Department of Civil Engineering

M. Tech Geotechnical Engineering Curriculum

FIRST SEMESTER

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	CE1011	FOUNDATION ENGINEERING	4-0-0	4
2	CE1012	ADVANCED SOIL MECHANICS	4-0-0	4
3	CE1013	GEOTECHNICAL EARTHQUAKE ENGINEERING	4-0-0	4
4		Elective I	4-0-0	4
5		Elective II	4-0-0	4
6	CE1061	GEOTECHNICAL LAB-I	0-0-4	2
7	CE1062	COMPUTATIONAL LAB	0-0-4	2
TOTAL				**24**

SECOND SEMESTER

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	CE2011	SOIL DYNAMICS AND MACHINE FOUNDATION	4-0-0	4
2	CE2012	GROUND IMPROVEMENT	4-0-0	4
3	CE2013	APPLIED NUMERICAL METHODS	4-0-0	4
4		Elective III	4-0-0	4
5		Elective IV	4-0-0	4
6	CE2061	GEOTECHNICAL LAB-II	0-0-4	2
7	CE2062	Seminar - I (Non-Project)	0-0-2	1
8	CE2063	Project-I	0-0-2	1
TOTAL				**25**

THIRD SEMESTER

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	CE3061	Project–II		11
2	CE3062	Project Seminar - I		2
TOTAL				**13**

FOURTH SEMESTER

Sl. No	Sub. Code	Subject	L-T-P	Credits
1	CE4061	Project–III		11
2	CE4062	Project Seminar - II & Viva Voce		3
TOTAL				**14**

SUMMARY OF COURSES

Sub Discipline: DEPARTMENTAL CORE

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE-1011	Foundation Engineering	4-0-0	4	Dr. K Bhattacharya & Dr. S Pal

Soil Exploration: Exploration Methods; Planning the Exploration Program; Boring and Sampling; In Situ Tests: Standard Penetration Tests, Field Vane & Borehole shear tests, Rock Sampling, Core Recovery, RQD; Geophysical Exploration; Preparation of Soil Report.	[8]
Shallow Foundations: Bearing Capacity:- Bearing capacity of foundation based on in-situ tests. Bearing capacity for foundation on slope, mat foundations including floating raft, Effect of Water Table; Footings with Eccentric or Inclined Loads, on Layered Soils.	[10]
Deep Foundations: Mechanics of load transfer in piles, load carrying capacity, pile load test, Vertically loaded piles, Static capacity, Dynamic formulae; Bearing Resistance of Piles on Rock; Uplift Resistance; Laterally Loaded Piles –Ultimate Lateral Resistance; Negative Skin Friction; Under Reamed Piles; Ultimate Capacity of Pile Groups in Compression, Pullout & Lateral Load; Efficiency; Settlements of Pile Groups.	[10]
Sheet piles: Design of anchored sheet piles: Free Earth Support Method, Fixed Earth Support Method, Problems.	[6]
Coffer Dams: Cellular cofferdams- Circular and Diaphragm type, Merits and demerits, Deign of circular type cofferdams, practice problems.	[6]
Braced Cuts: Pressure envelope for Braced – Cut design, Pressure envelope for cuts in layered soil, Design of various components of a braced cut, Bottom heave of cut in clay, Stability of the bottom of cut in sand.	[4]

TEXT BOOKS:

1. Design Aids in Soil Mechanics and Foundation Engineering S.R. Kaniraj
2. Foundation Engineering by V.N.S Murthy

REFERENCE BOOKS:

1. Foundation Engineering by B.M.Das
2. Foundation Engineering By J.E. Bowles

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE-1012	Advanced Soil Mechanics	4-0-0	4	Dr. S Pal

Stresses, Strains, and Elastic Deformations of Soils [15]

Stresses and strains, Idealized stress-strain response and yielding, Hooke's Law, Plane strain and axial symmetric conditions, Anisotropic Elastic states, stress and strain states, Total and Effective stresses, Lateral Earth pressure at rest, stresses in soil from surface loads, stress and strain invariants, stress paths, practical example.

One-Dimensional Consolidation Settlement of Fine-Grained Soils [12]

Basic concepts, calculation of primary consolidation settlement, One-Dimensional Consolidation Theory, Secondary Compression settlement, One-Dimensional Consolidation Laboratory Test, Relationship between laboratory and field consolidation, Typical values of consolidation settlement parameters and empirical relationships, Preconsolidation of soils using wick Drains, practical example.

Two-Dimensional flow of water through soils [13]

Two-Dimensional flow of water through porous media, Flownet sketching, interpretation of Flownet, Finite difference solution for Two-Dimensional flow, Flow through Earth Dams, Soil filtration, practical example.

TEXT BOOKS:

1. Advanced Soil Mechanics by BrajaM.Das
2. Soil Mechanics and Foundationsby M. Budhu

REFERENCE BOOKS:

1. Elasticity and Geomechanics by R.O. Davis and A.P.S. Selvadurai.
2. Principles of Soil Mechanics by R F Scott

CE-1013	Geotechnical Earthquake Engineering	4-0-0	4	Dr. K Bhattacharya

Introduction to Geotechnical Earthquake Engineering: Scope and objective; ground shaking, liquefaction, land slide, tsunami.	[6]
Engineering seismology: seismic waves, faults, plate boundaries, Intensity, Strong ground motion, Measuring of Earthquake, Earthquake Magnitude-Local (Richter) magnitude, surface wave magnitude, Moment magnitude, Seismic energy, Correlations. Spectral Parameters: Peak Acceleration, Peak Velocity, Peak Displacement, Frequency Content and duration, Spatial Variability of Ground Motion, Attenuation Relationships, Fourier Amplitude Spectra. Earthquake measuring instruments.	[12]
Dynamic Soil Properties: measurement of dynamic soil properties by field and laboratory test, stress strain behavior of cyclically loaded soils.	[4]
Seismic Hazard Analysis: Deterministic Seismic Hazard Analysis (DSHA), Probabilistic Seismic Hazard Analysis (PSHA).	[4]
Response of SDF and MDF system, Development of response spectra, Use of response spectra for frames, retaining wall and earthen dams. Examples.	[4]
Local site effect and design ground motion: effect of local site condition on ground motion, development of ground motion time histories.	[4]
Soil improvement for remediation of seismic hazard.	[6]

TEXT BOOKS:

1. Earthquake Engineering by Anil K. Chopra
2. Earthquake Resistant Design Of Structures by Pankaj Agarwal and M.Shrikende

REFERENCE BOOKS:

1. Dynamics of Structures by Prof. Madhujit Mukhopadyay

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE-2011	Soil Dynamics and Machine Foundation	4-0-0	4	Dr. K Bhattacharya

Introduction to machine foundation.	
General theory (theory of sdf and mdf system, damping of single and two degree freedom system, transient response and periodic response.	[4] [8]
Design parameters (dynamic soil parameters under compression, bending yawing etc., difference between static and dynamic parameters, eveluation, application of elastic base theory.	[8]
Block foundation (mode of vibration, theoretical and recommended methods of dynamic analysis, design of reciprocating machine foundation.	[12]
Hammer foundation	
Turbo generator foundation (special consideration in planning and design, design data recommended, dynamic analysis and design.	[8] [6]

TEXT BOOKS:

1. Handbook of Machine Foundation by C.V. Vaidyanathan and P. Srinivashalu

REFERENCE BOOKS:

1. Dynamics of Structures by Madhujit Mukhopadyay

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE-2012	Ground Improvement	4-0-0	4	Dr. S Pal

Introduction: Formation of soil, major soil type, collapsible soil, expansive soil, reclaimed soil,sanitary land fill, ground improvements; objective, potential.	[6]
General Principal of Compaction: Mechanics , field procedure, quality control in field.	[6]
Ground Improvement in Granular Soil: In place densification by (i) Vibrofloatation (ii)Compaction pile (iii) Vibro Compaction Piles (iv) Dynamic Compaction (v) Blasting.	[10]
Ground Improvement in Cohesive Soil: Preloading with and without vertical drains.Compressibility, vertical and radial consolidation, preloading methods. Types of Drains, Design of vertical Drains, construction techniques. Stone Column: Function Design principles, load carrying capacity, construction techniques, settlement of stone column foundation	[10]
Ground Improvement by Grouting and Soil Reinforcement: Grouting in soil, types of grout,desirable characteristics, grouting pressure, grouting methods. Soil Reinforcement: Mechanism,Types of reinforcing elements, reinforcement-soil interaction, Reinforcement of soil beneath the roads.	[8]
Drainage & Dewatering in soils	[4]
Liquefaction Potential and Measures to prevent liquefaction	[2]

TEXT BOOKS:

1. Ground Improvement by M.P.Mosely
2. Theory and Practice of Foundation Design by N.N.Som & S.C.Das.

REFERENCE BOOKS:

1. Highway Engineering Handbook by K.B. Woods, D.S. Berry and W.H. Goetz.
2. Foundation Engineering Hand book by Winterkorn& Fang.

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE-2013	Applied Numerical Methods	4-0-0	4	Dr. A K Banik

Fundamentals of numerical methods, Elements of matrix algebra, Solution of Linear equations and eigenvalue problems; Solution of differential equationsError analysis and stability of algorithms.	[2]
Nonlinear equations: Newton Raphson method, Muller's method, system of non-linear equations. Roots of polynomial equations.	[6]
Linear system of algebraic equations: Gauss elimination method, LU decomposition method; matrix inversion, iterative methods, ill conditioned systems. Eigenvalue problems: Jacobi, Given's and Householder's methods for symmetric matrices, Power and inverse power methods.	[8]
Interpolation and approximation:Newton's, Lagrange and Hermite interpolating polynomials, cubic splines; least square and minimax approximations.	[6]
Numerical differentiation and integration: Newton-Cotes and Gaussian type quadrature methods.	[6]
Ordinary differential equations: Initial value problems: single step and multistep methods, stability and their convergence. Boundary value problems: functional approximation, finite difference method, finite element method.	[8]

Partial Differential Equations: Difference methods for solution of parabolic and hyperbolic equations in one and two-space dimensions, stability and their convergence, difference methods for elliptic equations. Computer oriented algorithms; Numerical solution of different problems.	[6]

TEXT BOOKS:

1. Numerical Methods for Scientists and Engineers byR. W. Hamming, Dover Publications
2. Numerical Methods: Problems and Solutions byMahinder Kumar Jain (Author), S.R.K. Iyengar (Author), R. K. Jain.

REFERENCE BOOKS:

1. Applied Numerical Methods for Engineers Using Matlab and C byRobert J. Schilling (Author), Sandra L. Harris,

Sub Discipline: DEPARTMENTAL ELECTIVES

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9040	Probability and Statistics	4-0-0	4	Dr. P Roy

Probability: Axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, problems.	[5]
Random Variables: Discrete, continuous random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, moments, probability and moment generating function, Markov inequality, Chebyshev's inequality problems.	[6]
Special Distributions: Discrete uniform, binomial, geometric, negative binomial, hypergeometric, Poisson, continuous uniform, exponential, gamma, Weibull, beta, normal, lognormal.	[8]
Function of a random variable: Different functions of a random variable .	
Joint Distributions: Joint, marginal and conditional distributions, product moments, correlation and regression, independence of random variables, bivariate normal distribution.	[2] [4]
Sampling Distributions: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-Square, t and F distributions, problem	
Estimation: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions.	[3] [6]
Testing of Hypotheses: Null and alternative hypotheses, the critical and acceptance regions, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportion.	[8]
Goodness of fit tests: Chisquare goodness of fit test and its applications, problems.	[2]

TEXT BOOKS:

1. Probability Concepts in Engineering Planning and Design: Volume 1, Basic Principles by Ang, A. H. S. and Tang, W. H.
2. Probability Concepts in Engineering Planning and Design: Volume 2 Decision, Risk and Reliability by Ang, A. H.-S. and Tang, W. H.

REFERENCE BOOKS:

1. Applied Statistics and Probability for Engineers by Montgomery, D.C. and Runger, G.C.

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9041	Geo Environmental Engineering	4-0-0	4	Dr. S Pal

Sources and Site Characterization: Scope of Geoenvironmental Engineering, Various Sources of Contaminations, Need for contaminated site characterization; and Characterisation methods.	[6]
Soil properties: Geotechnical properties, Chemical properties.	
Pollution in Groundwater: Introduction, Hydrodynamic dispersion of pollutants in groundwater environment, Solute transport modelling by the finite element method.	[6] [8]
Contaminant Transport and Fate: Transport process, Mass-transfer process, Modeling, Advection-Dispersion equation for modelling of contaminant transport in porous media.	[12]
Remediation Techniques: Objectives of site remediation, various active and passive methods, remediation NAPL sites, Emerging Remediation Technologies.	[6]
Landfills: Types of landfills, Site Selection, Waste Containment Liners, Leachate collection system, Cover system, Gas collection system.	[6]

TEXT BOOKS:

1. Geotechnical practice for waste disposal by Daniel, D.E.
2. Geoenvironmental Engineering: Site remediation, waste containment and emerging waste management technologies by H.D. Sharma & K.R.Reddy

REFERENCE BOOKS:

1. Environmental Engineering: A Design Approach by Sincero and Sincero
2. Construction of Linings for reservoirs, Tanks and Pollution control facilities by Kays, W.B

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9042	Ground Water Hydrology	4-0-0	4	Dr. V K Dwivedi

Fundamentals of ground water Introduction – Characteristic of Ground water – Distribution of water - ground water column –Permeability - Darcy's Law - Types of aquifers – Hydro-geological Cycle – water level fluctuations.	[6]
Hydraulics of flow Storage coefficient - Specific field - Heterogeneity and Anisotropy -Transmissivity– Governing equations of ground water flow - Steady state flow – Dupuit Forchheimer assumptions – Velocity potential - Flow nets	[6]
Estimation of parameters Transmissivity and Storavity – Pumping test - Unsteady state flow - Thiess method – Jacob method - Image well theory – Effect of partial penetrations of wells - Collectors wells.	[6]
Ground water development Infiltration gallery - Conjunctive use - Artificial recharge Rainwater harvesting - Safe yield –Yield test – Geophysical methods – Selection of pumps.	[6]
Water quality Ground water chemistry - Origin, movement and quality - Water quality standards –	[6]

Saltwater intrusion –Environmental concern **Groundwater management** Ground water basin management; concepts of conjunction use	[4]

TEXT BOOKS:

1. Ground Water Hydrology by Raghunath H.M.
2. Ground Water Hydrology by Todd D.K.

REFERENCE BOOKS:

1. Ground Water by Bawvwr.

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9043	Finite Element Method	4-0-0	4	Dr. K Bhattacharya

Introduction: Basics of FE, discretization, nodes, elements, mesh, stiffness, degrees of freedom, element stiffness matrix, element load vector, element displacement vector, assembly procedure, global stiffness matrix global load vector, global displacement vector, stresses and strains, types of elements and properties, interpolation functions.	[4]
Different formulations: Galarkine's Residual Model, Virtual Work Model, Energy Principal etc. and derivation of shape functions in light of above of beam element.	[6]
Triangular and Rectangular Element formulation by basic method of displacement function with nodal variables. Examples.	[6]
Introduction of Isoparametric Elements, Plane stress and plane strain. Concept of Integration points, Jacobian matrix. Application in Geotechnical Engineering. Example.	[4]
3D elements and its formulation as Iso-parametric element. Application in Geotechnical Engineering. Example.	[6]
Difference between linear and quadratic elements. Example	[2]
Programming	12]

TEXT BOOKS:

1. Problems in Structural Analysis by Matrix method by P. Bhatt. Wheelers.
2. Finite Element Methods by Dhanraj Nair

REFERENCE BOOKS:

1. .Finite Element Analysis (Theory and Programming) by C.S. Krishnamurthy.

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9044	Offshore Structure Engineering	4-0-0	4	Dr. A K Banik

Loads and structural forms of different types of offshore structures;	[4]
Introduction of SDOF, free and forced vibrations; Analysis fortransient and steady state force; Equivalent damping for nonlinear systems; Dynamics of multi d.o.f. systems; Eigen values and vectors; Iterative and transformation methods; Mode superposition. Fourier series and spectral method for response of single d.o.f. systems;	[10]
Vibrations of bars, beams and cones with reference to soil as half space;	[4]
Behaviour of concrete gravity platform as a rigid body on soil as a continuum;	[4]

Short and long term statistics of wind; Static wind load; Effect of size, shape and frequency; Aerodynamic admittance function and gust factor, spectral response due to wind for various types of structures; Wave loads by Morison's equation; Static and dynamic analysis of fixed structures; Use of approximate methods.	[10]
Design of offshore platforms: Introduction, fixed and floating platforms. Steel, concrete and hybrid platforms. Design criteria. Environmental loading. Wind, wave and current loads after installation.. Behaviour under dynamic loading. Static and dynamic analysis of platforms and components.	[10]

TEXT BOOKS:

1. Dynamics of Offshore Structures by James F. Wilson.
2. Wave Forces on Offshore Structures by Turgut 'Sarp' Sarpkaya.

REFERENCE BOOKS:

1. Hydrodynamics of Offshore Structures by S.K. Chakrabarti

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9045	Remote Sensing and GIS	4-0-0	4	Dr. S Bhattacharyya

Remote Sensing – History, Physical basis, Electromagnetic spectrum, Spectral reflectance curves, Spectral signatures, Resolutions, Passive & active remote sensing, Remote sensing platforms.	[10]
Sensors – Different types, Satellite band designations & principal applications, FCC, Aerial photography & its interpretation.	[10]
Digital image processing – Pixels & DN values, Digital image formats, Image processing functions – Image enhancement, Image transformation, Image classification & analysis.	[10]
Geographic Information System – Introduction, GIS components – hardware, software & infrastructure, GIS data types, Data input & processing, Preparation of thematic map from RS data.	[10]
Integration of RS & GIS techniques and its applications in the fields of Geo- Environmental engineering.	[5]

TEXT BOOKS:

1. Remote Sensing & GIS by B. Bhatta.

REFERENCE BOOKS:

1. Remote Sensing and Image Interpretation by T.M. Lillesand and R.W. Kiefer
2. Concepts & Techniques of Geographic Information Systems by C.P. Lo & A.K.W. Yeung

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9046	Forensic Geotechnical Engineering	4-0-0	4	Dr. S Pal

Project reconnaissance and characterization of the distress, including document search such as plans, codes, and other technical specifications followed in the original design.	[10]
Diagnostic tests – Analysis of field data – selection of laboratory tests based on actual field parameters to evaluate the behaviour of soil/ground.	[12]
Scope and extent of application of Forensic Engineering techniques in geotechnical and foundation failure investigations, settlement of structures, expansive soils,	

lateral movement, other geotechnical and foundation problems, groundwater and moisture problems. **Back analysis:** Selection of theoretical model - methods of analysis, Instrumentation and Monitoring **Development of the most probable failure hypothesis** - cross-check with original design. Performing reliability checks, Legal issues involving jurisprudence system, insurance, repairs, reducing potential liability, responsibility of geotechnical engineers and contractors.	[10] [10]
TEXT BOOKS: 1 Forensic Geotechnical and Foundation Engineering by Robert W. Day 2 A Guide to Soil Mechanics by Malcolm D. Bolton	
REFERENCE BOOKS: 1. Technical, Ethical, and Legal Issues with Forensic Geotechnical Engineering - A Case History. by Saxena, D.S	

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9051	Soil Structure Interaction	4-0-0	4	Dr. P.Roy

Part I: Introduction, Superstructure-foundation interaction, static soil-structure interaction. Non-uniform contact pressure, Interaction problems of shallow foundation, Combined footing, Rigid method, Flexible method. Various Soil Models: Beams on elastic foundation, Infinite beam, Finite beam, Modulus of subgrade reaction and effecting parameters. Sheet pile wall, Cantilever and anchored sheet pile wall, Fixed earth support, Free earth support. Piles under different loading conditions, Analysis under lateral load, Different approaches, Mechanism of failure, Ultimate load, Deflections, Elastic continuum approach, Design, Analysis. Part-II: Introduction to Dynamic Soil Structure interaction. Estimations of damping ratio of DSSI. Geotechnical consideration of DSSI	[04] [06] [10] [04] [08] [02] [06] [02]
TEXT BOOKS: 1. Advanced Geotechnical Engineering soil-structure Interaction using Computer and Material Models by C.S.Desai, Musharraf Zaman. 2. Foundation analysis and Design by J.E.Bowles	
REFERENCE BOOKS: 1. Soil-Structure Interaction Numerical Analysis and Modelling by J. W. Bull. 2. Advanced Soil Mechanics by B.M. Das. 3. Dynamic Soil-Structure Interaction by John. P.	

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9052	Constitutive Modeling in Soil Dynamics	4-0-0	4	Dr. K Bhattacharya

Mechanics of continua (Stress and strain, Concept of strain, Displacement field, Concept of small domain, Body undergoing small deformation, Strain tensor, Derivative of a vector fixed in a moving reference, Physical interpretation of strain tensor, Cubical dilatation, Transformation of strains, Equations of compatibility, Stresses, Concept of stress, Principal stresses and strains, Invariants, Cauchy's stress quadric and Mohr diagram, Octahedral stresses and strains, Spherical and deviatoric stress components, Constitutive relations.	[16]
Equations of equilibrium (Some useful expressions, Differential equations at a point (general), Differential equations at a point (in terms of stresses), Differential equations at a point (in terms of displacements), General solution, Two-dimensional cases, Theorems of elasticity, Principles of superposition, Strain energy, Virtual work.	[12]
Development of soil dynamics to the present state of art, One-dimensional propagation of wave through an elastic medium, Three-dimensional propagation of waves in an infinite elastic medium , Propagation of waves in polar co-ordinates, Reflection/Refraction, Some background on integral transforms and other mathematical theorems, Lamb's solution for two-dimensional Problem.	[16]

TEXT BOOKS:

1. Theory of Elasticity by Timoshenko and Gudier.

REFERENCE BOOKS:

1. Foundation Engineering by J.E. Bowles

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9053	Rock Mechanics	4-0-0	4	Dr. S Pal

Engineering Classification of Rocks: Classification of intact rocks, Rock mass classifications, Rock Quality Designation (RQD), Rock Structure Rating (RSR), Rock Mass Rating (RMR), Strength and modulus from classifications, Classification based on strength & modulus and strength and fracture strain, Geoengineering classification.	[[10]
Engineering Classification of Rocks: Classification of intact rocks, Rock mass classifications, Rock Quality Designation (RQD), Rock Structure Rating (RSR), Rock Mass Rating (RMR), Strength and modulus from classifications, Classification based on strength & modulus and strength and fracture strain, Geoengineering classification.	[12]
Stability of Rock Slopes and Foundations on Rocks: Rock slopes, Modes of failure, Rotational failure, Plane failure, Design charts, Wedge method of analysis, Buckling failure, Toppling failure, Improvement of slope stability and protection. Foundations on Rock: Introduction, Estimation of bearing capacity, Stress distribution, Sliding stability of dam foundations, strengthening measures, Settlements in rocks, Bearing capacity of pile/pier in rock, Remedial measures, Foundations located on edge of jointed slope.	[22]

TEXT BOOKS:

1. Fundamentals of Rock Mechanics by Jaeger, J.C., Cook, N.G.W., Zimmerman, R.W.,
2. Experimental Rock Mechanics by Mogi Kiyoo.

REFERENCE BOOKS:

1. Rock Mechanics and Design of Structures by Obert and Duvall

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9054	Slope Stability and Earth Dams	4-0-0	4	Dr. S Pal

Slope Stability Analysis: Types of Failure: Failure surfaces - Planar surfaces, Circular surfaces, Non-circular surfaces, Limit equilibrium methods, Total stress analysis versus effective Stress analysis, Use of Bishop's pore pressure parameters, Short term and Long term stability in slopes.	[12]
Methods of Slope Stability: Taylor Charts,Effect of Tension Cracks, Vertical Cuts. Bishop's Analysis, Bishop and Morgenstern Analysis, Noncircular Failure Surfaces: Morgenstern and Price Analysis, Janbu Analysis, Sliding Block Analysis,Seismic stability,Stabilization of slopes: Drainage measures, Soil reinforcement (geosynthetics/soil nailing/micro piles etc), soil treatment (cement/lime/thermal treatment), surface protection (vegetation/erosion control mats/shotcrete).	[16]
Earth and Rockfill Dams: General features, Selection of site; Merits and demerits of the earth and rock fill dams, Classification of earth dams, Materials of construction and requirements, Causes of failure, Safe design criteria. Instrumentation in earth dams: Pore pressure measurements, Settlement gauges, Inclinometers, Stress measurements, Seismic measurements.	[16]

TEXT BOOKS:

1. Earth & Rock fill dams – Principles of design and construction by Christian Kutzner
2. Earth and Rock fill dams by Bharat Singh.

REFERENCE BOOKS:

1. Design of small dams by USIBR.

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9055	Reinforced Concrete Structure	4-0-0	4	Dr. K Bhattacharya

Refreshers course on RC Design-Beam, Column, Slab	[8]
Design of Mat foundation(Flexible & Rigid)	[12]
Design of Pile foundation	[8]
Design of sheet pile wall	[8]
Design of retaining wall	[4]
Design of Brace-cut	[4]

TEXT BOOKS:

1. Foundation design by B.M. Das
2. Foundation Engineering by J.E.Bowles

REFERENCE BOOKS:

1. Design of R.C Structure by Mallik & Gupta

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9056	Pavement Analysis and Design	4-0-0	4	Dr. V K Dwivedi

Characterization of Sub-Grade Soil and Mineral Aggregates – Introduction, particle size analysis of sols, soil gradation, moisture content, consistency test of soil, methods of soil classification, composition of soil mass, determination of soil compaction, strength determination of soils, strength properties of mineral aggregates	[8]
Bituminous Materials – Introduction, desirable properties of bitumen, tests on bituminous materials, other binders, engineering properties of bituminous materials, mix design.	[8]
Design of Cement Concrete Mixes for Pavements – Introduction, cement, properties of cement, mineral aggregates, water, admixtures, properties of fresh concrete, test on hardened concerete, design of cement concrete mix, factors considered for durable concrete, the Bureau of Indian Standards Method of Cement Concrete Mix Design, Indian Road Congress Method of Cement Concrete Mix Design (IRC : 44-2008), Dry Lean Cement Concrete (MORTH 201), Concrete Mix Design for Rural Roads (IRC :SP:62-2004)	[8]
Factors Affecting Pavement Design – Types of pavements, factors affecting design of pavements	[4]
Analysis and Design of Flexible Pavements – Stress analysis of flexible pavements, flexible pavement design methods, benefits of pavement design based on M-E method, test roads, design methods of flexible pavements	[4]
Structural Evaluation of Pavements – Purpose, types, and methods of structural evaluation, structural evaluation by static loading, structural evaluation by steady – state Vibratory Loading, structural evaluation by impulse lading, Models of Falling Weight Deflectometer, structural evaluation of flexible pavement using FWD, back calculation of Layer Moduli from FWD Test data, uses of Back-calculated Pavement Layer Moduli, Structural Evaluation of Rigid Pavement using FWD.	[8]
Structural Evaluation of Unbound Granular and Sub-Grade Layers using Dynamic Cone Penetrometer (DCP) – Development of DCP Test, The Dynamic Cone Penetrometer, material testing with DCP, determination of DCP index values, factors affecting DCP test results, correlation of DCP index values with other standard test values, application of DCP test data, limitation of DCP	[8]

TEXT BOOKS:

1. Highway Engineering by R. Srinivas Kumar

REFERENCE BOOKS:

1. Principles of Pavement Engineering by Nick Tom

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9057	Reinforced Earth and Geotextile	4-0-0	4	Dr. S Pal

Introduction to Geosynthetics - Types – Geotextiles - polymer type geotextiles – woven and non-woven geotextiles, geogrids, geo membranes and geocomposites, functions and mechanisms in reinforcement, filtration, drainage, liquid barrier, multiple functions - Materials and manufacturing processes - Mechanical, endurance, hydraulic and degradation properties - Testing and evaluation.	[8]
Principles of soil reinforcement - load transfer mechanism and strength development -Design and construction of geosynthetic reinforced soil retaining structures – walls and slopes, Codal provisions, Soil Bearing capacity improvement using reinforcing elements.	[14]
Geosynthetics in pavements- Advantages and disadvantages of placing geosynthetics in surfacing, base, sub base and sub grade layers, Embankments on soft soils, Geosynthetics in roads and railways, separators, drainage and filtering in road pavements, railway tracks, overlay design and constructions, trench drains .	[8]
Geosynthetics in Environmental control, liners for ponds and canals, covers and liners for landfills, material aspects and stability considerations, landslides - occurrences andmethods of mitigation, Erosion causes, control and construction techniques.	[10]

TEXT BOOKS:

1. Reinforced Soil & it's Engineering Applications by Swami Saran
2. R. A. Jewel, "Soil Reinforcement with Geotextiles

REFERENCE BOOKS:

1. Designing with Geosynthetics by Koerner, R. M

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 9058	Modelling , Simulation & Computer Applications.	4-0-0	4	Dr. S Pal

Systems and Models: Fundamentals of systemic approach, System modelling, Classification of models, Model structure, Linear, non-linear, time-invariant, time variant models, State-space models, Distributed parameter models, System Synthesis, Direct and Inverse Problems, Role of optimization, Role of computers. Examples from Civil Engineering. Preliminary Data Processing; Regression Analysis: Linear and Multiple Regression Analysis, Analysis of Residues, Tests of goodness of fit.	[8]
Parsimony criterion Spatial Distribution: Polynomial surfaces, Krigging, Spline functions, Cluster Analysis, Numerical Production of Contour Maps Time Series Analysis: Auto-cross correlation analysis, Identification of trend, Spectral analysis, Identification of dominant cycles, Smoothening techniques. Filters, Forecasting Model Building: Choice of Model Structure: A priori considerations, Selection	[14]

based upon preliminary data analysis, comparing model structures Model Calibration: Role of historical data. Direct and Indirect methods of solving Inverse problem. **Validation Simulation: Random variables**: Basic concepts, Probability density and distribution functions, Expectation and standard deviation of discrete and continuous random variables and their functions, Covariance and correlation. [8] Commonly used theoretical Probability distributions (uniform, normal, binomial, Poisson's and negative exponential), Fitting distributions to raw data, Kolmogrov-Smirnov's tests of the goodness of fit, central limit theorem, various algorithms for generation of Random numbers. Queueing theory: Elements, Deterministic queues, Applications Monte Carlo simulation: Basic concepts, Generation of synthetic observations. Statistical interpretation of the output, Evaluation of definite integrals, Role in Civil Engineering, Examples. [10]	
TEXT BOOKS: 1. Numerical Methods on Geotechnical Engineering by Desai, C.S. and Christian, J.T	
REFERENCE BOOKS: 1. Numerical Methods by Hornbeck, R.W. 2. Monte Carlo statistical methods by Christian P. R., George C	

Sub Discipline: LABORATORY & SESSIONAL COURSES

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 1061	Geotechnical Lab-I	0-0-4	2	Dr. S Pal

Laboratory tests: Tri-axial test, Consolidation test, CBR test, Light and heavy compaction test, Swelling index and swelling pressure test, Field density test.	[40]
TEXT BOOKS: 1. Basic and applied Soil Mechanics by Gopal Ranjan and A. S. R. Rao 2. Geotechnical laboratory measurements for Engineers by John T. Germaine and Amy V. Germaine.	
REFERENCE BOOKS: 1. SP 36 (Part I) 1987 Compendium of Indian Standards on soil Engineering: Part I Laboratory testing of soils for civil engineering purposes. 2. Departmental Geotechnical Lab Manual	

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 1062	Computational Lab.	0-0-4	2	Dr. K Bhattacharya

Analysis of frame 2D & 3D	[8]
Plane frame on soil structure(Plane stress)	[4]
Retaining wall on soil structure(Plane strain)	[4]
Consolidation problem 2D	[8]
3D frame analysis	[4]
Eigen value analysis & SSI	[4]
MODAL Method (spectral) of 2D frame	[8]
TEXT BOOKS: 1. Documentation of ABAQUS	

SUBJECT CODE	SUBJECT	L-T-P	CREDIT	DEVELOPER
CE 2061	Geotechnical Lab-II	0-0-4	2	Dr. S Pal

Laboratory tests: Determination of porosity of soil, Hydraulic conductivity (vertical and horizontal direction), Adsorption test in soil (Batch test, column test, kinetic reaction studies), pH test, pHzpc, Organic carbon determination of soil.	[40]

TEXT BOOKS:

1. Geo Environmental Engineering : Site Remediation, Waste containment, and Emerging Waste Management Technologies by Sharma HD and Reddy KR

REFERENCE BOOKS:

1. SP 36 (Part I) 1987 Compendium of Indian Standards on soil Engineering: Part I Laboratory Testing of soils for civil engineering purposes.

2. Departmental geotechnical lab manual