EVALUATION SCHEME
&
SYLLABI

FOR

MASTER OF TECHNOLOGY
in
CIVIL ENGINEERING
(GEOTECHNOLOGY)

(Effective from Session: 2020-21)

Offered by

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

EVALUATION SCHEME
M.TECH. (GEOTECHNOLOGY)
I- Year (I-SEMESTER)
(Effective from session: 2020-2021)

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	40	40	80	120	200	4
2	TCG 512	Engineering Rock Mechanics	3	1	0	40	40	80	120	200	4
3	TCG 513	Soil Dynamics	3	1	0	40	40	80	120	200	4
4	TCE 513	Soil Exploration	3	1	0	40	40	80	120	200	4
5	TCE 515	Optimization and Geo-statistics in Civil Engineering	3	1	0	40	40	80	120	200	4
6	TAC 51X	Audit Course	2	0	0	20	20	40	60	100	0
PRACTICALS											
7	PCG 511	Advanced Soil Mechanics Lab	0	0	2	10	15	25	25	50	1
8	PCG 514	Soil Exploration Lab	0	0	2	10	15	25	25	50	1
9	GPP 511	General Proficiency	0	0	0	0	50	50	0	50	0
SEMESTER TOTAL			17	5	4	220	230	450	650	1100	22

AUDIT COURSES

TAC 511	Constitution of India
TAC 512	English for Research Paper Writing
TAC 513	Pedagogy Studies
TAC 514	Personality Development through Life Enlightenment Skills
TAC 515	Stress Management by Yoga

EVALUATION SCHEME
M.TECH. (GEOTECHNOLOGY)
I- Year (II-SEMESTER)
(Effective from session: 2020-2021)

S. No.	Course Code	SUBJECT	PERIODS			EVALUATION SCHEME					
						Sessional Exam			ESE	Subject Total	Credits
			L	T	P	CT	TA	Total			
THEORY											
1	TCG 521	Finite Element Method in Geotechnical Engineering	3	1	0	40	40	80	120	200	4
2	TCG 522	Advanced Foundation Engineering	3	1	0	40	40	80	120	200	4
3	TCG 523	Machine Foundation	3	1	0	40	40	80	120	200	4
4	TCG 524	Slope Stability Analysis and Stabilization	3	1	0	40	40	80	120	200	4
5	TRM 521	Research Methodology and IPR	2	0	0	20	20	40	60	100	2
PRACTICALS											
6	PCG 522	Advance Foundation Engineering Lab	0	0	2	10	15	25	25	50	1
7	PCE 526	Advance Software's Lab	0	0	2	10	15	25	25	50	1
8	GPP 521	General Proficiency	0	0	0	0	50	50	0	50	0
SEMESTER TOTAL			14	4	4	200	210	410	590	1000	20

EVALUATION SCHEME
M.TECH. (GEOTECHNOLOGY)
II - Year (III-SEMESTER)
(Effective from session: 2021-2022)

S. No.	Course Code	SUBJECT	PERIODS			EVALUATION SCHEME					Credits
						Sessional Exam			ESE	Subject Total	
			L	T	P	CT	TA	Total			
THEORY											
1	ECG 61X	Elective - I	3	1	0	40	40	80	120	200	4
2	ECG 62X	Elective - II	3	1	0	40	40	80	120	200	4
PRACTICALS											
3	PCG 631	Dissertation 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	2	20	80	330	410	490	900	18

Elective I

ECG 611 Advanced Pavement Analysis
ECG 612 Earth Retaining Structures
ECG 613 Earthquake Resistant Design of Foundation
ECG 614 Environmental Geo-Technology
ECG 615 Computational Methods in Civil Engineering
ECG 616 Disaster Preparedness and Planning

Elective II

ECG 621 Constitutive Modeling in Geotechnical Engineering
ECG 622 Design of Bridge Sub structure
ECG 623 Landslide Analysis and Control
ECG 624 Ground Improvement Technique
ECG 625 Cost Management in Engineering Projects
ECG 626 Environmental Impact Assessment

EVALUATION SCHEME

M.TECH. (GEOTECHNOLOGY)

II - Year (IV-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			
PRACTICALS											
1	PCG 641	Dissertation II	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	400	400	400	800	16

TCG 511 ADVANCED SOIL MECHANICS 3L:1T:0P

Unit 1: Theory of Elasticity- Basic Concepts of Material Behavior – Elastic, Viscous and Plastic idealization, Mechanics of Continua: Stress and strain - concept of stress and strain – Three dimensional and two-dimensional state of stress – Plane stress, plane strain and axisymmetric problems – equilibrium and compatibility conditions, constitutive relations, stress functions – Two dimensional problems in Cartesian and polar co-ordinates.

Unit 2: Flow Through Porous Media- Pore water pressure developed due to isotropic stress application, Pore water pressure parameter B, Pore water pressure due to uniaxial loading, Directional variation of A, Pore water pressure under triaxial test conditions, Henkel's modification of pore water pressure equation, Pore water pressure due to one-dimensional strain loading (oedometer test).

Seepage - Equation of continuity, Use of continuity equation for solution of simple flow problem, Flow nets, Hydraulic uplift force under a structure, Flow nets in anisotropic material, Construction of flow nets for hydraulic structures on nonhomogeneous subsoils, Numerical analysis of seepage, Seepage force per unit volume of soil mass, Safety of hydraulic structures against piping, Filter design, Calculation of seepage through an earth dam resting on an impervious base, Plotting of phreatic line for seepage through earth dams.

Unit 3: Consolidation- Theory of one-dimensional consolidation, Degree of consolidation under time-dependent loading, Numerical solution for one-dimensional consolidation, Standard one-dimensional consolidation test and interpretation, Effect of sample disturbance on the *e* versus log σ' curve, Secondary consolidation, General comments on consolidation tests, Calculation of one-dimensional consolidation settlement, Coefficient of consolidation, One-dimensional consolidation with viscoelastic models, Constant rate-of-strain consolidation tests, Constant-gradient consolidation test, Sand drains, Numerical solution for radial drainage (sand drain).

Unit 4: Shear Strength of Soils- Mohr–Coulomb failure criteria, Shearing strength of granular soils, Critical void ratio, Curvature of the failure envelope, General comments on the friction angle of granular soils, Shear strength of granular soils under plane strain condition, Shear strength of cohesive soils, Unconfined compression test, Modulus of elasticity and Poisson's ratio from triaxial tests, Friction angles and C_u, Effect of rate of strain on the undrained shear strength, Effect of temperature on the undrained shear strength, Stress path, Hvorslev's parameters, Relations between moisture content, effective stress, and strength for clay soils; Correlations for effective stress friction angle, Anisotropy in undrained shear strength, Sensitivity and thixotropic characteristics of clays, Vane shear test, Relation of undrained shear strength S_u and effective overburden pressure p', Creep in soils, Other theoretical considerations—yield surfaces in three dimensions, Experimental results to compare the yield functions.

Unit 5: Critical State Concept- Critical State Theory, Normal consolidation line, critical state line, Roscoe surface, Hvorslev surface, no tension line, Constitutive laws for soils.

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. Suklje, L., “Rheological Aspects of Soil Mechanics”, John Wiley, 1969
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

TCG 512 ENGINEERING ROCK MECHANICS 3L:1T:0P

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: 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 semi-infinite media – one-, two- and three-dimensional wave propagation; Attenuation of stress waves – material and radiation damping; Dispersion, waves in a layered medium.

Unit 3: **Dynamic Soil Properties-** Stress & strain conditions, concept of stress path; Measurement of seismic response of soil at low and high strain, using laboratory tests; Cyclic triaxial, cyclic direct simple shear, resonant column, shaking table, centrifuge and using field tests - standard penetration test, plate load test, block vibration test, SASW/MASW tests, cross bore hole; Evaluation of damping and elastic coefficients; Stress-strain behaviour of cyclically loaded soils; Effect of strain level on the dynamic soil properties; Equivalent linear and cyclic nonlinear models; Static and dynamic characteristics of soils.

Unit 4: **Ground Response Analysis-** Introduction-, one-, two- and three-dimensional analyses; Equivalent and nonlinear finite element approaches; Introduction to soil-structure interaction.

Unit 5: **Liquefaction-** Introduction, pore pressure, liquefaction related phenomena – flow liquefaction and cyclic mobility: Factors affecting liquefaction, liquefaction of cohesionless soils and sensitive clays, liquefaction susceptibility; State Criteria –CVR line, SSL, FLS; Evaluation of liquefaction potential: characterization of earthquake loading and liquefaction resistance, cyclic stress ratio, Seed and Idriss method; Effects of liquefaction.

COURSE OUTCOMES:

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

1. Assess properties of soil effected by seismic wave propagation.
2. Know about Strong Ground Motion Characteristics.
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.

TCE 513	SOIL EXPLORATION	3L:1T:0P

Unit 1: Introduction- 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 2: 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 3: Geotechnical investigation (Semi-direct methods)- Vane Shear test, Standard Penetration Test, Pressure meter Test, Cone Penetration Test, Dilatometer test, Rock core drilling, Sampling of rock, Core stacking, Rock Quality Designation (RQD), Total Core Recovery (TCR).

Unit 4: Geophysical Tests (Indirect methods)- Seismic reflection survey, Seismic refraction survey, Electrical resistivity Survey, Applications, Advantages, Disadvantages and Limitations.

Unit 5: Soil Properties and their Correlation, Soil Exploration Report- Commonly measured soil properties, Correlations of soil properties, Components of Soil Exploration Report, Drafting of Reports, Graphic Presentations of Bore Log, Study of Sample Reports.

COURSE OUTCOMES:

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

1. Identify the objects of site investigation; and describe the use of different types of samples and samplers.
2. Understand the process of soil exploration by different boring methods.
3. Perform standard penetration test, static and dynamic cone penetration tests, in-situ vane shear test, geophysical exploration methods.
4. Locate ground water table, perform offshore exploration, prepare site investigation report.

TEXT/REFERENCE BOOKS:

1. Braja M. Das, Cengage, “Principles of Geotechnical Engineering”.
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.

TCE 515 OPTIMIZATION AND GEO-STATISTICS IN CIVIL ENGINEERING 3L:1T:0P

Unit 1: Introduction to Optimization- Basics of engineering analysis and design, need for optimal design, Difficulties associated with optimization problems, Problems of global and local optima, Single and multivariable problems, Necessary and sufficient condition for optimality.

Unit 2: Classical Optimization 1- Basics of constrained and unconstrained problems, Stationary points, points of maxima, points of minima and inflection points, Exhaustive search method, Bounding phase method, Region elimination method, Interval halving method, Golden section search method, Newton-Raphson Method and Bisection method.

Unit 3: Classical Optimization 2- Definition of descent direction, Steepest descent direction method, Newton method, Quadratic approximation of a function, convex and concave functions, convex optimization problem, Kuhn-Tucker conditions, Linear Programming, Simplex method and Dynamic programming, Graph theory.

Unit 4: Non-Classical and Metaheuristic Optimization Algorithms- Evolutionary algorithms, Introduction to Genetic Algorithm (GA), Differential Evolution (DE), Particle Swarm Optimization (PSO), Shuffled Frog Leaping Algorithm (SFLA), Simulated Annealing (SA), Invasive Weed Growth Optimization (IWO) and other metaheuristic principles of biomimicry.

Unit 5: Geo-statistics- Review of fundamentals of probability and statistics, Concepts of conditional probability, Random variables and their transformations, commonly used probability distribution functions, Principles of hypotheses testing; Principles of Monte Carlo simulation and Least squares minimization, Random fields and stochastic-dynamic systems. Spatial interpolation methods: Inverse Distance Weight method, Spline interpolation for surfaces, kriging. Applications of Geo-statistics in civil engineering.

COURSE OUTCOMES

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

1. Determine the need for optimal design in engineering, necessary and sufficient conditions of optimality.
2. Determine the optimality of constrained and unconstrained problems using classical search techniques.
3. Determine the optimality of non-linear problems and linear problems using classical optimization methods.
4. Apply evolutionary algorithms for basic problems as wells as advanced engineering design problems.
5. Apply the concepts of Geo-statistics for the engineering problems and interpolation of datasets using different techniques.

TEXT BOOKS / REFERENCES:

1. Deb. K., “Optimization for engineering design: Algorithms and examples”, PHI Pvt Ltd., 1998.
2. Arora., J.S., “Introduction to optimum design”, McGraw Hill International edition, 1989.
3. Hafta, R.T. and Gurdal. Z., “Elements of structural optimization”, Kluwer academic publishers, Third revised and expanded edition, 1996.

4. Bennis, Fouad, and Rajib Kumar Bhattacharjya, "Nature-Inspired Methods for Metaheuristics Optimization: Algorithms and Applications in Science and Engineering", Vol. 16. Springer Nature, 2020.
5. Hayter, A.J., "Probability and statistics", Duxbury, 2002.
6. Bras, R.L. and Rodriguez-Iturbe, I., "Random Functions and Hydrology", Dover Publications, 1994.

PCG 511 ADVANCED SOIL MECHANICS LAB 0L:0T:2P

EXPERIMENTS:

1. Determination of field density of soil
2. Determination of Moisture Content and Specific gravity of soil
3. Grain Size Distribution Analysis and Hydrometer Analysis
4. Atterberg Limits (Liquid Limit, Plastic limit, Shrinkage limit)
5. Classification of soil
6. Vibration test for relative density of sand
7. Standard and modified proctor compaction test
8. Falling head permeability test and Constant head permeability test
9. Consolidation test
10. Direct Shear test
11. Triaxial 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. Vane Shear Test
2. Standard Penetration Test
3. Pressure meter Test
4. Cone Penetration Test,
5. Dilatometer test
6. Seismic reflection survey
7. Seismic refraction survey
8. Electrical resistivity Survey
9. Study of various codal provisions
10. Study of sample soil exploration reports

COURSE OUTCOMES:

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

1. Plan subsurface investigation based on the requirement of civil engineering project and site condition. Can finalize depth and number of boreholes.
2. Execute different subsurface exploration tests, collect disturbed/undisturbed samples for laboratory tests and can suggest design parameters.
3. Understand and experience experimental measurement of the mechanical soil properties commonly used in engineering practice.

TEXT/REFERENCE BOOKS:

7. Terzaghi, K. and Peck, R.B., "Soil Mechanics in Engineering Practice", John Wiley, 1967.
8. Bowles, J.E., "Physical and Geotechnical Properties of Soil", McGraw-Hill Book Company, 1985.
9. Roy E. Hunt., "Geotechnical Engineering Investigation Handbook", Second Field Instrumentation in Geotechnical Engineering.

TCG 521 FINITE ELEMENT ANALYSIS IN GEOTECHNICAL ENGINEERING 3L:1T:0P

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, Solution Algorithms

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".

TCG 522 ADVANCED FOUNDATION ENGINEERING 3L:0T:0P

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 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.

TCG 524 SLOPE STABILITY ANALYSIS AND STABILIZATION 3L:1T:0P

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:

After the completion of this 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.

PCG 522 ADVANCE FOUNDATION ENGINEERING LAB 0L:0T:2P

EXPERIMENTS:

1. California Bearing Ratio Test
2. Plate load Test
3. To find out the Bearing Capacity of shallow and deep foundations using software such as PLAXIS etc.
4. To estimate the Settlement of shallow and deep foundations using software such as PLAXIS etc.
5. To observe the effect of soil-structure interaction for laterally loaded piles, sheet piles etc.

COURSE OUTCOMES:

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

1. Determine the CBR value of soil subgrade.
2. Determine the Bearing Capacity of shallow and deep foundations using PLAXIS.
3. Estimate the Settlement of shallow and deep foundations using PLAXIS.
4. Simulate the geotechnical problem and observe the effect of soil structure interaction, and decide the most appropriate and optimized techniques to strengthen the ground up to a desirable limit.

TEXT/REFERENCE BOOKS:

1. Bathe, K. J., “Finite element analysis in engineering analysis”, Prentice-Hall New Jersey., 1982.
2. Zienkiewicz., O. C., “The finite element method”, McGraw - Hill, London., 1977.
3. Peck, R.B., Hanson, W.E. and Thornburn, T.H., “Foundation Engineering”, John Wiley., 1974.
4. PLAXIS 2D-Reference Manual., CONNECT Edition V21.01., 2021.

PCG 526 ADVANCE SOFTWARE'S LAB 0L:0T:2P

EXPERIMENTS:

1. To perform Stability analysis of earth slope using various software such as PLAXIS etc.
2. Analysis of Piled-raft foundation using various software such as PLAXIS etc.
3. Analysis of excavation of a shield tunnel using various software such as PLAXIS etc.
4. Rapid Drawdown analysis using various software such as PLAXIS etc.
5. Ground response analysis using various software such as Deepsoil, PLAXIS etc.
6. Dynamic analysis of a generator on an elastic foundation using various software such as PLAXIS etc.
7. Free vibration and earthquake analysis of a building using various software such as PLAXIS etc.

COURSE OUTCOMES:

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

1. Observe the ground response analysis using Deep soil and PLAXIS.
2. Analyse behaviour of footings of various shapes on confined fill conditions using Deep soil and PLAXIS.
3. Evaluate the slope stability using PLAXIS software.
4. Analyse free vibration and earthquake analysis of a building using PLAXIS.

TEXT/REFERENCE BOOKS:

1. Bowles, J.E., "Physical and Geotechnical Properties of Soils", McGraw Hill Publishers (1979).
2. Head K.H., "Manual of Soil Laboratory Testing", Vol. 1,2, 3 (1982).
3. Lambe, "Soil Testing in Engineering", Wiley & Sons (1951).
4. Mandal, J.N. and Divshikar, D.G., "Soil Testing in Civil Engineering", Oxford & IBH Publishing Company Pvt. Ltd., New Delhi (1994).
5. IS 2720 (1983), "Methods of Test for Soils, Bureau of Indian Standards".
6. PLAXIS 2D-Reference Manual., CONNECT Edition V21.01., 2021

ECG 611 ADVANCED PAVEMENT ANALYSIS 3L:1T:0P

Unit 1: Introduction: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements, functions of pavement components.

Unit 2: Pavement Design Factors: Design wheel load, strength characteristics of pavement materials, climatic variations, traffic - load equivalence factors and equivalent wheel loads, Axle's configuration and tyre pressure. Drainage – Estimation of flow, surface drainage, sub-surface drainage systems, design of sub-surface drainage structures.

Unit 3: Flexible Pavement Design: Empirical, semi-empirical and theoretical approaches as Methods for design of flexible pavements; Group Index method, California Bearing Ratio (CBR) method, California Resistance Value method, Triaxial Test method, Burmister method, McLeod's method. Design of highway by IRC as per latest IRC code, AASHTO Methods, applications of pavement design software.

Unit 4: Rigid Pavements Design: Westergaard's Theory and Assumptions, Stresses due to Curling, Stresses and Deflections due to Loading, Frictional Stresses. Wheel load & its repetition, sub grade strength & proportion, strength of concrete- modulus of elasticity. Reinforcement in slab. Design of joints. Design of Dowel bars. Design of Tie bars. IRC methods of Rigid Pavement design.

Unit 5: Pavement Evaluation and Rehabilitation: Pavement evaluation and rehabilitation, condition and evaluation surveys – PSI models, Need for Overlays, Overlays design methods for Flexible and Rigid pavements.

TEXT/REFERENCE BOOKS:

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

COURSE OUTCOMES:

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

1. Appreciate the functions of various components of a pavement.
2. Identify the factors affecting design of pavements.
3. Design flexible & rigid pavements.
4. Evaluate performance of pavement and design the overlay on flexible and rigid pavement.

ECG 612 EARTH RETAINING STRUCTURES 3L:1T:0P

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:

After the completion of this 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

ECG 613 EARTHQUAKE RESISTANT DESIGN OF FOUNDATION 3L:1T:0P

Unit 1: Introduction- General requirements, types of shallow and deep foundations and their use; performance of various types of foundations during past earthquakes, IS codes for bearing capacity and settlement of foundations. foundation design, modes of soil failure.

Unit 2: Shallow Foundations- Safe bearing capacity, differential & total settlements, increase in permissible stress under earthquake loads methods of analysis, experimental investigations, combined footings for earthquake loads, raft foundation, modulus of sub grade reaction, Winkler model, beam on elastic foundation, soil line method.

Unit 3: Bearing Capacity under Transient & Earthquake Type Loads- Types of dynamic loads; Footing requirements to account for settlements and earthquake induced forces; Pseudo-Static analysis of footings with eccentric & inclined loads, effect of horizontal load and moment. Dynamic Analysis of shallow foundations for various modes of vibrations, Design seismic coefficients for various foundation soil systems, provisions of IS codes and their limitations; seismic coefficient and response spectra methods.

Unit 4: Pile Foundations- Types of piles based on usage, material, construction etc. pile load capacity in compression, Bearing capacity of piles, group action of piles, settlement of a pile group, laterally loaded piles, elastic analysis; Reese and Matlock approach, fixity of pile heads, dimensionless factors; Pile with dynamic loads. soil-pile analysis with spring-mass & FEM idealisation, elements for slip and separation, soil-pile interaction, IS code of practice for design of pile foundations, piles through liquefiable soils

Unit 5: Well Foundations & Caissons- Types; components; scour depth, depth & bearing capacity of wells, static forces considered in stability of wells; Lateral stability of well foundations. Pseudo-static analysis with earthquake induced loads, Lateral load resistance of well foundation; Terzaghi’s approach; IRC, IS and Indian Railway Codes, their limitations.

COURSE OUTCOMES:

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

1. Understand various types of foundations, required soil investigations, soil parameters, and codes of practice.
2. Design seismic resistant foundations (Shallow and Deep).
3. Focus on techniques used in design of foundations so that it does not fail during earthquakes.
4. Design deep foundations for lateral loads.

TEXT/REFERENCE BOOKS:

1. Prakash S., “Soil Dynamics", McGraw-Hill Company, New York, 1981
2. Kramer S.L., “Geo Technical-Earthquake Engineering”, Pearson Education Pvt. Ltd., Singapore, 1996.
3. Bowles J.E., “Foundation Analysis and Design”, McGraw Hill International Editions, Singapore,1997.
4. Ranjan G. and Rao A.S.R., “Basic and Applied Soil Mechanics”, New Age Int. Ltd., New Delhi, 2004.
5. Saran S., “Soil Dynamics & Machine Foundation”, Galgotia Pub. Pvt. Ltd, New Delhi, (2006).

ECG 614 ENVIRONMENTAL GEO-TECHNOLOGY 3L:1T:0P

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.

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.

ECG 615 COMPUTATIONAL METHODS IN CIVIL ENGINEERING 3L:1T:0P

Unit 1: Basic equations used in Civil Engineering: Continuum Mechanics and Mechanics of Materials. Approximation of equations using numerical analysis – Taylor's series of expansion, Error analysis, Sources of errors – truncation error, roundoff error.

Unit 2: Mathematical nature of PDEs, Hyperbolic, Parabolic, Elliptic Equations and flow equations. Basic Discretization techniques: Finite Difference Method (FDM), Implicit and explicit formulations of FDM, Stability criteria of the forms of equations using error minimization.

Unit 3: Application of FDM to wave, Heat and Laplace equations. Linear multi-step methods; Predictor-corrector schemes, ADI methods, Grid transformations according to the appropriate boundaries. Lax-Wendroff Technique and MacCormack's Technique.

Unit 4: The Finite Volume Method (FVM) and conservative discretization. Analysis and Application of Numerical Schemes: Modified equation, The Runge-Kutta schemes, Numerical solution of the compressible Euler equations: Mathematical formulation of the system of Euler equations;

Unit 5: Basics of the Finite Element Method (FEM) and the Galerkin formulations. Basics of the computations of the differential equations using the three methods (FDM, FVM and FEM) in MATLAB, Python etc.

COURSE OUTCOMES:

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

1. Identify and formulate a solution procedure for different types of equations encountered in civil engineering curriculum.
2. Discretize the total domain of model using different techniques based on the type of equation that needs to be solved.
3. Apply different numerical techniques to solve the equations and to successfully prepare a numerical model in theory.
4. Develop models that can solve a given partial differential equation under different boundary conditions using Finite Difference Method (FDM), or Finite Volume Method (FVM), or Finite Element Method (FEM) using programming.

TEXT BOOKS / REFERENCES:

1. D. Dahlquist, and A. Bork, "Numerical Methods", Dan Prentice-Hall, Englewood Cliffs, N J., 1974.
2. H. C. Martin and G. F. Carey, "Introduction to Finite Element Analysis - Theory and Application", New York, McGraw-Hill.
3. J. D. Anderson (Jr.), "Computational Fluid Dynamics", McGraw-Hill International Edition, 1995.
4. Matlab programming for Engineers, Stephen J. Chapman, 5th Edition, Cengage Learning, 2015.

Unit 1: Introduction - Concepts and definitions: disaster, hazard, vulnerability, risks- severity, frequency and details, capacity, impact, prevention, mitigation).

Unit 2: Disasters - Disaster's classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility.

Unit 3: Disaster Impacts - Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.

Unit 4: Disaster Risk Reduction (DRR) - Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post-disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

Unit 5: Disasters, Environment and Development - Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land-use changes, urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods.

COURSE OUTCOMES:

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

1. Understand the application of Disaster Concepts to Management.
2. Analyze relationship between Development and Disasters.
3. Understand Categories of Disasters.
4. Understand realization of the responsibilities to society.

TEXT/REFERENCE BOOKS:

1. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
2. Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication.
3. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation

ECG 621 CONSTITUTIVE MODELLING IN GEOTECHNICAL ENGINEERING 3L:1T:0P

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, a 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.

ECG 622 DESIGN OF BRIDGE SUBSTRUCTURES 3L:1T:0P

Unit 1: Substructure Design- Introduction, Substructure – Definition and purpose, Role of foundation engineers, General requirements of substructure, Scope, Foundation Design Process, Develop Site Data and Preliminary Bridge Plan, Preliminary Foundation Design, Substructure and Foundation Loads.

Unit 2: Analysis and design of piers and pier caps- Introduction, types of piers, solid, cellular, hammered head type, framed type, trestle R.C piers, Materials of construction, Design procedure for analysis of pier, horizontal force due to water current, estimation of scour depth for foundation, design of Seismic restrainers.

Unit 3: Analysis and design of abutments- General, Abutment Types, Stub Abutments, Cantilever Abutments, Rigid Frame Abutments, Bent-Type Abutments, Abutments Supported By Mechanically-Stabilized Earth Walls, Embankment at Abutments, Abutment Loading, Abutment Bearings and Girder Stops, Abutment Expansion Joints, Abutment Wall Design, Drainage and Backfilling, Abutment Wing Walls and Curtain Walls, Wing Wall Design.

Unit 4: Bridge Bearing and Expansion joint- Bridge bearing, Types of bearing, Design of metallic bearing, Design of elastomeric bearing, Expansion Joint, Requirement to expansion joint, Types of expansion joint and their design. Essential design data and their acquisition.

Unit 5: Analysis and design of well and pile foundations- Estimation of pile capacity by static and dynamic formulae-Settlement of single pile - Laterally loaded piles - Brom's method - Ultimate lateral resistance of piles -Pile groups Consideration regarding spacing - Efficiency of pile groups – Pile Cap-Structural Design of Pile and pile cap, Introduction to well foundations. Sinking stresses in wells –Design of well cap, well steining, well curb, cutting edge and bottom plug.

COURSE OUTCOMES:

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

1. Decide suitable site exploration method for the bridge substructure.
2. Analyze the load coming on the bridge substructure.
3. Design the foundation for different substructure.
4. Design different parts of bridge substructure.
5. Design seismic restrainers.

TEXT/REFERENCE BOOKS:

1. Wai-Fah Chen, Lian Duan, "Bridge Engineering: Substructure Design", 2003.
2. Vijay Singh, "Wells and Cassions" Nem Chand & Sons, 1981.
3. S. Saram, "Analysis and Design of Substructures", 2012.
4. Ponnuswamy, "Bridge Engineering", 1986.
5. D. J. Victor, "Essentials of Bridge Engineering", 2001.
6. Rakshit, "Design and Construction of Highway Bridges", 2004.

ECG 623 LANDSLIDE ANALYSIS AND CONTROL 3L:1T:0P

Unit 1: Introduction- Landslide phenomenon, Types and causes of slope failures, Practical applications Stability analysis of infinite slopes with or without water pressures Stability analysis of finite and Infinite slopes: concept of factor of safety, pore pressure coefficients, rock falls, debris flows, Earthquake and seismically induced landslides.

Unit 2: Slope Stability Analysis- Rock & soil slopes – SMR & Slope Stability Assessment, Mass analysis, Wedge methods, friction circle method, method of slices, Bishop's method, Janbu's method, Effect of seepage, submerged and sudden draw down conditions Design of slopes in cutting, Embankments and Earth dams Site Investigation: Reconnaissance, Preliminary and detailed investigation, Investigation for foundations Advances in stability analysis of slopes.

Unit 3: Landslide Hazard and Risk Assessment- Concept & Techniques, Case Studies – Landslide Investigations: Geological, geophysical & geotechnical, hazard zonation's, mapping physical factors and preparation of a landslide hazard map, Groundwater system analysis for landslides.

Unit 4: Landslide Monitoring- Aerial and satellite remote sensing techniques, Landslide Instrumentation: Surface & sub-surface monitoring, slope movements, early warning devices, maintenance of slopes, Disaster Mitigation, Sustainability and environmental issues.

Unit 5: Landslide Control- Remediation techniques, Landslide Control Measures: Types of measures & design – Landslide case studies, landslide mitigation measures, Permanent measures for landslide damage reduction, Maintenance measures for roads and reservoirs in landslide areas, emergency response for landslides.

COURSE OUTCOMES:

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

1. Understand the mechanism of slope failure for various types of slopes both in static and seismic case.
2. Know Repair & Rehabilitation of the failed slopes.
3. Design various types of soil and rock slopes, earth dams, high embankments under various conditions.
4. Give an overview of landslide mapping products that are used in society for planning and mitigation.
5. learn about landslide detection and monitoring techniques and understand the role of landslides in the earth system.

TEXT/REFERENCE BOOKS:

1. Landslides: Analysis and Control, Volume 176 of Special report - Transportation Research Board, National Research Council, National Research Council (U.S.). Transportation Research Board, 1978.
2. Singh, B. and Goel, R.K., "Rock Mass Classification – A Practical Engineering Approach", Elsevier, 2006.
3. Hoek, E. and Bray, J.W., "Rock Slope Engineering", Institute of Mining Engg., 1981.
4. Giani, G.P., "Rock Slope Stability Analysis", A.A. Balkema, 2002.
5. Singh, B. and Goel, R.K., "Software for Engineering Control of Landslide and Tunneling Hazards", A.A. Balkema, 2002.

ECG 624 GROUND IMPROVEMENT TECHNIQUE 3L:1T:0P

Unit 1: Introduction- Typical situations where ground improvement becomes necessary, historical review of methods adopted in practice, current status and the scope in the Indian context.

Unit 2: Ground Improvement Techniques- Methods of ground improvement, mechanical compaction, dynamic compaction, impact loading, compaction by blasting, vibro-compaction; pre-compression, dynamic consolidation, design aspect of stone columns, use of admixtures, injection of grouts, design guidelines and quality control, design examples on preloading with sand drains, with geosynthetics

Unit 3: **Reinforced Earth**- basic mechanism, constituent materials and their selection; engineering application – 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

Unit 4: Geosynthetics- Geotextiles, selection and engineering applications, design examples, stabilisation/improvement of ground using geomembranes, geocells, genets, geosynthetic walls.

Unit 5: Special Techniques- Soil nailing. Construction of underground structures, landslide controls, deep vertical cuts, contiguous piles. Problematic soils, use of ply soil, improvement of saline soils, improvement of black cotton soils.

TEXT/REFERENCE BOOKS:

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

COURSE OUTCOMES:

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

1. Understand the mechanism of ground improvement.
2. Identify the necessity of ground improvement.
3. Identify the ground conditions and suggest suitable methods of improvement.
4. Design and assess the degree of improvement required.
5. Understand the functions of geosynthetics and soil nailing in engineering constructions.
6. Design reinforced soil structures.

ECG 625 COST MANAGEMENT IN ENGINEERING PROJECTS 3L:1T:0P

Unit 1: Basic Concepts- Scope, meaning and definition of construction project, project categories, characteristics of project, project life cycle and phases, project management functions, roles of project manager planning for construction projects, principles of planning, objectives, resource planning, scheduling, productivity chart, project tracking.

Unit 2: Project Scheduling and Network Analysis- Introduction to CPM, PERT, PDM, LOB, Scope management, WBS, PDRI, Time and cost management.

Unit 3: **Resource Allocation-** Time constrained resource allocation and resource constrained problems, Time Cost trade off, EVM meaning and definition, project updating and control using EVM (Earned Value Management), cost performance index, schedule performance index, cost variances, schedule variance, Final Cost, Final Project Duration.

Unit 4: Material related Management- Purchase & inventory control, time-cost-resource optimization, quality, safety planning & control, labour productivity variations, productivity improvement - work study.

Unit 5: Problems in Construction- Formulation, Graphical solution, Simplex method, Dual problem, sensitivity analysis and their application to Civil engineering, Identification of risks and impact, Management Information systems.

COURSE OUTCOMES:

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

1. Understand and apply the knowledge of management functions like planning, scheduling, executing and controlling to construction projects.
2. Demonstrate their capability for preparing the project networks to work out best possible time for completing the project.
3. Understand and exercise the time- cost relationship in practices.
4. Implement the safety aspects during the execution of civil engineering project.
5. Carry out the Human resource Management efficiently.

TEXT/REFERENCE BOOKS:

1. Jha K.N., "Construction Project Management-Theory and Practice", 2nd Edition, Pearson India Education Services, Pvt. Ltd., 2015.
2. Punmia B.C. and Khandelwal K. K., "Project Planning and Control with PERT and CPM", Laxmi Publication II Edition, 1989.
3. George 1. Ritz, "Total Construction Project Management", McGraw-Hill Inc.,1994.
4. Sengupta B., Guha M., "Construction Management and Planning", McGraw-Hill Companies, 1998.
5. Jay S. Newitt, "Construction Scheduling: Principles and Practices", Pearson, 2nd Edition, 2011.

ECG 626 ENVIRONMENTAL IMPACT ASSESSMENT 3L:1T:0P

Unit 1: Historical development of Environmental Impact Assessment (EIA)- EIA in Project Cycle, Concepts of EIA methodologies, Rapid and Comprehensive EIA, Types and limitations of EIA – EIA process- screening – scoping - setting – analysis – mitigation.

Unit 2: Environmental Risk Analysis- Definition of Risk, Matrix Method. Checklist method, Fault tree analysis.

Unit 3: Social Impact Assessment- Relationship between social impacts and change in community and institutional arrangements. Individual and family level impacts, measures of effectiveness of pollution control activities.

Unit 4: Introduction to Environmental Management Systems- Environmental Statement - procedures; Environmental Legislation, Policy and guidelines for planning and monitoring programs – Post project audits.

Unit 5: Environmental Audit- Cost Benefit Analysis; Life Cycle Assessment; Resource Balance, Energy Balance & Management Review; Operational Control; Case Studies on EIA.

COURSE OUTCOMES:

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

1. Understand the concept of Sustainable Development and justify the methods of achieving SD.
2. Appreciate the importance of EIA as an integral part of planning process.
3. Apply the different methodologies to predict and assess the impacts of project on various aspects of environment.
4. Enumerate the role of public participation in environmental decision-making process.
5. Characterize the environmental attributes.

TEXT/REFERENCE BOOKS:

1. Canter, L.W., "Environmental Impact Assessment", McGraw Hill, New York. 1996
2. Lawrence, D.P., "Environmental Impact Assessment – Practical solutions to recurrent problems", Wiley-Inter science, New Jersey. 2003
3. World Bank –Source book on EIA
4. Cutter, S.L., "Environmental Risk and Hazards", Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
5. Kolluru Rao, Bartell Steven, Pitblado R and Stricoff, "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996.
6. K. V. Raghavan and A. A. Khan, "Methodologies in Hazard Identification and Risk Assessment", Manual by CLRI, 1990.
7. Sam Mannan, Lees, "Loss Prevention in the Process Industries, Hazard Identification, Assessment and Control", 4th Edition, Butterworth Heineman, 2012.