# SIR PADAMPAT SINGHANIA UNIVERSITY

## Udaipur

## SCHOOL OF ENGINEERING

## Course Curriculum of 2-Year M. Tech. Degree Programme in Structural Engineering (Batch- 2018-20)

## Credit Structure

| Postgraduate Core (PC) | | Postgraduate Elective (PE) | |
|---|---|---|---|
| **Category** | **Credits** | **Category** | **Credits** |
| Departmental Core Subjects | 28 | Departmental Electives | 12 |
| Dissertation, Seminar, Viva | 17 | | |
| Basic Sciences | 3 | | |
| Total | 48 | Total | 12 |
| | | Grand Total | 60 |

## Distribution of Total Credits & Contact Hours in all Semesters

| S. No. | Semester Number | Credits/Semester | Contact Hours/Week |
|---|---|---|---|
| 1 | I | 16 | 17 |
| 2 | II | 17 | 19 |
| 3 | III | 15 | 20 |
| 4 | IV | 12 | 18 |
| | Total | 60 | -- |

# Course Structure: M. Tech. (Str.) 2018-20

## Semester - I

| S. No. | Course Code | Course Title | L | T | P | Credit(s) |
|---|---|---|---|---|---|---|
| 1 | CE-551 | Advanced Structural Analysis | 3 | 0 | 1 | 4 |
| 2 | CE-552 | Theory of Elasticity & Plasticity | 3 | 0 | 0 | 3 |
| 3 | CE-553 | Advanced Concrete Science & Technology | 3 | 0 | 0 | 3 |
| 4 | CE-582 | Air & Noise Pollution | 3 | 0 | 0 | 3 |
| 5 | MA-555 | Advanced Engineering Mathematics | 3 | 0 | 0 | 3 |
| | | | | | Total Credits | 16 |
| | | | | | Total Contact hours/week | 17 |

## Semester - II

| S. No. | Course Code | Course Title | L | T | P | Credit(s) |
|---|---|---|---|---|---|---|
| 1 | CE-554 | Advanced Foundation Design | 3 | 0 | 0 | 3 |
| 2 | CE-556 | Dynamics of Structures | 3 | 1 | 0 | 4 |
| 3 | CE-5XX | Departmental Elective - I | 3 | 0 | 0 | 3 |
| 4 | CE-5XX | Departmental Elective - II | 3 | 0 | 0 | 3 |
| 5 | ME-555 | Finite Element Methods in Engineering | 3 | 0 | 2 | 5 |
| | | | | | Total Credits | 18 |
| | | | | | Total Contact hours/week | 20 |

## Semester - III

| S. No. | Course Code | Course Title | L | T | P | Credit(s) |
|---|---|---|---|---|---|---|
| 1 | CE-567 | Advanced Construction Techniques & Management | 3 | 0 | 0 | 3 |
| 2 | CE-5XX | Departmental Elective - III | 3 | 0 | 0 | 3 |
| 3 | CE-5XX | Departmental Elective - IV | 3 | 0 | 0 | 3 |
| 4 | CE-580A | Dissertation - I | 0 | 0 | 5 | 5 |
| | | | | | Total Credits | 14 |
| | | | | | Total Contact hours/week | 19 |

## Semester - IV

| S. No. | Course Code | Course Title | L | T | P | Credit(s) |
|---|---|---|---|---|---|---|
| 1 | CE-580B | Dissertation - II | 0 | 0 | 9 | 9 |
| 2 | CE-580C | Dissertation Viva Voce | - | - | - | 3 |
| | | | | | Total Credits | 12 |
| | | | | | Total Contact hours/week | 18 |

## List of Departmental Elective(s) - I

| S. No. | Course Code | Course Title | L | T | P | Credit |
|---|---|---|---|---|---|---|
| 1 | CE-555 | Theory of Elastic Stability | 3 | 0 | 0 | 3 |
| 2 | ME-574 | Optimization Methods in Engineering | 3 | 0 | 0 | 3 |

## List of Departmental Elective(s) - II

| S. No. | Course Code | Course Title | L | T | P | Credit |
|---|---|---|---|---|---|---|
| 1 | CE-562 | Advanced Bridge Engineering | 3 | 0 | 0 | 3 |
| 2 | CE-564 | Environmental Impact Assessment | 3 | 0 | 0 | 3 |

## List of Departmental Elective(s) - III

| S. No. | Course Code | Course Title | L | T | P | Credit |
|---|---|---|---|---|---|---|
| 1 | CE-563 | Seismic Design of Foundation | 3 | 0 | 0 | 3 |
| 2 | CE-566 | Earthquake Resistant Design | 3 | 0 | 0 | 3 |

## List of Departmental Elective(s) - IV

| S. No. | Course Code | Course Title | L | T | P | Credit |
|---|---|---|---|---|---|---|
| 1 | CE-565 | Advanced Pre-stressed Concrete Design | 3 | 0 | 0 | 3 |
| 2 | CE-583 | Fracture Analysis & NDT | 3 | 0 | 0 | 3 |

# Detailed Syllabus for M. Tech. Degree Programme
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## Semester - I

## (Departmental Core Subject)

CE-551 L-T-P-C
Advanced Structural Analysis 3-0-1-4

**Objective**: *To impart in depth knowledge of the structural behavior & background of the provisions made in codes of design & to familiarize with the design of some important structures.*

**Course Content**

Matrix Method of Analysis**:** Matrix formulation of redundant beam analysis (Clapeyron's three moment theorem & slope deflection method). Stiffness & flexibility approaches for plane & space truss, plane & space frames, simple beams & grillage.

Dynamic analysis of structural frames: Wind & seismic analysis of regular & irregular planned structures as per I.S. Code provisions. Design & analysis of water tanks - circular & rectangular, towers, masts, bunkers, silos & chimneys.

Beams on elastic foundation: Winkler's theory & assumptions. Concept of infinite beams.

Theory of plates & shells: Thin plate analysis. Differential equation of bending under point & uniformly distributed load, various support systems. Rectangular & circular plates. Membrane analysis of thin shell, meridional & hoop stress, shell of revolution, cylindrical shells & applications.

**List of Experiments**

1. Modeling & analysis of bunkers, silos & chimneys.
2. Dynamic analysis of multi-storey RC framed structures.
3. Modeling & analysis of space truss & frames.

4. Analysis of Tall Structures.

**Text/Reference Books**


1. Analysis of Structures. Thandavamoorthy T.S. Oxford University Press. 2011.
2. Intermediate Structural Analysis. Wang C.K. Mc Graw Hills. 1983.
3. Theory of Plates & Shells. Bhavikatti S.S. New Age International. 2015.

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## Semester - I

## (Departmental Core Subject)

CE-552 L-T-P-C
Theory of Elasticity & Plasticity 3-0-0-3

**Objective**: *To equip students with concepts of elasticity & plasticity applied to structural engineering.*

**Course Content**

Analysis of Stress: Introduction, body & surface force, state of stress at a point, principal stresses, stress invariants, 2 & 3-dimensional stress tensors, equations of equilibrium & compatibility, plane stress problems & constitutive relationships, planes of maximum shear, octahedral stresses & the states of pure shear; decomposition into hydrostatic & pure shear states, equations in Cartesian, polar & cylindrical co-ordinate systems, Stress Quadric of Cauchy.

Analysis of Strain**:** Introduction, deformations, linear & rectangular strain components, strain invariants & strain tensors, shear strain components, cubical dilation, principal strains, plane strain problems in Cartesian, polar & cylindrical co-ordinates.

Stress-Strain Relations for Linearly Elastic Solids: Introduction, generalized statement of Hooke's Law, stress-strain relationships for isotropic materials, relations between the elastic constants & displacement equations of equilibrium.

Theories of Failure & introduction to ideally plastic solids**:** One-dimensional elastic-plastic relations, isotropic & kinematic hardening, yield function, flow rule, hardening rule, incremental stress-strain relationship, governing equations of elasto-plasticity, simple elastic plastic problem, expansion of a thick walled cylinder, Mohr's Theory of failure, ideally plastic solid, yield surfaces of Tresca & Von Mises, Prandtl-Reuss & Saint Venant-Von Mises equations.

Torsion: Torsion of general prismatic bars, circular & elliptical bars, rectangular bars. Membrane analogy, torsion of thin-walled open sections, torsional stress concentration.

**Text/Reference Books**


1. Advanced Mechanics of Solids. Srinath L.S., 2nd Edition. TMH Publishing Co. Ltd. New Delhi. 2003.
2. Advanced Strength & Applied Stress Analysis. Budynas R.G. 2nd Edition. McGraw Hill Publishing Co. 1999.
3. Theory of Elasticity. Timoshenko S.P. & Goodier J.N. 3rd Edition. McGraw Hill Publishing Co. 1970.

# Detailed Syllabus for M. Tech. Degree Programme in Structural Engineering

## Semester - I

## (Departmental Core Subject)

CE-553 L-T-P-C
Advanced Concrete Science & Technology 3-0-0-3

**Objective**: *To familiarize the students with the new construction materials, their testing & construction practices.*

**Course Content**

Cement: Importance of Bogue's compounds, Structure of a Hydrated Cement Paste, Volume of hydrated product, porosity of paste & concrete, transition Zone, Elastic Modulus, factors affecting strength & elasticity of concrete, Rheology of concrete in terms of Bingham's parameters.

Chemical Admixtures: Mechanism of chemical admixture, Plasticizers & super plasticizers & their effect on concrete property in fresh & hardened state, Marsh Cone test for optimum design of super plasticizer, retarder, accelerator, air-entraining admixtures & new generation superplasticizers.

Mineral Admixture: Fly ash, Silica fume, GGBS & their effect on concrete property in fresh state & hardened state.

Mix Design: Factors affecting mix design, design of concrete mix by BIS method.

RMC concrete: Manufacture, transporting, placing, precautions, methods of concreting - pumping, under-water concreting, shortcrete, High volume fly ash concrete- concept, properties, typical mix.

Self- compacting concrete: Concept, materials, tests, properties, application & typical mix.

Ferro cement: Materials, techniques of manufacture, properties & applications.

Fibre reinforced concrete: Fibre types & properties, behavior of FRC in compression, tension including pre-cracking stage & post-cracking stages, behavior in flexure & shear.

Light weight concrete: Materials properties & types. Typical light weight concrete mix, high density concrete, high strength concrete & high performance concrete- materials, properties & applications, typical mix.

**Text/Reference Books**


1. Concrete Technology. Neville A.M. & Brookes J.J. Pearson Publishers. New Delhi.
2. Properties of Concrete. Neville A.M. Pearson Publishers. New Delhi. 2004.
3. Concrete Technology. Shetty M.S. S. Chand & Company. New Delhi. 2002.
4. Concrete Technology. Gambhir M.L. Tata McGraw Hills. New Delhi. 1995.

# Detailed Syllabus for M. Tech. Degree Programme in Structural Engineering

## Semester - I

## (Departmental Core Subject)

CE-582 L-T-P-C
Air & Noise Pollution 3-0-0-3

**Objective**: *With increasing noise & air pollution nationally & globally, it is necessary to be familiar with basic information regarding air & noise pollution to allow proper assessment of impacts arising from the various projects or activities & devising appropriate mitigation or control measures.*

**Course Content**

Sources of Air Pollution: Stationary & mobile, fugitive emissions, secondary pollutants; Effects of air pollution in regional & global scale, air pollution episodes; Emission factors, inventory & predictive equations.

Atmospheric Meteorology: Wind profiles, turbulent diffusion, topographic effects, separated flows, temperature profiles in atmosphere, stability, inversions & plume behavior.

Air Quality Monitoring**:** Objectives, time & space variability in air quality; air sampling design, analysis & interpretation of air pollution data, guidelines of network design in urban & rural areas. Stack monitoring. Air pollution standards & indices. Dispersion of air pollutants & modeling, Basic concepts, inversion layer & mixing height, atmospheric stability classes, theory & application of acoustic sounding (SODAR) technique. Boxmodel, the Gaussian dispersion model point, area & line sources. Prediction of effective stack height physics of plume rise, Holland's equation, Briggs equation, etc. modifications of Gaussian dispersion models; indoor air quality models. Air Pollution control devices.

Effects of Air Pollution & Air Monitoring Instruments: Human, health, plants, animals & microbes, archeological monuments & aesthetics, Orsat apparatus, respirable dust sampler & source monitors.

Noise Pollution: Basics of acoustics & specification of sound; sound power, sound intensity & sound pressure levels; plane, point & line sources, multiple sources; outdoor & indoor noise propagation; psycho-acoustics & noise criteria, effects of noise on health, annoyance rating schemes; special noise environments: Infra-sound, ultrasound, impulsive sound & sonic boom; noise standards & limit values; noise instrumentation & monitoring procedure. Noise indices.

**Text/Reference Books**


1. Environmental Engineering. Arcadio P. S. & Gregoria A. S. Prentice Hall of India. 1999.
2. Environmental Pollution Control Engineering. Rao C.S. Wiley Eastern Ltd. New Delhi. 1996.
3. Environmental Noise Pollution. Cunniff P.E. McGraw Hill. New York. 1987.
4. Handbook of Noise Measurement Peterson A.P.G. & Gross PH, latest edition. Englewood cliffs New Jersey.
5. Air Pollution Control Equipment. Brauer H. & Verma Y.B.G. Berlin Heidelberg. New York.

# Detailed Syllabus for M. Tech. Degree Programme in Structural Engineering

## Semester - I

## (Basic Sciences Subject)

MA-555 L-T-P-C
Advanced Engineering Mathematics 3-0-0-3

**Objective**: *To impart in depth knowledge of various mathematical tools applied to diversified problems in structural engineering*.

**Course Content**

Vector & Tensor Analysis in Cartesian system, effect of rotation of coordinate systems. Review of ODEs; Laplace & Fourier methods, series solutions, & orthogonal polynomials. Sturm-Liouville problem. Review of 1st & 2nd order PDEs. Linear systems of algebraic equations. Gauss elimination, LU decomposition etc., Matrix inversion, ill-conditioned systems. Numerical Eigen solution techniques (Power, Householder, QR methods etc.).Numerical solution of systems of nonlinear algebraic equations; Newton-Raphson method. Numerical integration: Newton-Cotes methods, error estimates, Gaussian quadrature. Numerical solution of ODEs: Euler, Adams, Runge-Kutta methods, & predictor-corrector procedures; stability of solutions; solution of stiff equations. Solution of PDEs: finite difference techniques. Probability & Statistics - Probability Distribution, Bays Theorem, Parameter Estimation, Testing of Hypothesis, Goodness of Fit. Laboratory: Basics of programming. Numerical experiments with the algorithms covered in class.

**Texts/Reference Books**


1. Advanced Engineering Mathematics. Kreyzig E. New Age International. 1996.
2. Fundamentals of Matrix Computations. Watkins D. S. John Wiley. 1992.
3. Numerical Methods for Scientific & Engineering Computation. Jain M.K., Iyenger S.R.K. & R.K. Jain. 3rd Ed., New Age International, 1993

4. Continuum Mechanics. Chandrashekaraiah D.S. & Debnath L. Academic Press. 1994.
5. Computational Methods for Partial Differential Equations. Jain M.K., Iyenger S.R.K. & R.K. Jain. New Age International. 1994.
6. Methods of Mathematical Physics. Courant R. & Hilbert D. Wiley. 1989.
7. Advanced Engineering Mathematics. O'Neil P.V. Cengage Learning. 2007.
8. Mathematical Methods for Physicists. Arfken G.B., Weber H.J. & Harris F. 5th Ed. Academic Press.

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## Semester - II

## (Departmental Core Subject)

CE-554 L-T-P-C
Advanced Foundation Design 3-0-0-3

**Objective**: *To equip the students to understand the analysis & design of various foundation systems required for various infrastructure projects*.

**Course Content**

Bearing Capacity:-Bearing capacity on slopes, settlement analysis of foundation on sand & clay. Advanced bearing capacity theories.

Shallow Foundation:-Design of isolated footing & steel grillage, combined footing of rectangular, trapezoidal cantilever types, Mat or raft foundation of dry & saturated soil floating foundations.

Deep Foundation:-Settlement of piles; vertical & lateral loads in pile foundation, negative skin friction & uplift capacity of pile, design of pile caps, design of well foundation & cassions of different types, design of bridge pairs resting on piles & machine foundation.

Retaining structures:-Design of retaining walls- Gravity, cantilever & counterfort type.

Design of sheet piles & cofferdams, braced excavations.

**Text/Reference Books**


1. Design of Foundation Systems: Principles & Practices. Kurien N.P. Narosa. New Delhi. 1992.
2. Foundation Analysis & Design. Bowles J.E. Mc-Graw Hill Book & Company.
3. Principles of Foundation Engineering. Das B.M. Thomson Brooks/Cole.

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## Semester - II

## (Departmental Core Subject)

CE-556 L-T-P-C
Dynamics of Structure 3-1-0-4

**Objective:** *To impart in depth knowledge of structural behavior under dynamic loads & thus to establish foundation for acquiring principles of seismic design.*

**Course Content**

Dynamic Loading: Nature of harmonic, earthquake & blast loadings. Amplitude, frequency & time-period of vibrations.

Single Degree of Freedom System: Free & forced vibrations, resonance, harmonic force, periodic force & impulse.

Multi Degree of Freedom system:-Free & forced vibrations of lumped MDOF system, numerical method of finding the natural frequencies & mode shapes, orthogonality relationship of the principal modes, Rayleigh's Principle & its application for finding the fundamental frequency, mode superposition method & evaluation of dynamic response; Time-History analysis.

Continuous Systems:-Equation of motion: Undamped free vibrations: Forced vibrations of bars & beams; introduction to wind loads.

**Text/Reference Books**


1. Dynamics of Structures. Chopra A.K. 4th Edition. Prentice-Hall International. 2011.
2. Dynamics of Structures. Clough R.W. & Penzien J. Computers & Structures Inc. University Ave. Berkeley, CA94704. USA.
3. Structural Dynamics: Theory & Computation. Paz M. 4th Edition. Kluwer Academic Publishers. 2003.

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## Semester - II

## (Departmental Core Subject)

ME-555 L-T-P-C
Finite Element Methods in Engineering 3-0-2-5

**Objective:** *To build up the back ground, basic concepts & basic formulation of finite element method to enable the students to understand various element formulations & use them for analysis including programming*.

**Course Content**

Historical background, basic concept of the finite element method, comparison with finite difference method; Variational methods: calculus of variation, the Rayleigh-Ritzand Galerkin methods; Finite element analysis of 1-D problems: formulation by different approaches (direct, potential energy & Galerkin); Derivation of elemental equations & their assembly, solution & its post processing. Applications in heat transfer, fluid mechanics & solid mechanics. Bending of beams, analysis of truss & frame. Finite element analysis of 2-D problems: finite element modelling of single variable problems, triangular & rectangular elements; Applications in heat transfer, fluid mechanics & solid mechanics; Numerical considerations: numerical integration, error analysis, mesh refinement. Plane stress & plane strain problems; Bending of plates; Eigen value & time dependent problems; Discussion about preprocessors, postprocessors & finite element packages.

**List of Experiments**

1. Determination of load required to achieve a desired total extension of the spring.
2. Stress analysis of tapered cantilever with two load cases.
3. Simulation of tuning fork & to compute fundamental eigen mode of tuning fork.

4. Simulation of swirl flow around a rotating disc.
5. Modeling of air box around a device in order to model convective cooling in the box & to determine total heat flux on a boundary of heat sink.
6. Simulation of 1-D Heat transfer with radiation.
7. Simulation of 2-D Heat transfer with convective cooling.

**Text/Reference Books**


1. An introduction to the Finite Element Method. Reddy J.N. McGraw-Hill New York.1993.
2. Concepts & Applications of Finite Element Analysis. Cook. R.D., Malkus D.S. & Plesha M.E. 3rd Ed. John Wiley New York. 1989.
3. Finite Element Procedures in Engineering Analysis. Bathe K.J. Prentice-Hall, Englewood Cliffs, NJ, 1982.

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## Semester - III

## (Departmental Core Subject)

CE-567 L-T-P-C
Advanced Construction Techniques & Management 3-0-0-3

**Objective:** *To enable the students familiarize with modern construction techniques, materials, methods, equipment & their applications.*

**Course Content**

Construction planning-Construction facilities, Schedules, Layout of Plant utilities, Construction methods: Excavation & handling of Earth & Rock; Production & handling of Aggregates & Concrete, cooling of concrete in dams, Drainage treatment of aquifers/sub-terrainian reservoirs; Tunneling, Tunneling in soft rocks, Grouting, chimney formation, etc.; Construction control & management, CPM/PERT, Human Factors, Organization.

**Text/Reference Books**


1. Construction Planning, Equipment & Methods. Peurifoy R.L. & Ledbetter W.B. McGraw Hill Singapore. 1986.
2. Total Project Management- The Indian Context. Joy P.K. MacMillan India Ltd. New Delhi.1992.

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## Semester - III

## (Departmental Core Subject)

CE-580A L-T-P-C
Dissertation - I 0-0-5-5

**Course Content**

The Dissertation for M.Tech programme consists of two parts: Dissertation - I & Dissertation - II. Dissertation - I is undertaken during the III Semester. The Dissertation is by far the most important single piece of work in the post-graduate programme. It provides the opportunity for student to demonstrate independence & originality, to plan & organize a large Dissertation over a long period & to put into practice some of the techniques students have been taught in the course. Students will choose a dissertation, in consultation with a faculty member, who will act as the Supervisor. Dissertation involves a combination of sound background research, a solid implementation, or piece of theoretical work & a thorough evaluation of the dissertation's output in both absolute & relative terms. The very best dissertations invariably covers some new ground, e.g. by developing a complex application which does not already exit, or by enhancing some existing application or method to improve its functionality, performance etc. The student will prepare the Dissertation report as per the prescribed format/guidelines & present the same as a seminar at the end of the semester. The Dissertation will be evaluated continuously over the span of the III Semesters, as per the approved procedure.

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## Semester - IV

## (Departmental Core Subject)

| | |
|---|---|
| CE-580B | L-T-P-C |
| Dissertation - II | 0-0-9-9 |

**Course Content**

After completion of Dissertation - I, students will undertake the Dissertation - II in the IV Semester. The idea conceived & progress made in the Dissertation-I shall be extended as Dissertation - II under the supervision of a faculty member. Students shall complete the theoretical & practical aspect of the project. Thereafter they will prepare a report, as per the prescribed format/ guidelines, incorporating the results, their analysis & interpretation. The report, duly certified by the Supervisor, should be submitted to the Head of the Department. The report should also be presented as a seminar at the end of the semester. Progress made by the student will be continuously monitored throughout the semester & evaluated as per the approved procedure.

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## Semester - IV

## (Departmental Core Subject)

| | |
|---|---|
| CE-580C | L-T-P-C |
| Dissertation Viva Voce | 0-0-0-3 |

**Course Content**

Dissertation Viva Voce is the verbal defense of the dissertation carried out by the student in front of a panel of examiners. The objective of Viva Voce examination is to confirm that the piece of work submitted as a dissertation is student's own work, he/she has a sound understanding of the subject of the dissertation, aware of the recent works in the area of dissertation, methodology adopted & importance/relevance/merits of the output in relation with the existing results in the area.

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## Semester - II

## (Departmental Elective - I)

CE-555 L-T-P-C
Theory of Elastic Stability 3-0-0-3

**Objective**: *To impart in depth knowledge of the stability configuration of several structural components in structural engineering*.

**Course Content**

Euler's Buckling Load: Assumptions, derivations of Euler's critical load, members with eccentric loading & initially imperfect columns.

Beam Columns: Beam column equations, beam column with concentrated load, several concentrated load, continuous lateral load. Beam-column with end couple.

Column Stability: General differential equation, buckling problem as characteristic value (eigen value) & orthogonality relations; inelastic behavior of materials, effect of dynamic loading.

Energy methods for buckling: Theorem of stationary potential energy, comparison with the principle of conservation of energy, energy & stability considerations, Rayleigh-Ritz method, Timoshenko's concept of solving buckling problems, columns with variable cross-section & the use of Trigonometric series.

**Text/Reference Books**


1. Theory of Elastic Stability. Timoshenko S. & Gere J. 2nd Ed. Mc-Graw Hill Inc. 1961.
2. Stability Analysis & Design of Structures. Gambhir M.L. Springer. 1st Ed. 2004.
3. Stability of Structures. Bazant Z. & Cedolin L. Oxford University Press. Inc. 1991.

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## Semester - II

## (Departmental Elective - I)

ME-574 L-T-P-C
Optimization Methods in Engineering 3-0-0-3

**Objectives:** *The objective of the course is to provide the students the basic concepts of optimization problems, decision analysis, non-linear optimization, non-traditional optimization & NP-Complete problems.*

**Course Content**

Introduction to optimization; Formulation of optimization problems; Classical optimization techniques; Linear Programming; Non-linear Programming; single variable, multi-variable & constrained optimization; Specialized algorithms for integer programming & geometric programming; Non-traditional optimization algorithms.

**Text/Reference books**


1. Theory & Applications, Rao S. S., Optimization. 2nd Ed. Wiley Eastern. 1984.
2. Optimization for Engineering Design-Algorithms & Examples. Deb K. Prentice-Hall India. 1995.
3. Introduction to Optimum Design. Arora J. S, McGraw-Hill. 1989.
4. Engineering Optimization-Methods & Applications. Reklaitis G. V. Ravindran A. & Ragsdell K. M. Wiley. 1983.
5. Optimization Methods for Engineering Design. Fox R. L. Addison Wesley. 1971.

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## Semester - II

## (Departmental Elective - II)

CE-562 L-T-P-C
Advanced Bridge Engineering 3-0-0-3

**Objective:** *To impart the students with some knowledge on important types of bridge structures, their selection & planning, structural configurations, assessment of loads, choosing the appropriate method of analysis according to the situation & perform the design.*

**Course Content**

Site Investigation, Bridge Hydrology, Geometry of Bridges, Steel, R.C.C., Prestressed Road & Rail Bridges; Suspension & Cable Stayed Bridges: Bearings, Joints, etc. Grillage Analogy, Design of composite bridges (steel & concrete): box girder bridges in concrete. Design of abutments, piers & their foundations. Design of bearings. Construction methods & maintenance of bridges. Multi-beam & multi-cell R.C.C. bridges.

**Text/Reference Books**


1. Design of Bridge Structures. Jagadeesh T.R. Prentice-Hall International. 2nd Ed. 2009.
2. Elements of Bridge Engineering. Pant M.K. Katson Publication. 1st Ed. 2014.

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## Semester - II

## (Departmental Elective - II)

CE-564 L-T-P-C
Environmental Impact Assessment 3-0-0-3

**Objective:** *To make the students aware of the several norms, policies, rules & regulations of the Environmental Impact Assessment*.

**Course Content**

Introduction, Historical development of EIA, EIA in project cycle, Legal Aspects & objectives of EIA, General Methodology, Public participation in EIA, different components of EIA, mathematical modeling for impact prediction, cumulative impact assessment, documentation of EIA findings, Environmental impact analysis, Mitigation & impact management, case studies & environmental auditing. Concept of socio-economic impact assessment.

**Text/Reference Books**


1. Environmental Impact Assessment – Practical solutions to recurrent Problems. Lawrence D.P. Wiley- Interscience. New Jersey. 2003.
2. Environmental Impact Assessment. Canter L.W. McGraw Hill. New York.1996.

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## Semester - III

## (Departmental Elective - III)

CE-563 L-T-P-C
Seismic Design of Foundation 3-0-0-3

**Objective:** *To make students capable of analyzing & designing various types of structural foundation exhibiting ample safety under probable earthquakes*.

**Course Content**

Elements of earthquake, Seismic loading; Soil properties for seismic design; Earth pressure under seismic condition; Liquefaction of soil; determination of ground acceleration; Damping of soil; Foundation design under earthquake loading; Seismic design of slopes. Seismic design of reinforced concrete mat footing.

**Text/Reference Books**


1. Seismic Design of Reinforced Concrete Buildings. Moehle J. Tata Mc-Graw Hill Education. 1st Ed. 2014.
2. Geotechnical Earthquake Engineering. Kramer S.L. Pearson Publications. 3rd Ed. 2003.

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## Semester - III

## (Departmental Elective - III)

CE-566 L-T-P-C
Earthquake Resistant Design 3-0-0-3

**Objective:** *To impart in depth knowledge to the students for planning & designing various types of structures exhibiting ample safety under probable earthquakes*.

**Course Content**

A seismic Design of Structures. Philosophy & principles of earthquake resistance design – Strength & stiffness, ductility design & detailing, design of energy absorbing devices, concepts of seismic base isolation & seismic active control. Building forms & architectural design concepts – Horizontal & vertical eccentricities due to mass & stiffness distribution, structural redundancy & setbacks. Equivalent static lateral earthquake force on building (IS:1893). Equivalent static method: Seismic coefficients– evaluation, estimation of fundamental time period, base shear & its distribution, Vulnerability Atlas. Use of codes with reference to Masonry Buildings like IS:4326, IS:13828, IS:13827. Use of codes of RC & steel structures like IS:13920. Detailing of reinforcement & 30 joints. Restoration & Retrofitting – Evaluation (Seismic qualification) of existing buildings – Aging, weathering, development of cracks, improper load path, asymmetry. Materials & equipment for restoration & retrofitting. Methodologies for retrofitting – For walls, roofs, slabs, columns & foundation of building in stones, brick or reinforced concrete structures.

**Texts/References**

1. Earthquake Resistant Design of Structures. S.K. Duggal. Oxford University Press. 2007.

2. Earthquake Resistant Design of Structures. Agarwal P. & Shrikh M. Prentice Hall of India Pvt. Ltd.

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## Semester - III

## (Departmental Elective - IV)

CE-565 L-T-P-C
Advanced Pre-stressed Concrete Design 3-0-0-3

**Objective:** *To make students familiar with the concepts of design of typical pre-stressed concrete structural elements.*

**Course Content**

Prestressed concrete - specification of materials, method of prestressing & losses of prestress. Concept of pre-tensioning & post-tensioning, minimum concrete grade. Analysis & design of members for flexure, shear, bond & bearings. Cable layouts. Design of circular systems, domes & slabs. Stresses in anchorage zones of pre-tensioned & post-tensioned members, design of end block. Partial prestressing, two-way prestressing & circular prestressing. Design of pre-stressed bridges & continuous beams.

**Text/Reference Books**


1. Prestressed Concrete. Ramamrutham S. Dhanpat Rai & Sons Publication.1996.
2. Prestressed Concrete. Krishna Raju N. Tata McGraw-Hill Education. 2012.

# Detailed Syllabus for M. Tech. Degree Programme
# in
# Structural Engineering

## Semester - III

## (Departmental Elective - IV)

CE-583 L-T-P-C
Fracture Analysis & NDT 3-0-0-3

**Objective:** *The subject deals with nucleation, growth & propagation of cracks in civil engineering structures & systems. Non-destructive techniques (NDT) which are used to inspect & predict failures will also be dealt in this subject.*

**Course Content**

Griffith's theory of brittle failures; Irwin's stress intensity factors; linear elastic fracture Mechanics: The stress analysis of crack tips, macroscopic theories in crack extension, Fatigue crack propagation: Fatigue crack growth theories, crack closure, Microscopic theories of fatigue crack growth; Application of theories of fracture mechanics in design & materials development

Non-destructive testing methods in Civil Engineering: dye penetrant, magnetic particle testing, Ultrasonic testing, radiographic testing & acoustic emission.

**Text/Reference book**


1. Fracture Mechanics Fundamentals & Applications. T. L. Anderson. CRC Press. 1994.
2. Elementary Engineering Fracture Mechanics. Brock D. Maritinus Nijhoff Publishers.1982.
3. Fracture & Fatigue Control in Structures. Rolfe S. T. & Barson J. M. PHI. 1977.