SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR - 440013

An Autonomous College affiliated to
Rashtrasant Tukadoji Maharaj Nagpur University,
Nagpur, Maharashtra (INDIA)

PROGRAMME SCHEME & SYLLABI
2019-20

M.TECH. (STRUCTURAL ENGINEERING)

Published by
Dr. R.S. Pande
Principal
Shri Ramdeobaba College of Engineering & Management
Ramdeo Tekdi, Gittikhadan, Katol Road, Nagpur - 440 013
Ph. : 0712-2580011 Fax : 0712 - 2583237
ISO 9001 : 2015 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

To be a knowledge centre in civil engineering education, training, research, entrepreneurship and industry outreach services for creating sustainable infrastructure and enhancing quality of life.

Department Mission :

To generate quality civil engineers with strong technical and managerial skills through creation of conducive environment for creative learning and research in association with stake holders.

Programme Educational Objectives :

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

Programme Outcomes :

PO1: An ability to independently carry out research / investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report / document.

PO3. Student should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

Scheme of Examination of Master of Technology (Structural Engineering)
Semester Pattern
I Semester M. Tech. (Structural Engineering)

SN	Course Code	Course Name	L	P	Credits	Maximum Marks			Exam Duration	Category
						Continuous Assessment	End Semester Examination	Total		
1	CET595	Engineering Computational Techniques	4	0	4	40	60	100	3	FC
2	CET551	Matrix Method	4	0	4	40	60	100	3	PC
3	CEP551	Matrix Method (P)	0	2	1	25	25	50	-	PC
4	CET552	Structural Dynamics	4	0	4	40	60	100	3	PC
5	CEP552	Structural Dynamics (P)	0	2	1	25	25	50	-	PC
6	CET553	Advanced Steel Structures	4	0	4	40	60	100	3	PC
7	CEP553	Advanced Steel Structures (P)	0	2	1	25	25	50	-	PC
8	CET554	Programme Elective I	4	0	4	40	60	100	3	PE
		Total	**20**	**6**	**23**	**275**	**375**	**650**	**15**	

Course Code	Programme Elective I
CET554-1	Theory of Elasticity & Elastic Stability
CET554-2	Composite Structures

Scheme of Examination of Master of Technology (Structural Engineering)
Semester Pattern
II Semester M. Tech. (Structural Engineering)

SN	Course Code	Course Name	L	P	Credits	Maximum Marks			Exam Duration	Category
						Continuous Assessment	End Semester Examination	Total		
1	CET555	Foundation Design	4	0	4	40	60	100	3	PC
2	CET556	Advanced Concrete Structures	4	0	4	40	60	100	3	PC
3	CEP557	Computer aided analysis and design (P)	0	2	1	25	25	50	-	PC
4	CET558	Design of Earthquake Resistance RCC Structures	4	0	4	40	60	100	3	PC
5	CET596	Research Methodology	3	0	3	40	60	100	3	FC
6	CET597	Group Elective I	4	0	4	40	60	100	3	GE
7	CEP597	Group Elective I (P)	0	2	1	25	25	50	-	GE
8	CET599	Open Elective	3	0	3	40	60	100	3	OE
		Total	**22**	**4**	**24**	**290**	**410**	**700**	**18**	

Course Code	Group Elective I (T + P)
CET/ CEP 597-1	Applied Soil Engineering
CET/ CEP 597-2	Finite Element Method
CET/ CEP 597-3	Instrumentation & Material Science
CET/ CEP 597-4	Soil Dynamics

Course Code	Open Elective
CET 599-2	Geoscience
CET 599-4	Watershed Management

Scheme of Examination of Master of Technology (Structural Engineering)
Semester Pattern
III Semester M. Tech. (Structural Engineering)

SN	Course Code	Course Name	L	P	Credits	Maximum Marks			Exam Duration	Category
						Continuous Assessment	End Semester Examination	Total		
1	CET598	Group Elective II	4	0	4	40	60	100	3	GE
2	CET651	Programme Elective II	4	0	4	40	60	100	3	PE
3	CEP652	Project Phase I (D)	0	3	6	50	50	100	-	PC
		Total	**8**	**3**	**14**	**130**	**170**	**300**	**6**	

Course Code	Group Elective II
CET 598-1	Design of Bridges
CET 598-2	Design of Environmental Structures
CET 598-3	Geo-Environmental Engineering
CET 598-4	Soil Structure Interaction

Course Code	Programme Elective II
CET651-1	Design of High Rise Structures
CET651-2	Theory of Plates & Shells
CET651-3	Design of Earthquake Resistance Steel Structures

Scheme of Examination of Master of Technology (Structural Engineering)
Semester Pattern
IV Semester M. Tech. (Structural Engineering)

SN	Course Code	Course Name	L	P	Maximum Marks				Exam Duration	Category
					Credits	Continuous Assessment	End Semester Examination	Total		
1	CEP653	Project Phase II (D)	0	6	12	100	100	200	-	PC
		Total	**0**	**6**	**12**	**100**	**100**	**200**	**-**	

Semester	L	P	Credits	Maximum Marks		
				Internal Assessment	End Semester Examination	Total
First Semester	20	6	23	275	375	650
Second Semester	22	4	24	290	410	700
Third Semester	8	3	14	130	170	300
Fourth Semester	0	6	12	100	100	200
Total	**50**	**19**	**73**	**795**	**1055**	**1850**

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

Course Code: CET595 **Course: Engineering Computational Techniques**

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

Course Outcomes

1. The graduates will be able to analyze various mathematical problems involved in structural engineering
2. The graduates will be able 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-ø 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., Thilagavthy 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 methods: *Salvadori M., PHI learning Pvt, ltd. New Delhi, (1987.)*

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

Course Code: CET551 **Course : Matrix Method**

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

Course Outcomes :

1. The graduates will be able 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 will be able 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 Methods of Structural Analysis 1st ed.: P. N. Godbole, R. S. Sonparote, S. U. Dhote, PHI Learning Private Limited, Delhi (2014).
2. Matrix Analysis of Structural Analysis 3rd ed.: Gere, W. and Weaver. J. M. Van Nostrand Reinhold, NY, (1990).
3. Matrix Analysis of Structures: Kasmali Aslam Books/cole Publishing Co. (1999)

4. Matrix Method of Structural Analysis: Meghre A. S. and Deshmukh S. K., Charotar Publishing House, Anand, India (2003)
5. 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: CEP551 **Course: Matrix Method**

L:0 Hr., P:2 Hrs., Per week **Total Credits : 1**

Course Outcomes :

1. The graduates will be able to understand and apply basic steps involved in structural analysis using computer software like Structural Analysis Program (SAP).
2. The graduates will be able 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

Analytical Solution & Computer Simulation of following problems

1. Truss
2. Beams
3. 2D Frames
4. Grid Frame
5. Problems considering effect of temperature
6. Problems considering inclined support.

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

Course Code: CET552 **Course : Structural Dynamics**

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

Course Outcomes :

1. The graduates will have detailed knowledge about dynamic forces and loadings caused due to earthquake, vibrations etc.
2. The graduates will be able to analyze various type of structure subjected to dynamic loading.
3. The graduates will be able 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 ed.: 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).
4. Introduction of Structural Dynamics: Biggs J. M. McGraw Hill NY, (1964).

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

Course Code: CEP552 **Course : Structural Dynamics**

L:0 Hr., P:2 Hrs., Per week **Total Credits : 1**

Course Outcomes :

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

Syllabus :

1. To study the various instruments for imparting dynamic force.
2. To study the various instruments for response of vibrating structures.
3. To study the waves of water in a rectangular water tank subjected to harmonic base motion.
4. To study the response of SDOF system and to find out natural frequency.
5. Soil liquefaction.
6. To observe mode shapes and corresponding natural frequency of their DOF

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

Course Code: CET553 **Course : Advanced Steel Structures**

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

Course Outcomes :

1. The graduates will be able to recognize the design philosophy of steel structures and understand the concept of limit state design.
2. The graduates will be able 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 will be able 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: CEP553 **Course : Advanced Steel Structures**

L:0 Hr., P:2 Hrs., Per week **Total Credits : 1**

Course Outcomes :

1. The graduates will be able 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 will be able 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 from the following :-

1. Design of moment resistant connections-bolted/welded.
2. Design of steel stack/chimney
3. Design of gantry girder.
4. Design of industrial shed.
5. Design of foot bridges
6. Design of railway bridges.

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

Course Code: CET554-1 **Course: Programme Elective I-Theory of Elasticity and Elastic stability**

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

Course Outcomes :

1. The graduates will be able to apply the principles of mathematics in numerical analysis and to develop numerical model of simple structures.
2. The graduates will be able 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: CET554-2 **Course : Programme Elective I-Composite Structures**

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

Course Outcomes :

1. The graduates will be able to understand the need, advantages and limitations of composite material.
2. The graduates will be able to apply basic mechanical principles in analysis of composite structures like beams, columns, floors, shear connectors, etc.
3. The graduates will be able 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 II, M. Tech. (Structural Engineering)

Course Code: CET555 **Course: Foundation Design**

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

Course Outcomes :

1. The graduates will be able to understand basic requirement of IS 456:2000 design specifications.
2. The graduates will be able to design various types of foundation systems like isolated, combined, pile, etc. as per codal provisions.
3. The graduates will be able 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.

Introduction to floating foundation, analysis and design of pile foundations, negative skin friction, group action in piles, design of pile cap.

Foundation subjected to eccentric loads.

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 : CET556 | **Course : Advanced Concrete Structures**

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

Course Outcomes :

1. The graduates will be able 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 will be able 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 will be able to understand advanced methods for analysis and design of reinforced concrete structures such as bridges, 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 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, IS recommendations.

Roofing for large column free area, design of grid slab, design of flat slab.

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 : CEP557 | **Course : Computer Aided Analysis and Design**

L : 0 Hr., P : 2 Hrs., Per week | **Total Credits : 1**

Course Outcomes :

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

Syllabus

Mini project on Analysis and Design of residential building using STAAD.pro.

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

Course Code: CET558 **Course : Design of Earthquake Resistant RCC Structures**

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

Course Outcomes :

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

Syllabus

Basic Concepts : Origin of earthquake, quantification of earthquake, (magnitude, energy, intensity of earthquake) Determination of magnitude, epicenter, epicenter distances, focal depth, seismic zones in India.

Seismic performance of structures and structural components during past earthquakes, ground motion and their characteristics, factor affecting gound motion.

Study of IS 1893 -Part i, concept of response spectra, generation of site -specific spectrum, generation of response spectrum from available earthquake records.

Seismic Design Philosophy : Concept of strength, over strength and ductility, factors affecting ductility, capacity design. Seismic design consideration in building with irregularities.

Seismic Analysis of Buildings : Equivalent Static Analysis, response spectrum analysis, Time history analysis; Modelling concept of reinforcd concrete building.

Seismic Design of Building Components (Beam and Column) : Seismic resistant properties of reinforced concrete; Seismic behaviour and design of linear reinforced concrete elements; codal provisions (IS: 13920)

Text Books :

1. Kramer, S.L. " Geotechnical Earthquake Engineering", Prentics Hall, New Jersey 1996.
2. Shrikhande, M. " Earthquake Resistant Design of Structures."
3. Arya A.S., "Introduction to Earthquake Engineering Structures."
4. Jain A.K., "Introduction to Earthquake Engineering Structures."
5. S.K. Duggal, " Earthquake Resistant Design of Structures."

References Books :

1. Murthy, C.V.R. "Earthquake Tips." IIT Kanpur Documents
2. Chopra A.K., Dynamics of Structures, Theory & Application to earthquake Engineering, 2nd edition Pearson Education (Sigapore) Pvt, Ltd, New Delhi, 1995.
3. Dowrick, D.J. "Earthquake Resistant Design for engineers and Architects", 2nd Editiion,1987.

Reference codes :

1. IS:1893-2002 and 2016 Part I Earthquake Criteria
2. IS:13920-1993 and 2016 Ductile Detailing

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

Course Code : CET596 **Course : Research Methodology**

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

Course Outcomes :

1. The graduates will be able to define research problem, describe the research process and research methods for execution of research project in relevant field.
2. The graduates will be able to know how to apply the basic aspects of the research process in order to plan and execute a research project.
3. The graduates will be able to adopt various numerical method and mathematical tools for analysis of research data.
4. The graduates will be able to understand ethics in research

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.

Research Paper and its contents, Choice on topic, Method of writing research paper, Plagiarism including rules of plagiarism

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
5. Schaum's Quick Guide to Writing Great Research Papers: Laurie Rozakis, 2nd edition, McGraw Hill, New York, USA.

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

Course Code: CET 597-1 **Course : Group Elective I-Applied Soil Engineering**

L:4 Hrs., P:0 Hrs., Per Week **Total Credits : 4**

Course Outcomes :

1. To build the student's knowledge in the engineering behavior of soils such as arching, soil pressure on conduits and silos.
2. Also, to gain knowledge in geotechnical design of different types of earth retaining structures.
3. Student will able to apply basic concepts in soil engineering for analysis of complex geotechnical problems.

Syllabus

Earth pressure theories :

Theories of earth pressure, general and local states of plastic equilibrium, Active and passive states in cohesive and cohesion less soils, Rankine's and Coulomb,s approaches, effects of wall movement, uniform surcharge, wall angle, wall friction, back fill slope; lateral pressure on wall due to concentrated construction, Culmann's method; , earth pressure at rest.

Retaining Walls :

Types of retaining wall, Stability analysis of rigid type and R. C. cantilever type retaining walls, introduction of Georeinforce wall, Gabion wall, soil nailing.

Sheets pile walls :

Types, analysis and design of cantilever and anchored sheet pile walls in cohesive and cohesion less soil, bulkheads, analysis with free earth and fixed earth supports. Rowe`s moment reduction factors, location of deadman and its anchorage capacity.

Cofferdams :

Types, suitability, stability analysis and design of cellular and diaphragm type cofferdams, TVA method for various failures, interlock stress, stability of cellular cofferdams in deep sands and clays.

Stability of slopes:

Finite and infinite slopes, analysis for stability of slopes of embankments, cuts and earth dams. Critical conditions, plane and curved failure surfaces, centre of critical slip circle; slices method with inter slices forces,

pore pressures and seepage forces, Ø-circle method, Taylor's stability numbers & stability curves; Bishop's method, Bishop-Morgenstern stability coefficient, Use of design charts based on Ø-circle method and Bishop`s method. Stability of earth dam slopes during steady seepage and sudden drawdown conditions, Filters types, selection and design criteria, Remedial measures to improve the slop stability.

Text books :

1. T.B. of soil mechanics and foundation engineering: Murthy VNS, CBS pub. (2004)
2. Principles of Geotechnical Engineering: Das B.M.,Thomson Bks, Cengage publ.(2002)
3. Geotechnical Engineering-principles & practices: Coduto D.P., Peavson edn. Asia, (2002)

Reference books :

1. Principles of Foundation Engineering: Das B.M., PWS publication co., (1999)
2. Foundation Analysis & Design: Bowles, J.E., McGraw Hill (1996)
3. Theory & practice of Foundation Design: Som N.N. & Das S.C., Prentice Hall Edn, Asia (2002)

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

Course Code: CEP 597-1 **Course : Group Elective I-Applied Soil Engineering**

L:0 Hrs, P:2 Hrs., Per Week **Total Credits : 1**

Course Outcomes :

1. Student will have an ability to calculate pressure on conduits and silos.
2 Student will have an ability to design different types of earth retaining structures.
3 Student will have an ability to determine soil engineering for analysis of complex geotechnical problems.

Work out the Design / solution of minimum 6 problems/ assignments from the following :

1) Design of cantilever bulkhead in cohesive soil retaining granular backfill.
2) Design of anchored bulkhead by free earth support method.
3) Design of anchored bulkhead by fixed earth support method.
4) Design of braced cofferdam.
5) Culmann's graphical method for active or passive pressure on cantilever wall retaining broken surface backfill with concentrated load.
6) Poncelet construction for active and passive pressure on gravity retaining wall with sloping backfill.
7) Stability of homogeneous C-Ø soil slope by slices method of F- circle method (for min. F.S.) (software based)
8) Stability of homogeneous C-Ø soil slope by Bishop method (for min. F.S.) (software based)

The work shall be submitted in the form of Journal of above, and same shall be assessed by the concerned teacher/s through viva-voce examination.

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

Course Code: CET 597-2 | **Course : Group Elective I-Finite Element Method**

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

Course Outcomes :

1. The graduates will be able to understand solution methodologies for solving complex stress analysis problems.
2. The graduates will be able 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 will be able 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 will be able 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 Element Method, P. N. Godbole, I. K. International Publishing House Pvt. Ltd., (2013).
2. Introduction to Finite Elements in Engineering: Chandrapatla T. R. and Belegundu A. D., Prentice Hall, India, (1991).
3. A First Course in the Finite Element Method: Logan D. L, Thomson Publishing (2007)
4. "Finite Element Analysis: Theory and Programming", 2nd ed.: Krishnamurthi C. S., Tata Mc Graw Hill Publishing Company Limited, 1994, Reprint 2005.
5. 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: CEP 597-2 | **Course: Group Elective I-Finite Element Method**

L:0 Hr., P:2 Hrs., Per week | **Total Credits : 1**

Course Outcomes :

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

Syllabus

Analytical Solution & Computer Simulation of following problems

1. Truss
2. Bar
3. Beams
4. 2D plane stress problem
5. 2D plain strain problem
6. 2D Axisymmetric problem
7. 3D problem

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

Course Code: CET 597-3 | **Course : Group Elective I- Instrumentation and Material Science**

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

Course Outcomes :

1. The graduates will have fundamental understanding of the theoretical basis of various measuring instruments used in structural health monitoring.
2. The graduates will be able to select and apply appropriate instrument, method of analysis for measurement of quantities like strain, strength, etc. of structural components.
3. The graduates will be able 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 II, M. Tech. (Structural Engineering)

Course Code: CEP 597-3 **Course: Group Elective I- Instrumentation and Material Science**

L:0 Hr., P:2 Hrs., Per week **Total Credits : 1**

Course Outcomes :

1. The graduates will able to identify suitable measuring instruments for structural health monitoring.
2. The graduate will be able to operate various instruments, interpret the results and will be able to prepare a report.

Syllabus

Minimum Six practicals based on Theory syllabus

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

Course Code: CET597-4 **Course : Group Elective I-Soil Dynamics**

L:4 Hrs., P:0 Hrs., Per Week **Total Credits : 4**

Course Outcomes :

1. The graduates will have knowledge in dynamic loading, theory of vibrations, dynamic soil properties, dynamic earth pressure, dynamic bearing capacity, vibration isolation, liquefaction of soils
2. The graduates will have knowledge of machine foundation design.
3. The graduates will able to realize the occurrence of liquefaction and the analyzing it.

Syllabus

Dynamic properties of soil :

Idealization of soil as elastic material for dynamic analysis, elastic constant (E,G) and damping property, coefficient of elastic uniform compression and shear, their determination from elasticity theory; Laboratory test and field test to determine dynamic properties. Salient feature and interpretation of resonant column test. Ultrasonic pulse test, block resonance test and cyclic plate load test, factor affecting elastic properties of soil, damping form hysteresis loop, shear models of cohesive and cohesion less soils for low and high strain amplitude problems, application Hooke's law to soil, influence of initial stresses in soil on its elastic deformation, Cross hole propagation test.

Theory of vibration and machine foundation :

Time dependent forces on soil foundation system and their frequency ranges, nature of dynamic forces from m/c forces and earth quake, mass-spring analogy for m/c foundation analysis, theory of free and forced vibration with and without damping, dynamic response characteristics, concept of apparent soil mass, elastic half space approach, Richart's solutions, correlation and comparison of dynamic response evaluation from mass-spring analogy and elastic half space approach.

Machine Foundation Design :

Type of machines, dynamic force characteristics, Analysis and design of single engine reciprocating and impact type machine foundation under vertical dynamic forces; Design and analysis of block foundation, frame foundation (Turbo engine). Computation of dynamic force, method of decreasing vibration of foundation, Analysis and design of m/c foundation with dynamic dampness and absorbers. Vibration isolation and vibration screening. Permissible amplitude of vibration.

Liquefaction of soil :

Phenomenon, liquefaction induced failures, factors affecting liquefaction, Evaluation of liquefaction potential, concept of cyclic stream ratio (CSR), CSR developed by design earthquake and that required to produce liquefaction, SPT based approaches, CPT based approach, remedial measures to prevent liquefaction.

Text books :

1. Geotechnical Earthquake Engineering: S.L. Kramer, Prentice Hall of India (1996)
2. Vibration of soil and foundation: Richarts, Hall and Woods, Prentice Hall of India (1970)
3. Advanced Foundation Engineering (Chapter 15): VNS Murthy, CBS Publisher (2007)

Reference books:

1. Geotechnical Engineering: D.P. Coduto, Pearson Education Asia, (2002)
2. Soil Dynamics: Shamsher Prakash
3. Theory and Practice of Foundation Design: N.N. Som and S.C. Das, Prentice Hall of India (2003)
4. Basic of Soil Dynamics: Das B.M. , Ramana G.V., NPTEL Videos on Soil Dynamics

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

Course Code: CEP597-4 **Course: Group Elective I-Soil Dynamics**

L:0Hrs., P:2 Hrs., Per Week **Total Credits : 1**

Course Outcomes :

1. The graduates will have knowledge in dynamic loading, theory of vibrations, dynamic soil properties, dynamic earth pressure, dynamic bearing capacity, vibration isolation, liquefaction of soils
2. The graduates will have knowledge of machine foundation design.
3. The graduates will able to realize the occurrence of liquefaction and the analyzing it.

Syllabus

Each student shall complete the following design assignments indivisually (with different data)

1. Analysis and design of reciprocating machine foundation by;
   a. Barken's approach using Cu, with and without apparent soil mass consideration.
   b. Pauw's method for spring constant and apparent soil mass.
2. Analysis and design of reciprocating machine foundation with spring absorber system.
3. Analysis and design of forge hammer foundation.
4. Evaluation of liquefaction potential of given ground for a known design earthquake.

The work record shall be submitted in the form of journal and the same shall be assumed by concerned teacher through viva voce examination.

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

Course Code: CET 599-2 **Course : Open Elective-Geoscience**

L:3 Hrs., P:0 Hrs., Per Week **Total Credits : 3**

Course Outcomes :

1. The graudate will be able to understand the different behavior of soil.
2. The graudate will be able to understand the swelling and shrinkage characteristics of soil.
3. The graudate will be able to analyse the mechanism of clay and the phenomena of flow.
4. The graudate will be aware of modern instrumentation methods and also thermal, electromagnetic identification techniques of soil

Syllabus

Overview of Basic Geotechnical Engg :

Broad perspective of geotechnical engineering, rational solution to problems associated with soil, & rock soil as engineering material, Soil formation & its geomorphology. Soil properties, granulomettry, consistency, relative density, permeability, shear strength, compressibility. IS soil classification, suitability of various soil groups, field identification.

Physico-Chemical properties of clay:

Formation, lattice structures and classification of clay minerals, causes of electro-chemical activity of clays, specific surface, dipole water molecule, adsorption of ions and dipoles, isomorphic substitution, Inter-particle forces in clay-water-electrolyte system, clay structure, force distance, law, force fields between clay particles and exchangeable ions, adsorption complex, base exchange, physico-chemical mechanisms controlling strength, compressibility, permeability, plasticity and shrinkage behavior of clays; sensitivity and thixotropy; capillary phenomenon and hygroscopic moisture. Identification of clay minerals, X-ray diffraction, electron microscope and differential thermal analysis.

Expansive soils:

Mechanism of swelling, moisture migration, soil suction characterization of swelling soil by free swell indices, swelling potential & free swell ratio, field & laboratory identification of swelling soil, swelling pressure, factors

affecting volume change and swelling pressure, vertical soil movement & estimation of ground heave, concept and application of unit swell potential, feature and preparation of black cotton soil, properties and uses of bentonite slurry. Nature of damages to different structures causes of damages, conversional design approaches to construction in black cotton soil (excluding under reamed piles), stabilization of black cotton soil with cement, lime, fly ash and chemical admixtures. Concepts and principle of CNS technique, application, specification of CNS material, thickness of CNS Layer

Text books :

1. Foundation on Expansive Soil: Chen F.H. , Elsevier Publication co. (1975)
2. Principles of Soil Mechanics: Scott R. F., Addison-Wesley Publication co. (1963)
3. Basic and Applied soil Mechanics: Gopal Ranjan & A.S. Rao, New Edge International Ltd., (2004)

Reference books :

1. Geotechnical Engineering–Principles & Practices: Coduto, D.P. Peavson Edn. Asia (2002)
2. Soil Mechanics: Jumikis, A.R., D.Van Nostrand co., (1965)
3. Soil Mechanics in Theory and Practices: Alam Singh, Asia publisher and distributor, 1975

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

Course Code: CET 599-4 **Course : Open Elective-Watershed Management**

L:3 Hrs., P:0 Hrs., Per Week **Total Credits : 3**

Course Outcomes :

At the end of the course students will be able to;

1. The graduates will be able to identify problems associated with water management
2. The graduates will be able to suggest suitable techniques for watershed management

Syllabus :

Watershed types, Rainfall-Runoff relationship, Necessity of soil and water conservation, Soil-Water-Plant relationship, Land use capability classification, soil erosion definition, processes and forms, factors influencing soil erosion, Erosion hazard assessment, effects on water yield, soil and water conservation practices in catchments. Soil and water conservation practice in commands, Agro-forestry, Soil conservation on private land, Watershed development: ridge-to-valley concept, Water harvesting techniques for life saving irrigations, Land Treatment, Drainage line treatment, Role of geology, Design of structures, Estimation of water harvested, impact on environment, Hydrology of micro– watershed, Case studies

Reference Books :

1. Soil and Water Conservation Engineering by Glen O. Schawb et al Wiley Publications
2. Soil and Water Conservation by F.R.Troeh et al Prantice Hall Int. Publication
3. Soil Conservation by N. Hudson, Batsford Academic Publications
4. Soil Erosion and Conservation by Morgan, R.P.C. Longman scientific Publication
5. Watershed Hydrology by V.S.R. Murthy
6. ICRISAT Manual on Watershed

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

Course Code: 598-1 **Course: Group Elective II-Design of Bridges**

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

Course Outcomes :

1. The graduates will be able to understand the philosophy of analysis and design of bridge
2. The graduates will be able to understand the loading conditions, codal provisions and behavior under earthquake of bridge superstructure and substructure

Syllabus

Types of bridge superstructure and introduction to their design, sub-structure, bearings, IRC / IRS Bridge loadings and other codal recommendations, Performance of Bridges in past earthquakes. Seismic design philosophy for Bridges, State of art Modeling of bridges, Seismic Design of Substructures, Capacity design of substructures and ductile detailing, Seismic design of well and pile foundations, Modeling soil flexibility. Earthquake behavior and Design of retaining wall and Abutments, IS code recommendations. Design of Bearings (Free, Guided and Restrained).

Reference Books :

1. Chen, W.F. and Duan, L, “Bridge Engineering Handbook”, CRC Press, 1999.
2. Fintel, M., “Handbook of Concrete Engineering” 2nd Edition, CBS Publishers Delhi, 1986.

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

Course Code: CET 598-2 | **Course: Group Elective II-Design of Environmental Structures**

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

Course Outcomes :

1. The graduates will be able to understand the basic principles used in design of environmental structures like water tanks, pump house, water treatment units, etc.
2. The graduates will be able 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 will be able 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 will be able to employ design procedure as per code of practice for design calculations and prepare drawings in appropriate formats.

Syllabus

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.

Design of Elevated Service Reservior.

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: CET 598-3 | **Course: Group Elective II Geo-Environmental Engineering**

L:4 Hrs., P:0 Hrs., Per Week | **Total Credits : 4**

Course Outcomes :

1. The graduates will be aware about Geo-Environmental techniques, landfill engineering, and contaminant transport.
2. The graduates will be able to understand the concept of design of waste containment facilities like landfill and waste containment pond.
3. The graduates will be able to understand the importance of recycled and reuse of waste material.
4. The graduates will be able to understand the problem of land erosion and to give the effective solution.

Syllabus

Surface & subsurface contamination, biological & chemical contamination sources & effect of subsurface contamination, Fate & transport of underground contamination, advection, dispersion, diffusion, sorption, vertilization, chemical reaction, biodegradation radioactive decay. Geo-environmental soils characterization & remediation methods.

Contaminants of solid waste in land fills, characteristics of solid wastes, types of land fills, site selection, shape of size of land fills, liners, covers characteristics of solid wastes, types of land fills, site selection, shape & size of land fill, liners, covers and Leachete collection, waste containment principles, Types of barrier materials, planning & design aspects related to waste disposal. Land fill in ash ponds, infilling ponds & in rocks. Stability of land fills, sustainable waste management. Monitoring surface contamination, stabilization & modification of waste. Case studies in waste handling, soil-waste interaction.

Contaminable of slurry waste; Slurry transported wastes, slurry ponds, operation embankment construction & planning, design aspects, environmental impact & control.

Vertical barriers system & cutoff walls, slurry trench cutoff, backfill design & potential defects, use of bentonite & cement in slurry. Constructional features, use of geosynsthetics in land fills, barriers & cutoff, installation of soil mixed wall barrier by deep soil mixing.

Environmental monitoring around landfills, detection, control & remediation of subsurface contamination; engineering properties & geotechnical reuse of waste materials. Demolition waste dumps, regulations.

Soil erosion and land conservation; causes of soil erosion, factors contributory to erosion, erosion control measures.

Text Book:

1. Geoenvironmental Engineering- Principles and Applications: L.N. Reddy & H.F. Inyang, Marcel Dekkar (2004)
2. Geotechnical Practice for Waste Disposal: D.E. Daniel Chapman and Hall, London(1993)
3. Construction and Monitoring of Landfills: A. Bagchi, John Wiley and Pone N.Y.,(1994)

Reference Book :

1. Geotechnical Engineering (Chapter 09): D.P. Coduto, Pearson Education Asia,(2002)
2. Foundation Engineering Handbook (Chapter 20): H.Y. Fang, CBS Publishers (2004)

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

Course Code: CET 598-4 **Course: Group Elective II Soil-Structure Interaction**

L:4 Hrs., P:0 Hrs., Per Week **Total Credits : 4**

Course Outcomes :

1. The graduates will be able to understand the soil behavior and the methods to analyze the models
2. The graduates will be able to solve the problems for beam and plate on elastic medium.
3. The graduates will be able to analyze the pile for its settlement and load distribution.

Syllabus

Critical study of conventional methods of foundation designs, nature and complexities of soil-structure interaction

Interaction problems based on theory of sub-grade reaction and classic half space soil models, effects of parameters influencing subgrade modulus

Application of finite difference and finite element techniques of analysis for evaluation of soil-structure interaction for beams, rafts, thin places, piles, etc, with Winkler foundation and Pasternak model, elastic half space soil support, Settlement of foundation, analysis and computation of initial settlement and consolidation settlement for layered deposit, settlement of raft on NCC, sand, Bowle's finite grid method

Laterally loaded pile analysis, general equation of flexure, close form solutions, finite difference analysis of piles under lateral loads. Glessers recursive technique, procedure for accounting non-linear soil response. Finite element analysis of laterally loaded piles, effect of axial loading on piles response. Axially loaded piles analysis using stream transfer curve.

Pile head response under general loading, analysis of 2D piles group connected by rigid cap, introduction to elasto-plastic analysis.

Text Book:

1. Foundation Engineering Handbook: H.Y. Fang, CBS Publishers (2004)
2. Numerical Methods in Geotechnical Engineering: C.S. Desai, McGraw Hill (1977)

Reference Book:

1. Foundation Analysis and Design: J.E. Bowles, McGraw Hill (1996)

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

Course Code: CET651-1 **Course: Programme Elective II-Design of High Rise Structures**

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

Course Outcomes :

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

Syllabus

Seismic Design of Building Components : Concept of strong column and weak beam, Design of Beam - Column joints for ductile behaviours as per IS code provisions.

Seismic Analysis of Buildings : Frames - shear walled buildings, mathematical modelling of buildings with different structural systems, Analysis and design 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.

Seismic Design Philosophy : Introduction to Diaphragm and seismic design of floor diaphragm.

Multi - stories buildings with bracings and infills.

Introduction of Wind Analysis of multi -stories buildings as per IS 875 Part III.

Text Books :

1. Kramer S.L., :Geotechnical Earthquake Engineering" Prentics Hall, New Jersey 2005.
2. Shrikhande & Agrawal, " Earthquake Resistant Design of Structures."
3. S.K.Duggal, "Earthquake Resistant Design of Structures."

Reference Books:

1. IS: 1893-2016 Part I & IS13920-2016
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.
7. Foundation systems for High Rise structures by Rolf Kazenbach, Steffen Loppla, Deepankar Choudhary, CRC Press Edition 26 Aug. 2016.
8. IS 875 Part III

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

Course Code: CET651-2 **Course: Programme Elective II-Theory of Plates and Shells**

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

Course Outcomes :

1. The graduates will be able to understand the behavior of plates and shells of different shape and thickness under various loading and boundary conditions.
2. The graduates will be able to develop numerical solution using basic principles of mathematics for analysis of plates and shells.
3. The graduates will be able 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 III, M. Tech. (Structural Engineering)

Course Code: CET 651-3 | **Course: Programme Elective II-Design of Earthquake Resistance Steel Structures**

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

Course Outcomes :

1. The graduates will be able to understand the concepts of capacity design and failure mode control and their deployment in modern codes of practice.
2. The graduates will be able to employ step by step process of seismic design of a steel frame building in accordance to IS 800:2007.
3. The graduates will be able 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 III, M. Tech. (Structural Engineering)

Course Code : CEP652 | **Course: Project Phase I**

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

Course Outcomes :

1. The graduates will be able to identify a research topic through interaction with industry and society and to collect relevant data through literature survey.
2. The graduates will be able to formulate step by step procedure, equipment/material requirement for performing research work.
3. The graduates will be able 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: CEP653 **Course: Project Phase II**

L:0 Hr., P: 6 Hrs., Per week **Total Credits : 12**

Course Outcomes :

1. The graduates will be able to demonstrate skills in operating computer software, laboratory testing equipment's, internet navigation, spreadsheets generation, documentation of results, etc.
2. The graduates will be able to develop mathematical correlation between various factors affecting research outcomes and conclude the research work.
3. The graduates will be able 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