RAJASTHAN TECHNICAL UNIVERSITY
KOTA

COURSE SCHEME AND SYLLABUS

M. TECH.
GEOTECHNICAL ENGINEERING
w.e.f. SESSION 2020-21

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

M. Tech in GEOTECHNICAL ENGINEERING

Course Scheme Structure I Year

Semester I

S. No	Course Type	Course Code	Course Name	Contact			Marks				Credits
				L	T	P	Exam Hrs	IA	ET E	Total	
1	PCC	1MGT1-01	Advanced Soil Mechanics	3	0	0	3	30	70	100	3
2	PCC	1MGT1-02	Advanced Foundation Engineering	3	0	0	3	30	70	100	3
3	PEC	1MGT2-11	Soil Structure Interaction	3	0	0	3	30	70	100	3
		1MGT2-12	Ground Improvement Techniques								
		1MGT2-13	Pavement Analysis and Design								
4	PEC	1MGT2-14	Numerical and Analytical Methods in Geomechanics	3	0	0	3	30	70	100	3
		1MGT2-15	Environmental Geotechnology								
		1MGT2-16	Crititcal Soil Mechanics								
5	MCC	1MCC3-21	Research Methodology and IPR	2	0	0	2	30	70	100	2
6	PCC	1MGT1-06	Geotechnical Lab –I	0	0	4	4	60	40	100	2
7	PCC	1MGT1-07	Geotechnical Lab –II	0	0	4	4	60	40	100	2
8	SODECA	1MGT5-00	Social Outreach Discipline & Extra Curriculum Activities							100	2
			Total	**14**	**0**	**8**		**270**	**430**	**800**	**20**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA,

M. Tech in GEOTECHNICAL ENGINEERING

Course Scheme Structure I Year

Semester II

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ET E	Total	
1	PCC	2MGT1-01	Dynamics of soils and foundations	3	0	0	3	30	70	100	3
2	PCC	2MGT1-02	Subsurface investigations and Instrumentation	3	0	0	3	30	70	100	3
3	PEC	2MGT2-11	Marine Geotechniques	3	0	0	3	30	70	100	3
		2MGT2-12	Computational Geomechanics								
		2MGT2-13	Rock Engineering								
4	PEC	2MGT2-14	Earth Retaining Structures	3	0	0	3	30	70	100	3
		2MGT2-15	Design of Underground Excavations								
		2MGT2-16	Physical and Constitutive Modelling on Geomechanics								
5	MCC	2MCC3-XX	Audit Course-I	2	0	0		0	0	0	
6	PCC	2MGT1-06	Geotechnical Lab –III	0	0	4	4	60	40	100	2
7	PCC	2MGT1-07	Geotechnical Lab –IV	0	0	4	4	60	40	100	2
	REW	2MGT4-50	Mini Project with Seminar	0	0	4	4	60	40	100	2
8	SODECA	2MGT5-00	Social Outreach Discipline & Extra Curriculum Activities							100	2
			Total	**12**		**12**		**300**	**400**	**800**	**20**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

M.Tech. in GEOTECHNICAL ENGINEERING

Course Scheme Structure II Year

Semester III

S. No	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ET E	Total	
1	PEC	3MGT2-11	1. Stability Analysis of Slopes	3	0	0	3	30	70	100	3
		3MGT2-12	2. Foundation on Weak Rocks								
		3MGT2-13	3. Geotechnical Earthquake Engineering								
2	MCC	3MCC3-XX	Open Elective	3	0	0	3	30	70	100	3
3	MCC	3MCC3-XX	Audit Course-II	2	0	0					
4	REW	3MGT4-60	Dissertation-I / Industrial Project	0	0	20		240	160	400	10
			Total					**300**	**300**	**600**	**16**

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M. Tech in GEOTECHNICAL ENGINEERING

Course Scheme Structure II Year

Semester IV

SN	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Cr
				L	T	P	Exm Hrs	IA	ETE	Total	
1	REW	4MGT4-70	Dissertation-II	0	0	32		360	240	600	16
			Total					**360**	**240**	**600**	**16**

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Course Syllabus

M. Tech – I Year – I Sem. (Geo. Engg.)

1MGT1-01: Advanced Soil Mechanics

S. N.	Course Content	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**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 Taylors method)	7
3	**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.	8
4	**Stress path;** Drained and undrained stress path; Stress path with respect to different initial state of the soil; Stress path for different practical situations.	8
5	**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.	8
6	**Earth pressure:** Rankine, Columb and Graphical Methods, Retaining walls structures, Gravity cantilever and counter fort retaining walls, Stability checks and design.	8
	Total	**40**

Text Books:

1. Advanced Soil Mechanics by Braja M. Das
2. Basic and applied soil mechanics by Gopal Ranjan, A S R Rao

Reference Books:

1. Atkinson, J.H. and Bransby, P.L, The Mechanics of Soils: An introduction to Critical soil mechanics, McGraw Hill, 1978.
2. Atkinson J.H, An introduction to the Mechanics of soils and Foundation, McGraw- Hill Co., 1993. Das, B.M., Advanced Soil Mechanics, Taylor and Francis, 2nd Edition, 1997.
3. Wood, D.M., Soil Behavior and Critical State Soil Mechanics, Cambridge University Press, 1990. Craig, R.F., Soil Mechanics, Van Nostrand Reinhold Co. Ltd., 1987.
4. Terzaghi, K., and Peck, R.B., Soil Mechanics in Engineering Practice, John Wiley & Sons, 1967. Lambe, T.W. and Whitman, R.V., Soil Mechanics, John Wiley & Sons, 1979.

1MGT1-02: Advanced Foundation Engineering

S. N.	Course Content	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**Planning of soil exploration** for different projects, methods of subsurface exploration, methods of borings along with various penetration tests	7
3	**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.	8
4	**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.	8
5	**Well foundation**, IS and IRC codal provisions, elastic theory and ultimate resistance methods	8
6	**Foundations on problematic soils:** Foundations for collapsible and expansive soil.	8
	Total	**40**

Text books:

1. Advanced Foundation Engineering by V.N.S Murthy
2. Arora. K.R. Soil Mechanics and Foundation Engineering,6th Edition ,Standard Publishers Distributors, Delhi.

References 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 HallPublication, 1994.
4. Poulos, H. G. and Davis, F. H., “Pile Foundation Analysis and Design”, Wiley and Sons. 1988

1MGT2-11: SOIL STRUCTURE INTERACTIONS

S. No.	Contents	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**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.	7
3	**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 t their stiffness.	8
4	**Plate on Elastic Medium**: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.	8
5	**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.	8
6	**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.	8
	Total	**40**

Textbooks:

1. Gulhati, S. K. And Datta, M. J. Geotechnical Engineering, Tata McGraw-Hill Publ. Co. Ltd., New Delhi, 2005.
2. Numerical Methods in Geotechnical Engineering" by C S Desai and J T Christian

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. ACI 336. (1988), Suggested Analysis and Design Procedures for combined footings and Mats.

1MGT2-12: GROUND IMPROVEMENT TECHNIQUES

S. No.	Contents	Contact Hours
1	**Introduction:** situations where ground improvement becomes necessary	1
2	**Mechanical modification:** dynamic compaction, impact loading, compaction by blasting, vibro-compaction	7
3	**Pre-compression And Stone columns:** Preloading with and without vertical drains. Compressibility, vertical and radial consolidation, preloading methods. Types of Drains, Design of vertical Drains, construction techniques. Stone Column: Function Design principles, load carrying capacity, construction techniques, settlement of stone column foundation	8
4	**Chemical modification And Thermal modification:** modification by admixtures, stabilization using industrial wastes, grouting, ground freezing and thawing.	8
5	**Soil reinforcement:** Reinforced earth, basic mechanism, type of reinforcements, selection of stabilisation/improvement of ground using Geotextiles, Goegrid, geomembranes, geocells, geonets, and soil nails.	8
6	**Application of soil reinforcement:** shallow foundations on reinforced earth, design of reinforced earth retaining walls, reinforced earth embankments structures, wall with reinforced backfill.	8
	Total	**40**

Text books:

1. Ground Improvement Techniques by Dr. P. Purushothama Raj
2. Selvadurai, A.P.S, Elastic Analysis of Soil-Foundation Interaction, Elsevier, 1979.
3. Poulos, H.G., and Davis, E.H., Pile Foundation Analysis and Design, John Wiley,1980.

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.

1MGT2-13: PAVEMENT ANALYSIS AND DESIGN

S. No.	Contents	Contact Hours
1	Philosophy of design of flexible and rigid pavements,	1
2	Analysis of pavements using different analytical methods,	7
3	selection of pavement design input parameters – traffic loading and volume,	8
4	material characterization, drainage, failure criteria, reliability,	8
5	design of flexible and rigid pavements using different methods	8
6	comparison of different pavement design approaches, design of overlays and drainage system.	8
	Total	**40**

COURSE OUTCOME

- The students will be able to design flexible as well rigid pavements.

Text books:

1. Pavement Analysis and Design by Yang. H. Huang. Pearson Publications
2. Teng, Functional Designing of Pavements, McGraw- Hill, 1980

Reference Books:

1. Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.
2. Sharma and Sharma, Principles and Practice of Highway Engg., Asia Publishing House, 1980.

1MGT2-14: NUMERICAL AND ANALYTICAL METHODS IN GEOMECHNICS

S. No.	Contents	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	Introduction to numerical techniques, finite difference, finite element and boundary element methods.	7
3	Beams on elastic foundation, unlimited extent, semi infinite extent, finite under various types of loading and their applications.	8
4	Seepage through porous media and its solution through finite difference techniques.	8
5	Numerical solution of three dimensional consolidation.	8
6	Mathematical and mechanical models, Filoneko-Brodich Model, Hitney Model, Pasterneck Model, Elastic continuum approach.	8
	Total	**40**

Text books:

1. M.Hiteny in Analytical and numerical methods book.
2. Numerical Methods for Engineers by Santosh Kumar Gupta.

Reference Books:

1. O.C. Zienkiewicz and R.L. Taylor, Finite element methods Vol I & Vol II, McGraw Hill,1989,1992.
2. K.J. Bathe, Finite element procedures, PHI Ltd., 1996.
3. David M Potts and LidijaZdravkovic, "Finite Element Analysis in Geotechnical Engineering Theory and Apllication", Thomas Telford. 1999
4. E.H.Davis and H.G.Polous, Pile Foundation Analysis and Design ,John Wiley & sons,Inc.

1MGT2-15: ENVIRONMENTAL GEOTECHNOLOGY

S. No.	Contents	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**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.	7
3	**Soil mineralogy**; significance of mineralogy in determining soil behavior; Mineralogical characterization.	8
4	**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.	8
5	**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.	8
6	**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	8
	Total	**40**

Text books:

1. Environmental Geology by K.S Valdiya
2. Fang, H-Y., Introduction to Environmental Geotechnology, CRC Press,1997.

Reference books:

1. Mitchell, J.K and Soga, K., Fundamentals of Soil Behavior, John Wiley and Sons Inc., 2005.
3. Daniel, D.E, Geotechnical Practice for Waste Disposal, Chapman and Hall, 1993.
4. Rowe, R.K., Quigley, R.M. and Booker, J.R., Clay Barrier Systems for Waste Disposal Facilities, E & FN Spon, 1995.
5. Rowe, R.K, Geotechnical and Geoenvironmental Engineering Handbook,Kluwer Academic Publishers, 2001.

1MGT2-16: CRITICAL SOIL MECHANICS

S. No.	Contents	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**Soil Behavior**: State of stress and strain in soils, Stress and strain paths and invariants, behavior of soils under different laboratory experiments	7
3	**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	8
4	**Behavior of Overconsolidated samples**: The Hvorslev surface: Behaviour of overconsolidated samples, drained and undrained tests, The Hvorslev surface, complete State Boundary Surface, Volume changes and pore water pressure changes	8
5	**Behaviour of Sands**: The critical state line for sands, Normalized plots, the effect of dilation, Consequences of Taylor's model	8
6	**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.	8
	Total	**40**

Text books:

1. KR Arora, Soil mechanics and foundation engineering
2. Lambe T W. and Whitman R V, "Soil Mechanics", John Wiley & sons ,2008
3. Murthy V. N. S , "Principles of Soil Mechanics and Foundation Engineering", UBS Publishers Private Ltd. , 2002

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, 2010

1MGT1-06: Geotechnical Lab-I (Soil Mechanics-I)

List of Practicals:

S No.	Experiments
1	To determine the moisture content of the given soil by Oven Drying method
2	To determine the wet grain size distribution analysis of the given soil by Sieving.
3	To determine the specific gravity of a coarse grained soil sample by Pycnometer method.
4	To determine the liquid Limit by using Casagrande apparatus, Plastic limit and Shrinkage limit of the soil.
5	To classify the soil by Visual Classification Tests.
6	To determine the relative density of given coarse grained material by Vibration test of sand.
7	To determine the water content – dry density relationship for a given soil by Indian Standard light compaction test and hence, to obtain optimum moisture content and maximum dry density for the given soil.
8	To determine the water content – dry density relationship for a given soil by Indian Standard heavy compaction test and hence, to obtain optimum moisture content and maximum dry density for the given soil.
9	To determine the coefficient of permeability of the given soil sample by variable head permeability test.
10	To determine the coefficient of permeability of the given soil sample by constant head permeability test.

1MGT1-07: Geotechnical Lab-II (Soil Mechanics-II)

List of Practicals:

S No.	Experiments
1	To determine percentage silt and clay fractions of the given soil sample by hydrometer analysis.
2	To determine the shearing strength of the Soil sample using the direct shear apparatus.
3	To determine the settlement due to primary consolidation of soil by conducting one dimensional test.
4	To determine the undrained shear strength, of a given cohesive soil using laboratory vane shear apparatus.
5	To determine the unconfined compressive strength test of clayey soil sample
6	To determine the indirect measurement of tensile strength of rock by Brazilian test.
7	To find the shear of the soil by Unconsolidated - Undrained Triaxial Test (UU)
8	To find the shear of the soil by Consolidated - Undrained Triaxial Test (CU)
9	To find the shear of the soil by Consolidated - Drained Triaxial Test (CD)
10	To measure the shear strength properties of rock material by direct shear test.

1MCC3-21: RESEARCH METHODOLOGY & IPR

S. No.	Contents	Contact Hours
1	**INTRODUCTION :** Objective, scope and outcome of the course	1
2	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.	5
3	Effective literature studies approaches, analysis Plagiarism, Research ethics	6
4	Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee	6
5	**Nature of Intellectual Property:** Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	6
6	**Patent Rights: Scope of Patent Rights.** Licensing and transfer of technology. Patent information and databases. Geographical Indications. **New Developments in IPR:** Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies.	6
	Total	**30**

Recommended Text books

1. C.R Kothari, Research Methodology, Methods & Technique, New Age International Publishers, 2004.
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011.
3. Ratan Khananabis and Suvasis Saha, Research Methodology, Universities Press, Hyderabad, 2015
4. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students".
5. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
6. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"

Reference Books:

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
2. Mayall, "Industrial Design", McGraw Hill, 1992.
3. Niebel, "Product Design", McGraw Hill, 1974.
4. Asimov, "Introduction to Design", Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

2MGT1-01: DYNAMICS OF SOILS AND FOUNDATIONS

S. N.	Course Content	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**Fundamentals of vibrations:** single, two and multiple degree of freedom systems, vibration isolation, vibration absorbers, vibration measuring instruments	7
3	**Liquefaction of soils:** liquefaction mechanism, factors affecting liquefaction, studies by dynamic tri-axial testing, oscillatory shear box, shake table and blast tests, assessment of liquefaction potential.	8
4	**Dynamic elastic constants of soil:** determination of dynamic elastic constants, various methods including block resonance tests, cyclic plate load tests, wave propagation tests, oscillatory shear box test.	8
5	**Machine foundations:** Design criteria for machine foundations; Elastic homogeneous half space and lumped parameter solutions, analysis and design of foundations for reciprocating and impact type machines, turbines, effect of machine foundation on adjoining structures.	8
6	**Bearing capacity of foundations:** Introduction to bearing capacity of dynamically loaded foundations, such as those of water towers, chimneys and high rise buildings, response of pile foundations.	8
	Total	**40**

Textbooks:

1. Das, B.M., "Fundamentals of Soil Dynamics", Elsevier,1983.
2. Steven Kramer, "Geotechnical Earthquake Engineering", Pearson,2008.
3. Prakash, S., Soil Dynamics, McGraw Hill, 1981.

Reference Books:

1. Kameswara Rao, N.S.V., Vibration analysis and foundation dynamics, Wheeler Publication Ltd., 1998.
2. Richart, F.E. Hall J.R and Woods R.D., Vibrations of Soils and Foundations, Prentice Hall Inc., 1970.
3. Zaruba Q and Mencl V., " Land slides and their control", Developments in Geotechnical Engineering, Vol 31, Elsevier Scientific publishing company, 1982.

2MGT1-02: SUBSURFACE INVESTIGATION AND INSTRUMENTATION

S. No.	Contents	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**LABORATORY TESTS:** Soil classification and identification, organic content, pH value, soluble salts, sulphates, porosity, suction, permeability, capillarity, compaction, consolidation and expansivity. Shear testing, direct shear, unconfined compression, and triaxial compression, pore pressure measurements and vane shear. California Bearing Ratio test. Electrical analogy test.	15
3	**FIELD TESTS:** Permeability, Infiltration, Suction, Density, Shear strength, and Bearing capacity and deformation moduli. Dynamic and Static penetration tests, their applications. Pressure meters. Nuclear devices for moisture and density measurement.	15
4	**INSTRUMENTATION:** For measuring Earth pressure, Pore pressure, Horizontal and Vertical displacements in earth structures and foundations.	9
	Total	**40**

Textbooks:

1. Subsurface Investigation and Instrumentation 3 0 0 6 ... Bowles, J.E, Physical and Geotechnical Properties of Soil, McGraw-Hill Book Company, 1985. 2.
2. Roy E. Hunt - Geotechnical Engineering Investigation Handbook, Second
   Field Instrumentation in Geotechnical Engineering

Reference Books:

1. Bowles, J.E., Foundation Analysis and Design, McGraw-Hill International Edition, 1997.
2. Schnaid, F., " In Situ Testing in Geomechanics", Taylor and Francis.

2MGT2-11: MARINE GEOTECHNIQUES

S. N.	Course Content	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**Marine soil deposits:** Offshore environment, Offshore structures and foundations, Specific problems related to marine soil deposits, Physical and engineering properties of marine soils	7
3	**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	8
4	**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	8
5	**Foundations in marine soil deposits:** Different offshore and nearshore foundations, Gravity platforms, Jack-up rigs, pile foundations. cassions, spudcan	8
6	**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.	8
	Total	**40**

Textbooks:

1. Marine geotechnical investigation, a mature technology by U Dayal - 1986
2. Offshore geotechnical Engineering by Mark Randolph

References:

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

2MGT2-12: COMPUTATIONAL GEOMECHANICS

S. N.	Course Content	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**Solution of Non-linear Equations**: Bisection, False Position, Newton-Raphson, Successive approximation method, Iterative methods	4
3	**Solution of Linear Equations**: Jacobi's method, Gauss Seidal method, Successive over relaxation method.	5
4	**Finite Difference Method**: Two point Boundary value problems – Disichlet conditions, Neumann conditions; ordinary and partial differential equations.	5
5	**Finite Element Method**: Fundamentals, Constitutive finite element models for soils. design of foundations	5
6	**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.	5
7	**One-dimensional Consolidation** - Theory of consolidation, Analytical procedures, Finite difference solution procedure for multilayered systems, Finite element formulation	5
8	**Flow Through Porous Media** - Geotechnical aspects, Numerical methods, Applications and Design analysis, Flow in jointed media.	5
9	**Risk assessment in Geotechnical Engg**. - Probabilistic site characterisation and design of foundations	5
	Total	**40**

Textbooks:

1. Advanced Mathematical and Computational Geomechanics by Kolymbas, D.
2. Computational Geomechanics by Arnold Verruijt

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,

2MGT2-13: ROCK ENGINEERING

S. N.	Course Content	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**ENGINEERING CLASSIFICATION OF ROCKS:** Objectives, Intact rock classification, Rock mass Classification. Terzaghi's, Rock load classification, Austrian classification, Deere's rock quality classification, rock structure rating concept, RMR classification, Q classification. Inter relation between Q and RMR, prediction of ground condition and support pressure. Effect of Tunnel size on support pressure.	7
3	**ENGINEERING PROPERTIES AND LABORATORY TESTS ON ROCKS:** Porosity, Density,Moisture content, Degree of saturation, Co-efficient of permeability, Durability, Compressive strength, Tensile strength, Shear strength, elasticity, Plasticity Deformability. Sampling and Samples Preparations, Uniaxial Compressive strength, Tensile Strength – Brazilian test, Shear strength test – Direct Shear test and Punch shear test, Triaxial Test, Flexural strength.	8
4	**INSITU TESTS ON ROCKS:** Necessity of Insitu test, Plate load test for deformability, Shear test, Test for internal stresses – flat Jack, pressure meter test.	4
5	**STRENGTH OF ROCKS IN UNCONFINED CONDITION:** Ramamurthy Strength Criteria, Singh and Rao Strength Criteria, Kulatilake Methodology, Hoek Criteria, Barton Methodology.	4
6	**STRENGTH OF ROCKS IN CONFINED CONDITION:** History of Hoek and Brown Failure Criterions and latest methodology, Parabolic Strength Criteria.	4
7	**JOINTED ROCKS:**Rocks Joint properties, Joint properties, Joint Roughness Co-efficient, Scale effects, Dilation, Orientation of Joints, Gouge, Joint Intensity, Uniaxial Compressive strength of Jointed Rocks.	8
8	**BEARING CAPACITY OF ROCKS:** Bearing capacity of intact rocks, jointed rocks,IS Code methodology, Singh and Rao Method and latest methodologies.	4
	Total	**40**

Textbooks:

1. Ramamurthy, T., "Engineering in Rocks", PHI Learning Pvt. Ltd.
2. Fundamentals of Rock Mechanics Fundamentals of Rock Mechanics Fourth Edition J. C. Jaeger, N. G. W. Cook, and R. W. Zimmerman Blackwell

References:

1. Hudson J.A. and J.P. Harrison. Engineering Rock Mechanics: an Introduction to the Principles, 1997. Elsevier, Oxford
2. Goodman, R.E. Introduction to Rock Mechanics, John Wiley & Sons.
3. Jaeger, J.C. and Cook, N.G.W, Fundamentals of Rock Mechanics, Chapman and Hall, 1976.
4. Wyllie, D.C., Foundations on Rock, E & FN Spon. 2nd Edition, 1992.

2MGT2-14: EARTH RETAINING STRUCTURES

S. No.	Contents	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**Earth Pressure:** Rankine and Coulomb theories, active, passive and pressure at rest; concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill.	7
3	**Retaining walls:** Proportioning of retaining walls, stability of retaining walls, mechanically stabilized retaining walls/reinforced earth retaining walls	8
4	**Sheet Pile wall:** free earth system, fixed earth system	2
5	**Bulkheads:** bulkheads with free and fixed earth supports, equivalent beam method, Anchorage of bulkheads and resistance of anchor walls, spacing between bulkheads and anchor walls, resistance of anchor plates	8
6	**Tunnel and Conduit:** Stress distribution around tunnels, Types of conduits, Load on projecting conduits; Arching and Open Cuts: Arching in soils.	8
7	**Braced excavations**: Earth pressure against bracings in cuts, Heave of the bottom of cut in soft clays	4
	Total	**40**

COURSE OUTCOME

- The students will be able to do analysis and design of different types of retaining structures

Textbooks:

1. Das, Braja M., "Principles of Foundation Engineering", PWS Publishing. 1998
2. Bowles. J.E., Foundation Analysis and Design, Tata McGraw-Hill International Edition, 5th Edn, 1997.

Reference Books:

1. Koerner, R.M., Design with Geosynthetics (Third Edition), Prentice Hall, 1997
2. Militisky, J. and Woods, R., Earth and Earth retaining structures, Routledge, 1992
3. Rowe, R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kluwer Academic Publishers, 2001
4. Winterkorn, H.F. and Fang, H.Y., Foundation Engineering Handbook, Galgotia Booksource, 2000.

2MGT2-15: DESIGN OF UNDERGROUND EXCAVATIONS

S. N.	Course Content	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	Introduction, planning of and exploration for various underground construction projects, stereographic projection method, principle and its application in underground excavation design.	7
3	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	8
4	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 behavior of tunnels and caverns, New Austrian Tunneling Method (NATM), Norwegian Tunneling Method (NTM),construction dewatering.	8
5	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	8
6	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	8
	Total	**40**

Textbooks:

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

Reference books:

1. Singh, B. and Goel, R.K., "Tunnelling in Weak Rocks", Elsevier
2. Surface and underground excavation by Ratan Raj Tatiya.

2MGT2-16: PHYSICAL AND CONSTITUTIVE MODELLING ON GEOMECHANICS

S. N.	Course Content	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**Role of constitutive modeling**; Importance of laboratory testing with relation to constitutive modeling; Elasticity: linear, quasi linear, anisotropic;	7
3	**Plasticity basics**: yield criteria, flow rule, plastic potential, hardening/softening; Rate Independent Plasticity: mohr-coulomb, nonlinear failure criteria, Drucker Prager, and cap models;	8
4	**Critical state soil mechanics**: critical state concept, cam clay models, simulation of single element test using cam clay,	8
5	**Consolidation,** drained and undrained triaxial test; Stress dilatancy theory;	8
6	**Work hardening plasticity theory**: formulation and implementation; Applications of elasto-plastic models; Special Topics: hypo elasticity-plasticity, disturbed state concept.	8
	Total	**40**

Textbooks:

1. Hicher and Shao, "Constitutive Modeling of Soils and Rocks", John Wiley. 2008
2. C.S. Desai and H. J. Siriwardane, "Constitutive Laws for Engineering Materialswith Emphasis on Geologic Materials", Prentice-Hall, Inc., New Jersey. 1984

Reference books:

1. David M Potts and LidijaZdravkovic, "Finite Element Analysis inGeotechnical Engineering Theory and Application", Thomas Telford. 1999
2. C.S. Desai, "Mechanics of Materials and Interfaces: The Disturbed State Concept",CRC Press LLC. 2000
3. A.P.S. Selvadurai, M.J. Boulon, "Mechanics of Geomaterial Interfaces, Elsevier.
4. Constitutive Modeling of Geomaterials Advances and New Applications, Springer series in Geomechanics and Geoengineering.

2MGT1-06: Geotechnical Lab-III (Sub soil exploration)

List of Practicals:

S No.	Experiments
1	To conduct the soil exploration borings by using auger boring, wash boring,
2	To determine the quantitative estimation of rotary–percussion drilling efficiency in rocks.
3	To determine the relative density and angle of shearing resistance of cohesion less soils and also the strength of cohesive soils by Standard penetration test
4	To estimate soil strength by dynamic cone penetration test.
5	To determine geotechnical properties of soils by Static cone penetration test
6	To measure the shear strength properties of soil or rock material by field Direct Shear Test.
7	To determine the ultimate bearing capacity of soil and settlement of foundation by using plate load test.
8	To determine the modulus of subgrade reaction of rock at site by plate load test.
9	To conduct the Bearing Capacity Test at Rock site.
10	To determine the in situ stress by Flat Jack Technique/test.

2MGT1-07: Geotechnical Lab-IV

(Soil Dynamics & Software Lab)

List of Practicals:

S No.	Experiments
1	To determine the seismic velocity profiles for critical structures by using seismic cross-hole test.
2	To measure travel times of P and S waves by Seismic down-hole / up-hole test.
3	To determine the shear wave velocity by Seismic dilatometer test.
4	To determine the stress strain relations of in-situ soil by using Pressure meter test.
5	To conduct the Geophysical exploration tests of the soil.
6	To evaluate the strength and deformation properties of soil by Cyclic triaxial test
7	To evaluate the properties of soil by Cyclic Simple Shear Test.
8	To determine the unconfined compression test on rock.
9	Software Training on Plaxis Software / Udec Software

2MGT4-50: MINI PROJECT WITH SEMINAR

S No.	Some suggested topics are:
1	Stabilisation Of Expansive Black Cotton Soil – An Experimental Approach
2	Stabilization Of Soft Soils Using Industrial Wastes
3	Study Of Distressed Buildings On Black Cotton Soils
4	Study the Pile-soil relation of a construction site
5	Soil Stabilization With Rice Husk Ash And Lime Sludge
6	Investigation Of Strength Properties Of Black Cotton Soil Stabilised With Fly Ash And Geo Reinforcement

The student can take real time problem, collect data, analyze and present in a seminar.
Latest developments in the area of geotechnical can be studied from literature and presented in the form of seminar

3MGT2-11: STABILITY ANALYSIS OF SLOPES

S. N.	Course Content	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**Slopes:** Types and causes of slope failures, mechanics of slope failure, failure modes.	9
3	**Stability analysis:** infinite and finite slopes with or without water pressures; concept of factor of safety, pore pressure coefficients, Mass analysis, Wedge methods, friction circle method ; Method of slices, Bishop's method, Janbu's method, Morgenstern and Price, Spencer's method	10
4	**Stability analysis in the presence of seepage:** two dimensional flow – Laplace equation and it's solution, graphical method, determination of phreatic line, flow nets in homogeneous and zoned earth dams under steady seepage and draw-down conditions, seepage control in earth dams, influence of seepage on slope stability stability analysis of dam body during steady seepage	10
5	**Strengthening measures:** stabilization of slopes by drainage methods, surface and subsurface drainage, use of synthetic filters, retaining walls, stabilization and strengthening of slopes, shotcreting, rock bolting and rock anchoring, instrumentation and monitoring of slopes, slope movements, warning devices, maintenance of slopes	10
	Total	**40**

Textbooks:

1. Abramson L. W, Lee T. S , Sharma S and Boyce G M , " Slope Stability and Stabilization Methods", Willey Interscience publications,1996
2. Das B M,"Principles of Geotechnical Engineering", Thomson Books, 2004
3. Lambe T W. and Whitman R V, "Soil Mechanics", John Wiley & sons ,2008
4. Murthy V. N. S , "Principles of Soil Mechanics and Foundation Engineering", UBS Publishers Private Ltd. , 2002

References Books:

1. Chowdhary R and ChowdharyI , "Geotechnical Slope Analysis", CRC Press.
2. Harr M.E.," Ground Water and Seepage", McGraw Hill. 1962
3. Zaruba Q and Mencl V., " Land slides and their control", Developments in Geotechnical Engineering, Vol 31, Elsevier Scientific publishing company, 1982.

3MGT2-12: FOUNDATIONS ON WEAK ROCKS

S. N.	Course Content	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	Engineering properties of weak rocks, different rock mass classification systems, relative merits and demerits	7
3	Failure criteria for weak rocks, bi-linear Mohr-Coulomb failure criterion, Hoek and Brown criterion and modified Hoek and Brown failure criterion etc.	8
4	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	4
5	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	8
6	Pressure-settlement characteristics, effect of layering, anisotropy, heterogeneity andin- elasticity	4
7	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	8
	Total	**40**

Textbooks:

1. Piled foundation in weak rocks by Wallace W.A
2. Hudson J.A. and J.P. Harrison. Engineering Rock Mechanics: an Introduction to the Principles, 1997. Elsevier, Oxford

References books:

1. Wyllie Duncan C.," Foundations on Rock: Engineering Practice", E&FN Spon, Taylorand Francis.
2. Singh, B. and Goel, R.K.,"Rock Mass Classification- A Practical EngineeringApproach", Elsevier .
3. Ramamurthy, T., "Engineering in Rocks", PHI Learning Pvt. Ltd.
4. Hoek, E., "Practical Rock Engineering", Rock science.

3MGT2-13: GEOTECHNICAL EARTHQUAKE ENGINEERING

S. N.	Course Content	Contact Hours
1	**Introduction :** Objective, scope and outcome of the course	1
2	**Earthquake seismology** – Causes of earthquake, Plate tectonics, Earthquake fault sources,Seismic waves, Elastic rebound theory, Quantification of earthquake, Intensity and magnitudes, Earthquake source models.	7
3	**Earthquake ground motion** – Seismograph, Characteristics of ground motion, Effect of localsite conditions on ground motions, Design earthquake, Design spectra, Development of sitespecification and code-based design.	8
4	**Ground response analysis** – One-dimensional ground response analysis: Linear approaches,Equivalent linear approximation of non-linear approaches, Computer code "SHAKE"	8
5	Liquefaction and lateral spreading - Liquefaction related phenomena, Liquefactionsusceptibility: Historical, Geological, Compositional and State criteria. Evaluation ofliquefaction by cyclic stress and cyclic strain approaches, Lateral deformation and spreading, Criteria for mapping liquefaction hazard zones.	8
6	Seismic design of foundations, Seismic slope stability analysis: Internal stability and weakening instability and Seismic design of retaining walls.	8
	Total	**40**

Textbooks:

1. Steven Kramer, "Geotechnical Earthquake Engineering", Pearson, 2008.
2. Seco e Pinto, P., Seismic behaviour of ground and Geotechnical structure, A. A.

References books:

1. Naeim, F., The Seismic Design Handbook, Kluwer Academic Publication, 2nd Edition,2001.
2. Ferrito, J.M, Seismic design criteria for soil liquefaction, Tech. Report of Naval Facilities service centre, Port Hueneme, 1997.
3. Encyclopedia of Disasters – Environmental Catastrophes and Human Tragedies, Vol. 1 & 2, Angus M. Gunn, Greenwood Press, 2008