M.Tech. Degree

PROGRAMME

in

SOIL MECHANICS AND FOUNDATION ENGINEERING

(for Session 2019-2020)

GEOTECHNICAL ENGINEERING

(w. e. f. Session 2020-2021)

CURRICULUM

DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
KURUKSHETRA - 136119

VISION AND MISSION OF THE INSTITUTE

VISION OF THE INSTITUTE

To be a role model in technical education and research, responsive to global challenges.

MISSION

To impart technical education that develops innovative professionals and entrepreneurs and to undertake research that generates cutting-edge technologies and futuristic knowledge, focusing on the socio-economic needs.

VISION AND MISSION OF THE DEPARTMENT

VISION OF THE DEPARTMENT

To be a role model in Civil Engineering Education and Research responsive to global challenges.

MISSION

1. To impart quality Civil Engineering Education that develops innovative professional & entrepreneurs.
2. To undertake research that generates cutting-edge technologies & futuristic knowledge, focusing on the socio-economic needs.
3. To prepare professionals with emphasis on leadership, team work and ethical conduct.

VISION AND MISSION OF THE PROGRAMME

VISION OF THE PROGRAMME

To be a role model in Geotechnical Engineering Education and Research responsive to global challenges.

MISSION

1. To impart quality Geotechnical Engineering Education that develops innovative professionals to undertake research/investigations/developmental works independently.
2. To develop professionals with mastery in the geotechnical engineering field to generate cutting-edge technologies & futuristic knowledge, focusing on the socio-economic needs.
3. To prepare professionals with emphasis on leadership, team work, adaption to changing needs and ethical conduct.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. To impart concepts of Geotechnical engineering through the use of analytical techniques, experiments, computer simulation methods, and other modern engineering tools in the analysis and design of variety of civil engineering structures and their components.
2. Dissemination of the recent developments in Geotechnical engineering field through educating the students using updated codal provisions.
3. To develop habit of an individual in critical thinking for analyzing complex problems in Geotechnical engineering field.
4. To develop skill for communicating Geotechnical Engineering concepts effectively in written, graphical, and oral form.
5. Student's capacity building in up-coming areas of research in Geotechnical Engineering.

PROGRAMME OUTCOMES (POs)

The graduates of the programme:

1. shall be able to utilize domain knowledge required for analysing and resolving field problems in Geotechnical engineering.
2. shall have the ability to write and present a substantial technical report of the comprehended problem and its recommended solution.
3. shall demonstrate a definite higher degree of mastery in the comprehension and analysis of Geotechnical engineering problems.
4. shall be equipped with theoretical and practical skills to investigate and undertake complex projects of inter-disciplinary nature with wide impact.
5. shall imbibe social and environmental ethics, readily adapting to ever changing and transforming technical requirements and working towards sustainable development of the society.

Scheme of M.Tech (Civil) (Soil Mechanics and Foundation Engineering - for Session 2019-20)
(Geotechnical Engineering - w.e.f. Session 2020-21)

Sr. No.	Code	Course of Study	Teaching Schedule				Credits
			L	T	P	Total	
		SEMESTER-I					
1	MCE2C01	Engineering Properties of Soils	3	-	-	3	3
2	MCE2C03	Foundation Engineering	3	-	-	3	3
3	MCE2C05	Earth Dams & Slope Stability	3	-	-	3	3
4		Elective-1*	3	-	-	3	3
5		Elective-2**	3	-	-	3	3
6	MCE2S07	Seminar-1	-	-	2	2	1
7	MCE2L09	Advanced Geotechnical Lab-1	-	-	4	4	2
		Total contact hours	15	-	6	21	18
		SEMESTER-II					
1	MCE2C02	Soil Dynamics & Machine Foundations	3	-	-	3	3
2	MCE2C04	Earth Pressure & Retaining Structures	3	-	-	3	3
3		Elective-3*	3	-	-	3	3
4		Elective-4*	3	-	-	3	3
5		Elective-5***	3	-	-	3	3
6	MCE2S08	Seminar-2	-	-	2	2	1
7	MCE2L10	Advanced GeotechnicalLab-2	-	-	4	4	2
		Total contact hours	15	-	6	21	18
		SUMMER ACADEMIC ACTIVITY					
1	-	Preparatory work for dissertation	-	-	-	-	-
		SEMESTER-III					
1	MCE2-D/P/I-11	Dissertation/Project Work/Internship (Part-I)	-	-	28	28	14
		SEMESTER-IV					
1	MCE2-D/P/I-12	Dissertation/Project Work/Internship (Part-II)	-	-	28	28	14
Grand Total							64

*** specific to specialization**
**** from specialization or core & elective subjects of other specializations of the department**
***** from specialization or core & elective subjects of other specializations of the department/ other departments**

Electives for Odd Semester

MCE2E31 Rock Mechanics-I
MCE2E33 Ground Improvement Engineering
MCE2E35 Clay Mineralogy
MCE2E37 Engineering Geology
MCE2E39 Flow through Porous Media
MCE2E41 Case Histories in Geotechnical Engineering
MCE2E43 Computational and Statistical Methods

Electives for Even Semester

MCE2E32 Rock Mechanics-II
MCE2E34 Geotechnical Exploration and Advanced Soil Testing
MCE2E36 Modelling and Simulation
MCE2E38 Theoretical Soil Mechanics
MCE2E40 Advanced Rock Mechanics
MCE2E42 Design of Foundation Systems
MCE2E44 Computer Aided Design of Foundations

Open Elective

MCE2O71/72 Machine Foundations

General Guidelines & Evaluation process for M.Tech. Programmes

1. Each elective should have some minimum percentage of students admitted in that specialization. There should be at least five students for running any elective.
2. Orientation programme for fresh admitted students is to be done during the first week of first semester.
3. Supervisors are to be allocated just after the end semester examinations of 1st semester.
4. Dissertation areas are to be finalized during the gap period between 2nd and 3rd semester.
5. Open electives, if opted from other departments, should have at least 3 credit points. These are to be allocated centrally.

Evaluation Process

(a)	**Theory Papers**	
1	Mid Semester-I Exam	15
2	Mid Semester-II Exam	15
3	Teacher's Assessment	10
4	Attendance	10
5	End Semester	50
	Total	**100**
(b)	**Practicals**	
1	Viva Voce-I & II	15+15=30
2	Practical File & Class Work	20
3	Attendance	10
4	End Semester	40
	Total	**100**

1. The Dissertation Part-I
   - End semester evaluation by the Committee* on the basis of seminar/viva-voce/report submitted by the candidate - 100%. To be completed by December (every year).

   * Committee comprising the following members

     - HOD or faculty nominee proposed by HOD.
     - Dissertation Supervisor (and Co-Supervisor).
     - One faculty member as expert preferably from the same specialization.

2. The Dissertation Part-II shall be evaluated by a committee comprising the following through presentation cumviva voce examination.

   - HOD or faculty nominee proposed by HOD.
   - Dissertation Supervisor (and Co-Supervisor).
   - One external expert appointed by the Department.

Grade for dissertation is to be awarded as per the rules defined under:

Grade	Conditions to be fulfilled
A+	One paper accepted/published in SCI/SCIE/Scopus indexed nonpaid journal & on the basis of performance during viva voce examination
A	One paper accepted/published in nonpaid referred journal or two good quality papers presented/full length papers published in peer reviewed conferences organized by IISc/IIT/NIT/IIIT/Premier R&D organizations/ professional societies and on the basis of performance during viva voce examination
B/C/D	In other cases

MCE2C01 ENGINEERING PROPERTIES OF SOILS

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course Objectives:

1. To impart knowledge on the various factors governing the engineering behaviour of soils and suitability of soils for various geotechnical engineering applications.
2. To impart the knowledge of determination of coefficient of permeability by various methods and analyze the problem of seepage through earth dams.
3. To impart the knowledge about the shear strength and various methods of measurement of shear strength.
4. To impart knowledge about consolidation and behaviour of compacted soils.

Course Content:

General: Engineering Properties of natural soil deposits- Alluvial deposits, glacial deposits, aeolian, Loess and Residual Soils, Soil Profile, Soil moisture suction, suction plate method of determination, Effective stresses-Bishop's &Lambe's concepts, Sensitivity & thixotropic characteristics of clays.

Permeability & Seepage: Determination of Coefficient of Permeability by Parallel tube capillary model, Hydraulic radius model and other empirical relations, Seepage through Earth dam- Dupuit's solution, Schaffernak, Casagrande's and Pavlovsky's solution, seepage through dams under anisotropic conditions.

Shear Strength: Various types of triaxial tests- compression and extension, drainage conditions, Measurement of shear strength- Measurement and application of load, cell pressure, pore water pressure, and application of back pressure in a drained test,

ϕ Parameter in sands, Energy correction, Skempton's Pore Pressure parameters and their determination. Shear strength of partially saturated soils, Hvorslev Parameters, stress paths- Lambe's and Rendulic- Henkel unique stress paths & their characteristics, relation of undrained shear strength and effective overburden pressure.

Consolidation: Characteristics of NC & OC clays, Reconstruction of field virgin compression curve for NC & OC clays Schmertmann correction, secondary consolidation, three-dimensional consolidation, Sand drains.

Behaviour of compacted soils: General, effect of compaction on structure, swelling pressure, shrinkage, shear strength, p.w.p. & permeability. Comparison of dry and wet of OMC.

Books Recommended:

1. Principles of Soil Mechanics by R F Scott.
2. Foundation Engineering edited by Leonards.
3. Soil Mechanics by Lambe and Whitman.

Course Outcomes:

1. Students are able to understand engineering properties of natural deposits.
2. Students are able to determine the coefficient of permeability by various methods and analyze seepage through earth dams.
3. Students are able to understand shear strength parameters and various methods to measure shear strength.
4. Students are able to analyze the consolidation, types of consolidation and behaviour of compacted soils.

MCE2C02 SOIL DYNAMICS & MACHINE FOUNDATIONS

L T P/D Total Course credits - 3

3 - - 3

Course objectives:

1. Study theory of vibrations for their application to solve dynamic soil problems.
2. Calculate the dynamic properties of soils using laboratory and field tests.
3. Study the phenomenon of liquefaction.
4. Analyze and design machine foundations by Barkan's theory and elastic half space concept.
5. Analyze and design vibration isolation systems.

Course content:

Theory of vibrations: Nature of dynamic loads, characteristic elements of a vibrating system, properties of harmonic motion, analysis of single degree freedom system with undamped free vibration, damped free vibration, undamped forced vibration and damped forced vibration, logarithmic decrement, frequency dependent excitation force, determination of viscous damping, principle of vibration measuring instruments, transmissibility, active isolation, passive isolation, methods of active and passive isolation.

Wave propagation in an elastic medium: Wave propagation in elastic rods, elastic infinite medium, semi-infinite elastic half space, waves generated by a surface footing.

Dynamic stress deformation and strength characteristics of soils: Dynamic soil testing techniques, special requirements of apparatus for dynamic tests, pendulum loading apparatus, oscillatory simple shear test, resonant column apparatus, field tests, stress deformation and strength characteristics of saturated sands and cohesive soils under pulsating loads.

Dynamic earth pressure problems: Modification of Coulomb's theory and Culmann's construction for dynamic loads, analytical solutions for c-ϕ soils, point of application, Indian Standard Code of Practice.

Liquefaction of soils: Theory of liquefaction, criteria of liquefaction, factors affecting liquefaction characteristics, laboratory studies on liquefaction, evaluation of liquefaction potential of a soil deposit, vibration table studies, liquefaction analysis from SPT data, anti-liquefaction measures.

Machine foundations: Types of machines and machine foundations, criteria for satisfactory action of a machine foundation, methods of analysis, degrees of freedom of a block foundation, Barkan's soil spring constants and their determination, analysis of vibrations of block foundation by Barkan's theory and elastic half space theory, IS for design and construction of foundations for reciprocating machines, foundation for impact machines, IS for design and construction for impact machine, introduction to T.G. foundations, design examples.

Books Recommended:

1 Dynamics of bases and foundations by D DBarkan.
2 Soil dynamics by Shamsher Prakash.
3 Soil dynamics and machine foundations by Swami Saran.
4 Analysis and design of foundations for machines by Shamsher Prakash and V K Puri.
5 Handbook of machine foundations by Srinivasalu&Vaidyanathan.
6 Principles of soil dynamics by Braja M Das.

Course Outcomes:

1. Students are able to understand basics of dynamics, dynamic behaviour of soil.
2. Students are able to design and construct foundations for different type of machines.
3. Students are able to understand the theory of liquefaction, evaluate liquefaction potential.
4. Students are able to understand vibration isolation techniques and their implementation.

MCE2C03 FOUNDATION ENGINEERING

L	T	P/D	Total	Course credits - 3
3	-	-	3	

Course Objectives:

i. To study the three criteria, i.e. depth and location criterion, bearing capacity criterion and settlement criterion for the design of shallow foundations.
ii. To understand action of a single pile and piles in group, and methods of calculations of load capacity by various techniques.
iii. To study the design of well foundation, checking their lateral stability and procedure for construction of well foundations alongwith methods of rectification of tilt and shift.
iv. To study the methods of design of foundations on expansive soils.

Course content:

Shallow foundations: Factors deciding depth of foundation, effect of water table on bearing capacity, points of difference between Rankine's, Terzaghi's, Meyerhof's, Skempton's bearing capacity theories, IS Code equation, footings on slopes, bearing capacity of footings on layered soils, bearing capacity from SPT, SCPT, DCPT, bearing capacity of foundation with uplift forces, bearing capacity of rafts on sands and clays, distribution of contact pressure, plate load test and interpretation, settlement of footings, computation of immediate and consolidation settlement, settlement from SPT and SCPT data.

Pile foundations: Classification and uses of piles, dynamic formulae to calculate the load on piles, static methods of pile load capacity, pile load test, cyclic pile load test, negative skin friction, group action in piles, computation of settlement of single pile and pile group, piles subjected to lateral loads.

Caissons: Introduction, types of caissons and their advantages and disadvantages, forces acting on well foundations, factors governing depth, load carrying capacity in sands and clays, lateral stability of well foundations, procedure for construction of wells, tilts and shifts.

Foundations on difficult subsoils: Expansive soils, identification, swell potential and swell pressure, methods of foundations on expansive soils, replacement of soil and CNS concept, under-reamed piles.

Books Recommended:

1. Basic and applied soil mechanics by Gopal Ranjan, A S R Rao.
2. Soil engineering in theory and practice, vol. 1, fundamentals and general principles by Alam Singh.
3. Principles of Foundation Engineering by Braja M Das.
4. Foundation Engineering by J E Bowles.
5. Foundation Engineering by G A Leonards.
6. Foundation Engineering by R B Peck, W E Hanson, T H Thornburn.
7. Foundation design by W C Teng.

Course Outcomes:

1. Students are able to calculate allowable bearing pressure of soil for the design of shallow foundations.
2. Students are able to calculate various type of settlements.
3. Students are able to evaluate the load capacity of a pile and piles in group by various techniques.
4. Students are able to design well foundations and understand methods to rectify the tilts and shifts of wells.
5. Students are able to design foundations on expansive soils.

MCE2C04 EARTH PRESSURE & RETAINING STRUCTURES

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course Objectives

i. To impart in-depth knowledge about the mechanism of development of earth pressure.
ii. To impart knowledge about the analysis and design of earth retaining structures.
iii. To help the students to take proper engineering decisions in practical situations related to lateral pressure.

Course content:

Earth Retaining Structures: Definitions, uses of retaining walls, types of retaining walls, rockfill drains, stability considerations for retaining walls.

Earth Pressure due to Cohesionless Soil: Trial Wedge Method, Coulomb's method, Rankine's method, Culmann's graphical construction, Poncelet's construction, friction circle method.

Earth Pressure due to Cohesive Soil: Trial Wedge method, friction circle method, circle of stress method.

Anchored Bulkheads: Sheet pile structures, cantilever sheet piles, anchored bulkheads.

Arching Action in Soils: Theory of arching, Cain's theory, braced excavation, earth pressure against bracing in cuts, heave of bottom of cut in soft clay, deep cut in sands.

Earth Pressure on underground conduits.

Cofferdams: Various types, their applications, design and lateral stability of braced cofferdam, design and stability of cellular cofferdams.

Books Recommended:

1 Earth Pressure & Retaining Walls by Huntington.
2 Earth Pressure & Retaining Structures by Tschebatorioff.
3 Analysis and Design of Foundations & Earth Retaining Structures by Shamsher Prakash, Gopal Ranjan, Swami Saran.

Course Outcomes:

1. Students are able to understand various aspects of retaining walls.
2. Students are able to evaluate earth pressure by various methods for different soils.
3. Students are able to analyze various earth retaining structures.
4. Students are able to understand theory of arching.
5. Students are able to design and carry out stability analysis of braced and cellular cofferdams.

MCE2C05 EARTH DAMS & SLOPE STABILITY

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course Objectives:

i. To impart in-depth knowledge about the method of construction and causes of failures of earth dams.
ii. To impart knowledge about the analysis and design of earth dams.
iii. To impart knowledge about the various methods of seepage control and design of transition filters.
iv. To impart knowledge of various methods available for analysis of slopes and remedial measures to protect the slope.

Course content:

General: Purpose of earth dams, methods of construction, types of earth dams, materials required for earth dam construction, causes of failure of earth dams, design criteria for earth dams, suitable section for an earth dam, rockfill dams.

Seepage Analysis: General, phreatic line in earth dams and its location by various methods, problem of seepage control in earth dams-control of seepage through embankment, adverse effects of seepage, methods of seepage control, impervious core, selection of core material, core thickness, location of core in earth dam, selection and design of transition filters, rock toe, horizontal drainage, chimney drains, control of seepage through foundations-various options, upstream impervious blanket, Bennet's analysis for blanket length, relief wells, related problems.

Stability Analysis: Shear strength of soils, pore pressure in earth dams, various conditions of stability analysis for earth dams, methods of slope stability analysis, related problems.

Drainage: Gravity drainage, vacuum and osmotic drainage.

Instrumentation: Necessity, pore pressure measurement, vertical movement devices, horizontal movement devices, choice of instrumentation, instrumentation problems.

Books Recommended:

1 Earth and Rockfill Dams by J. L. Sherard et al.
2 Earth and Rockfill Dams by Bharat Singh & H. D. Sharma.

Course Outcomes:

1. Students are able to selecting an earth dam section on the basis of ground reality.
2. Students are able to isolate cause and recommend remedies for failure and damage to earth dams.
3. Students are able to carry out slope stability analysis under various conditions of loading.
4. Students are able to suggest instrumentation for the two movements.

MCE2E31 ROCK MECHANICS-I

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course Objectives:

i. To make the students understand engineering properties of rock and classification of rocks.
ii. To impart knowledge about the laboratory testing of rocks by different methods.
iii. To impart knowledge about the Institute Testing of rocks by various methods and techniques.
iv. To impart knowledge about the failure criteria, tunneling in rocks and various techniques to improve in-situ strength of rocks.

Course content:

Introduction: Importance of Rock Mechanics, Composition of rocks, geological classification of rocks, classification of rocks for engineering purposes, RQD method of classification of rocks.

Laboratory Testing of Rocks: Various methods of obtaining rock cores, methods of sample preparation, effect of specimen geometry on rock strength determination, compression testing machine, uniaxial compressive strength of rock samples, factors
affecting compressive strength, methods of finding tensile strength-direct and indirect methods, flexural strength test, shear strength tests-direct shear test, torsion test, shear box test, punch test, triaxial shear test.

In-situ Testing of Rocks: Field direct shear test on rock blocks, field triaxial strength, use of flat jacks, chamber test, plate load test, cable jacking test.

Stress Evaluation in Field: Stress relief technique(over coring), use of strain gauges, bore hole deformation cell, LVDT, photo-elastic stress meter, stress measurement with flat jack, typical results of evaluation, dilatometer, hydraulic fracturing techniques, uses and advantages.

Elastic and Dynamic Properties of Rocks: Static elastic constants of rocks and their determination, stress-strain behaviour, dynamic properties of rock mass, methods of finding dynamic properties.

Pressure on Roof of Tunnels: Terzaghi's theory, Bieraumer's theory, Kommeral theory, Protodyakanov theory, Kastner's theory, Labasse's theory.

Books Recommended:

1 Rock Mechanics Vol. I, II, III, IV by Lama et al.
2 Fundamentals of Rock Mechanics by Jaegar and Cook.
3 Rock Mechanics by Stagg &Zienkiewiez.
4 Art of Tunnelling by Schzy.

Course Outcomes:

1. Students are able to understand engineering properties of rock and various classifications of rocks.
2. Students are able to understand laboratory testing of rocks by various methods.
3. Students are able to understand the in-situ testing of rocks by various methods.
4. Students are able to analyze various theories for evaluation of pressure on tunnel roofs.

MCE2E32 ROCK MECHANICS-II

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course objectives:

i. To impart knowledge of Rock Joint properties.
ii. To impart knowledge of Rock mass classification for underground excavations.
iii. To impart knowledge of various structural defects in rocks.
iv. To impart knowledge of various types of folds and joints their effects and their civil engineering importance.

Course content:

Model studies on jointed rocks under uniaxial compression.

Significant Rock Joint Properties: Intensity of joints, Dilation of joints, roughness, scale effects, single joint orientation.

Rock Mass Classification for Underground Excavation: South African Geomechanics classification (RMR), rock structure rating (RSR), rock mass quality index (Q).

Structural Defects: Folds-parts, nomenclature, plunge, refolding, fold systems. Faults-general characteristics, nature of movement along fault, classifications. Joints-effects, parts, classification, types of joints in common rocks.

Empirical Strength Criteria: Intact rocks, anisotropic rocks, rock mass.

Importance of Geological Structures: Simple types of folds, slip folds, flexural slip folds, parasitic folds and flow folds. Effects of folding and their civil engineering importance, effects of joints and their civil engineering importance.

Books Recommended:

1 Rock Mechanics, Vol., I, II, III, IV by Lama et al.
2 Fundamentals of Rock Mechanics by Jaeger and Cook.
3 Rock Mechanics and Design of Structures in Rock by Obert and Duvell.

Course Outcomes:

1. Students are able to assess various Rock Joint properties.
2. Students are able to classify the rock mass for underground excavations.
3. Students are able to assess various structural defects in rocks.
4. Students are able to assess various types of folds and joint their effects and their civil engineering importance.

MCE2E33 GROUND IMPROVEMENT ENGINEERING

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course Objectives:

i. To impart knowledge of various problems associated with soil deposits and various methods to evaluate them.
ii. To impart knowledge of different techniques to improve the characteristics of soil.
iii. To impart knowledge of design techniques required to implement various ground improvement methods.

Course content:

Introduction: Need for ground improvement, historical review of methods adopted in practice, current status and scope in the profession.

Methods of Ground Improvement: Mechanical stabilization, dynamic compaction, impact loading, vibro-floatation, preloading, sand drains, stone columns, sand compaction piles, lime column, granular piles, dynamic consolidation, compaction by blasting, use of admixtures, injection of grouts- design guidelines and quality control, electrical and thermal methods, stabilization of black cotton soils.

Geosynthetics: Raw materials, durability and aging, manufacturing methods, geotextiles-testing and evaluation, geotextile as separators and as reinforcement, geotextile in filtration, drainage and erosion control, bearing capacity improvement by geotextiles.

Reinforced Earth: Basic mechanism, choice of soil and reinforcement, strength characteristics of reinforced earth, principles of design of reinforced earth wall.

Books Recommended:

1 Modern Geotechnical Engineering by Alam Singh.
2 Indian Geotechnical Conference (1986), Indian Geotechnical Society, Vol. I.
3 Soil Mechanics & Foundation Engineering, Vol. II, (Foundation Engineering) by V N S Murthy.
4 Designing with Geosynthetics by Koerner.
5 Engineering with Geosynthetics by Rao & Raju.

Course Outcomes:

1. Students are able to identify and evaluate the deficiencies in the soil deposits.
2. Students are able to improve the characteristics of the soil using mechanical techniques.
3. Students are able to improve the characteristics of the soil by the use of admixtures.
4. Students are able to improve the characteristics of the soil by the use of geosynthetics and reinforcing earth.

MCE2E34 GEOTECHNICAL EXPLORATION AND ADVANCED SOIL TESTING

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course Objectives:

1. To study the various types of explorations and boring methods.
2. To study various types of soil samples and samplers.
3. To study various indirect methods of soil explorations.
4. To study various advanced testing techniques.
5. To plan and execute sub-soil exploration programmes for different field projects.

Course content:

General: Purpose of soil exploration, preliminary investigations, site reconnaissance, phasing of soil exploration.

Excavation and Boring Methods: Exploration by pits, trenches, drifts and shafts, augur boring, shell and augur boring, wash boring, percussion drilling, rotary drilling, coring bits, shot core boring, stabilization of bore holes.

Sampling Techniques: Sample disturbance, type of soil samples, design features of sampler affecting sample disturbance, type of samplers, open drive samplers - thin wall, thick wall and split spoon samplers, rotary sampler, rock core drilling, core catcher, sampling from test pits, procuring and handling of disturbed and undisturbed samples.

Subsurface Soundings: Standard penetration test (SPT), static cone penetration test (SCPT), dynamic cone penetration test (DCPT), pocket penetrometer, Jodhpur penetrometer.

Geophysical Methods: Seismic refraction method, electrical resistivity method - resistivity sounding and resistivity profiling, magnetic method, gravitational method.

Recent Trends in subsurface exploration, important role of remote sensing, comparison with conventional methods.

Advanced Testing Techniques: In -situ shear test, shear box test, bore hole shear test, field vane shear test, in-situ permeability tests, pressure meter test, flat dilatometer test, field plate bearing test, dynamic tests, oedometer tests, special triaxial tests, soil expansivity tests - swell pressure, swell potential, differential free swell.

Planning and Execution of Sub-soil Exploration Programme: Depth and lateral extent of exploration for different Civil Engineering Works, selection of rig and sampling equipment, ground water observation, field tests vis-à-vis lab tests, deployment of personnel and equipment, bore logs, soil investigation report, planning of exploration and testing programme for different field projects.

Books Recommended:

1 Soil Engineering in Theory and Practice, Vol. II, Geotechnical Testing and Instrumentation by Alam Singh.
3 Foundation Analysis and Design by Bowles.
4 Principles of Foundation Engineering by B M Das.
5 Foundation Engineering by Brahma.
6 The Measurement of Soil Properties in the Triaxial Test by Bishop and Henkel.

Course Outcomes:

1. Students are able to understand various type of explorations including boring methods.
2. Students are able to categorize various type of soil samples and understand various sampling techniques.
3. Students are able to understand sounding and geophysical methods of soil explorations.
4. Students are able to understand various advanced soil testing techniques.
5. Students are able to plan soil exploration programmes including preparation of report of soil investigation.

MCE2E35 CLAY MINERALOGY

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course objectives:

i. The students are expected to understand the origin, occurrence, classification and structure of clay minerals.
ii. To understand the clay-water ions exchange theories.
iii. To study identification of different clay minerals by various techniques.
iv. To study effect of clay minerals on various soil properties.

Course content:

Introduction: Definitions, factors affecting properties of clay materials, inter-atomic bonding, secondary bonds.

Classification and Structure of Clay Minerals: Basic lattice structure, structural units of clay minerals, basic structure of silica, classification of clay minerals, Isomorphous substitution, inter sheet and inter layer bonding in clay minerals, the 1:1 minerals, montmorillonite minerals, mica-like clay minerals, chlorite minerals, chain structure clay minerals, mixed layer minerals, non-crystalline clay minerals.

Origin and Occurrence of Clay Minerals: Process and agents of weathering, formation of clay minerals, origin and occurrence of various clay minerals.

Identification of Clay Minerals: Differential thermal analysis, X-ray diffraction analysis, optical microscope studies of soils, electron microscope studies, shape and size of clay minerals.

Clay-Water: Influence of dissolved ions, possible mechanism of clay-water interaction, evidence on the structure and properties of adsorbed water.

Clay-Water Electrolyte Systems: Ion distribution in clay-water systems, cation exchange, cation exchange capacity, theories of ion exchange, anion exchange, engineering significance of base exchange.

Effect of Clay Minerals on Soil Properties: Effect on Atterberg limits, shrinkage and swelling characteristic, compressibility, soil structure, permeability, strength and deformation behaviour.

Books Recommended:

1 Fundamentals of Soil Behaviour by J. K. Mitchell.
2 Applied Clay Mineralogy by Grim.
3 Clay Mineralogy by Grim.

Course outcomes:

1. Students are able to understand classification and structure of clay minerals.
2. Students are able to understand origin and occurrence of various clay minerals.
3. Students are able to identify clay minerals on the basis of various analysis and studies.
4. Students are able to understand possible mechanism of clay-water interaction.
5. Students are able to understand effect of clay minerals on various soil properties.

MCE2E36 MODELLING AND SIMULATION

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course objectives:

i. To unable the students to model the domain.
ii. To impart the knowledge of establishing the relationship between the model and the constraints.
iii. To impart the knowledge to model the dynamic structures.

Course content:

Modelling Process: Taxonomy of model types; Steps in model building; simulation; algorithms and Heuristics; Simulation languages.

Primitive Models: Establishing relationships via physical laws; establishing relationships via curve fitting; Parameter estimation problems; elementary state transition models.

Forecasting Nature of data; Statistical attributes of data; Probability distribution and their mechanisms; Generation of random numbers; Time series.

Pattern Recognition: Neighborhood and distances; Cluster analysis; Individual and group preference patterns.

Static Equilibrium Models: graphical models and matrix models; Input-output type models; decomposition of large systems; Routing problems.

Linear Dynamical Structure: Block diagram representation of model structure; Transfer function representation; State space models; Stability; system control.

Growth and Decay Processes: Discrete and continuous growths; Limits to growth: Competition among species; Growth process and integral equations; discrete event approach; Population planning.

Simulation of Discrete and Continuous Processes: Monte Carlo methods; stochastic simulation; System identification; Inverse problems; Virtual reality; typical example and case studies related to Civil Engineering.

Books Recommended:

1. R. Haberman, Mathematical Models.
2. D.P. Maki and M. Thompson, Mathematical Models and Applications.
3. R.E. Shannon, System Simulation: Art and Science.

Course outcomes:

1. Students are able to model the domain.
2. Students are able to establish the relationship between the model and the constraints.
3. Students are able to model the dynamic structures.

MCE2E37 ENGINEERING GEOLOGY

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course Objectives:

i. To impart knowledge and skills in assessing the quality of foundation rocks, aggregates and building material derived from rocks, and assess the geological suitability of sites.
ii. To impart knowledge of weathering, development of soil and various hydrogeological properties of rocks.
iii. To impart knowledge of Plate tectonics, Hill slope stability and Landslides etc.
iv. To impart knowledge of surface and subsurface investigations for various civil engineering projects.

Course content:

Geomorphology: Endogenous and Exogenous process of development of landforms, Development of slopes.

Weathering: Rock types and influence of weathering on different types of rocks. Depth of weathering. Development of soil. Hydro-geological properties of rocks.

Earth Movements: Crust of earth, Elementary ideas about plate tectonics, Hill slope stability, Landslide, subsidence.

Geological investigations of selections of sites for various Civil Engg. Projects:

(a) Surface Investigations: Study of Satellite Imageries, Aerial Photos and geological maps, geological fieldwork (Field visits for under-construction Civil Engg. Projects).
(b) Subsurface Investigation: Resistivity survey and Lithologs date correlation.

Books Recommended:

1. A Text Book of Geology by E S Dana.
2. The Dynamic Earth by B. Skinner and S.C. Parter.
3. The Morphology of Earth by L.C. King.
4. Principle of Geomorphology by W. D. Thornbury.
5. Principle of Physical Geology by Holmes.
6. Ground Water Hydrology by D K Todd.
7. Aerial Photographic Interpretation by D. R. Lueder.
8. Geophysical Methods in geology by P. V. Sharma.
9. Elements of Engg. Geology by J. E. Richey.

Course Outcomes:

1. Students are able to assess the quality of foundation rocks, their aggregates and building material derived from rocks and assesses the geological suitability of sites.
2. Students are able to assess weathering, development of soil and various hydrogeological properties of rocks.
3. Students are able to assess Plate tectonics, Hill slope stability and Landslides etc.
4. Students are able to assess the surface and subsurface investigations for various civil engineering projects.

MCE2E38 THEORETICAL SOIL MECHANICS

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course Objectives:

i. To impart knowledge required for developing equations to assess the deformation characteristics of a soil body under external forces.

ii. To impart knowledge about stress distributions and displacements for two-dimensional and three-dimensional problems.

iii. To predict displacements at the boundaries of soil masses wherein they prevail

iv. To study the effect of wall movement on lateral earth pressure under various cases.

Course content:

Fundamental Relations: Concept of stress, concept of strain, rotation of axes, principal stresses and strains, invariants, Octahedral stresses and strains, equations of equilibrium, equations of equilibrium in polar coordinates, stress-strain relations, concepts of homogeneity and isotropy, generalized Hooke's law, two-dimensional analysis, plane stress case, plane strain case, equation of compatibility in terms of stress components and Airy's stress functions, Mohr's diagrams for stress as well as strain, problems.

Stresses and Displacements in Soil Mass as an Elastic Body: Line load (two-dimensional case), vertical, horizontal and inclined line loads on semi-infinite systems, distributed line loads (two-dimensional), uniform normal load over a strip, normal load over a circular and rectangular area, triangular and other loadings, problems.

Settlement and Consolidation: Finite Difference Method, Relaxation Method, Numerical Solution of one dimensional consolidation equation, problems.

Stability of Soil Structures: Soil strength, conventional methods, effect of wall movement on lateral earth pressure (Dubrova's method), various cases, effect of surcharge on lateral earth pressure, problems.

Limiting Equilibrium of Soil Structures: Dimensional similitude, fundamental concepts and relationships, mathematical considerations; characteristics, solution procedures, bearing capacity, stability of slopes, problems.

Book Recommended:

Foundations of Theoretical Soil Mechanics by M E Harr.

Course Outcomes:

1. Students are able todevelop equations to assess the deformation characteristics of a soil body under external forces.
2. Students are able tohandletwo- dimensional and three-dimensional problems related to stress distributions and displacements.
3. Students are able to evaluate earth pressures in various cases of wall movement.

MCE2E39 FLOW THROUGH POROUS MEDIA

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course objectives:

- **i.** To study the basic principles of flow.
- **ii.** To study the different mapping techniques.
- **iii.** To control the seepage and to analyze the seepage with various theories and techniques.
- **iv.** To impart the knowledge of various de-watering methods and drainage methods for stability of slope.

Course content:

Basic Principles: Darcy's Law, Permeability and its field determination, equation of continuity, velocity potential, stream function Laplace's equation.
Solution of Laplace's Equation: Solution by graphical method, flow nets in homogeneous soils, anisotropic soils and layered soils, computation of seepage quantity, seepage pressure, uplift pressure on structures, exit gradient, piping due to subsurface erosion and heave. Two and three dimensioned electrical analogy method, relaxation method.

Seepage through Earth Dams: Determination of phreatic line, Dupuit's solution, Casagrande's solution, Kozeney parabola, entrance and exit corrections, flow nets for zoned earth dams and earth dams on pervious foundations under steady seepage conditions, flow nets for homogeneous sections under sudden drawn down, introduction to control of seepage, filters -type, selection and design.

Solution by Mapping Techniques: Conformal mapping of elementary function, Kozeney's basic parabola, Schwarez-Christoffel transformation, Khosla's solution, Velocity hydrograph, flow characteristics at singular points, examples of velocity hydrograph, solution by complex velocity, solution of triangular dam.

Seepage in Foundations: Construction dewatering-Methods of dewatering, Design of dewatering for foundation excavations, foundation improvement by drainage, drainage in retaining structures, influence of seepage on stability of slopes, drainage methods for stability of slopes.

Book Recommended:

1. Harr, M.E. "Ground Water & Seepage".
2. Cedergren "Seepage, Drainage &Flownets".

Course Outcomes:

1. Students should be able to analyze the seepage with various theories and techniques.
2. Students should be able to utilize basic principles of flow.
3. Students should be able to use different mapping techniques.
4. Students should be able to perform analysis of the seepage by application of seepage theories.

MCE2E40 ADVANCED ROCK MECHANICS

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course Objectives:

i. To impart knowledge of various theories of failures and cracks.

ii. To impart knowledge of uses, properties and qualities of various types of explosives.
iii. To impart knowledge of blasting theory and various factors associated with blasting.
iv. To study the criteria of rock stability and design of slopes.
v. To study the stresses around tunnels and underground openings under different loading conditions.

Course content:

Strength and Failure of Rocks: Types of failure, theories of failure- Coulomb - Navier theory, Mohr's theory, fracture of jointed rocks in uniaxial compression, crack phenomenon and mechanism of failure, Griffith's two dimensional theory of cracks, elementary theory of crack propagation, strain energy associated with cracks, dynamics of crack propagation, modified Griffith's brittle fracture criterion.

Rock Blasting and Explosives: Explosives, uses, types, properties, composition of high explosives, choice and quality of explosives, mechanism of detonation, breaking ground with explosives, blasting theory, calculation of burden distance, factors involved in blasting, blast hole diameter, quarry blasting practice.

Rocks Slope Stability: Rock slope, mechanism of failure, shape of failure zone, criteria of rock stability, geological considerations, block sliding, principles of design of slopes.

Stabilization of Rocks: Rock bolting, principles of rock bolting, types and applications of rock bolt, rock grouting, grouting materials, grouting operations, methods of grouting, guniting.

Stress around Tunnels and under Ground Openings under various loading conditions, effect of number of tunnels and shape of tunnels, design of pressure tunnels in rocks.

Creep of Rocks: time dependents properties of rock.

Books Recommended:

5 Rock Mechanics Vol. I, II, III, IV by Lama et al.
6 Fundamentals of Rock Mechanics by Jaegar and Cook.
7 Rock Mechanics by Stagg &Zienkiewiez.
8 Art of Tunnelling by Schzy.

Course outcomes:

1 Students are able to assess various theories of failures and cracks of rocks.
2 Students are able to understand the uses, properties and qualities of various types of explosives.
3 Students are able to assess blasting theory and various factors associated with blasting.
4 Students are able to understand the criteria of rock stability and design of slopes.
5 Students are able to assess the stresses around tunnels and underground openings under different loading conditions.

MCE2E41 CASE HISTORIES IN GEOTECHNICAL ENGINEERING

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course objectives:

1. To impart knowledge of shear failure and settlement failure of foundations by different case studies.
2. To impart knowledge of foundation failure and seepage failure of earth dams by different case studies.
3. To impart knowledge of failure due to liquefaction of soils during earthquake by different case studies.
4. To impart knowledge of slope failure, landslides, landslips and Retaining wall failures.

Course content:

Case studies of shear failure and settlement failure of foundations e.g. foundation distress of Leaning Tower of Pisa, Transcona Grain Elevator, Settlement of Mexico City etc..

Case studies of foundation failure and seepage failure of earth dams e.g. Panchet Dam (Maharashtra), Nanak Sagar Dam, Sampna Dam, Ahroura Dam, Vaiont Reservoir Disaster, Fort Peck Dam Slide etc.

Case studies of failures due to liquefaction of soils during earthquake e.g. failures during Kobe Earthquake in Japan etc.

Case studies of landslides, landslips and other slope failures.

Case studies of retaining wall failures.

Books Recommended:

1 Earth and Rockfill Dams by Bharat Singh & H. D. Sharma.
2 Soil Mechanics by Perloff& Baron.
3 Soil Mechanics & Foundation Engineering by Oza.

Course Outcomes:

1. Students are able to assess the shear failure and settlement failure of foundations.
2. Students are able to assess the foundation failure and seepage failure of earth dams.
3. Students are able to assess the failure due to liquefaction of soils during earthquake.
4. Students are able to assess the slope failure, landslides, landslips and Retaining wall failures.

MCE2E42 DESIGN OF FOUNDATION SYSTEMS

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course Objectives:

1. To determine the bearing capacity of soil and the probable settlement and also to select the type of depth of foundation for a project.
2. To impart empirical knowledge of soil behaviour required by the geotechnical engineer for the design of foundation and other soil related structures.
3. To impart knowledge of structural design and various construction techniques of pile foundation and pile cap.
4. To impart knowledge of design of Retaining walls, piers, abutments and retaining wall for seismic forces.
5. To impart knowledge of design and construction methods of Marine Sub – structures.

Course content:

Shallow Foundations: Types and their suitability, bearing capacity and settlement, conventional method of design, soil line method, beams on elastic foundation analysis, finite difference method of design, footings and raft foundations subjected to eccentric- inclined loads, footing on slopes, footings in seismic zones, IS code.

Pile Foundations: Types, structural design, design of pile cap, design of pile foundation for a multi-storeyed building and other important structures, construction techniques.

Bridge Sub- structures: Forces on a bridge foundation (IRC & IRS specifications), well foundation components, stability analysis, design of various parts, material for construction, sinking of well, placing of curb, dredging, jetting, design of well foundation for piers and abutments.

Design of retaining walls for hydraulic structures on curves and with surcharge on backfill, design of piers, abutments and retaining walls for seismic forces.

Marine Sub-structures: Types of structures, breakwaters, wharves, sea well, design and construction methods.

Books Recommended:

1. Design of Sub-structures by Swami Saran.
2. Design of Foundation Systems by Kurian.
3. Foundation Analysis and Design by Bowles.
4. Foundation Design by Teng.

Course outcomes:

1. A comprehensive and well-defined knowledge on bearing capacity theories is expected.
2. Students are trained how to design the foundations of a particular project depending upon the properties of soil and type of projects.
3. Students are capable to design the Retaining walls, piers, abutments and retaining wall for seismic forces.
4. Students are able to assess the design and construction methods of Marine Sub – structures.

MCE2E43 COMPUTATIONAL AND STATISTICAL METHODS

L T P/D Total Course Credits – 3
3 - - 3

Course objectives:

i. To study linear and non-linear equations using numerical techniques.
ii. Apply finite difference and finite element method for analyzing behaviour of geotechnical structures.
iii. Apply correlation and regression analysis for the geotechnical data.

Course content:

Numerical Solution of Ordinary Differential Equations: Solution by Taylor's Series-Euler's Method – RungeKutta Methods – Simultaneous and Higher Order Equations-Boundary Value Problems – Applications.

Finite Difference Method: Finite Difference Representation of Differential Equations – Stability – Consistency and Convergence of Partial Differential Equations – Time integration – Finite Difference Methods in Solution of Steady and Unsteady Problem- Jacobi's Method, Gauss Seidel Method, Successive Over Relaxation Method and Method of Characteristics – Application and Examples.

Finite Element Method: Basic Concepts – Solution of Discrete Problems – Steady State and Time Dependent Continuous Problems – Application of Finite Method through Illustrative Examples.

Classification and Presentation of Data: Basic Concepts of Probability – Probability Axioms – Analysis and treatment of Data – Population and Samples – Measures of Central Tendency – Measures of Dispersion – Measures of Symmetry – Measures of Peakedness.

Probability Distribution: Discrete and Continuous probability Distribution Functions – Binomial, Poisson, Normal, Lognormal, Exponential, Gamma Distribution, Extreme Value Distribution - Transformations to Normal Distributions, Selecting a Probability Distribution, Parameter Estimation – Method of Moments, Method of Maximum Likelihood, Probability Weighted Moments and Least Square Method, Joint Probability Distributions.

Regression Analysis: Simple Linear Regression, Evaluation of Regression – Confidence Intervals and Tests of Hypotheses – Multiple Linear Regression – Correlation and Regression Analysis.

Books Recommended:

1. Applied Numerical Methods for Engineers by Akai.
2. Statistical Methods in Hydrology by Haan.
3. Computational Methods in Subsurface Flow by Huyorkon, Pinder.
4. Numerical Recipes – The Art of Scientific Computing by Press, Flannery, Tenklsky, Vetterling.

Course Outcomes:

1. Students would be able to apply finite difference and finite element method for analyzing behavior of geotechnical structures.
2. Students would be able to solve linear and non-linear equations using numerical techniques.
3. Students should be able to apply correlation and regression analysis on geotechnical data.

MCE2E44 COMPUTER AIDED DESIGN OF FOUNDATIONS

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course objectives:

i. To impart knowledge of various soil parameters and laboratory tests relevant to foundation design.
ii. To impart knowledge to design of shallow foundation, pile foundation and retaining walls by using components of CAD packages for respective structures.

Course content:

Soil Parameters for Foundation Design: Major soil types, physical and engineering properties of soils, processing of field and laboratory test data to obtain parameters relevant to foundation design.

Shallow Foundations: Footings and rafts, proportioning of foundations based on SPT, SCPT, PLT& consolidation test data. Structural analysis and design - conventional, beams on elastic foundation, finite differences method of analysis of footing and rafts, structural design details, components of CAD package on shallow foundations.

Pile Foundations: Design steps, proportioning a pile foundation - analytical estimation of load - settlement behaviour of piles, lateral analysis of piles, analysis of pile group subjected to vertical and lateral load, components of CAD package on pile foundations.

Retaining Walls: Design steps, types of walls and their selection, tentative dimensions, forces acting on the wall and their estimation, stability checks, structural design of components, drainage details, components of CAD package for retaining walls.

Books Recommended:

1. Course Package on "Computer Aided Analysis and Proportioning of Foundations" by G. Ramaswamy (Dept. of Continuing Education, Roorkee).
2. Foundation Analysis and Design by Bowles.
3. Design of Foundation systems by Kurian.

Course outcomes:

1. Students are able to assess various soil parameters and laboratory tests relevant to foundation design.
2. Students are able to design of shallow foundation and pile foundation by using CAD packages.
3. Students are able to design retaining walls by using components of CAD packages.

MCE2L09 Advanced Geotechnical Lab-1

L	T	P/D	Total	Course Credits – 2
-	-	4	4	

Course objectives:

1. To quantify grading and plasticity characteristics of soil.
2. To estimate compressibility and swell characteristics of expansive soil.
3. To know the procedures for assessment of strength characteristics of soils.
4. To analyze the problem of seepage through earth dams.
5. To understand the procedure of carrying out subsurface exploration by penetration tests.

Course content:

1. Determination of liquid limit by one point method and cone penetration method.
2. Determination of activity of an expansive soil.
3. Determination of shrinkage limit of a clayey soil.
4. Determination of compressibility characteristics of a cohesive soil by one-dimensional consolidation test.
5. Measurement of swell potential and swell pressure of an expansive soil.
6. Determination of sensitivity of a clay sample.
7. Determination of strength characteristics of a granular soil by direct shear test.
8. Determination of strength characteristics of an undisturbed sample of soil by triaxial test.
9. Location of phreatic line in model earth dam.
10. Soil exploration by sounding techniques.

Books Recommended:

1 Soil testing for engineers by S Prakash, P K Jain, Nem Chand & Bros.
2 Engineering soil testing by Lambe, Wiley Eastern.
3 Engineering properties of soils and their measurement by J E Bowles, McGraw Hill.
4 Soil Engineering in Theory and Practice, Vol. II, Geotechnical Testing and Instrumentation by Alam Singh, CBS Pub.

Course Outcomes:

On completion of the course, the students be able to:

1. Use compressibility and strength characteristics for the design of foundations.
2. Design foundations in expansive soils.
3. Recommend the use of a specific technique for soil exploration.
4. Design for seepage problems in soils.

MCE2L10 Advanced Geotechnical Lab-2

L	T	P/D	Total	Course Credits – 2
-	-	4	4	

Course objectives:

1. To quantify parameters for designing in rocks.
2. To understand behaviour of model footings and piles.
3. To know the procedures for chemical tests on soils.
4. To analyze the problem of designing with geosynthetics.
5. To understand the procedure of carrying out dynamic tests on soil.
6. To understand how to apply computing skills to geotechnical engineering.

Course content:

1. Testing of rocks: Taking out rock cores, tensile strength by Brazilian test, point load strength index test, uniaxial compression test, slake durability test.
2. Behaviour of model footings.
3. Model pile load tests on vertical and batter piles.
4. Chemical tests on soils.
5. Testing of geosynthetics.
6. Model demonstration of liquefaction of fine sands.
7. Block vibration tests.
8. Exposure to live site problems in Geotechnical engineering.
9. Development of simple programs for solving Geotechnical Engineering problems using MATLAB/C language/Excel.
10. Exposure to various Geotechnical related Softwares.

Books Recommended:

5 Soil Engineering in Theory and Practice, Vol. II, Geotechnical Testing and Instrumentation by Alam Singh, CBS Pub.

6 Experimental Rock Mechanics by Kiyoo Mogi, Taylor & Francis.

7 A Guide to Geotextiles Testing by D G Devshikar and J. N. Mandal.

8 Geotechnical Software Manuals.

9 Dynamic soil tests and applications by N S V Kameswara Rao, Wheeler Publishing.

Course outcomes:

On completion of the course, the students shall be able to:

1. Solve design problems in rocks.
2. Carry out design of shallow and pile foundations on the basis of model studies.
3. Assess concentration of various chemicals in soils and devise strategies of design.
4. Design foundations for dynamic loads and understand the phenomenon of liquefaction.
5. Carry out design with geosynthetics.
6. Apply computing skills to geotechnical engineering.

MCE2O71/72 Machine Foundations

L	T	P/D	Total	Course Credits – 3
3	-	-	3	

Course objectives:

i. To study various types of vibrations of single degree freedom system.
ii. To study various methods of evaluation of design parameters.
iii. Application of principles for the design of machine foundations.
iv. To study various vibration isolation techniques.

Course content:

1. **Theory of Vibrations:**
   Definitions, harmonic motion, vibrations of a single degree freedom system, transmissibility, theory of vibration measuring instruments.
2. **General Principles of Machine Foundation Design:**
   Types of machines and machine foundations, criteria for satisfactory action of a machine foundation, permissible amplitude, allowable soil pressure, permissible stresses in concrete and steel, permissible stresses in timber.
3. **Evaluation of Parameters:**
   Modes of vibration of a rigid block foundation, Barkan's soil spring constants, determination of coefficients of elastic uniform compression and Elastic uniform shear.
4. **Foundations for Reciprocating Machines:**
   Analysis of block foundation by Barkan's theory of linear elastic weightless spring analogy, Indian Standard for design and construction of foundation for reciprocating machine, design procedure, design examples.
5. **Foundation for Impact Machines:**
   Dynamic analysis, Barkan's recommendations for weight and base contact area, IS Code practice for design and construction of foundations for impact machines, design procedure, design examples.
6. **Foundations for Rotary Machines:**
   Special considerations, design criteria, methods of analysis and design.
7. **Vibration Isolation and Screening:**
   Active isolation, passive isolation, methods of isolation, wave screening, vibration absorbing materials, planning for vibration isolation.

Books recommended:

a. Dynamics of Bases and Foundations by D. D. Barkan.
b. Soil Dynamics by Shamsher Prakash.
c. Soil Dynamics and Machine Foundations by Swami Saran.
d. Principles of Soil Dynamics by B. M. Das.
e. Vibration and Shock Isolation by Crede.

Course Outcomes:

On completion of the course, the students shall be able to:

1. Understand theory and principles of design.
2. Evaluate and select parameters for design.
3. Design foundations for industrial machines.
4. Propose vibration and shock isolation techniques for various projects.