduct of Laboratory/analytical/ software studies*
3. *Analysis of Data, development of models, offer solutions to the research problem and provide conclusions of the work.*

The student will carry out the project under allotted supervisor, which may be development of Software / Hardware / Simulation studies / Design analysis / Experimental related to his/her specialization. The work will be monitored regularly by the guide. At the end of the semester student will write the report on the work done and submit to the guide. Student has to present his/her work before two faculty members (one guide and other to be appointed by chairman BOS) on a fixed day during last week of the semester in which project is offered. The final marks will be allotted based on the report, presentation and viva voce conducted by the external examiner whose name is suggested by Chairman BOS