EVALUATION SCHEME
&
SYLLABI

FOR

MASTER OF TECHNOLOGY

In

CIVIL ENGINEERING
(Geotechnology)

(Effective from the Session 2021-2022)

Offered by

Department of Civil Engineering
G. B. Pant Institute of Engineering and Technology
Ghurdauri, Pauri Garhwal, U.K. 246194

EVALUATION SCHEME
B.TECH. (Civil Engineering)
I- Year (I-SEMESTER)
(Effective from session: 2021-2022)

S. No.	Course Code	SUBJECT	PERIODS			EVALUATION SCHEME					
						Sessional Exam			ESE	Subject Total	Credits
			L	T	P	CT	TA	Total			
THEORY											
1	TCG 511	Advanced Soil Mechanics	3	1	0	30	20	50	100	150	3
2	TCG 512	Soil Dynamics	3	1	0	30	20	50	100	150	3
3	ECG 51X	Elective I	3	1	0	30	20	50	100	150	3
4	ECG 51X	Elective II	3	1	0	30	20	50	100	150	3
5	TAH 511	Research Methodology and IPR	2	0	0	30	20	50	100	150	2
6	TAH 51X	Audit Course I	2	0	0	30	20	50	100	150	0
PRACTICALS											
7	PCG 511	Advanced Soil Mechanics Lab	0	0	2	10	15	25	25	50	2
8	PCG 512	Soil Dynamics Lab	0	0	2	10	15	25	25	50	2
9	GPP 511	General Proficiency	0	0	0	0	50	50	0	50	0
SEMESTER TOTAL			**16**	**4**	**4**	**200**	**200**	**400**	**650**	**1050**	**18**

ELECTIVE I
ECG 511 Ground Improvement Techniques
ECG 512 Pavement Analysis and Design
ECG 513 Soil Structure Interaction

ELECTIVE II
ECG 514 Computational Geomechanics
ECG 515 Critical Soil Mechanics
ECG 516 FEM in Geomechanics

AUDIT COURSE I
TAH 514 Constitution of India
TAH 515 English for Research Paper Writing

EVALUATION SCHEME
B.TECH. (Civil Engineering)
I- Year (II-SEMESTER)
(Effective from session: 2021-2022)

S. No.	Course Code	SUBJECT	PERIODS			EVALUATION SCHEME					
						Sessional Exam			ESE	Subject Total	Credits
			L	T	P	CT	TA	Total			
THEORY											
1	TCG 521	Advanced Foundation Engineering	3	1	0	30	20	50	100	150	3
2	TCG 522	Subsurface Investigation and Instrumentation	3	1	0	30	20	50	100	150	3
3	ECG 52X	Elective III	3	1	0	30	20	50	100	150	3
4	ECG 52X	Elective IV	3	1	0	30	20	50	100	150	3
5	TAH 52X	Audit Course II	2	0	0	30	20	50	100	150	0
PRACTICALS											
6	PCG 521	Advanced Foundation Engineering Lab	0	0	2	10	15	25	25	50	2
7	PCG 522	Subsurface Investigation and Instrumentation Lab	0	0	2	10	15	25	25	50	2
8	PCG 523	Mini Project with Seminar	0	0	2	10	15	25	25	50	2
9	GPP 521	General Proficiency	0	0	0	0	50	50	0	50	0
SEMESTER TOTAL			**14**	**4**	**6**	**180**	**195**	**375**	**575**	**950**	**18**

ELECTIVE III
ECG 521 Engineering Rock Mechanics
ECG 522 Environmental Geotechnology
ECG 523 Marine Geotechniques

ELECTIVE IV
ECG 524 Constitutive Modelling in Geomechanics
ECG 525 Design of Underground Excavations
ECG 526 Earth Retaining Structures

AUDIT COURSE II
TAH 522 Disaster Management
TAH 526 Pedagogy
TAH 527 Stress Management by Yoga
TAH 528 Personality Development through Life Enlightenment Skills

EVALUATION SCHEME
B.TECH. (Civil Engineering)
Second- Year (III-SEMESTER)
(Effective from session: 2022-2023)

S. No.	Course Code	SUBJECT	PERIODS			EVALUATION SCHEME					
						Sessional Exam			ESE	Subject Total	Credits
			L	T	P	CT	TA	Total			
THEORY											
1	ECG 63X	Elective V	3	1	0	30	20	50	100	150	3
2	TOE 63X	Open Elective	3	0	0	30	20	50	100	150	3
PRACTICALS											
3	PCG 631	Dissertation Stage I	0	0	20	0	250	250	250	500	10
4	GPP 631	General Proficiency	0	0	0	0	50	50	0	50	0
SEMESTER TOTAL			**6**	**1**	**20**	**60**	**340**	**400**	**450**	**850**	**16**

ELECTIVE V
ECG 631 Foundations on Weak Rocks
ECG 632 Machine Foundation
ECG 633 Stability Analysis of Slopes

OPEN ELECTIVES
TOE 631 Business Analytics
TOE 632 Industrial Safety
TOE 633 Operations Research
TOE 634 Cost Management of Engineering Projects
TOE 635 Composite Materials
TOE 636 Waste to Energy

EVALUATION SCHEME
B.TECH. (Civil Engineering)
Second- Year (IV-SEMESTER)
(Effective from session: 2022-2023)

S. No.	Course Code	SUBJECT	PERIODS			EVALUATION SCHEME					
						Sessional Exam			ESE	Subject Total	Credits
			L	T	P	CT	TA	Total			
PRACTICALS											
1	PCG 641	Dissertation Final Stage	0	0	32	0	400	400	400	800	16
2	GPP 641	General Proficiency	0	0	0	0	50	50	0	50	0
SEMESTER TOTAL			**0**	**0**	**32**	**0**	**450**	**450**	**400**	**850**	**16**

Unit 1: Compressibility of soils: consolidation theory (one-, two-, and three-dimensional consolidation theories), consolidation in layered soil and consolidation for time dependent loading, determination of coefficient of consolidation (Casagrande method and Taylor's method)

Unit 2: Strength behavior of soils; Mohr Circle of Stress; UU, CU, CD tests, drained and undrained behavior of sand and clay, significance of pore pressure parameters; determination of shear strength of soil; Interpretation of triaxial test results.

Unit 3: Stress path; Drained and undrained stress path; Stress path with respect to different

initial state of the soil; Stress path for different practical situations.

Unit 4: Critical state soil mechanics; Critical state parameters; Critical state for normally, consolidated and over consolidated soil; Significance of Roscoe and Hvorslev state boundary surface; drained and undrained plane. critical void ratio; effect of dilation in sands; different dilation models.

Unit 5: Elastic and plastic deformations: elastic wall; introduction to yielding and hardening; yield curve and yield surface, associated and non-associated flow rule.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Know about the theory of elasticity and its application in Soil Mechanics.
2. Get a detailed idea about the pore water pressure due to undrained loading and seepage.
3. Get detailed information about consolidation in soil media.
4. Get a clear idea about shear stress and stress paths.
5. Understand the concept of Critical State Soil mechanics.

TEXT/REFERENCE BOOKS:

1. Das, Braja, M., "Advanced Soil Mechanics", Taylor & Francis, 1983
2. Lambe, T. William and Whitman, Robert V., "Soil Mechanics", John Wiley, 2000
3. Craig, R.F., "Soil Mechanics", Chapman & Hall, 1993
4. Atkinson J.H, "An introduction to the Mechanics of soils and Foundation", McGraw- Hill Co., 1993.
5. Terzaghi, K. and Peck, R.B., "Soil Mechanics in Engineering Practice", John Wiley, 1967
6. Davis, R.O. and Selvadurai, E.P.S. "Elasticity and Geomechanics", Cambridge University Press, 1995.

UNIT 1: Introduction: Background and lessons learnt from damages in past earthquakes, Internal Structure of the Earth, Continental Drift and Plate Tectonics, Elastic Rebound Theory, Geometric Notation, Location of Earthquakes, Size of Earthquakes.

UNIT 2: Wave Propagation: Waves in unbounded media in one- and three-dimensional wave propagation; Waves in semi-infinite media; Waves in a layered medium; Attenuation of stress waves - material and radiation damping.

UNIT 3: **Dynamic Soil Properties:** Stress & strain conditions, concept of stress path, Measurement of seismic response of soil at low and high strain; Field tests - Seismic reflection, Seismic refraction, Steady-state vibration (Rayleigh Wave) test, Standard penetration test; Laboratory tests- Shaking table, Centrifuge tests and determination of soil-spring constant - cyclic plate load and block vibration test; Stress-strain behaviour of cyclically loaded soils; Evaluation of damping and shear modulus; Effect of strain level on the dynamic soil properties.

UNIT 4: **Ground Response Analysis:** Introduction, one dimensional GRA-linear approach, Equivalent linear approximation of nonlinear response, Introduction of two and three dimensional GRA, Introduction to soil-structure interaction.

UNIT 5: **Liquefaction:** Introduction, liquefaction related phenomena – flow liquefaction and cyclic mobility, Factors affecting liquefaction, liquefaction susceptibility; historical criteria, geological criteria, compositional criteria, State Criteria; Evaluation of liquefaction potential, cyclic stress ratio, cyclic resistance ratio, Effects of liquefaction.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Understand the causes and quantification of earthquake.
2. Assess properties of soil effected by seismic wave propagation.
3. Design Ground Motion at a Site and Dynamic Response Analysis.
4. Determine the dynamic soil properties using various field tests (standard penetration test, plate load test, block vibration test, SASW/MASW tests. etc).
5. Evaluate soil liquefaction potential.

TEXT/REFERENCE BOOKS:

1. Ranjan G. and Rao A.S.R., “Basic and Applied Soil Mechanics”, New Age Int. Ltd., New Delhi., 2000.
2. Kameshwara Rao, N.S.V, “Dynamic Soil Tests & Applications”, Wheeler Publications, New Delhi., 2000.
3. Day Robert W., “Geotechnical Earthquake Engineering Handbook”, McGraw-Hill, New York., 2001.
4. Kramer S.L., “Geotechnical-Earthquake Engineering”, Pearson Education – Indian Low-Price Edition, Delhi., 2004.
5. Saran S. “Soil Dynamics & Machine Foundation”, Galgotia Pub. Pvt. Ltd, New Delhi., 2006.

Unit 1: Introduction: situations where ground improvement becomes necessary

Unit 2: Mechanical modification: dynamic compaction, impact loading, compaction by blasting, vibro-compaction; pre-compression, stone columns; Hydraulic modification: dewatering systems, preloading and vertical drains, electro-kinetic dewatering

Unit 3: Chemical modification; modification by admixtures, stabilization using industrial wastes, grouting

Unit 4: Soil reinforcement: Reinforced earth, basic mechanism, type of reinforcements, selection of stabilization/improvement of ground using Geotextiles, Goegrid, geomembranes, geocells, geonets, and soil nails.

Unit 5: Application of soil reinforcement: shallow foundations on reinforced earth, design of reinforced earth retaining walls, reinforced earth embankments structures, wall with reinforced backfill, analysis and design of shallow foundations on reinforced earth, road designs with geosynthetics

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Identify the necessity of ground improvement.
2. Understand the different types of ground modification can be done depending upon the site condition, type and purpose of structure to be constructed.
3. Understand the functions of geosynthetics and soil nailing in engineering constructions.

TEXT/REFERENCE BOOKS:

1. Hausmann, M.R., “Engineering Principles of Ground Modification”, McGraw-Hill International Editions, 1990.
2. Yonekura, R., Terashi, M. and Shibazaki, M. (Eds.), “Grouting and Deep Mixing”, A.A. Balkema, 1966.
3. Moseley, M.P., “Ground Improvement”, Blackie Academic & Professional, 1993.
4. Xanthakos, P.P., Abramson, L.W. and Bruce, D.A., “Ground Control and Improvement”, John Wiley & Sons, 1994.
5. Koerner, R. M., “Designing with Geosynthetics”, Prentice Hall Inc. 1998.
6. Shukla, S.K., Yin, Jian-Hua, “Fundamentals of Geosynthetic Engineering”, Taylor & Francis.

Unit 1: Philosophy of design of flexible and rigid pavements

Unit 2: analysis of pavements using different analytical methods

Unit 3: selection of pavement design input parameters – traffic loading and volume

Unit 4: material characterization, drainage, failure criteria, reliability, design of flexible and rigid pavements using different methods

Unit 5: comparison of different pavement design approaches, design of overlays and drainage

system.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

4. Design flexible as well rigid pavements.
5. Appreciate the functions of various components of a pavement.
6. Identify the factors affecting design of pavements.
7. Evaluate performance of pavement and design the overlay on flexible and rigid pavement.

TEXT/REFERENCE BOOKS:

1. Yang and 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.

Unit 1: Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behavior, Time dependent behavior.

Unit 2: Beam on Elastic Foundation- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to

their stiffness.

Unit 3: Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.

Unit 4: Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

Unit 5: Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts. An introduction to soil-foundation interaction under dynamic loads.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Apply different soil response models for specific problem based on the requirement.
2. Analyse footings/rafts resting on soil as beams/plates on elastic foundation and work out design bending moments/shear and displacements.
3. Compute pile response for various loading condition for design purpose.

TEXT/REFERENCE BOOKS:

1. Selvadurai, A.P.S, “Elastic Analysis of Soil-Foundation Interaction”, Elsevier, 1979.
2. Poulos, H.G., and Davis, E.H., “Pile Foundation Analysis and Design”, John Wiley,1980.
3. Scott, R.F., “Foundation Analysis”, Prentice Hall, 1981.
4. Structure Soil Interaction - State of Art Report, Institution of Structural Engineers, 1978.
5. ACI 336. (1988), “Suggested Analysis and Design Procedures for combined footings and Mats”, American Concrete Institute.

Unit 1: Solution of Linear & Non-linear Equations: Bisection, False Position, Newton-Raphson, Successive approximation method, Iterative methods. Jacobi's method, Gauss Seidal method, Successive over relaxation method.

Unit 2: Finite Difference and Finite Element Method: Two-point Boundary value problems – Disichlet conditions, Neumann conditions; ordinary and partial differential equations, Fundamentals, Constitutive finite element models for soils.

Unit 3: Correlation and Regression Analysis: Correlation - Scatter diagram, Karl Pearson coefficient of correlation, Limits of correlation coefficient; Regression –Lines of regression, Regression curves, Regression coefficient, Differences between correlation and regression analysis.

Unit 4: One-dimensional Consolidation - Theory of consolidation, Analytical procedures, Finite difference solution procedure for multilayered systems, Finite element formulation,

Unit 5: Flow Through Porous Media & Risk Assesment- Geotechnical aspects, Numerical methods, Applications and Design analysis, Flow in jointed media. Probabilistic site characterisation and design of foundations

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Understand different numerical and statistical tools for analyzing various geotechnical engineering problems.
2. Apply probabilistic approach for selection of design parameters and compute their impact on risk assessment.

TEXT/REFERENCE BOOKS:

1. S. Chandrakant., Desai and John T. Christian, "Numerical Methods in Geotechnical Engineering", Mc. Graw Hill Book Company, 1977.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering computations", Third edition, New Age International (P) Ltd. Publishers, New Delhi.
3. D.J. Naylor and G.N. Pande, "Finite Elements in Geotechnical Engineering", Pineridge Press Ltd., UK.
4. Sam Helwany, "Applied soil mechanics", John Wiley & sons, Inc.

Unit 1: Soil Behaviour: State of stress and strain in soils, Stress and strain paths and invariants, behaviour of soils under different laboratory experiments.

Unit 2: The Critical state line and the Roscoe surface: Families of undrained tests, Families of drained tests, the critical state line, drained and undrained surfaces, The Roscoe surface.

Unit 3: Behaviour of Over consolidated samples: The Hvorslev surface: Behaviour of over consolidated samples, drained and undrained tests, The Hvorslev surface, complete State Boundary Surface, Volume changes and pore water pressure changes.

Unit 4: Behaviour of Sands: The critical state line for sands, Normalized plots, the effect of dilation, Consequences of Taylor's model.

Unit 5: Behaviour of Soils before Failure: Elastic and plastic deformations, Plasticity theory, Development of elastic-plastic model based on critical state soil mechanics, The Cam-clay model, The modified Cam-clay model

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Appreciate the stress-stain relationships for soils.
2. Decide the type of mathematical models to be used for analyzing the behavior of soil mass at critical state.

TEXT/REFERENCE BOOKS:

1. J. H. Atkinson and P. L. Bransby, "The mechanics of soils: An introduction to critical state soil mechanics", McGraw Hill, 1978.
2. D. M. Wood, "Soil behaviour and critical state soil mechanics", Cambridge University Press, 1990.
3. B. M. Das, "Fundamental of geotechnical engineering", Cengage Learning, 2013.

Unit 1: Stress-deformation analysis- One dimensional, two dimensional and three-dimensional formulations.

Unit 2: Discretization of a Continuum- Elements, Strains, Stresses, Constitutive, Relations, Hooke's Law, Formulation of Stiffness Matrix, Boundary Conditions.

Unit 3: Principles of discretization- element stiffness and mass formulation based on direct, variational and weighted residual techniques and displacements approach, Shape functions and numerical integrations, convergence.

Unit 4: Displacement formulation- for rectangular, triangular and iso-parametric elements for two dimensional and axisymmetric stress analyses.

Unit 5: Settlement Analysis- 2-D elastic solutions for homogeneous, isotropic medium, Steady Seepage Analysis: Finite element solutions of Laplace's equation, Consolidation Analysis: Terzaghi consolidation problem, Choice of Soil Properties for Finite Element Analysis

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Understand the fundamentals of Finite element method.
2. Impart the knowledge and skill of analysing physical problems with FE software.
3. Understand the basic functions of FE based software and its applications in geotechnical engineering.
4. Select the appropriate element and mesh for FE analysis for given problem.
5. Evaluate the type of problem and develop the FE-model.
6. Estimate the stresses and strain in soil through FE analysis for given physical problem.

TEXT/REFERENCE BOOKS:

1. Zienkiewicz O.C. and Taylor R.L., "Finite element methods (Vol I & Vol II)", McGraw Hill.
2. Bathe K.J., "Finite element procedures", PHI Ltd.
3. Potts D.M. and Zdravkovic L., "Finite Element Analysis in Geotechnical Engineering", Thomas Telford.
4. Chandrupatla, R.T. & Belegundu, A.D., "Introduction to Finite Elements in Engineering".

EXPERIMENTS:

1. Determination of Moisture Content and Specific gravity of soil
2. Grain Size Distribution Analysis and Hydrometer Analysis
3. Atterberg Limits (Liquid Limit, Plastic limit, Shrinkage limit)
4. Visual Classification Tests
5. Vibration test for relative density of sand
6. Standard and modified proctor compaction test
7. Falling head permeability test and Constant head permeability test
8. Consolidation test

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Understand the procedure for classifying coarse grained and fine-grained soils.
2. Evaluate the index properties of soil.
3. Determine the engineering properties of soil.
4. Interpret the results of compaction test for relative compaction in the field
5. Conduct experiments analyze and interpret results for geotechnical engineering design.
6. Compute and analyze the consolidation settlements.

TEXT/REFERENCE BOOKS:

1. B.C. Punmia, “Soil Mechanics and Foundations” Laxmi Publications (P) Ltd.
2. V.N.S. Murthy, “Soil Mechanics and Foundation Engineering” CBS Publishers & Distributors Pvt. Ltd.
3. C. Venkatramaiah, “Geotechnical Engineering” New Age International Publishers

EXPERIMENTS:

1. Spectral analysis of surface waves (SASW) Test / Multi-channel analysis of surface waves (MASW) test
2. Seismic cross-hole test
3. Seismic down-hole / up-hole test
4. Seismic dilatometer test
5. Resonant column test
6. Piezoelectric bender element test
7. Cyclic triaxial test
8. Cyclic direct shear test

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Calculate the dynamic properties of soils using laboratory and field tests.
2. Determine shear strength of soil using cyclic triaxial test and cyclic direct shear test.

TEXT/REFERENCE BOOKS:

1. Steven Kramer, “Geotechnical Earthquake Engineering”, Pearson, 2008.
2. Prakash, S., “Soil Dynamics”, McGraw Hill, 1981.
3. Saran S. “Soil Dynamics & Machine Foundation”, Galgotia Pub. Pvt. Ltd, New Delhi, 2006.
4. Kameshwara Rao, N.S.V, “Dynamic Soil Tests & Applications”, Wheeler Publications, New Delhi. 2000.

Unit 1: Planning of soil exploration for different projects, methods of subsurface exploration,

methods of borings along with various penetration tests

Unit 2: Shallow foundations, requirements for satisfactory performance of foundations, methods of estimating bearing capacity, settlements of footings and rafts, proportioning of foundations using field test data, IS codes.

Unit 3: Pile foundations, methods of estimating load transfer of piles, settlements of pile foundations, pile group capacity and settlement, negative skin friction of piles, laterally loaded piles, pile load tests, analytical estimation of load- settlement behavior of piles, proportioning of pile foundations, lateral and uplift capacity of piles.

Unit 4: Well foundation, IS and IRC Codal provisions, elastic theory and ultimate resistance methods

Unit 5: Foundations on problematic soils: Foundations for collapsible and expansive soil.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Determine the earth pressures on foundations and retaining structures.
2. Analyze shallow and deep foundations.
3. Calculate the bearing capacity of soils and foundation settlements.

TEXT/REFERENCE BOOKS:

1. Bowles. J.E., “Foundation Analysis and Design”, Tata McGraw-Hill International Edition, 5th Edn, 1997.
2. Das B.M., “Shallow Foundations: Bearing capacity and settlement”, CRC Press, 1999.
3. Tomlinson M.J., “Pile design and construction Practice”, Chapman and Hall Publication, 1994.
4. Poulos, H. G. and Davis, F. H., “Pile Foundation Analysis and Design”, Wiley and Sons.

Unit –I Introduction to Soil Exploration: Objectives of Site Investigation, Phases of investigation, Classification, Planning for Subsurface Exploration, Fact finding and Geological survey, Reconnaissance, Preliminary Exploration, Detailed Exploration, Codal Provisions

Unit –II Methods of investigations and Sampling: Trial pits/Trenches, Borings/drilling, Auger boring, Wash boring, Percussion drilling, Rotary drilling, Sample Disturbance, Disturbed Sample, Undisturbed Samples, Sampling by standard split spoon, Sampling by thin-wall tube, Sampling by Piston sampler

Unit-III Geotechnical investigation (Semi-direct methods): Vane Shear test, Standard Penetration Test, Pressuremeter Test, Cone Penetration Test, Dilatometer test, Rock core drilling, Sampling of rock, Core stacking, Rock Quality Designation (RQD), Total Core Recovery (TCR)

Unit –IV Geophysical Tests (Indirect methods): Seismic reflection survey, Seismic refraction survey, Electrical resistivity Survey, Applications, Advantages, Disadvantages and Limitations

Unit-V Soil Exploration Report and Field Instrumentation: Components of Soil Exploration Report, Drafting of Reports, Graphic Presentations of Bore Log, Study of Sample Reports, Field Instrumentation: Pressure meters, Piezometer, Pressure cells, Sensors, Inclinometers, Strain gauges etc.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Describe the phases of soil investigation in depth and identify the plan for soil investigation.
2. Identify various methods of soil investigation and soil sampling.
3. Illustrate various field test of soils and rocks.
4. Examine components of soil exploration report and estimate properties using correlations.
5. Work with relevant instrumentation required for characterizing the soil.

TEXT/REFERENCE BOOKS:

1. Braja M. Das, “Principles of Geotechnical Engineering” Cengage.
2. Rajan & Rao, “Basic and applied Soil Mechanics”, New Age International Publishers.
3. Micheal Carter and Stephen P. Bentley “Soil Properties and their correlations”, Wiley Publications.
4. Latest version of relevant IS codes for various tests.

Unit 1: Physical Properties and Classification- Types of rocks and their formations; Distribution of Rocks in Indian Mainland; Laboratory Testing of Rocks; Strength, Modulus and Stress-Strain Response of Rocks; Engineering Classification of Rocks

Unit 2: In-situ Stress Conditions- In-situ stresses; Deformability tests in rock mass; Field shear test; Hydrofracturing technique, Flat jack technique; Estimation of Stresses in Rock Mass; Underground opening in infinite medium, Elastic and Elasto-Plastic approach. Stress concentration for different shapes of opening, Zone of influence.

Unit 3: Failure Criteria- Failure criteria for rock and rock masses; Mohr-Coulomb Yield Criterion, Drucker-Prager Criterion, Hoek-Brown Criterion, Tensile Yield Criterion; Strength and deformability of jointed rock mass; Fracture strength of jointed rock mass; Shear strength of Rock joints, Deformability of Rock joints, Concept of joint compliance.

Unit 4: Slopes and Foundations in Rocks- Stability of rock slopes, Modes of failure, Plane failure, Wedge failure, Circular failure, Toppling failure. Foundation on rocks, Estimation of bearing capacity, Stress distribution in rocks, Settlement in rocks, Pile foundation in rocks.

Unit 5: Excavation methods and Design of Support- Drilling and Blasting for Underground and Open Excavation; Stages of Excavation; TBM; Methods to improve rock mass responses.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Comment upon the behaviour of in-situ stresses.
2. Interpret different failure criteria.
3. Describe the laboratory investigation of shear strength of rock joints.
4. Analyse the stability of slopes in rocks.
5. Propose foundation on rocks.
6. Explain the underground excavation methods.
7. Select support system for excavation in rocks.

TEXT/REFERENCE BOOKS:

1. R. E. Goodman, “Introduction to Rock Mechanics”, John Wiley & Sons.
2. T. Ramamurthy, “Engineering in Rocks for Slopes, Foundation and Tunnels”, Editor Prentice Hall India Pvt. Ltd.
3. Jaeger, Cook and Zimmerman, “Fundamentals of Rock Mechanics”, Fourth Edition, Blackwell Publishing.
4. L. Obert and Wilbur I. Duvall, “Rock mechanics and the design of structures in rock”, John Wiley & Sons, Inc
5. J. A. Hudson and J. P. Harrison, “Engineering Rock Mechanics: An Introduction to the Principles”.
6. John Conrad Jaeger, Neville G. W. Cook, Robert Zimmerman, “Fundamentals of Rock Mechanics”, 4th Edition.

Unit 1: Soil as a Multiphase System- Soil-environment interaction; Properties of water in relation to the porous media; Water cycle with special reference to soil medium.

Unit 2: Soil Mineralogy- significance of mineralogy in determining soil behaviour; Mineralogical characterization.

Unit 3: Mechanisms of Soil-Water Interaction- Diffuse double layer models; Force of attraction and repulsion; Soil-water-contaminant interaction; Theories of ion exchange; Influence of organic and inorganic chemical interaction.

Unit 4: Concepts of Waste Containment- Sources, production and classification of wastes, Environmental laws and regulations, physico-chemical properties of soil, ground water flow and contaminant transport, desirable properties of soil; contaminant transport and retention; contaminated site remediation.

Unit 5: Soil Characterization Techniques- volumetric water content; gas permeation in soil; electrical and thermal properties; pore-size distribution; contaminant analysis. contaminated site characterization, estimation of landfill quantities, landfill site location, design of various landfill components such as liners, covers, leachate collection and removal, gas generation and management, ground water monitoring, end uses of landfill sites, slurry walls and barrier systems, design and construction, stability, compatibility and performance, remediation technologies, stabilization of contaminated soils and risk assessment approaches.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Understand soil environment interaction, composition, soil structure and its behaviour.
2. Specify site investigation techniques for characteristics of contaminated site.
3. Identify contaminant transport mechanisms in soils.
4. Specify site investigation techniques for characterization of contaminated site
5. Understand the principles of soil treatment techniques
6. Identify contaminants transport mechanism in soil.

TEXT/REFERENCE BOOKS:

1. Mitchell J.K and Soga K., “Fundamentals of Soil Behavior”, John Wiley and Sons Inc.
2. Fang H-Y., “Introduction to Environmental Geotechnology”, CRC Press
3. Daniel D.E, “Geotechnical Practice for Waste Disposal”, Chapman and Hall
4. Rowe R.K., Quigley R.M. and Booker J.R., “Clayey Barrier Systems for Waste Disposal Facilities”, CRC Press
5. Rowe R.K, “Geotechnical and Geo-environmental Engineering Handbook”, Kluwer Academic Publishers
6. Reddi L.N. and Inyang H.F, “Geo-environmental Engineering - Principles and Applications”, Marcel Dekker Inc.
7. Sharma H.D. and Lewis S.P, “Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation”, John Wiley & Sons Inc.

Unit 1: Marine soil deposits: Offshore environment, Offshore structures and foundations, Specific problems related to marine soil deposits, Physical and engineering properties of marine soils

Unit 2: Behavior of soils subjected to repeated loading: Effect of wave loading on offshore foundations, Behavior of sands and clays under cyclic loading, Laboratory experiments including repeated loading, Cyclic behavior of soils based on fundamental theory of mechanics, Approximate engineering methods which can be used for practical cases.

Unit 3: Site Investigation in the case of marine soil deposits: Challenges of site investigation in marine environment, Different site investigation techniques, sampling techniques, Geophysical methods, Recent advancements in site investigation and sampling used for marine soil deposits.

Unit 4: Foundations in marine soil deposits: Different offshore and nearshore foundations, Gravity platforms, Jack-up rigs, pile foundations. cassions, spudcans.

Unit 5: Numerical modeling of marine foundations subjected to wave loading: Numerical modeling of cyclic behavior of soils, empirical models, elastic-plastic models, FEM analysis of marine foundations subjected to wave loading

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Analyze distribution of marine sediments along the Indian coasts.
2. Analyze geotechnical challenges in case of marine sediments.
3. Implement in-situ testing procedures for determining the properties of marine clays.
4. Analyze behavior of marine soil deposits under repetitive loading conditions.

TEXT/REFERENCE BOOKS:

1. H. G. Poulos. “Marine Geotechnics”, Unwin Hyman Ltd, London, UK, 1988
2. D. V. Reddy and M. Arockiasamy, “Offshore Structures*”, Volume: 1,* R.E. Kreiger Pub and Co., 1991
3. D. Thomson and D. J. Beasley, “Handbook of Marine Geotechnical Engineering”, US Navy, 2012

Unit 1: Introduction to Constitutive Modelling- Importance of laboratory testing with relation to constitutive modelling; Stress/strain relationships, Elasticity: linear, quasi linear, anisotropic behaviour.

Unit 2: Simple Constitutive Models- Mohr-Coulomb models, Review s-t, p-q spaces, Introduction to critical state framework (with examples) with effects of pre-consolidation pressures and drained/undrained loading

Unit 3: Modelling Aspects- Work done / energy balances, Plasticity, Normality rules and yield surfaces, Compare models with observed soil behaviours.

Unit 4: Extended Constitutive Models- Cam-clay models, Simulation of single element test using Cam-clay.

Unit 5: Work Hardening Plasticity Theory- Formulation and implementation; Applications of elasto-plastic models; Special Topics: hypo elasticity-plasticity, disturbed state concept.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Summarise and compare the main features and uses of a constitutive model.
2. Select and justify parameters to be used in a constitutive model.
3. Implement constitutive modelling to assess the stability of a geotechnical structure.

TEXT/REFERENCE BOOKS:

1. Hicher & Shao, “Constitutive Modelling of Soils and Rocks”, John Wiley and Sons.
2. C. S. Desai, “Mechanics of Materials and Interfaces”, CRC press.

Unit 1: Introduction, planning of and exploration for various underground construction projects, stereographic projection method, principle and its application in underground excavation design.

Unit 2: Elastic stress distribution around tunnels, stress distribution for different shapes and under different in-situ stress conditions, Greenspan method, design principles, multiple openings, openings in laminated rocks, elasto-plastic analysis of tunnels, Daemen's theory.

Unit 3: Application of rock mass classification systems, ground conditions in tunneling, analysis of underground openings in squeezing and swelling ground, empirical methods, estimation of elastic modulus and modulus of deformation of rocks; uniaxial jacking / plate jacking tests, radial jacking and Goodman jacking tests, long term behaviour of tunnels and caverns, New Austrian Tunneling Method (NATM), Norwegian Tunneling Method (NTM), construction dewatering.

Unit 4: Rock mass-tunnel support interaction analysis, ground response and support reaction curves, Ladanyi'selasto-plastic analysis of tunnels, design of various support systems including concrete and shotcrete linings, steel sets, rock bolting and rock anchoring, combined support systems, estimation of load carrying capacity of rock bolts

Unit 5: In-situ stress, flat jack, hydraulic fracturing and over coring techniques and USBM type drill hole deformation gauge, single and multi-point bore hole extensometers, load cells, pressure cells, etc. Instrumentation and monitoring of underground excavations, during and after construction, various case studies.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

1. Understand the use of elastic and plastic analysis in the design of underground support system.
2. Know about the field tests generally conducted during and after construction of under structures.

TEXT/REFERENCE BOOKS:

1. Hoek, E and and Brown, E. T.," Underground Excavations in Rocks", Institute of Mining Engineering.
2. Obert, L. and Duvall, W.I., "Rock Mechanics and Design of Structures in Rocks", John Wiley.
3. Singh, B. and Goel, R.K.,"Rock Mass Classification- A Practical Engineering Approach", Elsevier.
4. Singh, B. and Goel, R.K., "Tunnelling in Weak Rocks", Elsevier

Unit 1: Earth Pressure- Introduction to earth pressure – basic concepts, Earth Pressure Types, Rankine's theory, backfill features – soil type, surface inclination, loads on surface, soil layers, water level, Coulomb's theory, Effects due to wall friction and wall inclination, Graphical methods and their interpretations.

Unit 2: Earth Retaining Structures- Types of earth retaining structures, Rigid Retaining Structures, Types, Empirical methods and Stability analysis. Flexible Retaining Structures, Types, Material, Design specifications and pressure distribution variations.

Unit 3: Sheet Piles and Bulkheads- Sheet Piles and Bulkheads in Granular and Cohesive Soils - Materials Used for Sheet Piles – Free Earth and Fixed Earth Support Methods, Cantilever sheet piles, Anchored bulkheads, moment reduction factors, anchorage, Braced Excavation Types, Construction methods, Pressure distribution in sands and clays.

Unit 4: Seepage Analysis- seepage control in embankments and foundations, seepage analysis, stability analysis: upstream and down-stream for steady seepage, rapid draw down, end of construction, method of slices and Bishop's method, Coffer dams: Braced coffer dams – walls and supports, bottom heave and piping, Arching in Soils - Soil Pressures on Braced Walls and their Design.

Unit 5: Slope Protection and Geo-synthetics- Slope protection, filters, embankment construction materials and construction, quality control, grouting techniques. Instrumentation and performance observations in earth dams, Drum- debris walls, Classification of Geo-synthetics, Functions and applications, Properties of Geo-textiles, Geo-grids and Geo-membranes.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

1. Analyze the earth retaining structures for their stability against earth pressure.
2. Apply engineering knowledge for the designing of earth retaining structures in various site conditions.
3. Evaluation of retaining structures using appropriate design methods, factors of safety, earth pressure diagrams and check their stability.
4. Determine the required depth of penetration and embedment of free and fixed sheet pile walls in cohesion and cohesionless soils.
5. Evaluate anchored sheet pile walls in free and fixed earth support conditions, spacing between bulkheads and anchors, resistance of anchor plates.

TEXT/REFERENCE BOOKS:

1. Terzaghi, K., "Theoretical Soil Mechanics", John Wiley, 1965
2. Bowles, J.W., "Analysis and Design of Foundations", McGraw-Hill, 4th and 5th Ed. 1996
3. Lambe, T.W. and Whitman, R.V., "Soil Mechanics", Wiley Eastern Limited, 1976
4. Gulhati, K. Shashi and M. Datta, "Geotechnical engineering", Mc. Graw Hill book company, 2005

EXPERIMENTS:

1. Unconfined compression test
2. Direct shear test
3. Unconsolidated Undrained Tri-axial test
4. Consolidated Drained Tri-axial test
5. Consolidated Undrained Tri-axial test
6. Laboratory vane shear test
7. Field Vane shear test

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Evaluate the shear strength of soil using direct shear, vane sear, and tri-axial test.
2. Conduct experiments to analyse and interpret results for geotechnical engineering design.

TEXT/REFERENCE BOOKS:

1. B.C. Punmia, “Soil Mechanics and Foundations” Laxmi Publications (P) Ltd.
2. V.N.S. Murthy, “Soil Mechanics and Foundation Engineering” CBS Publishers & Distributors Pvt. Ltd.
3. C. Venkatramaiah, “Geotechnical Engineering” New Age International Publishers

EXPERIMENTS:

1. Study of various boring tools and techniques
2. Study of various sampling tools
3. Vane Shear test
4. Standard Penetration Test
5. Cone Penetration Test
6. Pressure meter Test
7. Dilatometer Test
8. Seismic refraction Test
9. Electrical resistivity Test
10. Study of Field Instrumentation

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Perform various soil investigation tests.
2. Plan a soil investigation survey according to the structure and the sub-soil.
3. Choose the appropriate field instrumentation for a particular test.

TEXT/REFERENCE BOOKS:

1. Geotechnical Testing, Observation, and Documentation, 2nd Edition, Tim Davis, ASCE Press, 2008.
2. In Situ Testing Methods in Geotechnical Engineering, Alan J. Lutenegger, CRC Press, 2021.
3. Geotechnical instrumentation in practice: Purpose, performance and interpretation, ICE Publishing, 1990.
4. Latest version of relevant Indian and International codes for various tests.

Unit 1: Engineering properties of weak rocks, different rock mass classification systems, relative merits and demerits.

Unit 2: Failure criteria for weak rocks, bi-linear Mohr-Coulomb failure criterion, Hoek and Brown criterion and modified Hoek and Brown failure criterion etc. Effect of structural planes on rock foundations, possible modes of failure of foundations on rocks/ rock masses, determination of in-situ shear strength of rocks and rock masses

Unit 3: Requirements for satisfactory performance of foundations, bearing capacity of foundations on rocks and rock masses, allowable bearing pressure of rock foundations using a nonlinear failure criterion, monotonic and cyclic plate load tests.

Unit 4: Shallow foundations, shallow foundations on sloping ground, raft foundations, stilt foundations, foundations for suspension bridges, transmission line towers, framed buildings etc., treatment of foundations - open joints, solution cavities, weak seams.

Unit 5: Piles in weak rocks, bearing capacity and settlement of piles, piles in stratified rock masses, field load tests on piles in weak rocks, behaviour of bored / driven piles in soft / weathered rocks

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Classify different types of rock mass and design different types of foundations placed over rock mass.
2. Design the shallow foundation on a weak rock.
3. Design the pile foundation on a weak rock.

TEXT/REFERENCE BOOKS:

1. Wyllie Duncan C., “Foundations on Rock: Engineering Practice”, E&FN Spon, Taylor and Francis.
2. Hudson J.A. and J.P. Harrison. “Engineering Rock Mechanics: An Introduction to the Principles”, 1997. Elsevier, Oxford
3. Singh, B. and Goel, R.K., “Rock Mass Classification- A Practical Engineering Approach”, Elsevier.
4. Ramamurthy, T., “Engineering in Rocks”, PHI Learning Pvt. Ltd.
5. Hoek, E., “Practical Rock Engineering”, Rock science.

Unit 1: Theory of Vibrations: Degree of freedom, Undamped and Damped free vibration with viscous damping, forced vibrations, Vibration Isolation, Vibration of Multiple-Degree Freedom Systems, Theory of Vibration Measuring Instruments, Undamped Dynamic Vibration Absorbers.

Unit 2: Introduction: Various types of machine foundations; Permissible amplitudes of vibrations, factors affecting the resonant frequency and amplitudes of vibrations; Estimation of damping and plastic coefficients.

Unit 3: Foundations under Reciprocating Machine: Resonant frequency of the block foundations; Weightless spring and weighted spring method, Elastic half space method, miscellaneous methods; Behaviour and design of block foundations, permissible amplitudes.

Unit 4: Hammer Foundations: Hammer foundations, classification, natural frequencies and amplitudes of foundation vibrations; Design principles, permissible amplitudes.

Framed Foundations: Framed foundations, their advantage for high-speed machines; Permissible amplitudes, design principles.

Unit 5: Vibration Isolation and Screening: Methods of decreasing vibrations on existing foundations; Isolation of vibrations; Screening of vibrations.

IS Code of Practice: Critical review of IS code provisions for design of machine foundations.

Structural Design: General principles of design; Construction aspects; Case histories of failures of machine foundations.

COURSE OUTCOMES:

After the completion of this course, the student will be able to:

1. Understand Theory of Vibrations and its application to the design of machine foundations.
2. Design various types of machine foundation.
3. Learn the essentials of vibration isolation and capable of selecting the types of vibration isolation materials and techniques.

TEXT/REFERENCE BOOKS:

1. Srinivsulu, P. and Vaidyanathan, C. V., "Handbook of Machine Foundations", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2007.
2. Kameshwar Rao, N.S.V., "Vibration Analysis and Foundation Design", Wheeler Publishing, New Delhi, 1998.
3. Saran S., "Soil Dynamics & Machine Foundation", Galgotia Pub. Pvt. Ltd, New Delhi 2006.
4. Bhatia K.G., "Foundation for Industrial Machines – A Handbook for Practicing Engineers", D-CAD Publishers, New Delhi, 2008.

Unit 1: Introduction to Slope Stability Concepts- Aim of slope stability analysis, Types of slopes, Factors contributing to slope failure, Concept of slope stability and contributing factors, Inputs for slope stability analysis.

Unit 2: Various important aspects in Slope Stability- Various geological features associated with slopes, Groundwater in slope stability analysis, Geological site exploration for input data, Laboratory testing and interpretation ofproperties of slope structure.

Unit 3: Slope Stability Analysis- Various modes of failure, Factor of safety concept, Block analysis, Infinite slope analysis, Planar surface analysis, Circular surface analysis, Methods of slices, Design charts.

Unit 4: Advanced Analysis of Slope Stability- Seismic analysis of slope stability, Three-dimensional slope stability analysis, Rock slope stability, FEM analysis of slopes.

Unit 5: Slope Stabilization Methods- Buttressing, providing drainage, Reinforcement of the soil section, Retaining walls, Surface slope protection, Rock slope stabilization, Selection of stabilization method.

COURSE OUTCOMES:

At the end of the course, the student will be able to:

1. Explain slope failures and identify the factors contributing to slope failure.
2. Describe various important aspects in slope stability.
3. Perform slope stability analysis.
4. Examine various advanced analysis methods of slope stability.
5. Compare various slope stabilization methods and choose the suitable one.

TEXT/REFERENCE BOOKS:

1. Hoek, E. and Bray, J.W., “Rock Slope Engineering” Institution of Mining Engineering, 1981.
2. Giani, G.P., “Rock Slope Stability Analysis”, A A Balkema, 1982.
3. Wyllie Duncan C and Christofer W Mah, “Rock Slope Engineering” Spon Press, Taylor and Francis Group, 2004.
4. Singh, B. and Goel, R.K., “Software for Engineering Control of Landslides and Tunneling Hazards”, A A Balkema, 2002.
5. Harr M.E., “Ground Water and Seepage”, McGraw Hill, 1962.
6. Chowdhary Robin and Chowdhary Indrajit, “Geotechnical Slope Analysis”, CRC Press, 2009.