

Guru Nanak dev Engineering College, Ludhiana
(An Autonomous College under UGC Act)
Civil Engineering Department

Course Scheme: M. Tech (Geotechnical Engineering)—Full Time

Schedule of Teaching and study scheme

Semester	Subjects	Credits	Contact Hours/week			No. of subjects	Distribution of marks		Total Credits
			L	T	P		Ext	Int	
1	Core subjects	4	4	-	-	3	100	50	20
	Program elective	3	3	-	-	1	100	50	
	Open elective	3	3	-	-	1	100	50	
	Laboratory-1	2	--	-	4	1	50	50	
2	Core subjects	4	4	-	-	3	100	50	20
	Program elective	3	3	-	-	1	100	50	
	Open elective	3	3	-	-	1	100	50	
	Laboratory -2	2	--	-	4	1	50	50	
3	Program elective	3	3	-	-	1	100	50	10
	Program elective	3	3	-	-	1	100	50	
	Pre-thesis seminar	1	-	-	2	1	50	50	
	Pre-thesis project	3	-	-	3	1	50	50	
4	Thesis/Dissertation	15	-	-	14	--	100	200	15

List of Core Subjects

S. No.	Subjects	Subject Code
1	Soil Dynamics	MTGT-501
2	Advanced Foundation Engineering	MTGT-502
3	Applied Soil Mechanics	MTGT-503
4	Research Methodology	MTGT-504
5	Analysis of Settlement of Soils & Foundations	MTGT-505
6	Site Investigations	MTGT-506

List of Laboratory/Practical work

S. No.	Subject	Subject Code
1	Laboratory-1	MTGT-507
2	Laboratory-2	MTGT-508
3	Pre-thesis seminar	MTGT-509
4	Pre-thesis project	MTGT-510
5	Thesis	MTGT-511

List of Program Electives

S. No.	Subjects	Subject Code
1	Soil-Structure Interaction	MTGT-601
2	Rock Mechanics	MTGT-602
3	Geosynthetic Engineering	MTGT-603
4	Structural Design of Foundations	MTGT-604
5	Clay Mineralogy	MTGT-605
6	Retaining Structures	MTGT-606
7	Slope Stability Analysis	MTGT-607
8	Case Histories in Geotechnical Engineering	MTGT-608
9	Earth Anchors	MTGT-609
10	Design of Highway and Airport Pavements	MTGT-610
11	Strength of Materials	MTGT-611
12	Buried Structures	MTGT-612
13	Environmental Impact assessment & Management	MTGT-613
14	Advanced Soil Mechanics	MTGT-614
15	Disaster Reduction and management	MTGT-615
16	Environmental Geotechnology	MTGT-616
17	Ground Improvement	MTGT-617
18	Earthen Embankment	MTGT-618
19	Geomechanics	MTGT-619
20	Highway Materials & Construction	MTGT-620

List of subjects to be offered as ‘Open Electives’

1	Experimental Methods in Engineering	MTCE-621
2	Numerical Methods in Engineering	MTCE-622
3	Instrumentation and model simulation	MTCE-623
4	Advanced Engineering Mathematics	MTCE-624
5	Probabilistic Methods in Engineering	MTCE-625
6	Limit Analysis	MTCE-626

MTGT-501: Soil Dynamics

Internal Marks: 50
External Marks: 100
Total Marks: 150

Course Credits --4

L	T	P
4	0	0

Course Content

1. Introduction: Nature of dynamic loads, Stress conditions on soil, Elements under E.Q. loading (basic concepts only), Fundamentals of theory of vibrations-simple harmonic motion, Response of SDOF system-Vibration analysis procedure- Free and forced vibration with and without damping. Adverse effects of Seismic hazard and Site improvement methods for mitigation of earthquake hazards.
2. Dynamic Bearing Capacity: General, Failure Zones & Ultimate Bearing capacity criteria for satisfactory action of footing. Introduction to bearing capacity and settlement analysis under earthquake loading- Seismic design considerations, Codal provisions,
3. Dynamic response of Retaining wall: Seismic design consideration of Retaining Walls during Earth Quakes, Modification of Coulomb's Theory, Indian standard code of Practice.
4. Liquefaction of Soils: Soil liquefaction - Criterion and Factor Affecting Liquefaction, Susceptibility, initiation and effects of soil liquefaction, Laboratory and Field methods for estimation of liquefaction potential- CSR and CRR. Liquefaction behaviors of dense sand.
5. M/C Foundations: Introduction, Design criteria for satisfactory M/C foundation as per IS codes, Methods of analysis- Linear elastic weightless spring and elastic half space theory approach. Design of Block Foundation for reciprocating engine and low speed machines. Vibration Isolation techniques & Screening of Waves.

References

1. Robert W Day. Geotechnical Earthquake Engineering Handbook, McGraw Hill, New York. 2007
2. Kramer, S. Geotechnical Earthquake Engineering, Pearson, New Delhi. 1995
3. Ishihara, K. Soil Behaviour in Earthquake Geotechnics, Oxford Science, NY. 1996
4. Lkuo Towhata, Geotechnical Earthquake Engineering, Springer, NY. 1995
5. Bharat Bhusan Prasad Fundamental of Soil Dynamics and Earth quake Engineering, PHI, 2005
6. Prakash S and Puri, Foundations for Machines: Analysis and design, Wiley, New York, 1988.
7. Braja M. Das and G.V. Ramana Principle of Soil Dynamics, Cengage Learning . 2010.
8. Swami Saran, Soil Dynamics and machine foundations, Galgotia Publishers, New Delhi, 1997.
9. Murthy V. N. S, Soil Mechanics and Foundation Engineering CBS Publishers & Distributors, New Delhi, 2009.

Note: All relevant Indian Standards are allowed in the Examination.

MTGT-502 Advance Foundation Engineering

Course Credits --4

Internal Marks: 50
External Marks: 100
Total Marks: 150

L	T	P
4	0	0

Shallow Foundation: Terzaghi's bearing capacity equation, General bearing capacity equation, Balla's & Meyerhof's theory, Effect of water table, special footing problems, I.S. Code, Footing pressure for settlement on sand, Soil pressure at a depth, Boussinesq's & westergaard methods, Computation of settlements (Immediate & Consolidation) Permissible settlements, Proportioning of footing, Inclined & Eccentric loads.

Pile Foundation: Timber, concrete, Steel piles, estimating pile capacity by dynamic formula, By wave equation & By static methods, Point Bearing piles, Pile loads tests, Negative skin friction, Modulus of subgrade reaction for laterally loaded piles, Lateral resistance.

Single Pile v/s Pile Groups, Pile group consideration, Efficiency, Stresses on underlying strata, Settlement of pile group, Pile caps, Batter piles, Approximate and exact analysis of pile groups, I.S code.

Well foundation: Types (open end & closed or box, pneumatic, drilled) shapes, Bearing capacity and settlements, Determination of grip length by dimensional analysis, Design of well foundation construction, Tilts & shifts.

Machine Foundations: Types, Analysis and design by Barkens methods, Determination of coeff. of uniform elastic compression, Pauw's analogy and design of a Block type M/C foundation, I.S.I method of design, Co- vibrating soil mass.

Sheet Pile Structure: Types, Cantilever, Anchored sheet piling , Design by Fixed earth Method and modifications by Anderson & Techabotarioff, Anchor Braced sheeting cofferdam , Single well cofferdams, Cellular cofferdam, Stability of cellular cofferdam, Instability due to Heave of bottom.

References

1. Barken, D.D. " Dynamic of Bases and Foundation "
2. Peek Hansen " Foundation Engineering and Thornolour"
3. Leaconards " Foundation Engineering "
4. Bowles " Foundation Design"
5. Rechartetal "Vibration of Soils - Foundations."

MTGT-503: Applied Soil Mechanics

Internal Marks: 50
External Marks: 100
Total Marks: 150

Course Credits --4

L	T	P
4	0	0

1. Introduction to stability of slopes, Stability number, Friction circle, Bishop's method of slices-simple and rigorous; Wedge method, Factor of safety w.r.t height and strength.
2. Earth work construction, Embankments, Earth dams, Field compaction, Seepage and piping in embankments and dams construction problems.
3. Stabilisation of soils: Mechanical, Electrical and Chemical methods of stabilisation, Problems of excavation, Dewatering, Stability of base and embankment.
4. Arching in Soil & underground culvert and conduits.
5. Swell and shrinkage, Soils characteristics, swelling pressure of soils, Mechanics of Swelling, Crack.
6. Design of open cuts.

References:

1. "Soil Mechanics", Lambe & Whitman, Wiley Publisher
2. "Soil Mechanics and Foundation Engineering", Dr. K R Arora, Standard Publisher Distributors, New Delhi
3. "Applied Soil Mechanics", Braja M Das
4. "Fundamentals of Soil Mechanics", D W Taylor

MTGT – 504 Research Methodology

Course Credits --4

Internal Marks: 50
External Marks: 100
Total Marks: 150

L	T	P
4	0	0

OVERVIEW OF RESEARCH

Nature and Objectives of research; historical, descriptive and experimental. Study and formulation of research problem. Scope of research and formulation of hypotheses; Feasibility, preparation and presentation of research proposal

METHODS OF DATA COLLECTION

Primary data and Secondary Data, methods of primary data collection, classification of secondary data,

SAMPLING METHODS

Probability sampling: simple random sampling, systematic sampling, stratified sampling, cluster sampling and multistage sampling. Non-probability sampling: convenience sampling, judgement sampling, quota sampling. Sampling distributions.

PROCESSING AND ANALYSIS OF DATA

Statistical measures and their significance: Central tendencies, variation, skewness, Kurtosis, time series analysis, correlation and regression, Testing of Hypotheses :Parametric (t, z and F) Chi Square, ANOVA. Measures of central tendency and dispersion: mean, median, mode, range, mean deviation and standard deviation. Regression and correlation analysis.

DESIGN OF EXPERIMENTS:

Basic principles, study of completely randomized and randomized block designs. Edition and tabulation of results, presentation of results using figures, tables and text, quoting of references and preparing bibliography.

Note: Application and use of various software for case studies should essential be covered in the lectures.

References:

Levin, R.I. and Rubin, D.S., Statistics for Management, 7th Edition, Pearson Education: New Delhi.

Malhotra, N.K., Marketing Research An Applied Orientation, 4th Edition Pearson Education: New Delhi.

Zikmund, W.G., Business Research Methods, 7th Edition, Thomson South-Western.

Krishnaswami, K.N., Sivakumar, A. I. and Mathirajan, M., Management Research Methodology, Pearson Education: New Delhi.

Kothari C.R., Research Methodology Methods and techniques by, New Age International Publishers, 2nd edition

MTGT 505: Analysis of Settlement of Soils & Foundations

Course Credits --4

Internal Marks: 50

L T P

External Marks: 100

4 0 0

Total Marks: 150

Stress Strain Relation; Evaluation of parameters, types of settlements- elastic and inelastic, Method for estimation; Consolidation theories- one and three dimensional.

Settlement of footings- isolated footings, strip footing, Rafts, Piles and piles groups, Analysis of foundation Soil system.

References

1. Leonards- "Foundation Engineering"
2. Das Braja M _- "Advanced Soil Mechanics"
3. Lambe & Whitman -"-Soil Mechanics"

MTGT-506: Site Investigations

Course Credits --4

Internal Marks: 50
External Marks: 100
Total Marks: 150

L	T	P
4	0	0

1. Soil formation -Processes – Characteristics of major soil deposits of India. Necessity and Importance of soil exploration Method of sub surface exploration Test pits , Trenches, Caissons, Tunnels and drifts, Wash boring , Percussion drilling , Rotary drilling, Factors affecting the selection of a suitable method of boring. Extent of boring, Factors controlling spacing and depth of bore holes, Spacing and depth for various Civil engineering structures.
2. Indirect method of exploration, Seismic method, Electrical resistivity, Resistivity sounding and profiling, Qualitative and quantitative interpretation of test results, Comparison of resistivity and seismic surveys, Shortcomings.
3. Stabilization of bore holes, Different method of stabilisation of the bore holes, their relative merits and demerits.
4. Ground water Observation: Different method of ground water observation: Time lag in observation, Sampling of ground water.
5. Sampling: Source of disturbance and their influence, Type of sampler, Principle of design of sampler, Representative and undisturbed sampling in various types of soils, Surface sampling, Amount of sampling, Boring and sampling record, Preservation and shipment of sample preparation of bore log.
6. In situ Permeability. Pumping in test in a cased hole with open end, Falling head packer test constant head packer test, Pump in out tests in a single test wall and open pit or unlined hole. Piezometer methods .
7. Water content at site: Speedy moisture tester, Their relative merits and demerits.
8. Fields Tests: Standard penetration test, Dynamic cone penetraion tests with and without bentonite mud slurry. Static cone penetration test, Surface sampling. Cyclic plate load test, Large shear box test, Vane shear test, Pile load, , Block resonance test, wave propagation test. Small size penetrometers, Pressuremeter test and Dilometer test. Various corrections in the test results and interpretation of test results for design of foundations. Correlation among various test results. Precautions to be exercised during the execution of these tests. Preparation of bore hole log.
9. Investigation below sea/river bed – methods and equipments – interpretation of offshore exploration, Instrumentation in soil engineering - strain gauges - resistance and inductance type - load cells, earth pressure cells - settlement and heave gauges - piezometers and slope indicators - inclinometer, Field visit, data and report preparation.

References

1. Hvorsler M. "Subsurface exploration and sampling of soil for Civil Engg. purposes.
2. Simon and Cayton " Site investigation"

MTGT-507: Laboratory-1

Internal Marks: 100
External Marks: 50
Total Marks: 150

Course Credits --2

L	T	P
0	0	4

- 1) Algorithm/flow chart for various geotechnical engineering problems using spread sheet, C++ etc.
- 2) Stability analysis using various softwares such as GEO5, PLAXIS etc
- 3) Bearing Capacity of shallow and deep foundations using software such as GEO5, PLAXIS etc.
- 4) Settlement analysis of shallow and deep foundations using software such as GEO5, PLAXIS etc.
- 5) Analysis of soil-structure interaction problems such as piled-raft, laterally loaded piles, sheet piles etc.
- 6) Analysis of ground improvement problems such as soil nailing, use of geogrids/geosynthesis etc

MTGT-508 Laboratory-2

Course Credits --2

Internal Marks: 50
External Marks: 50
Total Marks: 100

L	T	P
0	0	4

1. Relative Density of sand Test
2. Proctor Compaction Test
3. CBR Test
4. Permeability of Clay/ Sand Soils.
5. Free Swell, Swell Potential, Swell Pressure Test
6. Standard Penetration Test
7. Dynamic Cone Penetrometer Test
8. Bearing capacity of footing in Soil box- isolated footings, pile and piled-raft footings
9. Analysis of cuts and slopes

MTGT-604: Structural Design of Foundations

Internal Marks: 50
External Marks: 100
Total Marks: 150

Course Credits --3

L	T	P
3	0	0

Shallow Foundation

Design of footing e.g. isolated footing in B.B.C. and steel grillage, combined footings of rectangular, Trapezoid cantilever types. Mat or raft foundation for dry and saturated soil, floating foundations

Deep Foundation

Design of Piles, Pile caps and pile foundations buildings, Design of retaining structures

Earth Retaining Structures

Design of retaining walls for dry and saturated back fills with surcharge loads. Retaining walls resting on piles, Design of bridge abutments, Design of sheet piles used for coffer dams , Design of sheeting bracing in excavation trenches ,

Special Structures

Design of foundation for transmission Design of basement walls, Bridges structures Analysis and Design: Design of walls foundation and caissons of different types, Design of bridge piers resting on piles.

References:

1. "Advanced RCC Design" Pillai & Mennon, Tata MacGraw Hill
2. "Advanced Design of Structures", N. Krishna Raju
3. "Limit State Design", A.K. Jain
4. "Limit state Design of Reinforced Concrete"; Varghese P C; Prentice-Hall of India Pvt. Ltd".
5. "Reinforced Concrete and masonry Structures", Hool and kinne

MTGT– 616 Environmental Geotechnology

Course Credits --3

Internal Marks: 50
External Marks: 100
Total Marks: 150

L	T	P
3	0	0

Books:- Introduction and soil mineralogy: Scope of environmental geotechnology and its applications, Soil Formation, Composition and Structure: Introduction, Soil formation, Solids composition and characterization, Mineral composition, Different scales of soil structure, Structural variations due to consolidation and compaction, Role of Composition and soil structure in the engineering behavior of soils.

Contamination in soils: Subsurface contamination, Mass transport mechanisms, Mass transfer mechanisms, Governing equation for mass transport, Soil as a geotechnical trap, effects of subsurface contamination its detection and monitoring.

Mechanisms of soil-water interaction: Diffuse double layer and simple DDL models; Force of attraction and repulsion; Soil-water-contaminant interaction; Effect of contaminants on engineering properties of soil.

Site investigation: Introduction, Site investigation approach, phase investigations, Geophysical techniques, Hydro-geological investigations, Hydro-geochemical investigations, Geochemical data collection and analysis.

Concepts of waste containment facilities: Desirable properties of soil; contaminant transport and retention; containment of solid waste in landfills, environmental impact of slurry waste and containment of slurry wastes, contaminated site remediation.

Case histories: Case histories on geoenvironmental problems pertaining to use of readily available local soils, bioremediation of spills etc.

Books:-

1. Mitchell, J.K. and Soga, K., Fundamentals of Soil Behaviour, John Wiley & Sons, Inc., New Jersey., 2005
2. Reddy, L.N. and Inyang. H. I., Geoenvironmental Engineering –Principles and Applications, Marcel Dekker, Inc., New York., 2000
3. Mohamed, A.M.O. and Antia, H.E., Geoenvironmental Engineering, Elsevier, Netherlands., 1998
4. Hsai_Yang Fang and Daniels, J.L. Introductory Geotechnical Engineering an Environmental Perspective, Taylor & Francis, Oxon., 2006
5. Yong, R. N., Geoenvironmental Engineering: Contaminated Soils, Pollutant Fate and Mitigation”, CRC press LLC, Florida., 2001.
6. Fang, H.Y, Introduction to Environmental Geotechnology, CRC Press, 1997.
7. “ Proceedings of the International symposium of Environmental Geotechnology (Vol. I and Vol. II) “,4. Environmental Publishing Co., 1986 and 1989

MTGT – 617 Ground Improvement

Internal Marks: 50
External Marks: 100
Total Marks: 150

Course Credits --3

L	T	P
3	0	0

1. Introduction , Economic considerations, Consolidation by preloading and sand drains , Strengthening by granular columns and lime columns, Compaction by vibro - flotation, Blasting , Dynamic consolidation, Grouting techniques and principles grounds anchors , Reinforced earth construction Geo- textiles Problems.

2. Stabilization: Mechanical, Lime, Cement, Resins & Other Chemicals.

References:

1. M.P. Moasley "Ground Improvement"
2. P. Purushothama Raj "Ground Improvement"
3. Das Braja M. "Principles of foundation Engineering"

MTGT-619 Geomechanics

Course Credits --3

Internal Marks: 50
External Marks: 100
Total Marks: 150

L	T	P
3	0	0

1. Superficial deposits. weathering and erosion processes, Mechanism involved , Detailed description of the resulting geomorphologic feat covering weather effects river actions ,Sea action , Wind action and ice action, Their origin, Mechanism involved and engineering significance.
2. Detailed geologic and physiographic account of extra peninsular India and Indo gangetic Plains.
3. Study of important Rock: forming minerals, Quartz group, Mica, Feldspar group, Pyroxene group, Amphibole group and miscellaneous mine of common occurrence. Structures and texture of the main rock group geological and engineering characteristics of the important rock by: Microscopic study of important rock and minerals including preparation of thin sections.
4. Geotectonics: North movement, Diastrophism, Oscstasy and central drafts, formation of major structural feature in rock folds. Faults, Joints and unconformities, their effects on cut crops mechanism involved, Their engineering significance.
5. Rock as a constructional materials: sand and gravel characteristics of aggregates, Stability of slopes and cutting, Landslides and Landoidence. Geological exploration of engineering sites. Geological investigation in the case of Dams and Reservoirs Canals. Building foundation and highways.
6. Earthquakes: Mechanism involved; Geological consideration for construction; Reservoir related earthquakes.
7. Groundwater: Ground water investigation in Civil engineering, Ground water provinces in India.
8. Geological Mapping: Interpretation of geological mapping sections.

References:

1. Leggey "Engg. Geology"
2. Slyth "Engg Geology"
3. D.S. Arora "Geology for Engineers"

MTGT 620 Highway Materials and Construction

Course Credits --3

Internal Marks: 50
External Marks: 100
Total Marks: 150

L	T	P
3	0	0

Subgrade Soil:- significance, characteristics of soil, desirable properties, Index Properties, Soil classification based on grain size, IS soil classification, GI of soil, Subgrade strength, Evaluation of soil strength- Direct Shear Test, Triaxial Comp. test, UCS test, plate bearing test, Modulus of subgrade reaction, CBR Test.

Stone Aggregates:- Introduction, desirable properties, crushing test, impact test, soundness test, shape test, specific gravity & water absorption, bitumen adhesion test.

Bituminous Materials:- Introduction, types of bitumen materials, desirable properties, penetration test, ductility test, viscosity test, float test, specific gravity test, softening point test, flash & fire point test, solubility test, spot test, loss on heating test, water content test, Cutback bitumen, bitumen emulsion, tar.

Bituminous Paving Mixes:- Requirements of bituminous mixes, design of bituminous mix, Marshall Method of bituminous mix design, modified Hubbard field method of bituminous mix design, Hveem method of bituminous mix design.

Bituminous Pavement Construction:- Introduction, types of pavement construction, excavation equipments, embankment construction, preparation of subgrade, compaction equipments, field control for compaction, construction of earth roads, construction of gravel roads, construction of WBM roads, construction of bituminous pavements, Bituminous construction procedures.

Cement Concrete Pavement Construction:- Introduction, Mix design, concrete strength, size of aggregates & gradation, workability, construction of cement concrete pavement slab, construction of joints, joints filler & sealer, pre-stressed concrete pavements.

References:

1. Atkins, N. Harold, Highway Materials, Soils and Concretes, Fourth Edition, 2002, Prentice-Hall.
2. Kerbs Robert D. and Richard D. Walker, Highway Materials, McGraw-Hill, 1971.
3. Relevant IRC and IS Codes of Practices (Separate List will be given).
4. Read, J. And Whiteoak, D., "The Shell Bitumen Handbook", Fifth edition, Shell Bitumen, Thomas Telford Publishing, London 2003
- 5 Relevant IRC and IS codes

MTCE-622: Numerical Methods in Engineering

Course Credits --3

Internal Marks: 50
External Marks: 100
Total Marks: 150

L	T	P
3	0	0

1. Equation: Roots of algebraic transcendental equation, Solution of linear simultaneous Equations by different methods using Elimination, Iteration, Inversion, Gauss-Jordan and Gauss Siedel iteration method – Factorisation method – Ill conditioned matrix. Numerical integration: Newton Cotes closed quadrature – Trapezoidal rule – Simpson's $1/3^{\text{rd}}$ rule – $3/8^{\text{th}}$ rule method. Homogeneous and Eigen Value problem, Non-linear equations, Interpolation.
2. Finite Difference Technique: Partial differential equation: Laplace, Poisson and wave equation – Explicit and implicit methods. Initial and Boundary value problems of ordinary and partial differential equations, Solution of Various types of plates and other civil engineering related problems
3. Statistical Methods: Method of correlation and Regression analysis for fitting a polynomial equation by least square
4. Initial Value problem: Galerkin's method of least square, Initial Value problem by collocation points, Runge kutta Method

References:

1. James B. Scarborough: Numerical Mathematical Analysis, Oxford and IBH Publishing, 1955.
2. S.S. Sastry : Introductory Methods of Numerical Analysis, PHI Learning (2012).
3. J.B Dixit : Numerical Methods, USP (Laxmi publication),
4. Akai T J: Applied Numerical methods for Engineers, John Wiley & Sons New York, 1994
5. Chapra S.C. and Canale R.P. Numerical methods for Engineers, Tata Mc.Graw Hill Publishing Co. Ltd., New York, 1985
6. Gerald: Applied Numerical Analysis, Pearson Education, New Delhi ,2003
7. Krishnamurthy E V and Sen S. K. :Numerical algorithms, East- West Press Pvt Ltd., New Delhi. 1986
8. Rajasekharan S. Numerical methods in Science and Engineering , Wheeler & Co. Pvt. Ltd., New Delhi. 1986
9. Rao S.S. *Optimisation theory and applications*, Wiley Eastern Ltd., New York. 1979