SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR

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

TEACHING SCHEME & SYLLABUS
2014-15

M.TECH. GEOTECHNICAL ENGINEERING

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ISO 9001 : 2008 CERTIFIED ORGANISATION

About the Department

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

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

Department Vision

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

Department Mission

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

Programme Educational Objectives

A. The Programme will prepare graduates to perform analysis and design of various geotechnical structures.

B. The Programme will prepare graduates to take up industrial project in the field of

geotechnical engineering and allied areas and also research work in the relevant domain.

Program Outcomes

a. The graduates are expected to have an ability to apply knowledge of mathematics, science and engineering while analysis and design of geotechnical structure and its components.
b. The graduates are expected to have ability to predict geotechnical problems and adopt innovative solutions.
c. The graduates are expected to solve complex geotechnical engineering problems and able to propose optimal, feasible and economical design solution.
d. The graduates are expected to have capability to take research projects in the field of geo-environment and to develop modern solution using advanced technological concepts.
e. The graduates are expected to identify and use modern tools/equipments for analysis and design of geotechnical engineering components.
f. The graduates are expected to communicate technical details effectively through oral presentation and written documents.
g. The graduates are expected to engage themselves in life-long learning and keep on updating themselves with technological advances.
h. The graduates are expected to understand and follow ethical practices in geotechnical engineering.
i. The graduates are expected to critically examine, judge and decide independently the outcome of work carried out.

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

I Semester M. Tech. (Geotechnical Engineering)

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	CET521	Geosciences	4	-	4	8	40	60	100	3 Hrs.
2	CET522	Com. Prog. & Num. Method	4	-	4	8	40	60	100	3 Hrs.
3	CEP522	Com. Prog. & Num. Method	-	2	2	2	25	25	50	-
4	CET523	Geotech. Exploration & Investigation	4	-	4	8	40	60	100	3 Hrs.
5	CEP523	Geotech. Exploration & Investigation	-	2	2	2	25	25	50	-
		Total	12	4	16	28				

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

II Semester M. Tech. (Geotechnical Engineering)

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	CET524	Advance Soil Mech.	4	-	4	8	40	60	100	3 Hrs.
2	CET525	Applied Soil Engg.	4	-	4	8	40	60	100	3 Hrs.
3	CEP525	Applied Soil Engg.	-	2	2	2	25	25	50	-
4	CET526	Foundation Engg.- I	4	-	4	8	40	60	100	3 Hrs.
5	CEP526	Foundation Engg.- I	-	2	2	2	25	25	50	-

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

III Semester M. Tech. (Geotechnical Engineering)

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	CET621	Foundation Engg. - II	4	-	4	8	40	60	100	4 Hrs.
2	CEP621	Foundation Engg. - II	-	2	2	2	25	25	50	-
3	CET622	Ground Improvement	4	-	4	8	40	60	100	3 Hrs.
4	CEP622	Ground Improvement	-	2	2	2	25	25	50	-
5	CET623	Elective - I	4		4	8	40	60	100	3 Hrs.
		Total	12	4	16	28				

Course Code	Elective - I
CET623-1	Rock Mechanics
CET623-2	Special Geotechnical Construction

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

IV Semester M. Tech. (Geotechnical Engineering)

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	CET624	Dynamics of Soil and Foundation	4	-	4	8	40	60	100	3 Hrs.
2	CEP624	Dynamics of Soil and Foundation	-	2	2	2	25	25	50	-
3	CET625	Research Methodology	3	-	3	6	40	60	100	3 Hrs.
4	CET626	Elective - II	4	-	4	8	40	60	100	3 Hrs.
5	CEP627	Project Phase I	-	6	6	24	50	50	100	-
		Total	11	8	19	48				

Course Code	Elective - II
CET626-1	Soil-Structure Interaction
CET626-2	Geo-environmental Engineering

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

V Semester M. Tech. (Geotechnical Engineering)

Sr. No.	Code	Course	L	T	P	Credits	Maximum Marks			Exam Duration
							Internal Assessment	End Sem Exam	Total	
1	CEP721	Project Phase II	-	12	12	48	100	100	200	-
		Total	-	12	12	48				

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

Course Code : CET521	Course: Geoscience
L:4 Hrs., P:0 Hrs., Per Week	Total Credits : 8

Course Outcomes

1. To understand the different behavior of soil.
2. To know the swelling and shrinkage characteristics of soil.
3. To analyse the mechanism of clay and the phenomena of flow.
4. Impart knowledge in 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 I, M. Tech. (Geotechnical Engineering)

Course Code: CET522 Course: Computer Programming & Numerical Methods

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

Course Outcomes

1. To apply the basic knowledge of mathematics in engineering.
2. To provide a formidable base for analysis and programming using computer applications.
3. To develop the ability in programming and solutions based on the various analysis tools.

Syllabus

Introduction:

C-preliminaries, Event driven programming, Sequential Structures: Statements and expressions, Selective Structures; Relational and logical expressions, Control structures

Repetitive Structures: While loop, for loop, Nested loop, Do-while loop. Input-output files, File access, Subscripted Variables; Declaration statement, Arrays, Simple applications up to 2 D, Functions: Function call, Storage class (Internal, external, static), recursion

Pointers, structures and union: Functions and pointers, arrays and pointers, Strings and pointers, pointer arrays, Introduction to structures, structures and functions, structures and arrays, structures containing pointers, unions.

Numerical Methods

Flexibility matrix method: Basics, formulation of method, application to two dimensional problems, Stiffness matrix method: Element & global stiffness matrix, rotation, translation, Matrix, translation to axis transformation, application to two-dimensional problems.

Solution of simultaneous equation : Gauss elimination method; FDM- forward and backward difference method; Finite element method: step in FEM, 1-D & 2-D formulations for stress-deformation analysis, boundary condition, solution algorithms, discrtisation, use of FEM 2- D program and commercials packages.

Application to Geotechnical Problem: Programming of simple geotechnical problems related to shallow and deep foundation, seepage, settlement etc.

Text books:

1. Let us C: Yashwant Kanetkar, BPB publication, New Delhi (1999)
2. Programming in C: Pradip Dey & Manas Ghosh, publish in India by Oxford University Press, (2007)
3. Numerical method in geotechnical engineering: Desai,C.S.&Christion, S.T. Mcgraw Hill, (1977)

Reference books:

1. Programming with C: Byron Gotfried, McGraw Hill (1977)
2. Introductory methods of Numerical Analysis: S.S. Shastri, Prentice Hall of India (1994)
3. Numerical Method in Science engineering a practical approach, 2nd ed: S. Raajsekaran, wheelers publisher, Allahabad (1992)

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

Course Code : CEP522 Course: Computer Programming & Numerical Methods
L: 0 Hrs. P: 2 Hrs. Per Week Total Credits : 2

Course Outcomes

1. Student will have an ability to identify input parameters and other requirements for development of computer programs.
2. Student will have an ability to develop computer applications related to geotechnical engineering.

The practicals shall consist of Adequate number of assignments on computer work with respect to programming of basic geotechnical problems / analysis related to seepage, shallow-deep foundation, stress-strain analysis, settlement etc.

Solution of geotechnical problems using FEM 2D program and commercial packages.

The report on the work shall be submitted in the form of Journal and it shall be assessed by the concerned teacher/s through viva-voce examination.

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

Course Code : CET523	Course: Geotechnical Exploration & Investigation
L: 4 Hrs, P:0 Hrs, Per Week	Total Credits : 8

Course Outcomes

1. Students will able to dermine the properties of soil.
2. To familiarize the students with principles of exploration, geophysical methods, modern methods of drilling, sampling, offshore investigation 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

Importance and objects of Geotechnical exploration:

Principle methods of subsurface exploration, open pits and shafts. Types of borings, selection of suitable boring type; stabilization of boreholes; number, location and depth of boring for different structures, and for different nature of ground profile.

Planning of subsurface exploration program for major civil engineering projects

Indirect methods of exploration:

Seismic refraction method, electrical resistivity method, qualitative and quantitative interpretation of test results, limitations

Sampling:

Types of soil samples & their suitability, precautions in sampling, parameter for sampler design, boring and sampling records handling, preservation & shipment of samples; underwater sampling.

Field investigation:

Standard Penetration test, Static Cone and dynamic cone penetration tests, interpretation of test results and correlations for obtaining design soil parameters of cohesive and cohesion less soil, Field vane shear test , Design value of undrained strength of clays, correction factor; ground water table location.

Plate load test – purposes procedure interpretation for bearing capacity and settlement of foundation.

Pressure meter test – Principle, equipment, use & interpretation of results

Sub-surface Investigation Report: Salient features and boring logs;

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

Text books:

1. Basic and Applied soil mechanics: Gopal Ranjan & A.S. Rao, New Edge International Ltd., (2004)
2. Soil Mechanics and Foundation Engineering: K.R. Arora, Standard Publisher and Distributor, 1989 and later.
3. Foundation Analysis & Design: Bowles, J.E., McGraw Hill (1996)

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)

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

Course Code : CEP523 Course: Geotechnical Exploration & Investigation
L:0 Hrs., P:2 Hrs., Per Week Total Credits : 2

Course Outcomes :

1. Student will have an ability to identify geotechnical properties of soil.
2. Student will have an ability to determine the various index and engineering properties.
3. Students will able to conduct various field test and its applications related to geotechnical engineering.

Practical work shall comprise of :

I) Laboratory test on C-φ soil (by groups of 4 students)

1. Determination of granulometry by combined wet sieving and sedimentation analysis.
2. Determination of Atterberg Limits and indices.
3. Direct shear test on saturated soil (UU-Test)
4. Triaxial shear test on saturated soil (UU-Test) with pore pressure measurement
5. UCS-test on Black cotton soil (saturated)
6. FSI and FSR test on black cotton soil.

II) Field tests (By group of maximum 8 students) any three of the following.

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

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

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

Course Code: CET524	Course: Advanced Soil Mechanics
L:4 Hrs., P:0 Hrs., Per Week	Total Credits : 8

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 affects 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-Ø 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, K_f & K_o lines , stress paths for cases of foundation loading, excavation, active & passive earth pressure conditions, stress–strain models and constitutive relations, Duncan-Chang model

Flow of water through soil:

General conditions to completely specify flow of fluid through porous media, Derivation of flow equations for compressible fluid flow through non homogeneous, anisotropic soil for 3- D flow in cartesian & cylindrical coordinates

Steady state flow:

Continuity equation, Laplace equation for 3-D flow in cartesian coordinates, cylindrical and spherical flow; flow from wells, confined and unconfined aquifers. Mathematical solution of Laplace equation for simple cases, stream function and potential function, finite difference solution of flow problems, phreatic line location, determination of discharge in homogeneous dam with steep and flat slopes with and without downstream filter, deflection of flow lines at interface of dissimilar soils. Typical flow net, flow net for K-anisotropic soils

Transient Flow:

3-D consolidation equation, mathematical solution of Terzaghi's 1-D consolidation equation, characteristics of theoretical consolidation curve, distribution of consolidating pressure, field consolidation curve, determination of consolidating property parameter, a_v, m_v, c_c, c_v 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.(2008)

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 International Ltd., (2004)
3. Principles of Geotechnical Engineering: Das B.M., Thomson Bks, Cengage publication (2002)

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

Course Code: CET525 Course: Applied Soil Engineering

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

Course Outcomes

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

Syllabus

Earth pressure and retaining walls:

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; Stability analysis of rigid type and R. C. cantilever type retaining walls, earth pressure at rest.

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.

Braced excavation:

Sheeting and bracing systems in shallow and deep open cuts in different types of soils, failure modes, pressure distribution, Terzaghis`s analysis for log spiral failure. Stability analysis for bottom heaves of excavation.

Underground conduits, shaft and tunnels:

System behavior of different types of underground conduits, classification, loads on ditch and projecting conduits, Marston's solutions, Imperfect ditch conduit, stress distribution in the vicinity of shafts and around tunnels, arching in soil, practical cases of arching action.

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. (2008)
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)

Course Code: CEP525 Course: Applied Soil Engineering

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

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 cellular cofferdam.
5) Design of braced cofferdam.
6) Culmann's graphical method for active or passive pressure on cantilever wall retaining broken surface backfill with concentrated load.
7) Poncelet construction for active and passive pressure on gravity retaining wall with sloping backfill.
8) Stability of homogeneous C-Ø soil slope by slices method of F- circle method (for min. F.S.)

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

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

Course Code: CET526 Course: Foundation Engineering I

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

Course Outcomes

1. To study basic features and theory regarding shallow foundations.
2. To familiarize students with different types of shallow foundations, analysis and geotechnical design of shallow foundations.
3. Also to acquaint students with foundations provided in various soil conditions, flexible analysis and soil-structure interaction models.

Syllabus

Ultimate bearing capacity of shallow foundation:

Features & criteria for various types of shear failure in foundation soil, types of footings and rafts, considerations in deciding location and depth of footings. Overview of theories of bearing capacity under centric vertical, inclined & vertical loads; Terzuaghi's theory, theories of Meyerhof's, Balla, Vesic, Reddy-Srinivasan etc. Effect of interference of footings, stuart's interference factor, general equation of ultimate bearing capacity, empirical coefficients for shape, depth & load inclination, Salient features of Prakash-Saran's theory. Ultimate load computation for rectangular footing/raft ; considerations of limited depth of soil below shallow foundation, Soil compressibility and c-f soil anisotropy, familiarity of analysis for footing on 2 layer soil systems of various nature. Theoretical approaches for footings on slope and on top of slope. Ultimate & allowable b.c. determination and settlement estimation from data of penetration test (SPT & SCPT), plate load test and pressure meter test.

Settlement analysis: Concept of seat of settlement, Boussineq's theory, pressure distribution for strip load, square and circular areas, pressure bulbs, contact pressure and its distribution.

Methods of computation of elastic settlement, Janbu's equation, use of strain influence factor, Schmentmann's approach, settlement from elasticity theory, computation of primary and secondary consolidation of foundation on NCC & OCC; Differential settlement & its permissible values. Control of excessive settlement.

Special considerations for rafts on sand and clay, concept and design principle of floating raft foundation, proportioning the footings of public building for equal settlement. Overview of shallow foundation on reinforced earth under centric vertical load.

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)

Reference books:

1. Foundation Engineering: Verghese P.C., Prentice Hall of India, (2007)
2. Advanced Foundation Engineering: Murthy V.N.S., CBS Publishing, (2007)

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

Course Code: CEP526 Course: Foundation Engineering I

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

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 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 (Minimum 6 assignments)

II) Working out a complete analysis & design of shallow foundation (footings or raft)

With respect to soil failure and structural failure, for a given locations of columns and column loads of framed building and for a given ground characteristics.

The terms work shall be submitted in the form of a journal for the above work and shall be assessed by the concerned teachers through viva-voce examination.

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

Course Code : CET621 Course: Foundation Engineering II

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

Course Outcomes

1. To study basic features and theory regarding Deep foundation.
2. To familiarize students with different types of deep foundations such as piles, piers, well foundation etc.
3. Analyze and geotechnical design of deep foundations for axial and lateral load.
4. Also to acquaint students with foundations provided in various soil conditions, for offshore structure.

Syllabus

Axially loaded Piles:

Load transfer mechanism, piles is sand and clay, computation of end bearing and skin resistance; α, β and λ methods, drained and undrained capacity, effect of pile installation methods on load capacity and pile behaviors, mobilization of base resistance and shaft resistance with pile penetration, critical length of piles in sands, dynamic formulae: comments and limitations. Effects of pile driving on ground, & adjacent structures. Constructional features of bored piles is different site conditions, large diameter bored piles and pier foundation, Load Capacity of single and multi undreamed pile, various methods to determine base resistance of piles (Meyerhofft, Veric, Janbu, Coyle-Castello etc.). Settlement analysis of single pile, simplified method to construct load-settlement curve, group action in piles, overlapping of stresses, group efficiency and effect of pile spacing, capacity of free standing group and piled foundation, settlement computation of group by simple approaches, load capacity of piles in rock, structural design of piles and pile cap.

Laterally loaded piles:

Application, lateral resistance of single pile, long and short piles, failure mechanisms, Appraoches of analysis with Winkler model for soil, Reese-Matlock's dimensional analysis, Equivalent Cantilever approach, IS code provisions, p-y concept, construction of p-y curves for piles in soft clays and sands, effect of cyclic loading, salient features & design charts of Brom's analysis for different pile-soil systems.

Foundation for offshore structures:

Nature and magnitude of loads, features and construction methods of template type piled platforms, Gravity platforms and Tensionleg platforms, Pile behaviors under environmental loading conditions, India's offshore construction activities, Bombay High geotechnical features, familiarity with North Sea structures & their foundations.

Anchor foundations:

Behavior and failure mechanism of shallow anchors & deep anchors, Ultimate anchor capacity; Mariupolskii's approach of analysis, methods of analysis by Balla, Meyerhof – Adam and Vesic, geometry of rupture surface.

Well foundation:

Uses, constructional features, sinking of wells, tilt and shift, their rectification, depth of well, grip length.

Stability of well:

Introduction to methods based on elastic theory and ultimate resistances function and design of component part of well foundation.

Text books:

1. Principles of Foundation Engineering: Das B.M., PWS publishing co., (1999)
2. Advanced Foundation Engineering: Murthy V.N.S., CBS Publishing, (2007)
3. Foundation Engineering Handbook: H.Y. Fang, CBS Publishing (2004)

Reference books:

1. Foundation Engineering: Verghese P.C., Prentice Hall of India, (2007)
2. Theory & practice of foundation Design: Som N.N. & Das S.C., Prentice Hall Edn, Asia (2002)

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

Course Code : CEP621 Course: Foundation Engineering II

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

Course Outcomes

1. Student will have an ability to design Deep foundation. For axially and laterally loaded pile.
2. Student will have an ability to identify field application such as piles, piers, well foundation etc.
3. Student will have an ability to design of foundations provided in various soil conditions, for offshore structure.

Each students shall complete the following design assignments individually (with different data)

1. Design of axially loaded pile foundation (single pile and pile group) for given column load and site characteristics of site of (a) sandy soil & (b) clayey soil; along with estimation of settlement.
2. Determination of free and fixed headed pile response under lateral load and moment at pile head by Reese-Matlock solution.
3. Determination of anchors foundation capacity of circular shallow and deep anchors by Meyerhof- Adams method.
4. Designs of well foundation for given load and site data.

The terms work (submitted in the form of Journal) shall be the report of the above design assignments and the same shall be assessed by concerned teacher/s through viva-voce examination.

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

Course Code : CET622 Course: Ground Improvement

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

Course Outcomes

1. To enable students to identify problematic soils and their associated issues.
2. Students will study the various ground improvement techniques.
2. Also, to propose suitable remedial techniques and design.

Syllabus

Introduction to ground improvement techniques:

Concepts and essential requirements of ground improvement, classification of ground improvement techniques, economic considerations and suitability.

Compaction and Consolidation:

Theory of compaction equipments and control of field compaction, surface compaction and deep compaction, vibrofloatation. Preloading by static loads and by vacuum, accelerated consolidation by sand drains, drainage wicks, fabric drains, and rope drains, Theory of radial consolidation by sand drains, free strain and equal strain cases, design of sand drain layout.

Stabilization:

Methods of stabilization, mechanical stabilization, organic and inorganic stabilizing agents and their characteristics-lime, cement, flyash, bitumen and chemicals, stabilization by electro-osmosis.

Grouting:

Materials and methods of grouting grout volume and grouting pressure, grout requirements and tests.

Reinforced earth and Geotextiles:

Basic theory of reinforced earth, materials, method, application and design of reinforced earth, characteristics of reinforced earth masses; geotextiles, georids and geosynthetics, their basic features, functions and applications.

Stone columns:

Application, layout feature, procedures of installation, vibrofloat, rammed & vibrofloated column, quality control in construction; Analysis for stone column treated ground, unit cell concept, load transfer mechanism, load capacity and settlement analysis, Design for stone column layout for intended requirements, methods of improving the effectiveness of stone column, skirted and cemented stone column technique, geotextiles encased stone column.

Drainage and dewatering:

Methods, layout and design consideration of well point system; introduction to soil nailing and ground anchors

Text books:

1. Gound Imrovement Techniques: P.P. Raj, Prentice Hall of India (2005)
2. Engineering Principles of Ground Modification: M.R. Housmann, McGraw Hill (1990)

Reference books:

1. Constructional and Geotechnical Methods in Foundation Engineering: R.M. Koener, McGraw Hill (1985)
2. Design and Construction of Stone Column: FHWA Report no. RD 83/026, (1983)

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

Course Code : CEP622	Course: Ground Improvement
L:0 Hrs., P:2 Hrs., Per Week	Total Credits : 2

Course Outcomes

1. Student will have an ability to suggest suitable ground improvement techniques.
2. Student will have an ability to design and layout of propose techniques. .

The term work shall consist of analysis and design for any THREE of the following design assignments to be carried out by each student individually (with different data).

1. Design of sand layout in soft compressible clay deposit for required (accelerated) rate of consolidation.
2. Design of a reinforced earth retaining wall.
3. Design of stone column layout (using conventional incremented fill material or cemented granular fill material) for intended degree of improvement in safe load carrying capacity of soft soil ground.
4. Analysis and design of skirted stone columns.

The work shall be submitted in the form of a journal and shall be assessed by concerned teacher/s through viva-voice examination.

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

Elective I

Course Code : CET623-1 Course: Rock Mechanics

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

Course Outcomes

1. To make the students understand engineering properties of rock, classification of rocks,
2. Laboratory testing of rocks, failure criteria, tunneling in rocks
3. Various techniques to improve the in situ strength of rocks

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Syllabus

Introduction to rock mechanics:

Scope and application of rock mechanics, engineering classification of intact and fissured rocks, RQD, rock exploration, geotechnical description of rock mass.

Engineering properties of intact rock:

Porosity, void index, permeability, ultrasonic and electrical resistivity, uniaxial compressive strength, Brazilian test, Griffith`s theory of failure in tension and compression, elastic and dynamic constants, time dependant behavior.

Engineering properties of jointed rock:

Anisotropy, deformability and shear strength, rock discontinuity, friction along joints, residual strength, stick-slip theory, Barton`s chaubey`s correlation for shear strength, shear stiffness and dilation.

In- site stress in rock masses:

Analysis of stresses, thick wall cylinder formulae, Kreish equation, Green span method, opening in rock mass and stresses around opening, Borehole deformation meters, borehole inclusion stress meters, borehole strain gauge devices.

Underground excavation and subsidence, bearing capacity of homogeneous as well as discontinuous rocks, support pressure & slip of the joint, delineation of types of rock failure, unsupported span of underground openings.

Stability of rock slopes:

Modes of failure, method of analysis, prevention and control of slope failure, rock bolting.

Text Book:

1. Rock mechanics in engineering practice: Stag and Zienkiewiz, John wiley & sons
2. Fundamentals of rock mechanics: Jagger, J.C. & Cook, N.G.W., Methuen & Co. 1971
3. Rock mechanics & Design of structures: Obert, L & Duvall, W.I., John Wiley & Sons

Reference Books:

1. Rock mechanics for engineers: Varma, B.P, Khanna Publishers
2. Introduction to rock mechanics: Goodman, Wiley International

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

Elective I

Course Code : CET623-2 Course: Special Geotechnical Constructions

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

Course Outcomes

1. To create awareness of the latest trends, modern standards and state-of-the-art techniques for solving geotechnical engineering problems.
2. To develop an ability to design a geosynthetic system to meet desired needs such as economic, environmental and sustainability related
3. To create ability to identify, formulates, and solve soil stability related problems

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Syllabus

The special geotechnical constructions and process to be studied are:

Diaphragm walls, Ground (soil and rock) anchors, Soil nailing, Screw piles, Secant pile walls, Gabbion walls, Deep soil mixing walls, Geofoam and Geocells.

The state of the art studying with respect to the following aspects is expected:

1. Types, uses and applications
2. Construction techniques / methods
3. Equipments, machineries required
4. General design considerations
5. Analysis and quantitative design solution
6. Important case studies (in India and Abroad)

Text Book:

1. Construction of Diaphragm wall: I. Hajal, J. Morton and Z. Regals, series in Engineering Publications
2. Foundation Engineering Handbook: Chapter no. 26, H.Y. Fang, CBS Publishers (2004)

Reference Books:

1. FHWA Reports and Publications
2. Relevant IS codes and papers from various referred journals and proceedings

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

Course Code : CET624 Course: Dynamics of Soil & Foundation

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

Course Outcomes

1. To enhance Students' 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, Pauw's method of vibration analysis, 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.

Geotechnical earthquake engineering:

General introduction to earthquakes, magnitude and intensity of earthquake, elastic waves propagating in soil from source of disturbance, salient features and velocities of P, S and R-waves. Various effects of earthquake on soil-foundation-structure system. Ground motion during earthquake, accelerograms, influence of site profile and soil condition on shaking intensity & associated structural damages, Site response spectrum, induced

seismic forces and damage potential of structures.

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. Analysis and design of retaining wall under earth quake condition.

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)

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

Course Code: CEP624 Course: Dynamics of Soil & Foundation

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

Course Outcomes

1. Student will have an ability to calculate the dynamic soil properties, dynamic earth pressure, dynamic bearing capacity, vibration isolation, liquefaction of soils
2. Student will have an ability to design of machine foundation.
3. Student will have an ability to evaluation of liquefaction potential and suggest the preventive measures.

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

1. Analysis and design of reciprocating m/c foundation by
   a. Barkan`s approach using Cu,with & without apparent soil mass consideration.
   b. Pauw`s method for spring constant and apparent soil mass.
   c. Ricaharts solution for elastic half space model.
2. Analysis and design of reciprocating m/c 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 a journal and the same shall be assumed by concerned teachers through viva-voce examination.

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

Course Code: CET625	Course: Research Methodology
L:4 Hrs., P:0 Hrs., Per Week	Total Credits : 8

Course Outcomes

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

Syllabus

Introduction to Research:

What is research, how to do research, objectives of research, motivation in research, types of research, various research approaches, and 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.

Hypothesis:

What is hypothesis, characteristics of hypothesis, examples and types, hypothesis testing, concepts and procedure of hypothesis testing.

Data Collection and Analysis:

Methods of data collection, primary data, secondary data, analysis of data, simple regression, multiple regression analysis, linear and non linear correlation and regression.

Optimization:

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

Model Analysis:

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

Interdisciplinary Research:

Importance of interdisciplinary research, wireless sensor networks (WSN) as a technology for interdisciplinary

research, Application of WSN in civil engineering

Reference Books:

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

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

Elective- II

Course Code : CET626-1 Course: Soil-Structure Interaction

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

Course Outcomes

1. To understand the soil behavior and the methods to analyze the models
2. To solve the problems for beam and plate on elastic medium.
3. 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 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 files 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 IV, M. Tech. (Geotechnical Engineering)
Elective- II

Course Code: CET626-2 Course: Geo-Environmental Engineering
L:4 Hrs., P:0 Hrs., Per Week Total Credits : 8

Course Outcomes

1. To make the students aware about Geo-Environmental techniques, landfill engineering, and contaminant transport.
2. Student will understand the concept of design of waste containment facilities like landfill and waste containment pond.
3. To understand the importance of recycled and reuse of waste material.
4. 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, volatilization, 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 and size of land fills, characteristics of solid wastes, types of land fills, site selection, 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.

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

Vertical barriers system & cutoff walls, slurry travel 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 contributing 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).

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

Course Code: CEP627	Course: Project Phase I
L:0 Hrs., P:6 Hrs., Per Week	Total Credits : 24

Course Outcomes

1. To train the students to address to a group of people and to present technical topics in a well organized manner to the audience.
2. It is also intended for improvement of communication skills of students, to make them confident in expressing their views with clarity and to make them capable of taking part in debates / discussion.
3. This will help create self esteem and confidence that are essential for engineers.

Seminar and seminar report based on topic for research for project

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

Course Code: CEP721	Course: Project Phase II
L:0 Hrs., P:12 Hrs., Per Week	Total Credits : 48

Course Outcomes:

1. To improve the professional competency and research aptitude by touching the areas which are not covered by theory or laboratory classes.
2. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

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