M.Tech (Structural & Construction Engineering)
Curriculum and Syllabus 2019

CURRICULUM
First Semester

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Type</th>
<th>Course</th>
<th>L T P</th>
<th>Cr</th>
</tr>
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<tbody>
<tr>
<td>18MA618</td>
<td>FC</td>
<td>Linear Algebra, Legendre Equations and Numerical Methods</td>
<td>3- 0- 0</td>
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<tr>
<td>18SC601</td>
<td>FC</td>
<td>Advanced Structural Mechanics</td>
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<tr>
<td>18SC611</td>
<td>SC</td>
<td>Theory of Elasticity and Plasticity</td>
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<td>Experimental Techniques</td>
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<td>HU</td>
<td>Soft skills - I</td>
<td>P/F</td>
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<td>Cultural Education*</td>
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Credits 18

*Non Credit Course

Second Semester

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<td>Finite Element Analysis</td>
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<td>Research Methodology</td>
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Credits 19

*Non Credit Course

Third Semester

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<td>Dissertation</td>
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Credits 15
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**Total Credits 64**

### List of Courses

#### Foundation Core

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#### Subject Core

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#### Electives

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<td>Structural Dynamics</td>
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<td>18SC705</td>
<td>Theory of Plates and Shells</td>
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<td>18SC707</td>
<td>Quality Control and Safety in Construction</td>
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<td>Pre-stressed Concrete Design</td>
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<td>18SC709</td>
<td>Analysis and Design for Earthquake Forces</td>
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<tr>
<td>18SC710</td>
<td>Forensic Engineering and Rehabilitation of Structures</td>
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TEXT BOOKS / REFERENCES:


18SC601 ADVANCED STRUCTURAL MECHANICS 2-1-0-3

Review of the concepts: Basic concepts of structural analysis; Basis for principle of virtual work; Principle of virtual forces - standard and matrix formulation; Force method for analyzing skeletal structures; Principle of virtual displacements - standard and matrix formulation; Displacement method for analyzing skeletal structures; Extension of displacement method to the generalized stiffness method; Basic concepts associated with computer implementation of stiffness method. - One-dimensional beam element : Basis for cross-sectional level formulation of flexibility and stiffness; Gauss quadrature numerical integration scheme; Flexibility approach for determining element stiffness; Stiffness approach for determining element stiffness; Special consideration of shear effects in stiffness approach; Consideration of torsional effects for thin-walled member; Special considerations for finite joints (both rigid and flexible); Consideration of local load (incl. temperature) effects; Formulation of geometric stiffness due to axial force; Linearised buckling analysis.

TEXT BOOKS/ REFERENCES:


18SC611 THEORY OF ELASTICITY AND PLASTICITY 2-1-0-3

Introduction to the mathematical theory of elasticity: Two-dimensional idealisations, plane stress and plane strain problems, equations of equilibrium, strain-displacement relations,

TEXT BOOKS/ REFERENCES:


18SC612 ADVANCED STRUCTURAL DESIGN 3 -1-0-4

Stress-strain characteristics of concrete under multi-axial stresses- confined concrete- Effect of cyclic loading on concrete and reinforcing steel. Control of deflections- Control of cracking – Codal procedures on crack-width and deflection computation. Strut and Tie Models- corbels and deep beams. Design of corbels, Deep beams and RC walls. Inelastic behavour of concrete beams, moment – rotation curves, Strength and ductility concept- Design of joints in frames. Stress strain behaviour and strength of steel under static and cyclic loading; Buckling and post buckling behaviour of plates; Behaviour and design of members under tension, compression, bending, and combined forces. Fasteners: Methods of installation and behavior. Screws and rivets in cold formed steel construction. Types of connections, Behaviour of local elements, Analysis, Design and Detailing. Cold Formed Steel Members: Effective width and Direct Strength Design methods.

TEXT BOOKS/ REFERENCES:


**18SC613 CONSTRUCTION PROJECT MANAGEMENT**


**TEXT BOOKS/ REFERENCES:**


**18SC614 EXPERIMENTAL TECHNIQUES**

Concrete mix proportioning, Study of High performance concrete -Introduction to Non Destructive Test methods.- Principles of operations of hydraulic loading systems, strain gauges, strain and force measuring devices, etc.-Utilization of Mechanical, electrical resistance and other types of strain gauges to study the behavior of structural members.-Use of static and dynamic data recording and processing systems. Demonstration on wind tunnel testing.
TEXT BOOKS / REFERENCES:


18SC602  FINITE ELEMENT ANALYSIS  2-1-0-3

Basic Equations of Solid Mechanics - Review of equilibrium conditions, Strain displacement relations, Stress Strain relations, Principle of Virtual work & Stationery potential energy and variational formulation. Approximate methods - RayleighRitz, Weighted residual (Galerkin) and finite difference methods (examples on plates) - Finite Element Method: Displacement model-Shape functions-Lagrange and serendipity elements, Element properties - Isoparametric elements - numerical integration, technique, Assemblage of elements and solution techniques for static analysis. -Analysis of framed Structures - 2D and 3D truss and beam elements and applications. Analysis of plane stress/strain and axisymmetric solids triangular, quadrilateral and isoparametric elements, incompatible models. Three dimensional stress analysis - Isoparametric eight and twenty noded elements. Finite element programming and FEA Software.

TEXT BOOKS / REFERENCES:


18SC603  ADVANCED CONSTRUCTION PRACTICES  3-0-0-3

Sub-structure construction:- Construction of diaphragm walls, H walls and basement- Shoring for deep cutting - Underpinning; Trenchless Technology; Box jacking, Pipe Jacking, Tunneling Techniques- Piling Techniques-Driving Well And Caisson-Sinking Cofferdam - Cable Anchoring and Grouting.
Super Structure Construction:- Techniques of construction for continuous concreting operation in Tall buildings of various shapes and varying sections - cooling towers, silos, chimney - erection techniques of tall structures - erection of articulated structures - aerial transporting, handling, erecting light weight components on tall structures - Large span structures - In-situ
pre-stressing in high rise structures. Composite construction of steel and concrete. Rapid construction techniques. Special Structures:- Construction sequences in sky scrapers, bow string bridges, cable stayed bridges - Launching techniques for heavy decks and box decks - support structure for heavy equipment and machinery in industries.

TEXT BOOKS / REFERENCES:


18SC615 STRUCTURAL DESIGN STUDIO 0-1-2-3

Prerequisite: A course on Advance Structural Design


TEXT BOOKS/ REFERENCES:

5. Relevant IS Codes.

18SC616 CONSTRUCTION SOFTWARE LABORATORY 0-0-1-1
Project management software - Project estimation, project planning, project scheduling, network analysis, project time reduction and optimization, resource leveling, project time, cost and finance management, earned value analysis. Visualization software – Exposure to BIM modelling.

18SC617 RESEARCH METHODOLOGY 1-0-2-2


TEXT BOOKS / REFERENCES:


18SC618 INDUSTRIAL SEMINAR 0-0-2-1

The objective of the Industrial seminar is to expose the students to industry environment and practices. The students can identify the problem with the support of experts from industry at the end of first year (summer vacation) and start working on it. Apart from this, experts from the Civil Engineering industry are invited to deliver lectures on field related issues and share their professional experience including aspects of
Professional ethics. Each student is required to prepare a detailed report and present the same for evaluation.

18SC799 DISSERTATION  

18SC799 DISSERTATION

ELECTIVES

18 SC 701 MECHANICS OF COMPOSITE MATERIALS  3-0-0-3


TEXTBOOKS/REFERENCES:


18SC 702 ADVANCED CONCRETE TECHNOLOGY  3-0-0-3

TEXT BOOKS/ REFERENCES:

3. A R Santhakumar, *Concrete Technology* Oxford University Press, 2006

**18 SC703 CONSTRUCTION METHODS AND EQUIPMENT 3-0-0-3**

Planning Process for Equipment and Methods; Cost of Owning and Operating Construction Equipment - Ownership cost, Depreciation, Operating cost, and Ownership and operating costs calculation methods; Equipment Life and Replacement Procedures - Physical, profit and economic life, Replacement analysis; Engineering Fundamentals of Moving Earth - Rolling resistance, Effect of grade on tractive effort, Effect of altitude on performance of IC engines; Earthmoving, Excavating, and Lifting Equipment Selection - Bulldozers, Front-end Loaders, Scrapers, Trucks, Excavators, Backhoes, Front shovels, Cranes, and Forklifts; Piles and Pile-Driving Equipment; Production of Crushed-stone Aggregate; Concreting Equipment; Asphalt Mix Production and Placement - Asphalt Plants, and Paving Equipment; Estimating and Optimizing Construction Equipment System Productivity - Scheduling Equipment intensive construction projects; Equipment Financing Decision - Financing methods, Rental and lease contract considerations.

TEXT BOOKS/ REFERENCES:


**18SC704  STRUCTURAL DYNAMICS  3-0-0-3**


**TEXT BOOKS/ REFERENCES:**


**18 SC705  THEORY OF PLATES AND SHELLS  3-0-0-3**

Prerequisite: : A course on Theory of Elasticity.


**TEXT BOOKS/ REFERENCES:**

**18SC 706 SYSTEM INTEGRATION IN CONSTRUCTION 3-0-0-3**


**TEXT BOOKS/ REFERENCES:**


**18SC 707 QUALITY CONTROL AND SAFETY IN CONSTRUCTION 3-0-0-3**

Introduction to quality; Importance of quality; Quality transition - quality control and inspection, quality assurance, total quality management; Evolution of quality management; Planning and control of quality during design of structures; Tools and techniques for quality management; Inspection of materials and machinery; Quality assurance in construction; Formwork planning and design for quality. Systems quality management; Quality standards/codes in design and construction; (ISO:9000); Total quality management (TQM) - principles, tools and techniques. - Introduction to safety; Safety and health programs in construction industry; Planning for safety provisions; Analysis of construction hazards and accidents; Construction hazards and safety guidelines; Prevention techniques for construction accidents; Safety requirements for scaffolding; Site management with regard to safety
recommendations; Training for safety awareness and implementation; Construction safety and health manual.

TEXT BOOKS/ REFERENCES:

18 SC 708 PRE-STRESSED CONCRETE DESIGN 3-0-0-3

Introduction to prestressed concrete: types of prestressing, systems and devices, materials, losses in prestress. Analysis of PSC flexural members: basic concepts, stresses at transfer and service loads, ultimate strength in flexure, code provisions. - Statically determinate PSC beams: design for ultimate and serviceability limit states for flexure, and flexure combined with axial compression or tension; analysis and design for shear and torsion, code provisions. Transmission of prestress in pretensioned members; Anchorage zone stresses for post tensioned members. Composite construction with precast PSC beams and cast insitu RC slab Analysis and design, creep and shrinkage effects. Partial prestressing principles, analysis and design concepts, crack- width calculations. Analysis and design of prestressed concrete pipes, tanks and spatial structures slabs, grids, folded plates and shells.

TEXT BOOKS/ REFERENCES:
3. Arthur. H. Nilson, Design of Prestressed Concrete, Wiley India Pvt Ltd, 2011

18 SC709 ANALYSIS AND DESIGN FOR EARTHQUAKE FORCES 3-0-0-3

Engineering Seismology, Ground Motion parameters, Design philosophy, Code provisions(IS1893 & 13920), Building equivalent static analysis, design of water tanks, shear wall, special RC frame, Calculation of EQ load – 3D modelling of building systems and analysis (theory only), Design and detailing of frames, shear wall and frame. Cyclic loading behaviour of RC, steel and pre-stressed concrete elements - modern concepts – base isolation – Adoptive systems – case studies. Introduction to Inelastic Design Response Spectra (IDRS), Response
reduction factors, Pushover analysis, Inelastic cyclic behaviour of steel and reinforced concrete structures, ductility and energy dissipation capacity, Principles of Capacity Design. Aseismic design of steel buildings. Introduction to Wind load as per IS873 and its application on truss.

**TEXT BOOKS / REFERENCES:**


**18SC 710 FORENSIC ENGINEERING AND REHABILITATION OF STRUCTURES**


**TEXT BOOKS / REFERENCES:**


**18SC711 GEOTECHNICS FOR INFRASTRUCTURE**

Site investigation for infrastructure projects; Principles of exploration; Modern methods of boring and sampling; Sampling records, Soil profiles, various types of field tests; Excavation scheme. - Engineering properties of soft, weak and compressible deposits; Methods of soil
improvement using mechanical, chemical; Thermal, electrical methods; - Dynamic consolidation; Vibroflotation - Types of foundations for industrial structures; Sheet piles and cofferdams; Design of dewatering systems. Preloading and vertical drains, Introduction to Geotextiles and Geomembranes, Grouting and Injection. Recent trends in infrastructure projects like soil nailing, reinforced earth, gabion walls.

TEXT BOOKS/ REFERENCES:


18SC712 OPTIMIZATION TECHNIQUES 3-0-0-3


TEXTBOOKS / REFERENCES:


**TEXT BOOKS/ REFERENCES:**


**18 SC714 STABILITY OF STRUCTURES**


**TEXT BOOKS/ REFERENCES:**

18SC715  INDUSTRIAL STRUCTURES  3-0-0-3

Prerequisite: Nil


TEXT BOOKS/ REFERENCES:


18SC716  BRIDGE ENGINEERING  3-0-0-3

Introduction Classification and components of bridges, historical perspective, layout and planning, investigations for Bridges, choice of type of the bridges, conceptual bridge design, bridge aesthetics. Bridge appurtenances. Loads on bridges loading standards for highway (IRC) - Analysis and design of RC and PSC bridge decks: slab culvert bridges, slab and beam bridges, load distribution in slabs and beams, bowstring girder bridges, behaviour of skew bridge decks. Behaviour, analysis and design of composite construction. Design of bearings, substructure and foundations piers and abutments of different types, shallow and deep foundations design and constructional aspects.-Modern methods of construction of concrete, steel and composite bridges, their impact on analysis and design.

TEXT BOOKS/ REFERENCES:

18SC717  **PREFABRICATION ENGINEERING**  3-0-0-3

Types of prefabrication, prefabrication systems and structural schemes- Disuniting of structures- Structural behaviour of precast structures. Handling and erection stresses- Application of prestressing of roof members; floor systems two way load bearing slabs, Wall panels, hipped plate and shell structures.-Dimensioning and detailing of joints for different structural connections; construction and expansion joints. Production, Transportation & erection- Shuttering and mould design Dimensional tolerances- Erection of R.C. Structures, Total prefabricated buildings.-Designing and detailing prefabricated units for 1) industrial structures 2) Multistorey buildings and 3) Water tanks, silos bunkers etc., 4) Application of prestressed concrete in prefabrication.

**TEXT BOOKS/ REFERENCES:**


18SC718  **DESIGN OF OFFSHORE STRUCTURES**  3-0-0-3

systems - Sacrificial anode method and impressed current method – Online corrosion monitoring - Corrosion fatigue. Case studies on fixed platform construction and its erection

**TEXT BOOKS/ REFERENCES:**


**18SC719 PAVEMENT ANALYSIS AND DESIGN 3-0-0-3**


**TEXT BOOKS/ REFERENCES:**


TEXT BOOKS/ REFERENCES:


CHARACTERISATION OF MATERIALS

Characterization Techniques: Structure of solids: crystal systems and space groups, Bravais lattices, direct and reciprocal lattice, Bragg law, powder diffraction and phase identification, single crystal diffraction, structure factor, X-ray crystal structure determination. Fundamental principles and application to Material characterization: Macroscopic and microscopic techniques— visual examination-optical and electron microscopy (SEM,TEM); chemical and mineralogical analysis techniques – X-ray and neutron diffraction; spectroscopic techniques- image analysis, and nondestructive techniques. Methods for Structure Determination-X-ray

TEXT BOOKS/ REFERENCES:


18SC722 GEOTECHNICAL EARTHQUAKE ENGINEERING 3-0-0-3

Seismology and Earthquakes: Internal Structure of the Earth, Continental Drift and Plate Tectonics, Faults, Elastic rebound theory, Different sources of Seismic Activity, Geometric Notation, Location of Earthquakes, Size of Earthquakes.


Ground Response Analysis: Ground Response Analysis, One Dimensional Linear, Evaluation of Transfer Function, Uniform undamped soil on rigid rock, Uniform damped soil on Rigid Rock, Uniform damped soil on elastic rock, layered damped soil on elastic rock, Equivalent linear Approximation, Deconvolution.

Site characterization and Design: Different methods and experiments. Local site effects: ground motion amplifications, Development of response/design spectrum, Liquefaction hazard assessments, Landslide hazard assessment, Seismic slope stability analysis, Seismic Analysis and Design of Various Geotechnical Structures.
TEXT BOOKS/ REFERENCES:


18SC723 SOIL DYNAMICS AND MACHINE FOUNDATIONS  3-0-0-3


Wave propagation: Types of waves, Waves in unbound media, Waves in semi-infinite media, Waves in layered media. Dynamic soil properties: Laboratory tests, Field tests, Correlation of different parameters.


TEXT BOOKS/ REFERENCES:


18SC724 STATISTICAL AND PROBABILISTIC MODELING IN CIVIL ENGINEERING

The Role of Statistics and Probability in Civil Engineering, Elements of Probability theory: random variables, random events, Bayes theorem, Common Probabilistic models: models for Simple discrete random trails, Random occurrences and Limiting cases; Modeling of Observed
data and Estimation of model parameters - Maximum likely hood, K-means; Probabilistic Models for Civil Engineering problems


Sample size estimation and Field data training for civil engineering studies, Sampling distribution and Point estimation of parameter, Regression models - simple linear and multiple linear models, Parameter Estimation, Least Squares Estimators of the Regression Parameters, Statistical Inferences, Distribution of the Estimators, Coefficient of Determination, NSE and MSE, Real time Case studies and Applications.

TEXT BOOKS/REFERENCES:


18SC725 WIND EFFECTS ON STRUCTURES 3-0-0-3


TEXT BOOKS/REFERENCES:


**18SC726 ANALYSIS AND DESIGN OF SUB-STRUCTURES**

Foundation classification; Choice of foundations; Bearing capacity and settlement analysis of shallow foundations like footings and rafts, Deep foundations like piles, piers and Caissons; Foundations on problematic soils. Introduction to Limit State Design method; Structural design of continuous footings, individual footings and rafts of various types subjected to vertical and lateral loads, and moments; Design of circular rafts; Introduction to soil structure interaction. Analysis and design of deep foundations: pile foundations, piers, well foundations. Introduction to special foundations - ring foundations, offshore foundations. Foundations for transmission line towers, storage tanks, silos, chimneys etc.

**TEXT BOOKS/ REFERENCES:**


**18SC727 CONTRACT LAWS AND REGULATIONS**


**TEXT BOOKS/ REFERENCES:**


**18SC728 FORMWORK, SCAFFOLDING & SHORING 3-0-0-3**

Materials, Accessories and Proprietary Products - Lumber - Types - Finish - Sheathing ratio - Working stresses - Repetitive member stress - Plywood - Types and grades - Textured surfaces and strength - Reconstituted wood - Steel - Aluminium - Form lining materials

Planning- Overall Planning - Detailed planning - Standard units - Corner units - Schedule - Planning at Tender stage - Development of basic system - Planning for maximum reuse – Planning examples - Site layout plan - Crane arrangements - Recheck plan details - Planning for safety- Transporting plant - Wales and ties - Vertical transportable form work. Design considerations- Live loads and Wind pressure - Concrete pressure on form work- Concrete density - Height of discharge - Temperature - Rate of Placing - Consistency of concrete - Vibration - Hydrostatic pressure and pressure distribution - Examples - Adjustment for non-standard conditions - Basic simplification - Beam forms - Slab forms - Column forms - Wall forms - Allowable stresses - Check for deflection, bending and lateral stability - Codal provisions Examples on form designs. Building and Erecting the Framework- Location of job mill - Storage - Equipment - Form for Wall footings - Column footings - Slab on grade and paving work - Highway and Airport paving - External vibration - Prefabricated panel systems - Giant forms - Curved wall forms - Erection Practices - Column heads- Beam or girder forms - Suspended forms - Concrete Joint construction - Flying system forms.
Formwork Failures - Causes of Failures - Case studies- Finish of exposed concrete –Design deficiencies - Safety factors -Stripping sequence – Reshore installation -Advantages of reshoring.Special Formwork - Shell forms -Design considerations -Loads -Building forms – Strength requirements -Tunnel forming components - Curb and gutter forms - Invert forms - Arch forms - Concrete placement methods - Slip forms-Principles -Types -Advantages - Functions of various components-Planning -Safety in slip forms -Special structures built with slip form technique – Shuttering for Precast members and continuous casting forms.Scaffolding – Different types -Putlog and Independent scaffold -Single pole scaffolds - Fixing ties- Spacing of ties,- bracing, safety netting -General safety requirements-.Working & Erection at Site : Mock up and hands on assembly for various vertical & Horizontal formwork , assembly , checking & dismantling- key considerations. (Site visits preferred)

TEXT BOOKS/ REFERENCES:

3. Hurd, M.K., Formwork for Concrete, Special Publication No.4, American Concrete Institute, Detroit, 2005
4. Concrete Formwork Systems – Awad. Hanna- University of Wisconsin –Copy right Marcel Dekkel Inc.

LIVE-IN-LAB 3-0-0-3

The interested students will get an opportunity to work in any of the villages and solve the technical problems in areas related to the course by applying the engineering knowledge they have acquired through their study. The students can visit the village and identify the problem at the end of first year (summer vacation), start working on it and complete in the third semester.