Department of Civil Engineering
M. Tech Geotechnical Engineering

Basic Supporting Courses

Course Code	Course Name	L	T	P	Credits
COMP-805	Computer Programming	2	0	1	3
MAS-781	Advance Engineering Mathematics	2	1	0	3
CE-705	Finite Element & Finite Difference Methods	2	1	1	4
	Total				**10**

Core Courses

Course Code	Course Name	L	T	P	Credits
CE-701	Theory of Elasticity & Visco Elasticity	3	0	0	3
CE-707	Advanced Geotechnical Engg-1	3	1	0	4
CE-708	Geotechnical Processes	3	0	0	3
CE-780	Seminar-I	0	0	1	1
CE-718	Advanced Geotechnical Engg-2	3	1	0	4
CE-880	Seminar-II	0	0	1	1
CE899	Thesis	0	0	15	15
	Total				**31**

Specialized Courses

CE-820	Soil Exploration, Testing And Evaluation	0	0	2	2
CE-819	Structural design of foundation	3	0	0	3
CE-818	Reinforced Soil Structure	3	0	0	3
CE-821	Earthquake Geotechnical Engg	3	0	0	3
CE-822	Fuzzy Logic and its Application in Civil Engineering	3	0	0	3
CE-823	Rock Engineering	3	0	0	3

CE-824	Analysis and Design of Pavements	3	0	0	3
CE-825	Computer Methods in geotechnical Engineering	3	0	0	3
CE-826	Clay Mineralogy and Expansive Soil	3	0	0	3
CE-827	Ground Modification and Land Reclamation.	3	0	0	3
CE-828	Advanced Environmental Engineering	3	0	0	3
CE-829	Geoinformatics	3	0	0	3
CE-830	Pile Foundation	3	0	0	3
CE-831	Stability of Slopes	3	0	0	3
CE-832	Advanced Fluid Mechanics and Ground Water Engineering	3	0	0	3

M.Tech. (All Branches)

Computer Programming

Comp-805 **Credits: 3(2+0+2)**

1. Algorithms & Flow Charts
2. 'C' Programming
- (i) Preliminaries
- (ii) Constants & Variables
- (iii) Arithmetic Expressions
- (iv) Input-Output Statements
- (v) Control Statements
- (vi) Looping Statements
- (vii) Subscripted Variables
- (viii) Elementary Format Specifications
- (ix) Logical Statements & Decision Tables
- (x) Functions & Subroutines

3. Computer Oriented Numerical Methods
- (a) Solution of Non Linear Equation
  - (i) Bisection Method
  - (ii) Newton Method
- (b) Numerical Integration
  - (i) Trapezoidal Method
  - (ii) Simpson's 1/3 & 3/8 rule
- (c) Curve Fitting
  - (i) Construction of forward, backward difference table
  - (ii) Interpolation

4. Application of statistical packages

Reference Books:

Let Us C by Yashwant Kanetkar BPB publications
Computer Oriented Numerical Methods by R. S. Salaria, Khanna Book Publishing Co.

Practical List:

1. To find the largest among three numbers
2. To check whether a given string is a palindrome or not.
3. To find factorial of a given number by iteration.
4. To find whether the given integer is a prime number.
5. To find sum of n terms of series:
   a. n – n*2/2! + n*3/3! - n*4/4! + ...
6. To find sum and average of n integers using a linear array.
7. To read n numbers from the keyboard and display these numbers in the reverse order their entry.
8. To search a given number within a linear array.
9. To generate the fibbonacci series.
10. To find factorial of a given number using a function.
11. To deduce error involved in polynomial equation.
12. To Find out the root of the Algebraic and Transcendental equations using Bisection, Regula-falsi, Newton Raphson and Iterative Methods. Also give the rate of convergence of roots in tabular form for each of these methods.
13. To implement Newton's Forward and Backward Interpolation formula.

ADVANCE ENGINEERING MATHMATICS MAS-781 3(2-1-0)

Runge- Kutta methods derivation, error bounds and error estimates. Weak stability theory form Runge-kutta methods. Order and convergence of the general explicit one step methods. Linear multi step methods- derivation, order consistency, zero stability and convergence. Predictor-corrector methods, stiff system.

Polynomial ring over fields, extension of fields, Computation in GF(q), root fields of polynomials, Vector field over finite field, binary group codes, hamming codes, polynomials codes, the structure of cyclic codes, quadratic residue codes, reed Mueller Codes, Simplex codes.

Review of basic linear algebra, canonical factorization, Q-forms. Courant- Fischer minmax and related theorem. Matrix stability, Inequalities, g-inverse (A-, Am, A+). Direct, iterative, projection and rotation mretho0ds for solving linear system and eigen value problems, application.

FINITE ELEMENT & FINITE DIFFERENCE METHOD CE-705 4(2-1-2)

Finite Element Technique. Derivation of the elemental characteristics, condensation technique, conformable and non-conformable fields.

Application of the method to plane stress and plane strain problems. Asymmetric and three dimensional bodies. Plate bending problems. Dams, frames, shear walls, grid floors and rafts.

Derivation of difference relations. Richardson's extrapolation. Application of the Finite Difference Method to beam, buckling, vibration, plate and seepage. Flow Net and Flow Distribution problems.

References:

1. Finite Element Method for Engineers and scientists – O.C.Zienkiewicz
2. Numerical Methods in Finite Element Analysis – K.J.Bathe & E.L.Wilson
3. Matrix Computations for Engineers & scientists – Alan Jennings
4. Introduction to Finite Element Method – C.S.Desai & J.F.Abel
5. Finite Element Method in Engineering – S.S. Rao

THEORY OF ELASTICITY AND VISCO ELASTICITY CE-701 3(3-0-0)

Analysis of stress, components of stress invariants, principal stresses, equations of equilibrium, stress transformation formulae, boundary conditions.

Analysis of strain, components of strain displacement relationship, strain invariants, principal strain, strain transformation formulae, compatibility equation.

Strain Stress relations of elasticity, basic assumptions, isotropy, homogeneity, continuity, generalized Hook's law, formulation of elasticity problems, existence and uniqueness of solution, Saint Venant's principle, strain energy

Plane stress/strain problems, airy stress function, governing differential equation, problems in rectangular coordinates, bending of beams, and comparison with solution from bending theory.

Plane stress/plane strain problems in polar coordinate, equilibrium strain displacement, compatibility equations, stress concentration around holes in plates, stresses in rotating disks.

Torsion of noncircular section, St.Venant's theory, Warping function, membrane analogy, Solution for rectangular, elliptical/triangular sections, torsion of thin walled closed and open sections.

Yielding and various yield criterion, yield surface, Haigh- Westergard stress space, loading and unloading, plastic stress-strain relation/equations, Tresca criterion, General derivation of stress strain relation.

Plasticity: Yielding and various yield criteria, yield surface, Haigh- Wesetergard stress space subsequent yield surface, loading and unloading, plastic stress-strain relations.

Visco elasticity: Introduction to linear theory of viscoelasticity. Visco-elastic method, constitutive relations, correspondence principle.

References

1. Theory of Elasticity - Timoshenko & Goodier
2. Elasticity and Plasticity – Flugges. S.
3. Applied Elasticity -Wang.C.T.

ADVANCED GEOTECHNICAL ENGINEERING – 1 CE-707 4(3-1-0)

Soil aggregate and classification; Clay mineralogy; Permeability, Steady state flow, Seepage, Flow nets, Design of filters. Shear strength of cohesive and cohesion less soils: Stress-Strain

behaviour, Drained and undrained shear strength of soils; Stress-pore pressure relationships; Critical void ratio. Stress paths; Relationships between effective stress-water content; Hvorslev's strength parameters. Transient Flow: 1D and generalised consolidation theories, Primary and secondary consolidation settlements; Corrections to 1-d consolidation settlements; Stress path method for settlement computations

GEOTECHNICAL PROCESSES CE-708 3(3-0-0)

Dewatering,/Methods sumps and ditches, well point systems, deep well sumps, sheeting and open plumbing, electro osmosis, theory and analysis of groundwater lowering, choice, and design of dewatering system. Grouting, Purpose, Impermeability, consolidation, grouting classification, grouting materials, grouting pattern, selection of grouts, method of grouting and grouting pressure. Field test to check the effectiveness. Compaction, factors affecting compaction of soils, field compaction, field control tests. Stabilization, Necessity, mechanism, effects of engineering properties, design and construction techniques of soil cement, soil line, soil asphalt, soil chemical, mechanical, thermal and electroosmotic stabilization. Special techniques, vibrofloatation, compaction by impact, sand drain, stone columns, sand lime cement columns, compaction pile. Reinforced earth, Materials, application and design.

ADVANCED GEOTECHNICAL ENGINEERING - II CE-718 4(3-1-0)

Foundation classification; Choice of foundations; Bearing capacity and settlement analysis of shallow foundations like footings and rafts, Deep foundations like piles, piers and Caissons; Foundations on expansive soils, laterites, fills and rock; Construction aspects of foundations; Shoring and underpinning; Groundwater lowering and drainage; Legal aspects of foundation engineering; Field tests in foundation engineering including instrumentation for monitoring of foundation

SOIL EXPLORATION, TESTING AND EVALUATION CE-820 2(0-0-2)

Soil Exploration, Experiments to determine the shear strength properties of soil. Direct shear test, unconfined compression test, vane shear test. Triaxial shear tests, determination of total and effective stress parameters, determination of compaction and consolidation characteristics.

REINFORCED SOIL STRUCTURES CE-821 3(3-0-0)

Historical background; Principles, concepts and mechanism of reinforced earth; Design consideration for reinforced earth and reinforced soil structures; Geosynthetics-their composition, manufacture, properties, functions, testing and applications in reinforced earth structures; Design of reinforced soil structures like retaining walls, embankments, foundation beds etc.; Designing for Separation, Filtration, Drainage and Roadway Applications; Designing for Landfill Liners and Barrier Applications; Case histories of applications.

Textbooks/References

1. Clayton, C. R. I., Milititsky, J. and Woods, R. I., Earth Pressure and Earth Retaining Structures, Blackie Academic & Professional, 1993.
2. Ingold, T, Reinforced Earth, Thomas Telford Ltd., 1982.
3. Jones, C. J. F. P, Earth Reinforcement and Soil Structures, Butterworth, 1985.
4. Koerner, R. M, Designing with Geosynthetics, Prentice Hall, 1993.

EARTHQUAKE GEOTECHNICAL ENGINEERING CE-818 3(3-0-0)

Pre-requisites: Dynamics of Soils and Foundations (CE 532)/
Structural Dynamics (CE 504)
Earthquake seismology – Causes of earthquake, Plate tectonics, Earthquake fault sources, Seismic waves, Elastic rebound theory, Quantification of earthquake, Intensity and magnitudes, Earthquake source models.
Earthquake ground motion – Seismograph, Characteristics of ground motion, Effect of local site conditions on ground motions, Design earthquake, Design spectra, Development of site specification and code-based design.
Ground response analysis – One-dimensional ground response analysis: Linear approaches, Equivalent linear approximation of non-linear approaches, Computer code “SHAKE”.
Liquefaction and lateral spreading - Liquefaction related phenomena, Liquefaction susceptibility: Historical, Geological, Compositional and State criteria. Evaluation of liquefaction by cyclic stress and cyclic strain approaches, Lateral deformation and spreading, Criteria for mapping liquefaction hazard zones.
Seismic design of foundations, Seismic slope stability analysis: Internal stability and weakening instability and Seismic design of retaining walls.

Textbooks/References

1. Kramer S. L, Geotechnical Earthquake Engineering, Prentice Hall, 1996.
2. R. W. Day, Geotechnical Earthquake Engineering Handbook, McGraw-Hill, 2002.
3. Seco e Pinto, Seismic behaviour of ground and Geotechnical structure, A. A. Balkema, 1997.
4. Naeim, F, The Seismic Design Handbook, Kluwer Academic Publication, 2nd Edition, 2001.
5. Bolt, B. A, Earthquakes, W. H. Freeman and Company, 4th Edition, 1999.
6. Lourie, W, Fundamentals of geophysics, Cambridge University press, 1997.
7. Wang J. G. Z. Q and J. K Tim Law , Siting in Earthquake zones, A. A. Balkema, 1994.

8. Ferrito, J. M, Seismic design criteria for soil liquefaction, Tech. Report of Naval Facilities service centre, Port Hueneme, 1997.

ROCK ENGINEERING CE-823 3(3-0-0)

Pre-requisites: Nil

Geological formation of rocks, Structural Geology, Classification of rocks, Physicomechanical properties of rocks, Laboratory and field tests, Stress-strain behaviour,
Failure criteria for intact rock and rock masses, Fracture mechanism, Analysis and design of underground openings, Instrumentation in tunnels, Rock support and reinforcement, Foundations on rock, Rock blasting.

Textbooks/References

1. Mukerjee, P. K.,A text book of Geology, World Press, 1995.
2. Brady, B. H. G. and Brown, E. T, Rock Mechanics for Underground Mining, Chapman & Hall, 1993.
3. Brown, E. T, Rock Characterisation, Testing and Monitoring, Pergamon Press, 1986.
4. Herget, G, Stresses in Rock, Balkema, 1988.
5. Hoek, E. and Brown, E. T, Underground Excavation in Rock, Institution of Mining and Metallurgy, 1982..
6. Goodman, R. E, Introduction to Rock Mechanics, John Wiley & Sons, 1989.
7. Bieniawski, Z. T, Engineering Rock Mass Classification, John Wiley and Sons, 1989.
8. Coates, D. F, Rock Mechanics Principles, Canada Centre for Mineral and Energy Technology, 1981.
9. Jaeger, J. C. and Cook, N. G. W, Fundamentals of Rock Mechanics, Champman and Hall, 1976.
10. Wyllie, D. C, Foundations on Rock, E & FN Spon. 2nd Edition,1992.

ANALYSIS AND DESIGN OF PAVEMENT CE-824 3(3-0-0)

Philosophy of design of flexible and rigid pavements, analysis of pavements using different analytical methods, selection of pavement design input parameters – traffic loading and volume, material characterization, drainage, failure criteria, reliability, design of flexible and rigid pavements using different methods, comparison of different pavement design approaches, design of overlays and drainage system.

Textbooks/References

1. Yang H. Huang, Pavement Analysis and Design, Pearson Prentice Hall, 2004.
2. Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.
3. Sharma and Sharma, Principles and Practice of Highway Engg., Asia Publishing House, 1980.
4. Teng, Functional Designing of Pavements, McGraw- Hill, 1980.

CLAY MINERALOGY AND EXPANSIVE SOIL CE-826 3(3-0-0)

Origin and occurrence, Weathering and soil formation, clay minerals, composition, classification and nomenclature, non-clay and organic constituents, isomorphism substitution, cation exchange capacity, structure of clay mineral, Kaolinite, Illite and montmorillonite groups, identification by X-ray diffraction, electron microscope, chemical, DT A methods.

Clay water relationships, structure of soils effect of cations, Thixotropy, Electrical effects, Electro osmosis and electrophoresis, streaming potentials. Effects of clay minerals on engg. properties of soils, introduction to rheological properties of clay soils.

Classification of expansive soils, free swells index property tests, swelling potential, measurement and prediction.

Theories of swelling, mechanical concepts, physico chemical and electro chemical theories swell calculation for simple systems. Earth pressure and slope stability, code of practice, stabilization of expansive soils.

1. Foundation on expansive soils-Chen, F.H.
2. Clay mineralogy - Grim R. E.
3. Applied clay mineralogy- Grim R. E.

GROUND MODIFICATION AND LAND RECLAMATION CE-827 3(3-0-0)

1. Introduction: Objectives, classification and options of ground improvement

2.Mechanical modification: Introduction, principles of soil densification, properties of compacted soil and compaction control specifications for quality controls.

3.Hydraulic modification: Introduction, objectives, techniques, Dewatering methods, soil 8water relationship, Types of aquifer, Design of Dewatering systems, filtration, drainage and seepage, control, preloading and vertical drains, electro kinetic dewatering and stabilization.

4.Physical and chemical Modification: Modification by admixtures, grouting, and thermal modification.

5. Modification by inclusions and confinement: Soil reinforcement, ground anchorage, and rock bolting soil nailing, crib walls, and gabions.

6. Land reclamation: Hydraulic fills, colliery discard lagoons. Land affected by old mines and open cast mining. Land fill sites of industrial mining, chemical and domestic waste. Derelict sites of former industries. Soft or loose natural soils.

GEOINFORMATICS **CE-829** **3(3-0-0)**

Remote Sensing
Physics of remote sensing, Remote sensing satellites and their data products, Sensors and orbital Characteristics, Spectral reflectance curves for earth surface features, Methods of remotely sensed data interpretation – Visual interpretation and Digital image processing, Application of remote sensing in natural resources management

Geographic Information System (GIS)
Basic concepts of geographic data, GIS and its components, Data acquisition, Raster and Vector formats, Data editing, Spatial modeling, Data output, GIS Applications

Photogrammetry
Aerial Photographs – Basic terms & Definitions, scales, relief displacements, Flight Planning, Stereoscopy, Characteristics of photographic images, Fundamentals of aerial photo-interpretation.

Global Positioning System (GPS)
Introduction, Satellite navigation System, GPS- Satellite constellation, Space segment, Control segment, User segment, GPS satellite signals, Receivers, Static, Kinematic and Differential GPS

PILE FOUNDATIONS **CE-830** **3(3-0-0)**

1. PILE CLASSIFICATIONS
Function – classification of piles – Factors governing choice of pile foundation – Load transfer principles – piling equipments and methods – changes in soil condition during installation of piles – requirement of code of practice – responsibility of engineer and contractor.

2. AXIALLY LOADED PILES AND PILE GROUPS
Allowable load evaluation of piles and pile groups – Static method – cohesive – cohesion less soil – time effects – Dynamic method – pile driving formulae –Wave equation application – modeling – theoretical analysis – Interpretation of field test results and pile load test results –

Settlement of Piles and Pile groups.

3. LATERAL AND UPLIFT LOAD EVALUATION

Piles subjected to Lateral loads – Broms method, elastic –p-y curve analyses – Batter piles – response to moment – pile subjected to uplift loads – load –deformation behaviour – Lateral and uplift load test data interpretation. Foundation on weak compressible – collapsible soil – case studies.

4. STRUCTURAL DESIGN OF PILE AND PILE GROUPS

Pile foundation – structural design – pile cap analysis, pile – raft system basic interactive analysis – pile and pile groups subjected to vibrations – fundamental solutions.

REFERENCES :

1. Das, B.M., Principles of Foundation Engineering, Design and Construction, PWS., Publishing, 1999 (Fourth Edition)
2. Cernica, J.N. Geotechnical Engineering Foundation Design, John Wiley and Sons, Inc. 1995.
3. Poulos, H.G., Davis, E.H., Pile foundation analysis and design, John Wiley and Sons, New York, 1980.
4. Tomlinson, M.J. Foundation engineering, ELBS, Longman Group, U.K. Ltd., England 1995.
5. Bowles, J.E., Foundation Analysis and Design, McGraw Hill book Company, 1996.
6. Winterkorn, H.F. and Fang, H.Y – Foundation Engineering Handbook, Von Nostrand Reinhold, 1994.
7. Tomlinson, M.J., Pile design and construction practice, Cement and concrete association, 1977

STABILITY OF SLOPES CE-831 3(3-0-0)

Natural and manmade slopes, types of slope movements and landslides, Nature of soil and rock progressive failure of slopes.

Limit equilibrium methods, Planar Failure surface and slip surface of arbitrary shape. Some special aspects of slope analysis i.e., Earthquakes, Creep, Anisotropy, initial stresses.

Probabilistic approach in slope analysis. Centrifuge model testing.

References:

1. Slope stability-Chaudary, R. N.

2. Earth and Earth rock dams-Sherard, Woodward, Gizienski & Cleverages.

3. Earth and rockfill dam Engineering - Sowers G.F. and Sally. H.N.

ELIGIBILITY CRITERIA FOR THE M. TECH PROGRAMME:

Candidates must have consistently good academic record and minimum of first class or equivalent in B.E./B.Tech in Civil Engineering.