SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR

An Autonomous College of Rashtrasant Tukadoji Maharaj
Nagpur University, Nagpur, Maharashtra, India

TEACHING SCHEME & SYLLABUS
2014-15

M.TECH. STRUCTURAL ENGINEERING

Published by
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ISO 9001 : 2008 CERTIFIED ORGANISATION

About the Department

Civil Engineering Department was established in 1984 at the time of inception of Shri Ramdeobaba College of Engineering & Management (previously RKNEC) with intake of 60 students. The department has experienced and highly qualified faculty; it is equipped with sophisticated laboratories and latest computational softwares which helps the students to develop expertise in Civil Engineering. Civil Engineering Department offers Undergraduate Programme B. E. in Civil Engineering (1st shift and 2nd shift) and two Post Graduate Programmes namely M. Tech., Structural Engineering (Full Time) and M. Tech., Geotechnical Engineering (Part Time).

The Department of Civil Engineering is one of the prime partners in success stories of the institute. The department has all the state of the art laboratories and faculties that provide excellent opportunities for students as well as researchers. The department is accredited by National Board of Accreditation and well recognized by Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur. The department is closely associated with industry and extending its testing & consulting services. For overall development of the student, the department provides conducive atmosphere for organization & conduction of various co-curricular and extracurricular programs while imparting outcome based quality education.

Departmental Vision

The vision of civil engineering department is to impart knowledge and to develop excellence in civil engineering and technology with global perspective to the students and to make them ethically and professionally competent engineers to build the nation.

Department Mission

The mission of civil engineering department is to educate and train the students with strong conceptual fundamentals and to create awareness among students for sustainable development.

Programme Educational Objectives

A. The Programme will prepare graduates to perform structural analysis and Steel/RCC design of various structural systems.
B. The Programme will prepare graduates to take up industrial project and research work in the relevant domain.

Program Outcomes

a. The graduates are expected to have an ability to apply knowledge of mathematics, science and engineering while analysis and design of structural components.
b. The graduates are expected to have ability to think critically and adopt innovative approach for analyzing complex structural engineering problems.
c. The graduates are expected to solve complex structural engineering problems and able to propose optimal, feasible and economical design solution.
d. The graduates are expected to have capability to take research projects in relevant field and develop modern solution using advanced technological concepts.
e. The graduates are expected to identify and use modern tools/equipments/softwares used for analysis and design of structural engineering components.
f. The graduates are expected to participate in collaborative and multidisciplinary work in order to contribute the overall development of the society.
g. The graduates are expected to participate in group projects and have ability to manage project competently through efficient and optimal use of resources.
h. The graduates are expected to communicate technical details effectively through oral presentation and written documents.
i. The graduate are expected to engage themselves in life-long learning and keep on updating themselves with technological advances.
j. The graduates are expected to understand and follow ethical practices in structural engineering.
k. The graduates are expected to critically examine, judge and decide independently the outcome of work carried out.

Scheme of Examination of Master of Technology (Structural Engineering) Semester Pattern

I Semester M. Tech. (Structural Engineering)

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	CET501	Numerical Methods	4	0	4	8	40	60	100	3 Hrs.
2	CET502	Matrix Method	4	0	4	8	40	60	100	3 Hrs.
3	CEP502	Matrix Method (P)	0	2	2	2	25	25	50	-
4	CET503	Structural Dynamics	4	0	4	8	40	60	100	3 Hrs.
5	CEP503	Structural Dynamics (P)	0	2	2	2	25	25	50	-
6	CET504	Theory of Elasticity and Elastic stability	4	0	4	8	40	60	100	3 Hrs.
7	CET505	Advanced Steel Structures	4	0	4	8	40	60	100	3 Hrs.
8	CEP505	Advanced Steel Structures (P)	0	2	2	2	25	25	50	-
		Total	20	6	26	46	275	375	650	-

Scheme of Examination of Master of Technology (Structural Engineering) Semester Pattern

II Semester M. Tech. (Structural Engineering)

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	CET506	Finite Element Method	4	0	4	8	40	60	100	3 Hrs.
2	CEP506	Finite Element Method (P)	0	2	2	2	25	25	50	-
3	CET507	Foundation Design	4	0	4	8	40	60	100	3 Hrs.
4	CET508	Advanced Concrete Structures	4	0	4	8	40	60	100	3 Hrs.
5	CET509	Theory of Plates and Shells	4	0	4	8	40	60	100	3 Hrs.
6	CET510	Elective I	3	0	3	6	40	60	100	3 Hrs.
7	CEP510	Elective I (P)	0	2	2	2	25	25	50	-
		Total	19	4	23	42	250	350	600	-

Course Code	Elective I
CET510-1	Design of Earthquake Resistance Steel Structures
CET510-2	Design of Earthquake Resistance RCC Structures

Scheme of Examination of Master of Technology (Structural Engineering) Semester Pattern

III Semester M. Tech. (Structural Engineering)

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	CET601	Research Methodology	3	0	3	6	40	60	100	3 Hrs.
2	CET602	Design of High Rise Structures	3	0	3	6	40	60	100	3 Hrs.
3	CET603	Elective II	3	0	3	6	40	60	100	3 Hrs.
3	CEP604	Computer aided analysis and design (P)	0	2	2	2	25	25	50	-
4	CEP605	Project Phase I (D)	0	8	8	24	50	50	100	-
		Total	9	10	19	44	195	255	450	-

Course Code	Elective II
CET603-1	Composite Structures
CET603-2	Structural Instrumentation & Material Science
CET603-3	Design of Environmental Structures

Scheme of Examination of Master of Technology (Structural Engineering) Semester Pattern

IV Semester M. Tech. (Structural Engineering)

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	CEP606	Project Phase II (D)	0	16	16	48	100	100	200	-
		Total	0	16	16	48	100	100	200	-

Syllabus of Semester I, M. Tech. (Structural Engineering)

Course Code : CET501 Course: Numerical Methods

L:4 Hr., P:0 Hrs., Per week Total Credits : 8

Course Outcomes

1. The graduates are expected to analyze various mathematical problems involved in structural engineering.
2. The graduates are expected to develop computer program/applications for solving various mathematical methods involved in structural engineering.

Syllabus

Solution of algebraic equations: Bisection Method, Regula Falsi Method, Newton-Raphson method, Development of Computer Program

Solution of linear algebraic equations: Direct methods and iterative methods

Eigen values problems: Direct, Jacobi, LR method, QR method.

Initial & two point boundary value problem: Euler's, Runge-Kutta, Milne's Methods, Development of Computer Program.

Numerical Integration: Trapezoidal Method, Simpson's Method, Gauss Quadrature, Development of Computer Program.

Direct Integration Methods: Central difference method, Houbolt method, Newmark's method, Wilson - θ method.

Text Books:

1. Numerical methods, Principles, Analyses and Algorithms: *Srimanth Pal, Oxford University Press, New Delhi.*
2. Numerical Methods in Finite Element Analysis: *Bathe K. J., Wilson E. L., Prentice-Hall of India Private Limited, New Delhi, (1987).*

Reference Books:

1. Numerical Methods: *Kandasamy P., Thilagavathy K. and Gunavathi K., S. Chand & Company Ltd, New Delhi, (1997)*
2. Numerical Methods for Engineers with Programming and Software Applications: *Chapra. S. C. and Canale R. P.,3rd ed., Tata McGraw Hill, New Delhi, (2009).*
3. Numerical Mehtods: *Salvadori M., PHI learning Pvt, ltd., New Delhi, (1987)*

Syllabus of Semester I, M. Tech. (Structural Engineering)

Course Code : CET502 Course: Matrix Method

L:4 Hr., P:0 Hrs., Per week Total Credits : 8

Course Outcomes

1. The graduates are expected to analyze various types of load carrying structures like truss, beam, frame and grid and should be able to calculate member forces, shear force and bending moments.
2. The graduates are expected to incorporate various kinds of loading like temperature, sinking of support, lack of fit, etc. while analyzing various load carrying structures.

Syllabus

Introduction to matrix method for structural analysis

Flexibility Method, Stiffness Method, Comparison, Advantages of Stiffness Method.

Stiffness Method for

- Bar and Beam problems
- Plane truss and space truss
- Plane frame and space frame
- Plane Grid

Analysis for member loading (self, temperature & imposed), inclined supports, lack of fit, initial joint displacements.

Effect of shear deformation, internal member end releases.

Solution technique with banded & skyline technique, band minimization, application of boundary conditions, introduction to frontal technique.

Text Books:

1. Matrix Analysis of Structural Analysis 3rd ed.: *Gere, W. and Weaver. J. M. Van Nostrand Reinhold, NY, (1990).*
2. Matrix Analysis of Structures: Kasmali Aslam Books/cole Publishing Co. (1999)
3. Matrix Method of Structural Analysis : Meghre A. S. and Deshmukh S. K., Charofar Publishing House, Anand, India (2003)
4. Advanced Structural Analysis: Ashok K. Jain, Nemchand and Brothers, Roorkee, U. A., India (2011).

References Books:

1. Matrix Analysis of Structural Analysis 2nd ed.: *Kanchi M. B., John Willey & Sons (1999)*.
2. Introduction to Matrix Method of Structural Analysis: *Martin H. C. McGraw Hill Book Co., (1996)*
3. Introduction to Finite Element Method in Engineering: *Chandrupatala T R and Belegundu A D, Prentice Hall, India (2002)*
4. Finite Element Procedures 2nd ed.: *Bathe K. J. Springer, (2002).*
5. Concept and application of Finite Element Analysis: *Cook R. D.et. al, John Willey & Sons, NY, (1995).*

Syllabus of Semester I, M. Tech. (Structural Engineering)

Course Code : CEP502 Course: Matrix Method

L:0 Hr., P:2 Hrs., Per week Total Credits : 2

Course Outcomes

1. The graduates are expected to understand and apply basic steps involved in structural analysis using computer software like Structural Analysis Program (SAP).
2. The graduates are expected to analyze various kind of supporting structure subjected to different kinds of load using computer software and should be able to report results in presentable form.

Syllabus

Minimum Six practicals based on above syllabus

Syllabus of Semester I, M. Tech. (Structural Engineering)

Course Code : CET503 Course : Structural Dynamics

L:4 Hr., P:0 Hrs., Per week Total Credits : 8

Course Outcomes

1. The graduates are expected to have detailed knowledge about dynamic forces and loadings caused due to earthquake, vibrations etc.
2. The graduates are expected to analyze various type of structure subjected to dynamic loading.
3. The graduates are expected to understand and apply various clauses mentioned in Indian standards pertaining to structural dynamics.

Syllabus

Fundamentals of Rigid / Deformable body dynamics, Analysis of undamped and viscously damped, single degree freedom systems.

Response of single degree freedom systems to harmonic loading, support motion and transmissibility, Duhamels integral.

Study of IS 1893-1984 and 2000 applicable to buildings and water tanks.

Free vibrations of lumped mass multi degree freedom systems (upto 3 DOF), shear buildings, orthogonality criteria, Rayleigh's method

Dynamic response of MDOF (2DOF) systems-modal superposition method, approximate design method, Transformation factors.

Response spectra, Introduction to vibrations due to earthquake.

Text Books:

1. Dynamics of Structures 3rd edition : *Chopra A. K. (Prentice Hall, NY, (1970))*
2. Dynamics of Structures: *Clough, R. W. & Penzin, J., (McGraw Hill, (1993))*
3. Dynamics of Structures: *Humar J. L., (Prentice Hall, (1990))*

Reference Books:

1. Structural Dynamics: *Mario, Paz, CBS Publ. N. Delhi, (1995)*
2. Advanced Dynamics: *Timoshenko S., McGraw Hill Book Co., NY, (1948).*
3. Elements of Vibration Analysis 2nd ed.: *Meirrovitch L., McGraw Hill International Edition, Singapore, (1986).*

Introduction of Structural Dynamics: *Biggs J. M. McGraw Hill NY, (1964).*

Syllabus of Semester I, M. Tech. (Structural Engineering)

Course Code : CEP503 Course: Structural Dynamics

L:0 Hr., P:2 Hrs., Per week Total Credits : 2

Course Outcomes

1. The graduates are expected to have detailed knowledge about dynamic forces and loadings caused due to earthquake, vibrations etc.
2. The graduates are expected to analyze various type of structure subjected to dynamic loading.
3. The graduates are expected to understand and apply various clauses mentioned in Indian standards pertaining to structural dynamics.

Syllabus

Minimum Six experiments based on above syllabus

Syllabus of Semester I, M. Tech. (Structural Engineering)

Course Code : CET504	Course: Theory of Elasticity and Elastic stability
L:4 Hr., P:0 Hrs., Per week	Total Credits : 8

Course Outcomes

1. The graduates are expected to apply the principles of mathematics in numerical analysis and to develop numerical model of simple structures.
2. The graduates are expected to develop numerical solution for various structural engineering problems like bending, buckling, analysis of beams and plates, etc.

Syllabus

Analysis of stress and strain in 2 dimensions: Introduction, Types of forces, Components of stresses and strains, Stress-strain relation, Plane stress and plane strain, Strain at a point, Differential equation of equilibrium, Boundary conditions and compatibility equations(rectangular coordinates), Airy's stress function

Analysis of stress and strain in 3 dimensions: Components of stress, Principal stresses, Stress invarients, Maximum shearing stress, Differential equation of equilibrium, Boundary conditions and compatibility equations.

Bending of cantilever of narrow rectangular section loaded at end, Bending of simply supported beam with uniform load, torsion of non-circular sections, Elliptical cross section.

Differential equation for beams columns with concentrated loads, continuous lateral loads and couples for simply supported ends, Application of trigonometric series, Lateral buckling of beams.

Energy method for elastic bucking of columns, Approximate method, Buckling of columns on elastic foundation, Columns with intermediate compressive forces and distributed axial load, Columns with changes in cross section.

Effect of shearing force on critical load, Buckling of built up columns, Buckling of simply supported rectangular plates uniformly compressed in middle plane in one direction.

Text Books:

1. Theory of Elasticity, 3rd ed.: *Timoshenko, S. P., McGraw Hill, NY, (1970).*
2. Theory of Elastic stability 2nd ed.: *Timoshenko, S. P., McGraw Hill, NY, (1961).*

References Books:

1. Flexural Tortional Buckling of Structures: *Trahair, N. S., E & FM SPON, London.*
2. Theory of Beam-Column- Space Behaviour and Design 2nd Vol.,: *Chen, W. F.*

Syllabus of Semester I, M. Tech. (Structural Engineering)

Course Code : CET505 Course: Advanced Steel Structures

L:4 Hr., P:0 Hrs., Per week Total Credits : 8

Course Outcomes

1. The graduates are expected to recognize the design philosophy of steel structures and understand the concept of limit state design.
2. The graduates are expected to understand the behaviour of steel structures, in particular to the various forms of failure for members and connections under tension, compression, bending and combined actions.
3. The graduates are expected to apply the principles, procedures and current codal requirements to the analysis and design of advanced steel structures like chimney, storage vessels, industrial shed, crane and gantry girders, bridges, etc.

Syllabus

Design of connections.

Design of round tubular structures, Design of steel chimneys, Design of storage vessels.

Design of industrial sheds, crane / gantry Girders.

Design of bridges – highway and railways, Foot Bridge.

Reference Books:

1. Steel Designer Manual: *Owens, G.W. & Knowles P. R., Blackwell, (1994).*
2. Design of Steel Structures: *Gaylord,E.H. & Gaylord,C.N.., McGraw Hill Pub., (1998).*
3. Steel Design Manual: *ELBS and Granada Publishers, London.*
4. Composite Structures of steel and Concrete Vol-I: *Johnson R. P., Granado Publishing Ltd., London (1994).*
5. Steel Structures- Design and Behaviour: *Salmon and Johnson, Harper and Collins Publishers.*

Syllabus of Semester I, M. Tech. (Structural Engineering)

Course Code : CEP505	Course : Advanced Steel Structures
L:0 Hr., P:2 Hrs., Per week	Total Credits : 2

Course Outcomes

1. The graduates are expected to understand the behavior and undertake design of steel members to resist the external loads and apply the relevant code of practice.
2. The graduates are expected to employ design procedure for advanced steel structures like chimney, storage vessels, industrial shed, crane and gantry girders, bridges, etc. as per code of practice for design calculations and prepare drawings in appropriate formats.

Syllabus

Minimum Four practical designs based on above syllabus.

Syllabus of Semester II, M. Tech. (Structural Engineering)

Course Code : CET506 Course: Finite Element Method

L:4 Hr., P:0 Hrs., Per week Total Credits : 8

Course Outcomes

1. The graduates are expected to understand solution methodologies for solving complex stress analysis problems.
2. The graduates are expected to understand the general steps of finite element methods and be able to derive equations in finite element methods for 1D, 2D and 3D problems.
3. The graduates are expected to develop element stiffness matrix equation, Assemble element matrix equations into a global matrix, solve the resulting system and interpret the results obtained.
4. The graduates are expected to learn advanced topics and techniques in finite element methods and implement of these techniques to solve advanced stress analysis problems.

Syllabus

Principles and discretization, Elements stiffness formulation based on direct and variational techniques, Raleigh Ritz Method for Bar and Beam analysis.

Shape functions, Finite Element Formulation using Cartesian Coordinates, Application to 1D problems, Convergence criteria.

Triangular and Rectangular element formulation using Cartesian Coordinates, Application to 2D stress analysis.

Natural coordinates, Numerical integration, Isoparametric elements, Application to 1D Problems, Isoparametric elements for two-dimensional stress analysis

Axisymmetric Stress Analysis.

Tetrahedral and hexahedral element formulation, Application to 3D stress analysis.

Modeling techniques and solution techniques, Computer Implementation of FEM Procedure for 1D, 2D & 3D problems.

Text Books:

1. Introduction to Finite Elements in Engineering: *Chandrapatla T. R. and Belegundu A. D., Prentice Hall, India, (1991).*
2. A First Course in the Finite Element Method: *Logan D. L, Thomson Publishing (2007)*
3. "Finite Element Analysis: Theory and Programming", 2nd ed.: *Krishnamurthi C. S., Tata Mc Graw Hill Publishing Company Limited, 1994, Reprint 2005.*
4. Concepts and Applications of Finite Element Analysis, 3rd ed.: *Cook R. D., , Wiley India Text books, Wiley India Pvt. Limited, New Delhi, (1989).*

Reference Books:

1. The Finite Element Method (Volume -I), 1st ed.: *Zienkiewicz O. C. and Taylor R. L., Tata McGraw Hill Publishing Company Limited, New Delhi, (1989).*
2. Introduction to Finite Element Method: *Desai C. S. and Abel J. F., Van Nostrand Reinhold, New York (1972)*
3. "Finite Element Procedure": *Bathe K. J., Prentice-hall of India, New Delhi,(1997).*
4. Finite Element Analysis in Engineering Design: *Rajasekaran S, S. Chand & Co.Ltd. New Delhi, (1999).*

Syllabus of Semester II, M. Tech. (Structural Engineering)

Course Code : CEP506 Course: Finite Element Method

L:0 Hr., P:2 Hrs., Per week Total Credits : 2

Course Outcomes

1. The graduates are expected to identify the necessary information required to conduct a structural analysis using finite element software
2. The graduates are expected to interpret the solutions obtained from finite element analyses.
3. The graduates are expected to have basic skills in using commercial finite element software and effective presentation of their analysis results.
4. The graduates are expected to communicate effectively in writing to report (both textually and graphically) the method used, the implementation and the numerical results obtained.

Syllabus

Minimum Six practicals based on above syllabus

Syllabus of Semester II, M. Tech. (Structural Engineering)

Course Code : CET507 Course: Foundation Design

L:4 Hr., P:0 Hrs., Per week Total Credits : 8

Course Outcomes

1. The graduates are expected to understand basic requirement of IS 456:2000 design specifications.
2. The graduates are expected to design various types of foundation systems like isolated, combined, pile, etc. as per codal provisions.
3. The graduates are expected to prepare drawings and schedules for reinforcement in standard formats.

Syllabus

Design of isolated and combined footings, proportioning of footing for equal settlements.

Theory of sub grade reaction, beam on elastic foundation.

Design of rafts – I. S. code method, introduction to various methods.

Floating foundations, analysis and design of pile foundations, negative skin friction, group action in piles, design of pile cap.

Foundation subjected to eccentric loads, pull out resistance of foundation structures.

Analysis and design of simple machine foundation using I. S. code.

References Books:

1. Beam on Elastic Foundation: *Hetenyi, M., University of Michigan Press, (1946).*
2. Foundation Analysis & Design 5th ed.: *Bowles J. E., McGraw Hill, (1996).*
3. Soil Dynamics and Machine Foundation: *Swami Saran, Galgotia Publications (P) Ltd, New Delhi (1999).*
4. Handbook of Machine Foundation: *Srinivasulu P., Vaidyanathan C. V.*
5. Modern Foundations- Introduction to Advanced Techniques: *Kurian, N. P.*

Syllabus of Semester II, M. Tech. (Structural Engineering)

Course Code : CET508 Course : Advanced Concrete Structures

L:4 Hr., P:0 Hrs., Per week Total Credits : 8

Course Outcomes

1. The graduates are expected to understand the behavior of reinforced concrete structures such under standard loading conditions and design their structural components as per codal provisions.
2. The graduates are expected to estimate primary design loads on structural elements consulting appropriate standards and handbooks and combine primary design load cases as per design standards to find critical load combination that governs design.
3. The graduates are expected to understand advanced methods for analysis and design of reinforced concrete structures such as brideges, service reservoirs, multistoried buildings, pipes, etc based on design criteria prescribed in Indian standard codes.

Syllabus

Analysis and design of slab type and T-beam bridges, IRC recommendations

Analysis and design of elevated service reservoirs, IS recommendations for wind and earthquake and ductile detailing.

Analysis and design of multistoried buildings, calculation of loads, approximate analysis, primary sizing, IS: 875, 1893 recommendations, ductile detailing

Analysis and design of special structures i.e. pipes (underground, on ground and elevated), silos, bunkers, chimneys, IS recommendations.

Reference books:

1. Plain and reinforced concrete structures Vol. II: *Jain and Jaikrishna.*
2. IS: 1893, 2002, IS 456-2007
3. Seismic Design Handbook: *Farzad Neaim.*
4. Seismic design of RC & masonry buildings: *Paulay & Prestiley, Thomas P. & M. J. N. Prestiley* A. Wiley, Inter Science Publication.
5. Earthquake resistance design for engineers and architects: *Dowrick D. J,*
6. Concrete structures in earthquake regions: *Booth E.*
7. Design & Construction of Silos & Bunkers: *Sargis S. Safarian, Earnest C Harris*

Syllabus of Semester II, M. Tech. (Structural Engineering)

Course Code : CET509 Course : Theory of Plates and Shells

L:4 Hr., P:0 Hrs., Per week Total Credits : 8

Course Outcomes

1. The graduates are expected to understand the behavior of plates and shells of different shape and thickness under various loading and boundary conditions.
2. The graduates are expected to develop numerical solution using basic principles of mathematics for analysis of plates and shells.
3. The graduates are expected to analyze plate and shell elements used as structural components using approximate methods.

Syllabus

Introduction, Moment curvature relation in pure bending, Symmetrical bending of laterally loaded circular plates, Uniformly loaded circular plates with clamped and Governing differential equations of thin rectangular plates with various boundary conditions & loading.

Laterally loaded rectangular plates, Differential equation of the deflection surface (Lagrange's equation), Boundary conditions, Simply supported plates under sinusoidal loading, Navier's solution.

Finite difference method, Differential equation to bent surface of anisotropic plate, Application to grid.

General shell geometry, classifications, Membrane theory of cylindrical shells, equation of equilibrium, stress resultants under dead load and snow load for circular, cycloidal, catenary, and parabolic cylindrical shells.

Bending theory of cylindrical shells, Finster walder theory, Schorer's theory.

Approximate analysis of cylindrical shells by beam arch method.

References Books:

1. Theory of Plates & Shells: *Timoshenko S. P. & Kriegar, W., McGraw Hill, NY, (1970).*
2. Theory and Analysis of Plates: *Szilard, R. Prentice Hall, (1974).*
3. Thin Shells: *Novozhilov, V. V. Noordho of Groningen, (1964).*
4. Design of Concrete Shells: *Ramaswamy, G. S., Krieger Pulb.Co., (1984).*
5. Theory of Plates 1st ed.: *Chandrashekhar, K., University Press India Ltd. Hyderabad, (2001).*
6. A text book of Plates Analysis: *Bairagi, N. K.*
7. Theory and Design of Concrete Shells: *Chattergee, B.K.*
8. Design and Construction of Concrete Steel roofs by G. Ramaswamy.

Syllabus of Semester II, M. Tech. (Structural Engineering)

Course Code : CET510-1 Course : Elective I (Design of Earthquake Resistance Steel Structures).

L:3 Hr., P:0 Hrs., Per week Total Credits : 6

Course Outcomes

1. The graduates are expected to understand the concepts of capacity design and failure mode control and their deployment in modern codes of practice.
2. The graduates are expected to employ step by step process of seismic design of a steel frame building in accordance to IS 800:2007.
3. The graduates are expected to determine seismic actions on typical steel structures using simplified methods derived from fundamental structural dynamics and earthquake engineering concepts.

Syllabus

Basics of steel design, introduction to plastic analysis and design, introduction to IS800-2007.

Performance of steel structures in past earthquake, Capacity design concept, ductility of steel buildings, Seismic behavior of steel structures, stability considerations.

Design philosophy for steel structures, plastic design of beams economical design, portal frames, design of industrial buildings, girders, columns, roofing, and column base.

Seismic design and detailing of moment resistant frames (MRFs): Beams and columns, panel zones and connections.

Seismic design and detailing of Concentric Brace frames (CBFs).

Introduction to eccentric brace frames (EBFs) and special Truss moment frames (STMFs).

Reference Books:

1. Steel Structures Controlling Behaviour Through Design: *Englekirk, R.; John Wiley & Sons Inc.; (2003).*
2. Ductile Design of Steel Structures: *Bruneau, M.; Uang, C. M.; & Whittaker, A.; McGraw Hill.*
3. Theory and Design of Seismic Resistant Steel Frames: *Mazzolani, F. M.; & Piluso, V.; E&FN Spon.*
4. Earthquake-Resistant Design of Steel Structures: *Duggal, S. K.; Oxford University Press India.*

Syllabus of Semester II, M. Tech. (Structural Engineering)

Course Code : CEP510-1	Course: Elective I (Design of Earthquake Resistance Steel Structures).
L:0 Hr., P:2 Hrs., Per week	Total Credits : 2

Course Outcomes

1. The graduates are expected to apply the principles of the seismic design of structures, ductility based approach, code requirements, representation of the seismic action, methods of analysis, verification and detailing.
2. The graduates are expected to understand the behavioural features of moment and braced steel frames under seismic loading conditions.
3. The graduates are expected to apply the main design rules and detailing requirements for moment resisting and braced steel systems according to the provisions.

Syllabus

Minimum Four practicals based on above syllabus

Syllabus of Semester II, M. Tech. (Structural Engineering)

Course Code : CET510-2	Course: Elective I (Design of Earthquake Resistance RCC Structures).
L:3 Hr., P:0 Hrs., Per week	Total Credits : 6

Course Outcomes

1. The graduates are expected to understand the fundamental concept, principle and application of earthquake engineering.
2. The graduates are expected to understand response spectrum analysis to determine structure response and design earthquake forces.
3. The graduates are expected to understand the codal provision for earthquake resistance design of structures as per Indian standard.

Syllabus

Origin of earthquake, Engineering geology of earthquakes, faults, Propogation of earthquake waves, quantification of earthquake, (magnitude, energy, intensity of earthquake) Measurement of earthquake (accelerograph, accelogram, recording and analysis of earthquake records) seismocity of the world.

Analysis and interpretation of earthquake data, determination of magnitude, epicenter, epicenter distances, focal depth, focal mechanism, seismic zoning.

Causes or sources of earthquake damage, damage due to ground failure, History of past earthquakes, generation of response spectrum from available earthquake records, Evolution of seismic risk.

Concept of response spectra, generation of site-specific spectrum, Estimation of PGA, earthquake design spectrum and inelastic spectrum.

Concept of earthquake resistance design, Design philosophy four virtues of earthquake resistance design(stiffness, strength, ductility and configuration)

Introduction to capacity design concept, Study of IS: 1893, (codal coefficient and response spectrum method) IS:13920 for analysis and ductile design of RCC structures .

Test Books:

1. Geotechnical Earthquake Engineering: *Kramer, S. L., Prentics Hall, New Jersey (1996).*
2. Introduction to Earthquake Engineering Structures: *Agrawal P., Shrikhande, M., Prentice Hall India, New Delhi (2010)*
3. Introduction to Earthquake Engineering Structures: *Arya A.S.*
4. Introduction to Earthquake Engineering Structures: *Jain A.K.*

References Books:

1. Dynamics of Structures, Theory & Application to earthquake Engineering, 2nd ed.: *Chopra A.K., Pearson Education (Singapore) Pvt, Ltd, New Delhi, (1995).*
2. Earthquake Resistant Design for engineers and Architects 2nd ed.: *Dowrick, D. J.,(1987).*
3. Handbook on Seismis Analysis and design of Structures: *Farzad Naeim, Kluwer Academic Publisher, (2001).*
4. Seismic design of R C & Masonary Buildings 2nd ed.*: John Willey & Sons, (1999).*
5. IS:1893-2002 Earthquake Criteria, IS:13920-1993 Ductile Detailing

Syllabus of Semester II, M. Tech. (Structural Engineering)

Course Code : CEP510-2	Course: Elective I (Design of Earthquake Resistance RCC Structures).
L:0 Hr., P:2 Hrs., Per week	Total Credits : 2

Course Outcomes

1. The graduates are expected to incorporate guidelines given in standard design codes depending on site conditions.
2. The graduates are expected to apply the main design rules and detailing requirements for frame and wall systems according to the codal provisions.

Syllabus

Minimum Four practicals based on above syllabus.

Syllabus of Semester III, M. Tech. (Structural Engineering)

Course Code : CET601 Course: Research Methodology

L:3 Hr., P:0 Hrs., Per week Total Credits : 6

Course Outcomes

1. The graduates are expected to define research problem, describe the research process and research methods for execution of research project in relevant field.
2. The graduates are expected to know how to apply the basic aspects of the research process in order to plan and execute a research project.
3. The graduates are expected to adopt various numerical method and mathematical tools for analysis of research data.
4. The graduates are expected to prepare research paper/poster for presentation in a conference /journal of national/international repute.
5. The graduates are expected to participate in interdisciplinary research project benefiting to society.

Syllabus

What is Research?, How to do Research, The Objective of Research, Motivation in Research, Types of Research, Various Research Approaches, Significance of Research.

Research Methods, What is Research Methodology, Research Process, What is Research Problem, Various Components of Research Problem, How to Identify the Research Problem, Steps involved in formulation of Research Problem, Necessity and Techniques involved in Defining Research Problem, Feasibility Check.

What is Hypothesis?, its Characteristics, Examples and Types, Hypothesis Testing, Concepts and Procedure of Hypothesis Testing.

Data Collection, Methods of data collection, Primary Data, Secondary Data, Analysis of data, Simple regression, Multiple regression, linear and non linear correlation and regression .

Optimization, Principle, linear programming technique, simplex method, evolutionary programming techniques.

Model analysis of structures, direct and indirect method, dimensionless terms and their significance, structural similitude's, optimization of model.

Interdisciplinary Research, Importance of Interdisciplinary Research, Wireless Sensor Networks (WSN) as a technology for interdisciplinary research, Application of WSN in civil engineering

Reference Books

1. Research Methodology- Methods and Techniques: *Kothari C.K. (2004), 2/e, New Age International, New Delhi*
2. Simulation Modeling and Analysis, 2nd ed.: *Law, A. M., and W. D. Kelton, 1991, McGraw Hill*
3. Applied Statistics & Probability for Engineers: *Montgomery, Douglas C. & Runger, George C. (2007), 3/e, (Wiley India)*
4. Research Methods: A Modular Approach: 2nd edition, Sherri L. Jackson, Wadsworth Cengage Learngin, Belmont, USA

Syllabus of Semester III, M. Tech. (Structural Engineering)

Course Code : CET602	Course: Design of High Rise Structures
L:3 Hr., P:0 Hrs., Per week	Total Credits : 6

Course Outcomes

1. The graduates are expected to understand fundamental concept, principle and application of earthquake engineering.
2. The graduates are expected to analyze and design shear wall for earthquake forces as per Indian standards
3. The graduates are expected to apply various provisions for earthquake resistance design of structures as per Indian standard.
4. The graduates are expected to apply technical design principles and techniques such as p-delta effect, soil-structure interaction, etc for a design of high-rise building.

Syllabus

Performance of buildings, behaviors of various type of buildings in past earthquakes, modes of failures, influence of unsymmetrical, infill walls, Foundations, soft story & detailing of reinforcements in buildings.

Frames -shear walled buildings, mathematical modeling of buildings with different structural systems, Analysis of frames shear walled buildings, Analysis of coupled shear walled buildings

Special aspects in Multi-story buildings, Effect of torsion, flexible first story, P-delta effect, soil-structure interaction on building response, drift limitation.

Strength, ductility and energy absorption, ductility of reinforced members subjected to flexure, axial loads & shear. Detailing of RCC members, beam, column, Beam-column joints for ductile behaviors. IS code provisions.

Design of multi-story buildings with bracings & infills.

Seismic design of floor diaphragm

Reference Books:

1. IS: 1893-2002
2. Handbook on seismic analysis and design of structures: *Farzad neaim*
3. Seismic design of R C & masonry Buildings: *Paulay & Prestiley*
4. Earthquake resistant Design for engineers & Architects: *Dowrick D J*
5. Concrete Structures in earthquake regions: *Booth E.*
6. Reinforced Concrete Structures: *Park & Paulay*

Syllabus of Semester III, M. Tech. (Structural Engineering)

Course Code : CET603-1 Elective II Course: Composite Structures

L:3 Hr., P:0 Hrs., Per week Total Credits : 6

Course Outcomes

1. The graduates are expected to understand the need, advantages and limitations of composite material.
2. The graduates are expected to apply basic mechanical principles in analysis of composite structures like beams, columns, floors, shear connectors, etc.
3. The graduates are expected to understand and apply various codal provisions as per Indian standards in design of structural components using composite materials.

Syllabus

Introduction to composite construction, basic concepts, types of composite constructions

Steel concrete composite, Analysis and of composite beams

Composite floors, shear connectors: functions & types

Steel concrete composite columns, columns subjected to axial loads and moments.

Encased composite construction of beams and columns, concepts and design.

Study of IS: 11384, IRC-22 and their applications

Reference Books:

1. Steel design manual - Construction steel research and development organization.

2. IS:11384

3. IRC-22

4. INSDAG course Material

5. Composite Structures: *G. M. Sabnis*

Syllabus of Semester III, M. Tech. (Structural Engineering)

Course Code : CET603-2 Elective II Course: Structural Instrumentation and Material Science

L:3 Hr., P:0 Hrs., Per week Total Credits : 6

Course Outcomes

1. The graduates are expected to have fundamental understanding of the theoretical basis of various measuring instruments used in structural health monitoring.
2. The graduates are expected to select and apply appropriate instrument, method of analysis for measurement of quantities like strain, strength, etc. of structural components.
3. The graduates are expected to carry out meaningful interpretation of data obtained from various instruments and produce quantities report of measured parameter.

Syllabus

Study of various transducers & Principle of their working, displacement velocity acceleration.

Stress-strain measurement, strain gauges static and dynamics strain measurement, Calculation of stresses from measurement of strain, deflections etc.

Special materials for building constructions i. e. steel fibre reinforced concrete, fibre reinforced plastics.

Non-destructive testing of concrete / steel / ultrasonic techniques etc, model Analysis related to structures.

Admixture for concrete, theories of corrosion and its preventions.

Special concrete like lightweight concrete, no fines concrete, Ferro cement, fly ash concrete etc. high performance concrete.

References Books:

1. Experimental Stress Analysis: *Singh, Sadhu Khanna Publishers.*
2. Instrumentation in Industry: *Soisson, H. E. John Willey & Sons, NY, 1975*
3. Corrosion of Steel in Concrete: *Boon Field, J. P. E & FN SPON, 1997.*
4. Modal Analysis of Structures: *Ganesan, T. P., University Press,2000*
5. "IS: 13925 Repair and Seismic Strengthening of Buildings- Guidelines", Bureau of Indian Standard, New Delhi, 1993.
6. "SP: 25 Causes and Prevention of Cracks in Buildings", Bureau of Indian Standard, New Delhi, 1984.

Syllabus of Semester III, M. Tech. (Structural Engineering)

Course Code : CET603-3 Elective II Course: Design of Environmental Structures

L:3 Hr., P:0 Hrs., Per week Total Credits : 6

Course Outcomes

1. The graduates are expected to understand the basic principles used in design of environmental structures like water tanks, pump house, water treatment units, etc.
2. The graduates are expected to understand the behavior of structural components of various environmental structures under standard loading conditions and design them as per codal provisions.
3. The graduates are expected to estimate primary design loads on structural elements consulting appropriate standards and handbooks and combine primary design load cases as per design standards to find critical load combination that governs design.
4. The graduates are expected to employ design procedure as per code of practice for design calculations and prepare drawings in appropriate formats.

Syllabus

Design of Over Head Water Tanks

Design of Underground Water Tanks

Design of Jack Well/Pump House/Approach Bridge

Design of Pretreatment Unit i.e. Clarifloculators, Aerators, Flash Mixers, Sand Filters, etc.

References Books:

1. Guidelines for seismic design of liquid storage tanks: *Jain, S. K., Jaiswal, O.R., NICEE, IITK, 2004.*
2. Design of liquid retaining concrete structure: *Anchor, R.D., Edward Arnold, London, 1992.*
3. BIS, IS 3370, "Indian Standard code of practice for concrete structures for the storage of liquids", Part I to IV.
4. Ghali, A, "Circular Storage Tanks and Silos", E & F N Spon, London, 1979.

Syllabus of Semester III, M. Tech. (Structural Engineering)

Course Code : CEP604 Course : Computer Aided Analysis and Design

L : 0 Hr., P : 2 Hrs., Per week Total Credits : 2

Course Outcomes

1. The graduates are expected to understand and apply theories, methods and procedures for analysis and design of various structural systems using modern computer tools.
2. The graduates are expected to perform advanced modeling and simulation of Steel/RCC buildings subjected to various loadings as per Indian standards.
3. The graduates are expected to execute professional design projects using commercial software's like STAAD.pro.

Syllabus

Minimum Six analysis/practicals should be performed on STAAD.pro/SAP based on following topics

1. Analysis of simple beams
2. Analysis of trusses (2D and 3D)
3. Analysis of frames
4. Analysis of grid
5. Analysis of multi storied buildings
6. Analysis of buildings subjected to earthquake/wind forces

Syllabus of Semester III, M. Tech. (Structural Engineering)

Course Code : CEP605 Course: Project Phase I

L:0 Hr., P:8 Hrs., Per week Total Credits : 24

Course Outcomes

1. The graduates are expected to identify a research topic through interaction with industry and society and to collect relevant data through literature survey.
2. The graduates are expected to formulate step by step procedure, equipment/material requirement for performing research work.
3. The graduates are expected to demonstrate effective written and oral communication skill.

Syllabus

Seminar and Seminar report based on topic for research for project

Syllabus of Semester IV, M. Tech. (Structural Engineering)

Course Code : CEP606 Course: Project Phase II

L:0 Hr., P: 16 Hrs., Per week Total Credits : 48

Course Outcomes

1. The graduates are expected to demonstrate skills in operating computer software, laboratory testing equipment's, internet navigation, spreadsheets generation, documentation of results, etc.
2. The graduates are expected to develop mathematical correlation between various factors affecting research outcomes and conclude the research work.
3. The graduates are expected to demonstrate effective communication skills and prepare report/research paper in specific conventions and formats.

Syllabus

Seminar/research work based on some topic related to Structural Engineering