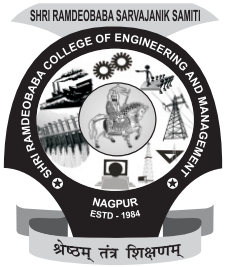

SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR – 440013

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

PROGRAMME SCHEME & SYLLABI
2021 – 2022

M. Tech. (Geotechnical Engineering)

Published By

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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 software's which helps the students to develop expertise in Civil Engineering. Civil Engineering Department offers Undergraduate Programme B. E. in Civil Engineering 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 extra-curricular programs while imparting outcome based quality education.

Departmental Vision

Tobeaknowledgecentreincivilengineeringeducation,training,research,entrepreneurshipandindustry outreachservicesforcreatingsustainableinfrastructureand 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 stakeholders.

Programme Educational Objectives

1. The Programme will prepare graduates to perform analysis and design of various geotechnical structures.
2. The programme will prepare graduates to take up industrial project in the field of geotechnical engineering and allied area and also research work in the relevant domain.

Programme Outcomes

1. An ability to indecently carry out research / investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report / document.
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program i.e. geotechnical engineering.

SCHEME OF EXAMINATION OF MASTER OF TECHNOLOGY (GEOTECHNICAL ENGINEERING) SEMESTER PATTERN

I Semester M. Tech (Geotechnical Engineering)

Sr. No.	Category	Course Name	L	T	Credits	Maximum marks			Exam Duration	Category
						Continuous Assessment	End Sem Exam	Total		
1.	CET581	Advanced Soil Mechanics	4	-	4	40	60	100	3 Hours	PC
2.	CEP581	Advanced Soil Mechanics (P)	-	2	1	25	25	50	--	PC
3.	CET582	Geotechnical Exploration & Investigation	4	-	4	40	60	100	3 Hours	PC
4.	CEP582	Geotechnical Exploration & Investigation (P)	-	2	1	25	25	50	--	PC
5.	CET583	Engineering Rock Mechanics	4	-	4	40	60	100	3 Hours	FC
		TOTAL	**12**	**4**	**14**					

SCHEME OF EXAMINATION OF MASTER OF TECHNOLOGY (GEOTECHNICAL ENGINEERING) SEMESTER PATTERN

II Semester M. Tech (Geotechnical Engineering)

Sr. No.	Code	Course Name	L	P	Credits	Maximum marks			Exam Duration	Category
						Continuous Assessment	End Sem Exam	Total		
1.	CET584	Advanced Foundation Engineering	4	-	4	40	60	100	3 Hours	PC
2.	CEP584	Advanced Foundation Engineering (P)	-	2	1	25	25	50	--	PC
3.	CET596	Research Methodology	3	-	3	40	60	100	3 Hours	FC
4.	CET597	Group Elective I	4	-	4	40	60	100	3 Hours	GE
5.	CEP597	Group Elective I (P)	-	2	1	25	25	50	--	GE
6.	CET599	Open Elective	3	-	3	40	60	100	3 Hours	OE
		TOTAL	**14**	**4**	**16**	**210**	290	500		

Course Code	Group Elective I (T + P)
CET / CEP597-1	Applied Soil Engineering
CET / CEP597-2	Finite Element Method
CET / CEP597-3	Instrumentation & Material Science
CET / CEP597-4	Soil Dynamics
CET / CEP 597-5	Engineering Computational Techniques

Course Code	Open Elective
CET599-1	Advanced Construction Materials & Techniques
CET599-2	Geoscience
CET599-3	Prestressed Concrete Structure
CET599-4	Watershed Management
CET599-5	Introduction to Numerical Modeling

SCHEME OF EXAMINATION OF MASTER OF TECHNOLOGY (GEOTECHNICAL ENGINEERING) SEMESTER PATTERN

III Semester M. Tech. (Geotechnical Engineering)

Sr. No.	Code	Course Name	L	P	Credits	Maximum marks			Exam Duration	Category
						Continuous Assessment	End Sem Exam	Total		
1.	CET598	Group Elective - II	4	-	4	40	60	100	3 Hours	GE
2.	CET681	Ground Improvement	4	-	4	40	60	100	3 Hours	PC
3.	CEP681	Ground Improvement	-	2	1	25	25	50	-	PC
4.	CET682	Earth and Rockfill Dams and Design of Slopes	4	-	4	40	60	100	3 Hours	PC
5.	CET683	Tunnel Engineering	4	-	4	40	60	100	3 Hours	PC
		TOTAL	**16**	**2**	**17**					

Course Code	Group Elective II
CET598-1	Design of Bridges
CET598-2	Design of Environmental Structures
CET598-3	Geo-Environmental Engineering
CET598-4\	Soil Structure Interaction

SCHEME OF EXAMINATION OF MASTER OF TECHNOLOGY (GEOTECHNICAL ENGINEERING) SEMESTER PATTERN

V Semester M. Tech. (Geotechnical Engineering)

Sr. No.	Category	Course Name	L	T	Credits	Maximum marks			Exam Duration	Category
						Continuous Assessment	End Sem Exam	Total		
1.	CET684	Program Elective I	4	-	4	40	60	100	3 Hours	PE
2.	CET685	Program Elective II	4	-	4	40	60	100	3 Hours	PE
3.	CEP686	Project Phase I	-	3	6	50	50	100	-	PC
		TOTAL	**8**	**3**	**14**					

Course Code	Program Elective I (T)
CET 684-1	Special Geotechnical Construction
CET 684-2	Geotechnical Earthquake Engineering
CET 684-3	Design of Underground Structures

Course Code	Program Elective II (T)
CET685-1	Pavement Analysis and Design
CET685-2	Advanced Methods of Working

SCHEME OF EXAMINATION OF MASTER OF TECHNOLOGY (GEOTECHNICAL ENGINEERING) SEMESTER PATTERN

V Semester M. Tech. (Geotechnical Engineering)

Sr. No.	Category	Course Name	L	T	Credits	Maximum marks			Exam Duration	Category
						Continuous Assessment	End Sem Exam	Total		
1.	CEP781	Project Phase II	–	6	12	100	100	200	–	PC
		TOTAL	**–**	**6**	**12**					

Semester	L	P	Credits	Maximum Marks		
				Internal Assessment	End Semester Examination	Total
First Semester	12	4	14	170	230	400
Second Semester	14	4	16	210	290	500
Third Semester	16	2	17	185	265	450
Fourth Semester	8	3	14	130	170	300
Fifth Semester	0	6	12	100	100	200
Total	**50**	**19**	**73**	**795**	**1055**	**1850**

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

Course Code : CET581 **Course : Advanced Soil Mechanics**

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

Course Outcomes

1. Student will understand engineering properties of soil through advanced parameters
2. To make students understand soil structure, stress-strain characteristics of soils, the mechanism of failure, the factors that affect the shear strength and the various test procedures to determine the shear strength.
3. Also, to impart knowledge about three dimensional consolidation, secondary consolidation and basics of rheological models

Syllabus

Effective Stress : Concepts of effective stress in soil, its computation under various conditions, effective stress in partly saturated soil. Stress states at a point under applied stress, limit equilibrium concept in geomechanics, principal stresses at failure in C- soil, Mohr's stress circles.

Shear strength of soils : Mohr Coulomb`s theory, Drainage conditions and field problems, UU, CU & CD tests, Skempton`s equation for pore pressure, shear strength characteristic of cohesive and cohesionless soil, volume changes during shear and stress dilatancy, critical void ratio & its determination, factor affecting shear strength of cohesive and cohesionless soil, apparent cohesion, concept of stress paths, Kf & Ko lines , stress paths for cases of foundation loading, excavation, active & passive earth pressure conditions, stress–strain models and constitutive relations, Duncan-Chang model

Transient Flow : 3-D consolidation equation, mathematical solution of Terzaghi's 2-D consolidation equation, characteristics of the theoretical consolidation curve, distribution of consolidating pressure, field consolidation curve, determination of consolidating property parameter, AV, MV, CC, CV and PC, secondary consolidation.

Text books

1. Fundamentals of soil mechanics: Taylor D.W., Asia Publishing House (1964)
2. Principles of Soil Mechanic: Scott R.F., Addison-Wesley Publication co. (1963)
3. T.B. of Soil Mechanics & Foundation Engineering: Murthy VNS, CBS pub.(2004)

Reference books

1. Geotechnical Engineering-principles & practices: Coduto D.P., Peavson Edn. Asia, (2002)
2. Basic and Applied soil mechanics: Gopal Ranjan & A.S. Rao, New Edge Int. Ltd., (2004)
3. rinciples of Geotechnical Engineering: Das B.M., Thomson Bks, Cengage publication (2002)

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

Course Code : CEP581 **Course : Advanced Soil Mechanics Lab**

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

Course Outcomes

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

1. Determine shear strength of soils using different methods
2. Conduct tests for determining swellability of expansive soils

List of experiments

1. Direct shear test on saturated soil (UU-Test)
2. Triaxial shear test on saturated soil (UU, CU-test) with pore pressure measurement
3. UCS-test on clayey soil (saturated)
4. Consolidation test for clay soils
5. FSI and FSR test for clay soils
6. Swelling pressure determination for clay soils

The test report shall be submitted in the form of the Journal and same shall be assessed by the concerned teacher/s through viva-voce examination

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

Course Code : CET582 **Course : Geotechnical Exploration and Instrumentation**

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

Course Outcomes

1. Students will able to determine solving real problems related to Geotechnical engineering.
2. To familiarize the students with principles of exploration, geophysical methods, modern methods of drilling, sampling and instrumentation.
3. Students will able to undertake various field techniques used in geotechnical engineering for ascertaining the nature and behavior of soil strata.

Syllabus

Method of Exploration

Planning of sub-surface programs, Stages in sub-surface exploration, Reconnaissance, Lateral extent and depth of exploration, Methods of exploration – trial pits, open excavation, boring etc. Types of borings, selection of suitable boring type; stabilization of boreholes; the number, location and depth of boring. Types of soil samples, Sample disturbance, storage, labeling and transportation of samples; Types of soil samplers and their suitability for different soils, hand carved samples.

Planning of subsurface exploration program for major civil engineering project

Indirect methods of exploration

Seismic refraction method, electrical resistivity method, qualitative and quantitative interpretation of test results, limitations; Test Determination of ground water table.

Field investigation

Standard Penetration test, cone penetration tests interpretation of test results and correlations for obtaining design soil parameters of cohesive and cohesion less soil, field vane shear test, Plate load test, Pressure meter test & interpretation of results,

Sub-surface Investigation Report: Salient features and boring logs

Soil survey and Mapping: methods of soil survey introduction of remote sensing.

Field Instrumentation: Rollers, Sensors, Inclinometers. Equipments used for boring.

Basics of Rocks

Introduction to formation of rocks; types of rocks, physical and mechanical properties of rocks; its determination to identify rock quality designation.

Text books

1. Basic and Applied soil mechanics: Gopal Ranjan & A.S. Rao, New Edge Int. ltd., (2004)
2. Soil Mechanics and Foundation Engineering: K.R. Arora, Standard Publisher and Distributor, 1949 and later.
3. Foundation Analysis & Design: Bowles, J.E., McGraw Hill (1996)
4. Quarterly Journal of Engineering Geology – Relevant articles

Reference books

1. Soil Mechanics in Theory and Practice: Alam Singh, Asia Publisher and Distributor, 1975
2. Advanced Foundation Engineering: Murthy VNS, CBS publishing, (2007)
3. Foundation Engineering Handbook: Fang, H.Y., CBS publishing, (2004)
4. Indian, British and ASTM Standards on site investigation and field tests

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

Course Code : CEP582 **Course : Geotechnical Exploration and Instrumentation Lab**

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

Course Outcomes

1. Student will have an ability to perform different laboratory investigations on soil.
2. Students will able to conduct various field test and its applications related to geotechnical engineering.
3. Student will have an ability to determine the various index and engineering properties.

I) Laboratory test on C-φ soil

1. Determination of granulometry by sedimentation analysis.
2. Determination of Relative density of sand
3. Determine shear strength parameters by Direct Shear Test, Tri-axial Tests, Unconfined Compressive Strength Test (Soil and Rock)
4. Consolidation Test
5. Swell Pressure Tests

II) Field tests any Two from the following.

1. Standard penetration test.
2. Static Cone Penetration test
3. Plate load test. (Demonstration)
4. Pressure meter test

III) Preparation of Detail soil Investigation Report

Reference

1. Das, B.M., Soil Mechanics Laboratory Manual, Oxford University Press, Sixth Ed.
2. Relevant IS, British and ASTM Standards

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

Course Code : CET583 **Course : Engineering Rock Mechanics**

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

Course Outcomes

1. The graduate will be able to understand engineering properties of rock, classification of rocks.
2. The graduate will be able to carry out laboratory testing of rocks, failure criteria, tunneling in rocks
3. The graduate will be able to understand and adopt various techniques to improve the in situ strength of rocks

Course Content

4. Classification of Intact rock and Rock masses, Strength and modulus from classifications.
5. Physico mechanical properties, Laboratory tests for various physical and mechanical properties. Field shear test, Deformability tests in rock mass, State of stress in the ground.
6. Insitu stress, various methods of stress measurement, Hydrofracturing technique, Flat jack technique, Overcoring technique.
7. Rock mass classifications : different classifications commonly used in field, stresses around mine opening , Planes of weakness in rocks, rock fractures and fractured rock
8. Stability of rock slopes, Modes of failure, Plane failure, Wedge failure, Circular failure, Toppling failure.
9. Foundation on rocks, Estimation of bearing capacity, Methods to improve rock mass responses, Grouting in Rocks, Rock bolting, Rock Anchors.

References

1. Introduction to Rock Mechanics by R.E.Goodman, John Wiley & Sons.
2. Engineering in Rocks for Slopes, Foundation and Tunnels, Editor T.Ramamurthy, Prentice Hall India Pvt. Ltd.
3. Fundamentals of Rock Mechanics, Fourth Edition, by Jaeger, Cook and Zimmerman, Blackwell Publishing.
4. Rock mechanics and the design of structures in rock, L. Obert and Wilbur I. Duvall, John Wiley & Sons, Inc

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

Course Code : CET584 **Course : Advanced Foundation Engineering**

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

Course Outcomes

At the completion of this course,

1. The student shall acquire knowledge and ability - to select and design appropriate foundations based on various criteria;
2. To check the stability of various components of foundations.
3. Student will have an ability to predict and calculate settlement of foundation

Shallow Foundations

Shallow foundations, methods of estimating bearing capacity of footings and rafts, foundations under eccentric loading.

Foundations under inclined loading, foundations on slope, foundations with tilted base.

Bearing capacity of foundations on layered soil.

Methods of estimating settlement of footings and rafts, concept of Beams on Elastic Foundation.

Proportioning of foundations using field test data, IS codes.

Pile Foundations

Pile foundations, pile load tests, methods of estimating load transfer of piles, analytical estimation of load-settlement behavior of piles.

Pile group capacity and settlement, negative skin friction of piles. Laterally loaded piles.

Uplift capacity of piles, foundations/anchors under uplift loads.

Well Foundation

Well foundation, bearing capacity of well foundations, lateral stability of well foundations.

IS and IRC codal provisions, elastic theory and ultimate resistance methods for well foundations.

Foundations on problematic soils:

Foundations for collapsible and expansive soil.

Text books

1. Principles of Foundation Engineering: Das B.M., PWS publishing co., (1999)
2. Foundation Analysis & Design: Bowles J.E., McGraw Hill, (1996)
3. Shallow Foundation: Das B.M., CRC Press, (2009)
4. V.N.S. Murthy, Advanced Foundation Engineering, CBS Publishers & Distributors,

Reference books

1. Principles of Foundation Engineering: Das B.M., PWS publication co., (1999)
2. Foundation Analysis & Design: Bowles, J.E., McGraw Hill (1996)

Theory & practice of Foundation Design: Som N.N. & Das S.C., Prentice Hall Edn, Asia (2002)

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

Course Code : CEP584 | **Course : Advanced Foundation Engineering Lab**

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

Course Outcomes

1. Student will have an ability to design shallow foundation on homogeneous and layered soil deposit.
2. Student will have an ability to predict and calculate settlement of foundation.
3. Student will have an ability to determine bearing capacity and settlement characteristics from the different field test.

Practical work shall comprise of

I) Bearing capacity & settlement problems

Solutions of problems on bearing capacity and settlement of footings and rafts for different cases of soil system, types of loading and using various analytical approaches Assignment based on settlement of foundation. (Minimum 5 assignments)

II) Working out a complete analysis & design of Pile foundation.

Bearing capacity and settlement of axially and laterally loaded pile on different cases of soil system.(Minimum 3 Assignment)

III) Design of well foundation by IS code method (minimum 1 Assignment)

Syllabus of Semester II, M. Tech. (Geotechnical Engineering) Group Elective - I

Course Code : CET597-1 **Course : Applied Soil Engineering**

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

Course Outcomes

1. The graduate will be able to apply basic concepts in soil engineering for analysis of complex geotechnical problems.
2. The graduate will have knowledge in geotechnical design of different types of earth retaining structures.
3. The graduate will be able to understand and analyze various slope failure issues and suggest appropriate remedial measures. (add)

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.
(Geotechnical Engineering) Group Elective - I

Course Code : CEP597-1 **Course : Applied Soil Engineering Lab**

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

Course Outcomes

2 The graduate will have an ability to calculate lateral pressure on retaining structures.(add) The graduate will have an ability to design different types of earth retaining structures.

3 The graduate 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.
(Geotechnical Engineering)

Course Code : CET597-2 **Course : Group Elective I - Finite Element Method**

L: 4 Hrs., 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.
(Geotechnical Engineering)

Course Code : CEP597-2 **Course : Group Elective I - Finite Element Method Lab**

L: 0 Hrs., 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 and computer simulation of following problems

- Truss
- Bar
- Beam
- 2D plane stress problem
- 2D plain stain problem
- 2D axisymmetric stress problem
- 3D problem

Syllabus of Semester II, M. Tech. (Geotechnical Engineering) Group Elective - I

Course Code : CET597-3 **Course : Instrumentation and Material Science**

L: 4 Hrs., 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.
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.
(Geotechnical Engineering) Group Elective - I

Course Code : CEP597-3 **Course : Instrumentation and Material Science Lab**

L: 0 Hrs., 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 practical's based on Theory syllabus.

Syllabus of Semester II, M. Tech.
(Geotechnical Engineering) Group Elective - I

Course Code : CET597-4 **Course : Soil Dynamics**

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

Course Outcomes

1. To enhance Student's knowledge in dynamic loading, theory of vibrations, dynamic soil properties, dynamic earth pressure, dynamic bearing capacity, vibration isolation, liquefaction of soils
2. To train the students in machine foundation design.
3. 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 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.,
5. NPTEL Videos on Soil Dynamics

Syllabus of Semester II, M. Tech.
(Geotechnical Engineering) Group Elective

Course Code : CEP597-4 **Course : Soil Dynamics Lab**

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

Course Outcomes

1. To enhance Student's knowledge in dynamic loading, theory of vibrations, dynamic soil properties, dynamic earth pressure, dynamic bearing capacity, vibration isolation, liquefaction of soils
2. To train the students in machine foundation design.
3. 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.
(Geotechnical Engineering)

Course Code : CET597-5 **Course : Engineering Computational Techniques**

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

Course Outcomes

1. The graduate will be able to understand and apply various mathematical techniques to analyze various geotechnical engineering problems.
2. The graduates will be able to solve mathematical equations, matrices, eigne value problems, integrations, etc.

Syllabus

Solution of algebraic equations : Bisection Method, Regula Falsi Method, Newton-Raphson method.

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

Numerical Integration : Trapezoidal Method, Simpson's Method, Gauss Quadrature.

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 II, M. Tech. (Geotechnical Engineering)

Course Code : CEP597-5 **Course : Engineering Computational Techniques Lab**

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

Course Outcomes

1. The graduates will be able to develop computer programs for various mathematical techniques used in analyzing varous problems in geotechnical engineering.
2. The graudates will be able to develop algorithm and remove programming errors in computer programs.

Syllabus

Development of computer program for any six methods covered in theory syllabus using FORTRAN/C/Python

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 II, M. Tech.
(Geotechnical Engineering) Open Elective

Course Code : CET599-1 **Course : Advanced Construction Material and Techniques**

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

Course Outcomes

1. The graduate will be able to classify and select advance construction materials on the basis of their properties.
2. The graduate will be able to demonstrate the use slip formwork technique in construction.
3. The graduate will be able to understand launching techniques of different civil engineering structures.
4. The graduate will be able to identify and suggest advance construction materials for improvement in functional performance of building components

Syllabus

Construction materials : Classifications, selection criteria for construction materials. Materials Engineering concept: Consideration of physical, Mechanical, thermal, and other Properties. nature of materials.

Ceramic Materials

Properties, Processing of ceramic, classification, refractories, glass, uses and application Engineering wood products Types of Plastics, Properties & Manufacturing process, Advantages of Reinforced polymers Types of FRP, FRP on different Geotechnical elements, Applications of FRP.

Composites

Requirements, classification, microscopic composites, macroscopic composites, their applications.

Thermal performance of materials and insulating materials Acoustics and sound proofing methods and materials False ceiling.

Types and properties of Water Proofing Compounds, Types of Flooring and Facade Materials and its application.

Launching Techniques

Suspended formwork-erection techniques of tall structures, Large span structures- in high rise structures. Erection of Lift.

Slip formwork techniques, Grouting methods.

Text Books

1. Engineering materials: Polymers, Ceramics and composites, Bhargava A K, PHI Publications, Second edition, 2012
2. Engineering Materials, Rangawala S.C., Chortor Publications
3. Building Materials, S.K. Duggal, New Age International Publications, Fourth edition, 2012
4. Building Materials Technology Geotechnical Performance & Environmental Impact, L. Reed Brantley, Ruth T. Brantley, McGraw Hill Inc Publications.

Reference Books

1. Materials for Civil and Construction engineers, Michael S Mamlouk, John P Zeniewski, Pearson Publications, Third edition, 2014.
2. Rai Mohan and Jai Singh.M.P," Advances in Building Materials and construction " CBRI Roorkee.
3. Jerry Irvine, " Advanced Construction Techniques ", California Rocketry, 1984.

Syllabus of Semester II, M. Tech.
(Geotechnical Engineering) Open Elective

Course Code : CET599-3 **Course : Prestressed Concrete Structure**

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

Course Outcomes:

1. The graduates will be able to understand codal provisions and apply them while designing prestressed concrete structures.
2. The graduates will be able to design various prestressed concrete structural components.

Syllabus

Basic concepts of prestressing, need for high strength steel & concrete, material and prestressing systems. Limit state design criteria, limit state of collapse and limit state of serviceability.

Design of section for flexure, axial tension, compression & bending, shear & torsion, bond and bearing. Design of post tensioned flexural members.

Design of prestressed concrete pipes Design of prestressed concrete slabs.

Reference Books

1. Design of Pre-stressed Concrete Structures, Lin, T.Y. and Burns, N.H, John Wiley & Sons, New York.
2. Design of Pre-stressed Concrete Structures, 4th ed.: Krishna Raju, Tata McGraw-Hill, New Delhi.

Syllabus of Semester II, M. Tech. (Geotechnical Engineering) Open Elective

Course Code : CET599-5 **Course : Introduction to Numerical Modelling**

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

Course Outcomes

1. Student will be able to perform tasks such as integration, solution of linear algebraic equations, Eigen system, regression analysis, etc.
2. Student will be able to apply numerical methods to obtain approximate solutions
3. Student will be exposed to advanced numerical methods like Finite Element Method and Numerical Optimization.

Contents

Numerical integration

Solution of Linear Algebraic Equations: Direct Methods and Iterative methods

Eigen values and Eigen vectors

Regression Analysis, Simple and multiple regression analysis

Introduction to Finite Element Method, General Steps of Finite Element Method, One Dimensional Finite Element Analysis

Introduction to Numerical Optimization

Reference Books

1. Numerical Optimization – Theoretical and Practical Aspects, J. Charles Gilbert and Claudia A. Sagastizabal, Springer, 2000
2. Introduction to Finite Element Method, P. N. Godbole, IK International Publising House Pvt. Ltd. 2013
3. Introduction to Numerical Analysis, J. Store and R. Bulirsch, Springer, 1991.
4. Elementary Numerical Analysis – An Algorithmic Approach, S. D. Conte and Carl de Boor, McGraw Hill, 1980
5. Numerical methods - Principles, Analyses and Algorithms: Srimanth Pal, Oxford University Press, New Delhi.
6. Numerical Methods: Salvadori M., PHI learning Pvt, ltd., New Delhi, (1987)
7. Introductory Methods of Numerical Analysis, S. S. Sastry, Prentice Hall of India 2012.

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

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

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

Course Outcomes

1. The graduates will be able to define research problems 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 nonlinear 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, Geotechnical 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 DelhiProgramme Scheme & Syllabi M. Tech. (Geotechnical Engineering)
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, US