CURRICULUM

M. TECH.
in
STRUCTURAL AND CONSTRUCTION ENGINEERING

(July 2019 admission onwards)

APPROVED BY

BOARD OF STUDIES (BOS)

12th MEETING, February 20, 2019

DEPARTMENT OF CIVIL ENGINEERING

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY,
Jalandhar
TEACHING SCHEME

Semester – I*

<table>
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<tr>
<th>Course No.</th>
<th>Course Title</th>
<th>Periods</th>
<th>Credits</th>
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Semester - II

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Note: 8 Core courses excluding Independent Study and Dissertations and 4 Elective courses need to be completed for the degree. Only Elective Courses will be offered in the 3rd Semester.

Semester – IV@

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@ The result of Dissertation Part I & II shall be forwarded cumulatively after evaluation of dissertation

Grand Total of Credits = 65
### LIST OF CORE COURSES FOR M. TECH.
(STRUCTURAL AND CONSTRUCTION ENGINEERING)

<table>
<thead>
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<td>Advanced Solid Mechanics</td>
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<td>Advanced Reinforced Concrete Design</td>
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<td>Structural Dynamics</td>
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<td>CE-504</td>
<td>Analysis and Design of Foundations</td>
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<td>Earthquake Resistant Design of Structures</td>
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<td>Advanced Structural Analysis</td>
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<td>CE-508</td>
<td>Advanced Construction Practices</td>
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<td>7</td>
<td>CE-509</td>
<td>Quantitative Methods in Construction Management</td>
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<td>8</td>
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### LIST OF LABORATORY COURSES FOR M. TECH.
(STRUCTURAL AND CONSTRUCTION ENGINEERING)

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<td>Foundation Engineering Laboratory</td>
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<td>CAD Laboratory</td>
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<td>Concrete Structures Laboratory</td>
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### LIST OF ELECTIVES FOR M. TECH.
(STRUCTURAL AND CONSTRUCTION ENGINEERING)

<table>
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<td>Quality and Safety Management in Construction</td>
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<td>Construction Economics and Finance</td>
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<td>Repair and Retrofitting of Structures</td>
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<td>Highway Construction and Maintenance</td>
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<td>Theory of plates And Shells</td>
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<td>Infrastructures Development Projects</td>
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<td>Analysis and Design of Tall Buildings</td>
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<td>CE-526</td>
<td>Construction Methods and Equipment</td>
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<td>CE-527</td>
<td>Design of Industrial Structures</td>
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<td>Advanced Steel Design</td>
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<td>CE-529</td>
<td>Soil Dynamics and Machine Foundations</td>
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<td>CE-530</td>
<td>Construction and Contract Management</td>
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<td>CE-531</td>
<td>Geoenvironmental Engineering</td>
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<td>CE-532</td>
<td>Landfill and Ash ponds</td>
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<td>Solid and Hazardous Waste Management</td>
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<td>Concrete Mechanics</td>
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<td>Recent Advances in Construction Materials</td>
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<td>Composite Materials</td>
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<td>Simulation &amp; Modelling</td>
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<td>Site Investigations and Ground Improvement</td>
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<td>Engineering Behaviour of Soils</td>
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<td>Geosynthetics</td>
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<td>CE-541</td>
<td>Pavement Analysis, Design and Construction</td>
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<td>Research Methodology</td>
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<td>CE-590</td>
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Course Objectives

- To understand solving Methods of three-dimensional stress and strain analysis and extended to allow the student and to obtain solutions using analytical as well as numerical methods.
- This subject will include the analyses of principal stresses and strains, state of stress and strain, true stress-true strain and generalized Hooke’s law and failure criteria.
- In addition, this subject will focus on plastic deformation of solids, including the analysis of residual stresses and the collapse load of structures subjected temperature and mechanical loading.
- To understand the responses of materials to fatigue and fracture, as well as their creep and viscoelastic behavior.

Course Syllabus

State of stress in a body. Tensor notations, Differential equations of equilibrium, Invariants of the stress tensor, Theory of strain, Displacement components, strain components and relation between them, Generalised Hooke’s law, Solution of the elasticity problem in terms of displacements, Basic equations of the theory of elasticity, Lame’s equations, Plane problem in cartesian co-ordinates, Plane problem in polar co-ordinates, Shrink fits, Rotating disks with uniform thickness, Plate with hole, Torsion in prismatic bars, Saint Venant’s method, Solution of torsion problem in terms of stresses Strain energy, Elastic plastic behaviour, Design philosophy, Linear elastic and plastic behaviour, Tresca and Von Mises yield criteria, Visco-elastic behaviour.

Course Outcomes

- This subject helps to understand the theory of elasticity including strain/displacement and Hooke’s law relationships;
- As outcome, subject helps to analyze solid mechanics problems using classical methods and energy methods;
- To solve for stresses and deflections of beams under unsymmetrical loading;
- To locate the shear center of thin wall beams; and to obtain stresses and deflections of beams on elastic foundations;
• To obtain solutions to column buckling and plate problems; as well as to apply various failure criteria for general stress states at points.

Text and Reference Books:

CE-502 Advanced Reinforced Concrete Design [3-0-0-3]

Course Objective:
• To make students Understandable about the various elements of different types of industrial and non-industrial RCC structures.
• To make students’ Knowledgeable of design provisions given in Indian standard code.
• To make students able to design the basic elements like, beams, slab.
• To make students able to analyze and design the chimneys, shear walls, virendeel girders, concrete trusses.

Course Syllabus:

Deflections of Reinforced Concrete Beams and Slabs; Estimation of Crack Widths in Reinforced Concrete Beams; Inelastic Analysis of Reinforced Concrete Beams and Frames; Design of Shear Walls, Cast-in-Situ Beam-Column Joints, Deep Beams, Chimneys, Ribbed Slabs; Design of Reinforced Concrete Members for Fire Resistance; Software Applications, Virendeel Girders, Concrete Trusses.

Course Outcome:
• Understand the various elements of different types of industrial and non-industrial RCC structures.
• Knowledge of design provisions given in Indian standard code.
- Able to design the basic elements like, beams, slab.
- Able to analyze and design the chimneys, shear walls, virendeel girders, concrete trusses.

**Books Recommended:**
4. SP 208 “Examples for the Design of Structural Concrete with Strut – and – Tie Models” Editor: Karl – Heinz Reineck, American Concrete Institute, Michigan, 2003.

**CE 503 Structural Dynamics [3-0-0-3]**

**Course Objective:**
- To analyze structures subjected to any kind of dynamic excitation and computing quantities like displacements, forces, stresses, etc.
- Understanding the analytical methods and procedures in a way that emphasize physical insight.
- Ability to apply the structural dynamics theory to real-world problems like seismic analysis and design of structures.
- To study the mode shapes and frequencies of single and multi degree of freedom of structures.

**Course Syllabus**

Concept of degrees of freedom and constraints, Equations of motion, Newton’s Law and De Alembert’s Principle, Response of single degree of freedom systems to initial conditions, Response to harmonic excitation, Dynamic amplification factor, Transmissibility, Base Isolation, Response to non harmonic excitations such as impulse, step loading and blast loading, Duhamel’s Integral, Earthquake response analysis, Response spectrum, Theory of vibration pick – ups, Estimation of dynamic characteristics through experimental investigations, Multi degree of freedom systems, Orthogonality of mode shapes, Mode superposition method for seismic analysis.
Course Outcome:

- Apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.
- Create simple computer models for engineering structures using knowledge of structural dynamics interpret dynamic analysis results for design, analysis and research purposes apply structural dynamics theory to earthquake analysis, response, and design of structures

Books Recommended:


CE-504 Analysis and Design of Foundation Structures [3-0-0-3]

Course Objective:

- To be able to develop deeper understanding of shallow and deep foundations.
- To be able to develop understanding of different design parameters.
- To be able to design foundations and reinforced retaining walls.

Course Syllabus:

Introduction to shallow and deep footings, Design of strap, Raft and combined footings, Design of pile footings, Caps for piles, design of different components of well foundations, Footings subjected to eccentric loading, uplift and overturning, Soil-Structure interaction, Sub grade reaction method, Geotechnical design considerations, Site and soil conditions, Soil liquefaction, Evaluating the liquefaction potential by Standard Penetration Tests, by Cone Penetration Tests, by
Shear Wave Velocity, Liquefaction of clayey soil, Mitigation of Liquefaction Hazard by site modification, Mitigation of Liquefaction Hazard by Structural Design, Seismic Settlement, Subsidence and Differential Compaction, Fault Rupture, Lateral Seismic Earth Pressures.

**Course Outcome:**
- Students will be able to design shallow and deep foundations.
- Students will be able to determine different design parameters.
- Students will be able to design reinforced retaining wall.

**Books Recommended:**

**CE-506 Earthquake Resistant Design of Structures [3-0-0-3]**

**Course Objective:**
- To Study the multimodal and multidirectional response spectrum analysis.
- To make students familiar regarding understanding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian standard code.
- To make students able to do seismic design and detailing of structures with reference to is code.

**Course Syllabus:**

Behaviour of buildings and structures during past earthquakes and lessons learnt, goals of earthquake resistant design. Linear static procedure for seismic load calculation – IS 1893 – 2002,

Course Outcome:
- Study the multimodal and multidirectional response spectrum analysis.
- Understanding the earthquake resistance design philosophy.
- To carry out lateral load analysis with reference to Indian standard code.
- Able to do seismic design and detailing of structures with reference to is code.

Books Recommended:

CE-507 Advanced Structural Analysis [3-0-0-3]

Course Objective:
- To make students able to determine the various properties of cement experimentally
- To determine the specific gravity and water absorption of fine and coarse aggregates.
- To perform various test of fresh and harden concrete.
- To make students able to carry out the test procedure of compressive test and flexure test.
Course Syllabus:
Basic concepts, Degree of static and kinematic indeterminacy, Matrix algebra, Solution of simultaneous equations by Gaussian Elimination, Flexibility and Stiffness Matrices, System Approach: Development of stiffness matrix, Applications of stiffness method to continuous beams, trusses and frames. Effect of temperature, and prestrain. Element Approach: Element stiffness, 2D truss element and beam element, Transformation matrix, Assembly of global stiffness matrix, Storage requirement of stiffness matrix i.e. full storage, banded storage and skyline storage, Effect of node and element numbering, Boundary conditions, Application of stiffness method to beams, trusses and frames. Computer applications, Material and geometrical non-linearity, Application of Virtual work and energy principles.

Course Outcome:
- Determination of various properties of cement experimentally.
- Determination of specific gravity and water absorption of fine and coarse aggregates.
- Various test of fresh and harden concrete.
- Carry out the test procedure of compressive test and flexure test.

Books Recommended:

CE-508 Advanced Construction Practices [3-0-0-3]

Course Objective:
- To give an experience in the implementation of new technology concepts which are applied in field of advanced construction.
To enable students to describe, analyze, compare and evaluate the technology of mass concreting, industrialised construction and special construction methods.

To aware the students of some of the problems that can be associated with construction in extreme weathers and difficult conditions.

**Course Syllabus:**
Concrete Construction Methods, Formwork Design and Scaffolding; Slip Forms and other moving forms; Pumping of Concrete; Grouting and Mass Concreting Operations (roller compacted concrete); Ready-Mix Concrete; Various Methods of Handling and Placing Concrete, Accelerated curing, Hot and cold weather concreting, Under water concreting, Prestressing. Steel and Composite Construction Methods, Fabrication and erection of structures including heavy structures, Prefab construction, Industrialised construction and Modular coordination. Special Construction Methods, Construction in Marine Environments, High Rise Construction, Bridge Construction including Segmental Construction, Incremental Construction and Push Launching Techniques; Geosynthetics; Safety, Quality Measures and Reliability.

**Course Outcome:**

- Students shall understand the latest construction techniques applied to Engineering Construction.
- Students will attain an overall picture of special construction methods with a good understanding of the onsite construction issues and gain an insight in constructing civil, industrial, bridges and building type projects in extreme conditions.

**Books Recommended:**

**CE-509 Quantitative Methods in Construction Management [3-0-0-3]**

**Course Objective:**

- Review the basic concepts of probability and statistics.
- To apply linear programming for optimization of various problems.
- To get familiar with queuing theory, decision theory and game theory.
- To get overview of modifications and improvement on CPM/PERT techniques.

**Course Syllabus:**
Introduction and concepts of probability and statistics, Optimization through Linear programming- Need for linear programming, Linear programming model, dual problem, dynamic programming. Transportation model, solution of Transportation model, Assignment problems, solution of assignment problem. Queuing theory- waiting line models, deterministic model, probabilistic model, Decision theory- decision analysis, decision under uncertainty, Nature of Games, Games model, solution of Games model, simulations as applied to construction-simulation models, steps in simulation, Monte carlo simulation. Modifications and improvement on CPM/PERT techniques.

**Course Outcome:**
- Students will learn the basics of probability and statistics, linear programming for optimization, queuing theory, game theory and CPM/PERT tecniques.

**Books Recommended:**

**CE 601 Independent Study [0-0-6-3]**

**Course Objective:**
- To develop students into self-directed learners and independent researchers.
• To provide more scope and depth in the Graduate Kinesiology curriculum by encouraging students to investigate areas of interest not currently included in any approved course at NIT Jalandhar.
• To study areas and develop projects that cut across existing course boundaries.
• To understand more deeply into specific parts of an existing course offering.
• To provide the student with sufficient circumstances to assess personal aptitude for the sport management, fitness management, or sports studies field.
• To develop a critical understanding of and the ability to apply theoretical knowledge from the student’s chosen concentration, sport management, fitness management, or sports studies, in a research or self-directed learning environment.

Guidelines:
This is a seminar oriented subject in which the student is required to select a topic of his interest related to recent developments and the state-of-the-art in the field under study in consultation with a designated faculty advisor. The student shall be required to carry out a comprehensive literature survey on the selected topic and compile a detailed report and present a minimum of two seminars comprising of one mid-term seminar and one end semester seminar. A continuous evaluation of the student performance in terms of seminar presentation and final report shall be carried out.

Course Outcome:
• Students will be required to identify, describe, and document at least three personal learning outcomes specific to their independent study to help ensure their independent study experience is congruent with their personal, professional goals.
• These outcomes must be included on the student’s independent study report and approved by their faculty advisor.

CE 600 Dissertation Part-I [0-0-6-6] and Dissertation Part-II [0-0-24-12]

Guidelines:
Candidate should carry out the preliminary literature survey and subsequently, identify the problem in broad terms for Dissertation and finalize/settle it in consultation with Guide/Supervisor.
Pursuant to this, the candidate shall refer multiple literatures pertaining to the theme of the problem and understand the problem and define the problem in the precise terms. Candidate should attempt solution to the problem by analytical/simulation/experimental methods. The solution shall be validated with proper justification. The learner shall compile the report in standard format.

Candidates are advised to publish in reputed International/National Conference and reputed International/National journal. The work to be pursued as a part of the dissertation shall be divided broadly in two parts, namely Dissertation I and Dissertation II. The topic of the Dissertation should be such that it is a value addition for the existing knowledge in the field and has some worthwhile research input.

**CE-520 Foundation Engineering Laboratory [0-0-3-2]**

**Course Objective:**

- The objective is to learn to perform tests on soil and determine the properties of various soils

**Course Syllabus:**

- Plate load test,
- Standard penetration test,
- Static cone penetration test,
- Dynamic cone penetration test,
- Triaxial shear test,
- Large shear box test and testing of Geotextiles and geofibres.

**Course Outcome:**

- Students will be able to perform different tests on soils

**CE 521 CAD Laboratory [0-0-3-2]**

**Course Objective:**

- To impart fundamental knowledge to students in the latest technological topics on Computer Aided Design, analysis of building and Computer Aided Engineering Analysis.
• To create congenial environment that promotes learning, growth and imparts ability to work with inter-disciplinary groups in professional, industry and research organizations.
• To provide guidance to students for their choices in research and professional career outlook and to encourage students to take up research.

Course Syllabus:
Introduction to various research and design softwares and their applications
• Comparison of Numerical and theoretical deflection of single and multispans beam with pinned and fixed supports
• Analysis and design of G+4 building against Dead and Live load using STAAD Pro.
• Analysis and design of Multistorey framed building against Earthquake & wind loading using STAAD Pro.
• Analysis and design of steel truss against seismic loading using STAAD Pro.
• Analysis and design of suspension Cable Bridge using STAAD Pro.
• Determine the stress and deformation of one way and two way slab using ABAQUS/CAE.
• Determine the stress and deformation of singly and doubly reinforced concrete beam using ABAQUS/CAE.
• Determine the stress and deformation of axially loaded reinforced concrete column using ABAQUS/CAE.
• Determine the stress and deformation of steel truss bridges using ABAQUS/CAE.

Course Outcome:
• Apply solutions or to do research in the areas of Design and simulation in the field of civil Engineering.
• Have abilities and capabilities in developing and applying computer software and hardware to mechanical design and manufacturing fields.
• Formulate relevant research problems; conduct analytical study and analyzing results with modern mathematical methods and use of software tools.
• Design and validate technological solutions to defined problems and communicate clearly and effectively for the practical application of their work.
CE-522 Concrete Structures Laboratory [0-0-3-2]

Course Objective:
- To perform the testing of PCC and SFRC samples under compression and flexural testing under static and fatigue loading.

Course Syllabus:
- Testing of PCC and SFRC samples under compression and flexural testing under static and fatigue loading.

Course Outcome:
- Testing of PCC and SFRC samples under compression and flexural testing under static and fatigue loading.

CE-523 Material Testing Laboratory [0-0-3-2]

Course Objective:
- To make students aware about the design of concrete mixes for high strength and high performance of fly ash concrete.

Course Syllabus:
- Design of concrete mixes for high strength and high performance of flyash concrete.

Course Outcome:
- Design of concrete mixes for high strength and high performance of fly ash concrete.
Syllabus of Electives
CE 505 Finite Elements Analysis [3-0-0-3]

Course Objective:

- To implement the basics of FEM to relate stresses and strains.
- To solve one, two and three dimensional and dynamic problems using Finite Element Analysis.
- To develop the ability to generate the governing FE equations for systems governed by partial differential equations;
- To understand the use of the basic finite elements for structural applications using truss, beam, frame, and plane elements;
- To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems through the use of a major commercial general-purpose finite element code.

Course Syllabus


Course Outcome:

- Implement numerical methods to solve mechanics of solids problems.
- Formulate and Solve axially loaded bar Problems.
- Formulate and analyze truss and beam problems.
- Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.
- Formulate and solve Axi-symmetric and heat transfer problems.
Books Recommended:


CE-510 Quality and Safety Management in Construction [3-0-0-3]

Course Objective:

- To introduce the students about quality and safety related challenges in construction industry.
- To make students aware about the globally recognized guidelines/theories for quality and safety in construction.
- To understand the importance of safety management in construction and the reduction of accidents on construction sites.

Course Syllabus:

Course Outcome:
- Students will understand the concept of QC (quality control), quality assurance (QA) and TQM (Total Quality Management) in construction projects.
- Students will be able to recognize and evaluate occupational safety and health hazards onsite, and to determine appropriate hazard controls following the hierarchy of controls. Students will furthermore be able to analyze the effects of onsite exposures, injuries and illnesses, fatalities and the methods to prevent incidents at construction site.

Books Recommended:

CE-511 Construction Economics and Finance [3-0-0-3]

Course Objective:
- To evaluate construction project economics, cost-benefit analysis, breakeven analysis and to analyze construction risks and uncertainties.
- Understand the importance of working capital management, budgeting and control.
- To study the need for financial management and means of achieving the same.
- Provide students with an economic perspective of the real estate and construction sectors, and an understanding of their roles on the general economy.

Course Syllabus:
Construction accounting, Income statement, Depreciation and amortization, Engineering economics, Time value of money, discounted cash flow, NPV, ROR, PI, Bases of comparison,

**Course Outcome:**
- On completion of this course the students will be able to know Life cycle costing, Financial Planning and Management for the construction project and Economical analysis of construction projects.
- Students will be able to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or more economic alternatives
- Students will understand the economic principles that underpin construction activities and will be able to use and apply cost planning and control techniques.

**Books Recommended:**

**CE-512 Repair and Retrofitting of Structures [3-0-0-3]**

**Course Objective:**
- To make students familiar about the understanding of the structure of earth.
- To understand the importance of geology applied to civil engineering practice.
- To make students Knowledgeable of different types of rocks and minerals and their physical properties.
• To make students Knowledgeable of in situ determination of engineering properties of rock masses.
• To make students understandable regarding the concepts of folds and faults, their classification and relation to engineering purposes.

Course Syllabus:
Principles of retrofitting, objective and principles of intervention, design steps for intervention, criteria for repair and retrofitting, repair materials and techniques, seismic vulnerability evaluation of buildings, feasibility assessment, design considerations, analytical and experimental techniques, retrofit design and implementation, techniques of retrofitting and improving structural integrity of masonry buildings, codes of practices for repair and retrofitting, techniques of retrofitting of RC buildings and structural elements, retrofitting of bridges and dams and heritage structures, retrofitting of structures by seismic base isolation, case studies of retrofitting of structures.

Course Outcome:
• Understand the structure of earth.
• To understand the importance of geology applied to civil engineering practice.
• Knowledge of different types of rocks and minerals and their physical properties.
• Knowledge of in situ determination of engineering properties of rock masses.
• Understand the concepts of folds and faults, their classification and relation to engineering purposes.

Books Recommended:
CE 513 Advanced Numerical Methods [3-0-0-3]

Course Objectives:
- To understand the different numerical methods and presently available methods
- To be able to use different numerical methods for solving various geotechnical problems

Course Syllabus:
Introduction
Solutions to linear equations, properties of matrices, Eigen values and Eigen vectors, solutions of linear systems; direct methods and iterative methods, Computation of Eigen values, solutions to the problems using programming languages (C, C++, FORTRAN, MATLAB).
Solutions of non linear equations, importance of non linear equations, different numerical techniques to solve non linear equations (Newton Raphson method, secant method, Aitken method).
Approximation of functions. Introduction, Taylor series, least squares, legendre polynomials, regression analysis.
Numerical differentiation and integration, ODE and PDE, truncation errors.

Course Outcomes:
- Student should be able to use different numerical methods for solving various geotechnical problems.

Text and Reference Books:
Course Objectives:

- To understand the requirement of materials and their role in pavements
- To gain knowledge of various types of failures in pavements and their specific remedy

Syllabus:

Materials for road construction: material properties (physical and chemical) of bitumen, cutback, emulsions, stabilizers, polymeric bitumen, elastomeric and plastomeric compounds, aggregates, coarse sand, stone dust, slags, river bed material, soil

Construction of low volume roads: Construction of Earth road, Construction of Gravel road, Construction of WBM roads

Flexible Pavement Construction: various layers: their advantages and requirements, standard materials’ requirements, possible types of materials in different layers.

Construction of rigid pavements: various layers: their advantages and requirements, standard materials’ requirements, possible types of materials in different layers.

Pavement maintenance and retrofitting: Pavement Failures, Pavement maintenance methods, Evaluation of pavement, Strengthening of existing pavements by overlaying, retrofitting of rigid pavements.

Course Outcome:

- The students will be able to evaluate the condition of pavement and specify requisite measure in terms of either pavement strengthening or maintenance.
- The course will enable students to make use of different materials in the specific layer of pavements.

Recommended Books:

CE-515 Theory of plates and Shells [3-0-0-3]

Course Objectives:
- To achieve fundamental understanding of the classical theory of plates and shells, address importance of plate and shell structures, introduce analytical solutions and numerical techniques and present detailed design of plate as well as shell structures.

Syllabus:

Course Outcome:
- To enable students to apply the theory of plates and shells to problems, involving various geometries, loading and boundary conditions, to diverse problems in civil engineering and other related fields such as aerospace and mechanical engineering.

Recommended Books:

CE 516 Geospatial Technologies [3-0-0-3]

Course Objectives:
The goals of this course are to:

- Provide knowledge about the fundamentals of remote sensing, sensor systems and image characteristics
- Provide knowledge about the GPS system and its components, the GPS signal structure, the types of GPS measurements and their errors and biases.
- Provide an introduction to LIDAR data and discusses how to integrate and manage LIDAR data in GIS
- Enhance student understanding of characteristics of spatial data that come from different sources
- Enhance student understanding of data quality issues when integrating different data sources in GIS.

Course Syllabus:
Chapter–1: Geospatial Overview: Introduction to Geospatial Technology, Why to study, Geospatial Technology, Importance of Geospatial Technology.
Chapter–2: Mapping & Cartography: What is Map & its Importance, Map Scale and Types, Elements of Map and Indexing, Map Coordinate System, Interpretation of Satellite Images.


Chapter–5: Geographical Information System (GIS), Fundamentals of GIS, Components of GIS. GIS Acquisition of GIS, Data Types of GIS, Application of GIS.


**Course Outcomes:**

Upon successful completion of the class, students should be able to:

- Critically evaluate and analyze data quality for their GIS project
- Design a geo-database and defend the data type selection
- Appraise the degree to which remote sensing data can be used efficiently and effectively
- Interpret the GPS signal and the factors that affect signal quality
- Interpret the significance of Dilution of Precision and its effect on position accuracies and evaluate correction techniques
- Decide and defend the use of raster versus terrain when performing analysis with LIDAR data
- Combine LIDAR data with multiple data sources to create more complex three-dimensional surfaces
Recommended Books:

CE-517 Prestressed Concrete Design [3-0-0-3]

Course Objective:
- To understand the general mechanical behavior of prestressed concrete.
- To analyze and design prestressed concrete flexural members.
- To analyze and design for vertical and horizontal shear in prestressed concrete.
- To analyze transfer and development length as well as prestress losses.
- To analyze and design for deflection and crack control of prestressed concrete member.

Course Syllabus:
Definition, Basic Principles, Types of prestressing, Systems of prestressing, Loss of prestress, materials used, Advantages and disadvantages. Critical load condition, Permissible stresses, Various suggested methods of design, Dimensionless Design variables, Solution of equations, Design Procedure based on flexure, Minimum weight design, Cable layout and profile of tendons, Design by load balancing method, Code provisions. Allowable stress considerations, Non-dimensionalised allowable stress equations and their solution, Shrinkage Stresses. Two span continuous beams and their analysis, Application of moment distribution method, Design of continuous beams, Continuous beams with variable section. One way and two way slabs, Beam and slab construction, Principal Stresses, failure due to shear, combined bending and shear, Bond, Prestressing cable at the centroidal axis, Symmetric multiple cable, cable with eccentricity, Inclined cables, Spalling and bursting stresses. Compression members, Tension members, Prestressed Concrete Pavements, Folded plates and Shells, Arches, Dams, Rigid frames, Cylindrical tanks.

Books Recommended:
2. Rajagopalan N “Prestressed Concrete” Narosa, New Delhi, 2002.
Course Outcome:

- Students will be able to identify and apply the applicable industry design codes relevant to the design of prestressed concrete members.
- Student will be familiar with professional and ethical issues and the importance of lifelong learning in structural engineering.
- Students will become familiar with the prestressed concrete fabrication and construction process.
- Students will be able to perform an industry relevant design project in a team setting.

CE-518 Infrastructure Development Projects [3-0-0-3]

Course Objective:

- To understand various concepts of infrastructure planning and management and know stages of an Infrastructure Project Lifecycle.
- To understand the role of Private sector and World Bank in infrastructure growth.
- To familiarize with the latest trends in Construction management, Construction materials and Construction machinery required for various types of infrastructure development project.

Course Syllabus:


**Books Recommended:**
2. India Infrastructure Report 2001 & 2002, Oxford University Press, New Delhi, 2001/02

**Course Outcome:**
After the completion of course, students will be able to:
- Gather background information and research and describe its impact on the infrastructure project.
- Understand the concepts of financial, economic, social and environmental impact and describe and explain how these are undertaken in an infrastructure project.
Students will be able to understand the challenges and strategies for successful Infrastructure Project Implementation.

**CE-519 Analysis and Design of Tall Buildings [3-0-0-3]**

**Course Objective:**
- To make students aware about the structural elements and types of structural elements for tall buildings.
- To make analysis off Tall Buildings with and without Shear Walls, tube-in-tube constructional and 3-Dimensional analysis of shear core buildings.
- To make students knowledgeable of design of Tall Buildings Procedures of elastic design, ultimate strength design and limit state design of super structures including structural connections.

**Course Syllabus:**

**Course Outcome:**
- Structural elements and types of structural elements for tall buildings.
- Analysis off Tall Buildings with and without Shear Walls, tube-in-tube constructional and 3-Dimensional analysis of shear core buildings.
- Design of Tall Buildings Procedures of elastic design, ultimate strength design and limit state design of super structures including structural connections.

**Books Recommended:**

CE-526 Construction Methods and Equipment [3-0-0-3]

Course Objective:
- Properly select heavy equipment based on applications, utilization, productivity, and other factors
- Understand the elements of equipment cost and evaluating equipment owning alternatives.
- Have a basic understanding of various aspects of construction and earthwork, including but not limited to: concrete construction, Pile driving, tunneling, construction equipment and dewatering.

Course Syllabus:
Factors affecting selection of equipment technical and economic, construction engineering fundamentals, Analysis of production outputs and costs, characteristics and performances of equipment for Earth moving, Erection, Material transport, Pile driving, Dewatering, Concrete construction (including batching, mixing, transport and placement) and Tunneling.

Course Outcome:
- Learn how to best utilize construction equipment on site work and heavy civil projects.
- Become familiar with construction methods, equipment and their capabilities.
- Understand standard designations, sizes, and gradations of equipment.

Books Recommended:

CE-527 Design of Industrial Structures [3-0-0-3]

Course Objective:
- To qualify the students to analyse and design of various types of industrial buildings and to understand the design concept of Cold-formed light gauges steel sections.
- To understand the design concept of chimneys, cooling towers and bunkers
- To understand the design concept of trussed girder bridges and bearing
- To develop clear understanding of the concepts and practical knowledge of modern Civil Engineering techniques for design of steel structures.

Course Syllabus:

Course Outcome:
- Capable of designing the industrial buildings with and without crane girders and students are capable enough to scrutinise the analysis and design of various industrial structures.
- Capable of designing the elements of steel construction.
- Capable of providing the design of concrete –Steel composite sections.
- Able to understand the analysis and design of trussed girder bridges and bearing.
- Able to analyze and design steel chimney, lattice tower and students able to independently design steel structures using relevant IS codes.
Books Recommended:

CE-528 Advanced Steel Design [3-0-0-3]

Course Objective:
- To make students able to plastic design, plastic hinge, plastic collapse load, plastic analysis of frames.
- To make students knowledgeable about the different configurations and components of elevated circular tanks.
- To make students aware about the design of light gauge steel.

Course Syllabus:
Plastic Design, Plastic Hinge, Plastic Collapse Load, Plastic Analysis of Frames; Wind Loads on Industrial Buildings, Braced and Unbraced Industrial Frames; Transmission Line Towers, Analysis by Tension Coefficients, Member Selection; Steel Tanks and Stacks, Different Configurations and components of Elevated Circular Tanks; Steel Stacks, Design Considerations; Design in Light Gauge Steel; Aluminum Structures; Residual Stresses.

Course Outcome:
- Able to plastic design, plastic hinge, plastic collapse load, plastic analysis of frames.
- Different configurations and components of elevated circular tanks.
- Design of light gauge steel.

Books Recommended:
CE-529 Soil Dynamics and Machine Foundations [3-0-0-3]

Course Objective:
- Identification of dynamic loads and their characteristic.
- To apply theories of vibrations.
- Able to determine dynamic soil parameters.
- Understand the concept of Vibration isolation and screening.

Course Syllabus:

Course Outcome:
- Students will learn the basics of dynamic loads and their characteristics, apply theories of vibrations.
- Students will be able to determine the dynamic soil parameters and understand the concept of vibration isolation.

Books Recommended:

**CE-530 Construction and Contract Management [3-0-0-3]**

**Course Objective:**
- To make Civil Engineering students able to analyze, evaluate and design construction contract documents.
- Resolve disputes collaboratively and amicably and outline alternative dispute resolution methods.

**Course Syllabus:**

**Course Outcome:**
Students will be able to
- Recognize different types of contracts and the effect of each type on the risk allocation strategy.
- Prepare contract schedules, notice inviting tender and contract documents.
- Apply contract administration tools and techniques to effectively manage the contract and avoid disputes during implementation.
Books Recommended:
4. McCaffer R and Baldwin A N: Estimating and Tendering for Civil engineering works”

CE 531 Geoenvironmental Engineering [3-0-0-3]

Course Objectives:
1. To make students aware about subsurface contamination and its sources
2. To make students learn about geotechnical aspects of planning and design of facilities for disposal of different kinds of solid waste
3. To make students learn about detection & monitoring of subsurface contamination and control & remediation of contaminated sites.
4. To make students learn about rehabilitation of waste dumps and geotechnical re-use of waste.

Course Syllabus:
Sources and effects of subsurface contamination; Physical, Chemical and biological characteristics of solid wastes; Soil-waste interaction; Contaminant transport; Laboratory and field evaluation of permeability; Factors affecting permeability;
Waste disposal on land. Types of landfills : Sitting criteria; waste containment principles; Types of barrier materials; Planning and design aspects relating to waste disposal in landfills, in ash ponds and tailing ponds, and in rocks.
Environmental monitoring around landfills; Detection, control and remediation of subsurface contamination; Engineering properties and geotechnical reuse of waste, demolition waste dumps; Regulations; Case studies.

Course Outcomes:
Students will be to
- plan and design the facilities for disposal of different kinds of solid waste
- plan the detection and monitoring of subsurface contamination
Text and Reference Books:

CE -532 Landfills And Ashponds [3-0-0-3]

Course Objectives
- To make students learn about design of waste disposal facilities
- To make students learn about the construction and operation of waste disposal facilities

Course Content
Integrated solid waste management of municipal solid waste, hazardous waste, coal ash and other wastes; Landfilling practice for different types of solid wastes; Municipal solid waste landfills: acceptability of waste; planning, design, construction, operation and closure including management of leachate and gas. Hazardous waste landfills: waste compatibility and acceptability; planning, design, construction, operation, closure and environmental monitoring. Ash ponds: Slurry disposal versus dry disposal; Engineering properties of bottom ash, fly ash and pond ash; planning and design; incremental raising of height by upstream and downstream methods; closure and reclamation.

Course outcomes
The student will be able to:
- To design the waste disposal facilities
- To contribute in construction and operation of the waste disposal facilities
- To plan the environmental monitoring around the waste disposal facilities.

Text and Reference Books:

CE -533 Solid And Hazardous Waste Management [3-0-0-3]

Course Objectives
- To make students understand the components of solid waste management system
- To make students learn about recycling, reuse and reclamation of solid wastes

Course Content

Course outcomes
After this course student will be able to:
- To review the components of solid waste management system
- Appreciate the significance of recycling, reuse and reclamation of solid wastes
- develop an insight into the collection, transfer, and transport of municipal solid waste
- understand the importance and operation of a various facilities for resource recovery and waste disposal

Text and Reference Books:
Course Objective:
- To make students aware regarding the theological modeling of fresh concrete, constitutive equations: nonlinear elasticity, plasticity, visco-elasticity understand the properties of composite materials.
- To share the concepts of Shear and torsion Bond-slip and phenomenon of cracking in reinforced concrete.
- To share the concepts of Statical and dynamical analysis of R. C. structures, trends.

Course Syllabus:

Course Outcome:
- Introduction, theological modeling of fresh concrete, constitutive equations: nonlinear elasticity, plasticity, visco-elasticity understand the properties of composite materials.
- Shear and torsion Bond-slip and phenomenon of cracking in reinforced concrete.
- Statical and dynamical analysis of R. C. structures, trends.

Recommended Books:
CE-535 Recent Advances in Construction Materials [3-0-0-3]

Course Objective:
- To introduce the students with various types of construction materials required in specific places and situations.
- To provide the knowledge regarding construction of infrastructure with the use of these materials that involves designing the constituents, mixes and gradations.
- To gain knowledge regarding use of cheap alternative materials in place of high cost construction materials.

Course Syllabus:

Course Outcome:
- The students will be able to make use of specific materials required for a given construction work.
- Course will enable them to decide the materials on basis of service life and expected performance on basis of their properties.

Recommended Books:

**CE-536 Composite Materials [3-0-0-3]**

**Course Objective:**
- To make students aware about the definition of composite materials, classification of composite materials, role of matrix in composite materials, polymer matrices, classification of polymer.
- To make students knowledgeable regarding the role of fibers in composites, comparison of fibres, role of interface in the fibre matrix composite.
- To make analysis of an orthotropic lamina and laminated composites, elastic properties of unidirectional laminate.

**Course Syllabus:**

**Course Outcome:**
- Definition of composite materials, classification of composite materials, role of matrix in composite materials, polymer matrices, classification of polymer.
- Role of fibres in composites, comparison of fibres, role of interface in the fibre matrix composite.
- Analysis of an orthotropic lamina and laminated composites, elastic properties of unidirectional laminate.
Recommended Books:

CE-537 Simulation & Modelling [3-0-0-3]

Course Objective:
- To impart the fundamental knowledge on using various analytical tools like STAAD Pro, ABAQUS, etc., for Engineering Simulation.
- Engineering problem modelling and solving through the relationship between theoretical, mathematical, and computational modelling for predicting and optimizing performance and objective.
- To impart knowledge on how these tools are used in Industries by solving some real time problems using these tools.
- Develop solutions and extract results from the information generated in the context of the engineering domain to assist engineering decision making.

Course Syllabus:
Competitive situations: Optimization, Single and multiple objectives optimizations, Pareto optimal solutions. Introduction to linear and geometric programmings. Zero degree and single degree of difficulty.
Growth and Decay processes: Discrete and continuous systems. Differential and Integral equation approach, Fibonacci growth.
Probability Distributions: Binomial and Poisson distributions, Normal, Lognormal and pareto distributions.
**Generation of random numbers:** Uniform variable, normal and lognormal variables.

**Queueing theory:** Montecarlo methods, solutions of Laplace equations in two dimensions.

**Course Outcome:**
- The student will be able to appreciate the utility of the tools like STAAD Pro or ABAQUS in solving real time problems and day to day problems.
- Use of these tools for any engineering and real time applications.
- Acquire knowledge on utilizing these tools for a better project in their curriculum as well as they will be prepared to handle industry problems with confidence when it matters to use these tools in their employment.

**Recommended Books:**

**CE-538 Site Investigations and Ground Improvement [3-0-0-3]**

**Course Objective:**
- Understand the basic principles, techniques of soil stabilization.
- Knowledge of different methods of soil stabilization.
- Identify the geosynthetic materials and its applications.
- To get familiar with different techniques of improvement of bearing capacity.

**Course Syllabus:**
Site Investigations: Planning of investigation programmes, Information required for planning different stages of investigations. Geophysical methods: electrical resistivity, and seismic refraction methods. Methods of site investigations: Direct methods, semi-direct methods and


Course Outcome:

- Students will learn the basics of stabilization and different techniques and materials used for stabilization.
- Students will learn about geosynthetics and their properties.
- Students will learn to design the foundations on stabilized soils and will be able to compare the results with not stabilized soils

Recommended Books:


CE-539 Engineering Behaviour of Soils [3-0-0-3]

Course Objective:

- To understand the mechanical stress, strain and strength of soil.
To understand the critical state soil mechanics.

Apply fundamental knowledge of the behaviour of soil as an engineering material in Civil Engineering Projects.

Analyse and solve a range of soil-related problems, especially those involving water flow and soil settlement.

Course Syllabus:
Shear behaviour of fine grained soils. Porepressure parameters. UU, CU, CD tests. Total and effective stress-strength parameters. Total and effective stress-paths. Water content contours.
Engineering Behaviour of soils of India: Black cotton soils, alluvial silts and sands, laterites, collapsible and sensitive soils, aeolin deposits.

Course Outcome:
- Students will be able to determine the stress, strain of soil, critical state of soil.
- Students will have knowledge regarding the behaviour of soil as an engineering material in Civil Engineering Projects.
- Students will learn to analyse and solve a range of soil-related problems, especially those involving water flow and soil settlement.
Books Recommended:

CE-540 Geosynthetics [3-0-0-3]

Course Objective:
- Understand different the basics of Geosynthetics
- Identify the geosynthetic materials and its applications.
- To get familiar with using different geosynthetics for improvement of bearing capacity and soil texture.

Course Syllabus:
Geosynthetics and Reinforced Soil Structures:
Types and functions; Materials and manufacturing processes; Testing and evaluations; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures - walls and slopes; Codal provisions; Bearing capacity improvement; embankments on soft soils; Indian experiences. Geosynthetics in Pavements:
Geosynthetics in roads and railways; separations, drainage and filtering in road pavements and railway tracks; overlay design and construction; AASHTO and other relevant guidelines; trench drains.
Geosynthetics in Environmental Control: Liners for ponds and canals; covers and liners for landfills - material aspects and stability considerations; Landslides - occurrences and methods of mitigation; Erosion - causes and techniques for control.

Course Outcome:
- Students should be able to distinguish between different geosynthetics.
Students should be able to determine the properties of geosynthetics.

Students should be able to determine the bearing capacity of soil after introducing geosynthetics.

Recommended Books:

CE-541 Pavement Analysis, Design and Construction  [3-0-0-3]

Course Objectives
1. To study the different types of pavements depending upon the mode of transportation using it and further, depending upon the structural behaviour.
2. To understand the concept of consideration of wheel loads, axle loads, wheel –axle configuration and allied aspects as a pre-requisite in the analysis and design of the pavement.
3. To study the various types of structural responses (stresses and deformations) inducing in the pavements due to wheel load and other climatic variations.
4. To introduce the constructions of different types of highway pavements.
5. To study the different types of distresses in the pavement, evaluation of the existing pavements using different methods and rehabilitation of the distressed pavements.
6. To study the design methodology and construction technology w.r.t. low volume roads.

Course Syllabus
Introduction: Pavement structure and functional attributes, factors affecting pavement design, types of wheel loads for highway and airports, development of design methods for highways and airport pavements.

Analysis of Pavements: Stresses in flexible pavements- Single layer, Two layer and Three layer theories, ESWL, EWLF, etc.; Stresses in rigid pavements- Wheel load, temperature and combined stresses.
Flexible Pavement Design: Various approaches for designing the highway and airport pavements (empirical, semi-empirical, mechanistic empirical, etc.), methods falling under each of these methods, overview of the revision of specifications pertaining to these methods, design of pavements using these methods.

Rigid Pavement Design: Various approaches for designing the pavements (highways and airports) and methods falling under each of these methods, overview of the revision of specifications pertaining to these methods, design of pavements using these methods, design of joints.

Highway Constructions: Construction of water bound macadam, wet mix macadam roads, bituminous concrete Roads, bituminous surfacing and treatment, cement concrete roads, semi-rigid and composite pavements, pavement construction using Pozzolanic and waste materials, roller compacted concrete pavement, fiber reinforced concrete pavements, quality control and quality assurance during constructions, etc.

Evaluation and Strengthening:
Distresses in flexible and rigid pavements, condition and evaluation surveys, present serviceability index, roughness measurement, pavement maintenance, Benkelman beam deflections, different methods of designing the overlays, overview of the revision of specifications pertaining to these methods, design of different overlays, skid resistance and measurement.

Low Volume and Low Cost Roads: Classification of low cost roads, stabilization of subgrade, sub-base and base and its advantages, low cost materials and methods used for construction, design of low volume roads.

Course Outcomes
On successful completion of the course, the learner shall be able to:

1. Understand the structural actions involved in the pavement due to different types of load acting thereon and the various methods of analysis of these pavements.
2. Understand the application of analysis in the design of pavements using various methods of pavement designs along with the design of low volume roads.
3. Understand the various aspects of the construction of different types of roads including that of low volume roads.
4. Know the different types of failures occurring in the existing pavements and carry out the structural and functional evaluation of pavements;
5. To apply the knowledge gained in evaluating the pavements in pre-empting the failure and subsequently, in arriving upon the methodology of the rehabilitation of pavements.
Books Recommended:

5. Das, Animesh, 2017. Analysis of Pavement Structures; CRC Group, Taylor and Francis Group

Reference Books

Additional Reading

Relevant specifications of Bureau of Indian Standards for Highway Material Testing, Indian Roads Congress (IRC) and Ministry of Road Transport and Highways (MoRTH) w.r.t. Pavement Design and Highway Construction revised time to time shall be referred to, e.g.:


Note: Some of the recent specifications may not have been incorporated in few books authored by Indian Authors. For this, titles of multiple books are given in the list of the Recommended Books. The latest editions shall be used. In addition to this, relevant specifications/ codes with the latest revisions thereof shall be referred to.

ID 601 Research Methodology [3-0-0-3]

Course Objectives:

- To understand research and research process.
- To acquaint students with identifying problems for research and develop research strategies.
- To familiarize students with the techniques of data collection, analysis of data and interpretation.

Course Syllabus:

Thinking Process: role of thinking in research, levels and styles of thinking, common sense and scientific thinking, examples.

Problem solving: problem solving strategies- reformulation or rephrasing, techniques of representation, logical thinking, division into sub problems, verbalization, awareness of scale, importance of graphical representation, examples.
**Experimental and modelling skills:** census and sample survey, sampling procedure, important scaling techniques, methods of data collection, estimation and reduction of random errors, detection and elimination of systematic error, guideline for constructing questionnaire, scientific method role of hypothesis in experiment, hypothesis testing, F test, t-test, chi square test, use of ANOVA.

Types of models, the art of making approximations, problem representation, logical reasoning, mathematical skills, techniques of numerical simulation.

**Problem finding and literature survey:** information gathering reading searching and documentation, types, attributes and sources of research problem; problem formulation, relative importance of various forms of publication; choice of journal entries using process, difference between publishing and patenting.

**Effective communication-oral and written:** examples in straightening the importance of effective communication, stages and dimensions of a communication process.

**stress management time management interpersonal skills professional ethics:** psychological faces of a PhD process, stress points, managing self, teamwork, sense of humor, plagiarism and research ethics.

**Course Outcome:**
Learner will be able to…
- Prepare a preliminary research design for projects in their subject matter areas.
- Accurately collect, analyze and report data.
- Present complex data or situations clearly.
- Review and analyze research findings.

**Recommended Books:**
1. E.M. Phillips and D S Pugh, — How to get a PhD – a handbook for PhD students and their supervisors, Viva books Pvt. Ltd for all scholars irrespective of their disciplines.
3. G L Squires, —Practical physics, Cambridge University Press for all scholars except those from Humanities and Management sciences.
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 Syllabus:

UNIT –I Research methodology
Meaning, Objectives and Characteristics of research - Research methods Vs Methodology - Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research - Developing a research plan.

UNIT –II Literature survey
Importance of literature survey - Sources of information - Assessment of quality of journals and articles - Information through internet. Literature review: Need of review - Guidelines for review - Record of research review.

UNIT –III Research design
Meaning of research design - Need of research design - Feature of a good design - Important concepts related to research design - Different research designs - Basic principles of experimental design - Developing a research plan - Design of experimental set-up - Use of standards and codes of Civil Engineering.

UNIT –IV Data collection and analysis:
Collection of primary data and Secondary data of different Civil Engineering fields - Data organization - Methods of data grouping - Diagrammatic representation of data - Graphic representation of data - Sample design - Need for sampling - Some important sampling definitions - Estimation of population - Role of statistics for data analysis - Parametric vs. non parametric methods - Descriptive statistics - Measures of central tendency and dispersion - Hypothesis testing - Use of statistical softwares. Data Analysis: Deterministic and random data - Uncertainty analysis
Tests for significance - Chi-square - Student’s t-test - Regression modeling - Direct and interaction effects - ANOVA - F-test - Time series analysis - Autocorrelation and autoregressive modeling.

UNIT – V Research report writing:

Course Outcome:
- Differentiate the research types and methodology.
- Able to do literature survey using quality journals.
- Able to collect research data.
- Process research data to write research report for grant proposal.

Recommended Books: