DEPARTMENT OF CIVIL ENGINEERING
ANNA UNIVERSITY, CHENNAI

OUR VISION:
Department of Civil Engineering, Anna University, shall strive hard to develop and impart technical knowledge and professional skills required for Civil Engineering practice through excellence in teaching, research, and consultancy to address sustainable infrastructure development needs at local, national, and international levels.

OUR MISSION:
Department of Civil Engineering, Anna University shall contribute to technological and social development by
1. Providing a firm scientific and technological base in Civil Engineering to achieve self-reliance.
2. Providing quality education through innovation in teaching practices at par with global standards.
3. Nurturing leadership and entrepreneurship qualities with ethical values.
4. Developing and disseminating latest knowledge and technologies in emerging areas of Civil Engineering.
5. Sharing intellectual resources and infrastructure facilities through collaborative partnership.
6. Ensuring supporting conditions for enhancing the employability skills.
ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM
M. E. SOIL MECHANICS AND FOUNDATION ENGINEERING (FULL-TIME)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

Graduates of the programme M. E., Soil Mechanics and Foundation Engineering will

PEO1 Gain knowledge and skills in geotechnical engineering which will enable them to have a professionally accomplishing career in public or private sector organizations.

PEO2 Become consultants on complex real-life problems related to geotechnical and geo-environmental engineering

PEO3 Become tech entrepreneurs capable of developing processes and technologies for sound, feasible and acceptable solutions to ensure the safety and stability of geotechnical infrastructure.

PEO4 Perform research-based investigations for solving geotechnical engineering problems using modern equipment and software tools.

PEO5 Function in multi-disciplinary teams to advocate policies, systems, processes and equipment for control and remediation of ground and foundation of structures.

Programme Outcomes (POs):

Graduates of the programme M. E., Soil Mechanics Foundation Engineering will be able to

PO1 Research Aptitude An ability to independently carry out research/investigation and development work to solve practical problems.

PO2 Technical Documentation An ability to write and present a substantial technical report/document.

PO3 Technical Competence Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4 Knowledge of Geotechnical Engineering discipline Demonstrate in-depth knowledge of Geotechnical Engineering discipline, with an ability to evaluate, analyze and synthesize existing and new knowledge.

PO5 Critical analysis of Geotechnical Engineering problems and innovation Critically analyze complex Geotechnical Engineering problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical, practical and policy context.

PO6 Conceptualization and evaluation of engineering solutions to geotechnical engineering issues Conceptualize and solve Geotechnical Engineering problems, evaluate potential solutions, and arrive at technically feasible, economically viable and environmentally sound solutions with due consideration of safety.
PEO / PO Mapping:

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1- Low, 2 – Medium, 3 – High
# MAPPING OF COURSE OUTCOME AND PROGRAMME OUTCOME

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1- Low, 2 – Medium, 3 – High
## MAPPING FOR PROFESSIONAL ELECTIVE COURSES [PEC]

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* 1-low, 2-medium, 3-high
### ANNA UNIVERSITY:: CHENNAI 600 025
### UNIVERSITY DEPARTMENTS
### M.E., SOIL MECHANICS AND FOUNDATION ENGINEERING (FULL-TIME)
### REGULATIONS – 2023
### CHOICE BASED CREDIT SYSTEM
### CURRICULUM AND SYLLABI FOR SEMESTERS I TO IV

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**TOTAL CREDITS TO BE EARNED FOR AWARD OF THE DEGREE: 72**

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**RESEARCH METHODOLOGY AND IPR COURSES (RMC)**

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**SUMMARY**

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UNIT I  ALGEBRAIC EQUATIONS  12

UNIT II  LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS  12
Laplace transform: Definitions, properties - Transform of error function, Bessel's function, Dirac Delta function, Unit Step functions – Convolution theorem – Inverse Laplace Transform: Complex inversion formula – Solutions to partial differential equations: Heat equation, Wave equation

UNIT III  FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS  12

UNIT IV  CALCULUS OF VARIATIONS  12
Concept of variation and its properties – Euler’s equation – Functionals dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries -Direct methods – Ritz and Kantorovich methods.

UNIT V  TENSOR ANALYSIS  12
Summation convention – Contravariant and covariant vectors – Contraction of tensors – Inner product – Quotient law – Metric tensor – Christoffel symbols – Covariant differentiation – Gradient, divergence and curl.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1 On successful completion of the course, the students will be able to
CO2 get familiarized with the methods which are required for solving system of linear, Non linear equations and eigenvalue problems.
CO3 develop the mathematical methods of applied mathematics and mathematical physics
CO4 solve boundary value problems using integral transform methods apply the concepts of calculus of variations in solving various boundary value problems
CO5 familiarize with the concepts of tensor analysis.

REFERENCES:

CO-PO MAPPING

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* 1-low, 2-medium, 3-high

SOCIAL PROPERTIES AND BEHAVIOUR

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UNIT I SOIL DEPOSITS AND CLAY MINERALS

UNIT II PHYSICAL AND PHYSIO CHEMICAL BEHAVIOUR OF SOILS

UNIT III SWELLING, SHRINKAGE AND COMPACTION BEHAVIOUR OF SOILS

UNIT IV COMRESSIBILITY, SHEAR STRENGTH AND PERMEABILITY BEHAVIOUR OF SOILS
Compressibility, shear strength and permeability behaviour of fine – and coarse-grained soils – mechanisms – factors influencing engineering properties – liquefaction of soil – causes and consequences – case studies.

UNIT V CONDUCTION PHENOMENA AND PREDICTION OF SOIL BEHAVIOUR

TOTAL: 45 PERIODS
LIST OF EXPERIMENTS

1. DETERMINATION OF INDEX PROPERTIES 12
   a. Specific gravity of soil solids
   b. Grain size distribution – (Sieve analysis & Hydrometer analysis)
   c. Liquid limit and Plastic limit tests
   d. Shrinkage limit and Differential free swell tests

2. CHEMICAL TESTS 12
   a. pH and Conductivity
   b. Quantification of CEC through flame Photometer
   c. Determination of organic, sulphate and chlorite content

3. COMPACATION AND CBR TESTS 16
   a. Field density Test (Sand replacement method)
   c. CBR Test

4. CONSOLIDATION AND PERMEABILITY TESTS 8
   a. Permeability determination (constant head and falling head methods)
   b. One dimensional consolidation test (Determination of consolidation parameters)

5. SWELL TESTS 12
   Determination of percent swell – swell pressure by
   a. Constant volume method
   b. Expanded - loaded method
   c. Double odometer test

TOTAL: 105 PERIODS

COURSE OUTCOMES:

- On successful completion of the course, the students will be able to
  CO1 classify the suitable and unsuitable soil based on index properties and classification
  CO2 understand the micro level understanding of the clay mineralogy and its intricacies and consequences apart from conventional procedures of handling fine- and coarse-grained soil
  CO3 explain the peculiar behaviour of clays which exhibits extreme volume changes (Swelling and shrinkage) owing to the presence of swelling mineral, in addition to field reclamation geotechnical projects through compaction techniques
  CO4 interpret the engineering behaviour of soils such as compressibility, permeability, and shear strength with index properties so as to design the safe foundation system.
  CO5 understand the various geotechnical applications of conduction phenomenon which are of great significance in the case of ground contamination and decontamination, ground improvement methods and land reclamation projects
REFERENCES:
9. I.S. Code of Practice (2720): Relevant Parts, as amended from time to time.

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* 1-low, 2-medium, 3-high

SF3102

CONSTITUTIVE BEHAVIOUR OF SOILS

UNIT I SHEAR STRENGTH OF COHESIONLESS SOILS


Attested

[Signature]

Director

Centre for Academic Courses
Anna University, Chennai-600 025
UNIT II  SHEAR STRENGTH OF COHESIVE SOILS 9
Shear strength of normally consolidated and over consolidated clays - Stress-strain behaviour - Total stress and effective stress approach - Triaxial testing and stress path plotting - pore pressure parameters of Skempton and Henkel - shear strength of partially saturated clay in terms of stress state variables. Factors influencing stress – strain characteristics – shear strength - field application.

UNIT III  FAILURE THEORIES 9
Concepts of yield and failure in soils- Failure theories of Von Mises, Tresca and their extended form, their applicability to soils - Detailed discussion of Mohr - Coulomb failure theory.

UNIT IV  CONSTITUENT MODEL AND DEFORMATION MODULUS OF SOILS 9

UNIT V  CRITICAL STATE SOIL MECHANICS 9
The critical state line- Rosco’s surface- Hvorslev’s surface- Behavior of sand- Effects of dilation- Limitations of Taylor model- Elastic and plastic deformation-Camclay critical state model- Modified Camclay model- Parameters for design

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On successful completion of the course, the students will be able to
  CO1 Select the shear strength parameters of cohesionless soil based on mode of shear, drainage conditions and differentiate the cyclic stress – strain behaviour of cohesionless soil due to earthquake loading.
  CO2 Select the shear strength parameters of cohesive soil based on mode of shear, drainage conditions, degree of saturation and degree of consolidation
  CO3 Apply different failure criteria and its applicability based on drainage conditions and type of soil.
  CO4 Apply constitutive models for soils and their applicability for different type of drainage conditions.
  CO5 Explain critical state behaviour, modelling of soils and to select the respective design parameters.

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• 1-low, 2-medium, 3-high

SF3103 SUBSURFACE INVESTIGATION AND INSTRUMENTATION

UNIT I PLANNING OF EXPLORATION AND GEOPHYSICAL METHODS
Scope and objectives, planning an exploration program, methods of exploration, exploration for preliminary and detailed design, spacing and depth of bores, data presentation. Geophysical exploration and interpretation, seismic method, Multichannel Analysis of Surface Waves (MASW), spectral analysis of surface waves (SASW) methods and electrical methods, cross hole– up hole - down hole methods.

UNIT II EXPLORATION TECHNIQUES
Methods of boring and drilling, non-displacement and displacement methods, drilling in difficult subsoil conditions, offshore drilling, limitations of various drilling techniques, stabilization of boreholes, bore logs.

UNIT III SOIL SAMPLING
Sampling Techniques – quality of samples – factors influencing sample quality - disturbed and undisturbed soil sampling advanced sampling techniques, offshore sampling, shallow penetration samplers, preservation, and handling of samples – Advanced Sampling for Rocks.

UNIT IV FIELD TESTING IN SOIL EXPLORATION
Field tests, penetration tests - SPT, SCPT, Field vane shear, Insitu shear and bore hole shear test, pressuremeter test, dilatometer test - plate load test–monotonic and cyclic; field permeability tests – block vibration test. Procedure, limitations, correction, and data interpretation of all methods.

UNIT V INSTRUMENTATION
Instrumentation in soil engineering, functional components of data acquisition system - strain gauges, resistance and inductance type, load cells, earth pressure cells, settlement and heave gauges, pore pressure measurements - slope indicators, sensing units, case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
• On successful completion of the course, the students will be able to
  CO1 Plan the subsurface investigation program for a given project also capable of extending consultancy service for real time Soil Mechanics and Foundation Engineering problems.
  CO2 Apply the knowledge of different methods of exploration to select appropriate method of boring for investigating real field condition.
Apply the knowledge of different sampling techniques to collect, store and transport soil samples from onshore and offshore to meet specified needs and to characterize the soil.

Carryout appropriate field test to arrive at required soil parameters for the design of geotechnical structures considering all the influential parameters

Plan the instrumentation programme, execute the same in the field and monitor the performance of geotechnical structures to ensure its stability during its life time. Also conduct research pertinent to soil mechanics and foundation engineering as well as engage in independent life-long learning

REFERENCES:

SF3104 COMPUTATIONAL GEOMECHANICS

UNIT I THEORY OF ELASTICITY

UNIT II STRESS AND DISPLACEMENT

UNIT III THEORY OF PLASTICITY

UNIT IV FLOW THROUGH POROUS MEDIA

Attested

[Signature]
UNIT V  RISK ANALYSIS IN GEOMECHANICS

Spatial variability and random field theory - soil variability and uncertainty quantification - Simple probabilistic methods for reliability analysis in geotechnical engineering - Reliability based design in geotechnical engineering.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On successful completion of the course, the students will be able to
  
  CO1 Explain the basic concept of elasticity, understand the mechanics of continuum, and solve field problems.
  
  CO2 Analyse stress distribution and displacement in homogeneous, nonhomogeneous, and anisotropic soil medium under the given loading conditions.
  
  CO3 Explain the basic concept of plasticity, understand the mechanism of collapse, and solve field problems.
  
  CO4 Understand the liquid flow theory, analyse the flow of liquid in different soil medium and verify the stability of geotechnical engineering problems
  
  CO5 Analyse various parameters using probabilistic methods and perform reliability-based design in geotechnical engineering related problems

REFERENCES:


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• 1-low, 2-medium, 3-high
UNIT I RESEARCH PROBLEM FORMULATION 9
Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9
Statistical design of experiments- types and principles; data types & classification; data collection -methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9
Sampling, sampling error, measures of central tendency and variation.; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9
Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9
Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon completion of the course, the student can
CO1: Describe different types of research; identify, review and define the research problem
CO2: Select suitable design of experiments; describe types of data and the tools for collection of data
CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures
CO5: Execute patent filing and licensing

REFERENCES:
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
UNIT I PILE CLASSIFICATIONS AND LOAD TRANSFER PRINCIPLE 10

UNIT II AXIAL LOAD CAPACITY OF PILES AND PILE GROUP 10

UNIT III LATERAL AND UPLIFT LOAD CAPACITIES OF PILES 10

UNIT IV STRUCTURAL DESIGN OF PILE AND PILE GROUP 9

UNIT V CAISSONS 6

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On successful completion of the course, the students will be able to
- CO1 Explain the importance of pile foundation and various functions and responsibilities of geotechnical engineer and contractor, in addition to the piling equipment.
- CO2 Determine the vertical load carrying capacity of pile and pile group- keeping the settlement of pile as an important criterion based on field practices and codal provisions.
- CO3 Apart from vertically loaded piles, the structures are exposed to the peculiar pile subjected to lateral and uplift load with reference to codal provision and case studies.
- CO4 Understand the design of pile and pile caps, considering the wind and seismic loads.
- CO5 Explain the importance of caisson foundation and checking the stability of caissons based on codal provisions.

REFERENCES:

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**SF3202 EARTH AND EARTH RETAINING STRUCTURES**

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<td>State of stress in retained soil mass – Earth pressure theories – Classical and graphical techniques (Culmann’s method) – Active and passive cases – Earth pressure due to external loads.</td>
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<td>UNIT II STABILITY OF RETAINING STRUCTURES</td>
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<td>Retaining structure – Selection of soil parameters - Lateral pressure due to compaction, strain softening, wall flexibility, drainage arrangements and its influence. – Stability analysis of retaining structure both for regular and earthquake forces.</td>
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<td>UNIT III SHEET PILE WALLS</td>
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<td>Types of sheet piles - Analysis and design of cantilever and anchored sheet pile walls – free earth support method – fixed earth support method. Design of anchor systems - isolated and continuous.</td>
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<td>UNIT IV SUPPORTED EXCAVATIONS</td>
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<td>UNIT V STABILITY OF SLOPES</td>
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<td>Stability of infinite and finite slopes, Limit Equilibrium method, Wedge analysis, Method of Slices, Bishop’s method, Janbu’s method etc. Special aspects of slope analysis, stability charts.</td>
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**TOTAL: 45 PERIODS**

[Signature]

Director
Centre for Academic Courses
Anna University, Chennai-600 025
COURSE OUTCOMES:

- On successful completion of the course, the students will be able to

**CO1** Analyse the earth pressure acting on retaining structures by applying classical theories considering all influencing parameters and suggest the earth pressure to be considered for the design of retaining structures.

**CO2** Apply the knowledge of engineering and earth pressure to analyse and design rigid retaining structures considering effect of compaction, wall flexibility, pore water pressure and earth quake forces.

**CO3** Apply the knowledge of engineering and earth pressure to analyse and design flexible earth retaining walls and acquire the knowledge of design of anchors.

**CO4** Apply the knowledge on lateral earth pressure behind and around excavation to analyse and design braced excavations, slurry supported excavations and underground utilities.

**CO5** Analyse the stability of infinite and finite slopes through total stress and effective stress analysis by considering the actual shape of failure surface expected in the field.

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Attested

DIRECTOR

Centre for Academic Courses
Anna University, Chennai-600 025
UNIT I  BASIC CONCEPTS  9
Basic concepts - discretization of continuum, typical elements, the element characteristic matrix, element assembly and solution for unknowns – applications, variational principles, variational formulation of boundary value problems, variational methods of approximation such as Ritz and weighted residual (Galerkin) methods.

UNIT II  DISPLACEMENT MODELS  9

UNIT III  ISOPARAMETRIC FORMULATION  8
Isoparametric element - Local and Natural Co-ordinates systems, Line, Triangular, Quadrilateral and Tetrahedral Element-Interpolation - Displacement Models Formulation of Isoparametric - Finite element matrices in Local and Global Coordinate system – refined elements – numerical integration techniques.

UNIT IV  GEOTECHNICAL CONSIDERATIONS  9

UNIT V  APPLICATION IN GEOTECHNICAL ENGINEERING  10
Use of FEM to problems in soils – description and application to consolidation – seepage - FEM to simulate soil – structure interaction problems – finite element theory for simulating and analyzing the real foundation problem such as footing, pile foundation and deep excavations.

DESIGN STUDIO LAB  60
Students must work individually with software packages for simulating and analyzing the various geotechnical engineering problems:
- Soil – structure interaction such as Foundations and Retaining walls
- Ground improvement related problems.
- Analyze and design real challenging problems - deep excavation – impact on adjacent structures
- Stability analysis of slope and embankment - surcharge adjacent to an existing structure
A detailed report on the work done should be submitted by individual students at least 10 days before the last working day of the semester. The students will be evaluated through a viva-voce examination by a team of internal staff.

TOTAL: 105 PERIODS

COURSE OUTCOMES:
On successful completion of the course, the students will be able to
CO1 understand the basic concept in finite element method using variational principles
CO2 differentiate various types of displacement models, select suitable finite element model and able to solve geotechnical problems
CO3 understand the basic concept of isoparametric finite element formulation and its use in solving geotechnical related problems
CO4 consider the various geotechnical concept in the finite element formulations including interfacial behavior
CO5 develop finite element formulation for different geotechnical engineering related problems
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### SF3204

**SHALLOW FOUNDATIONS**

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**FOUNDATION DESIGN DECISIONS**


Attested

DIRECTOR

Centre for Academic Courses
Anna University, Chennai-600 025
UNIT II  BEARING CAPACITY  

UNIT III  SETTLEMENT AND ALLOWABLE BEARING PRESSURE  

UNIT IV  INTERACTIVE ANALYSIS AND DESIGN OF FOUNDATIONS  

UNIT V  FOUNDATION FOR SPECIAL CONDITIONS  

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On successful completion of the course, the students will be able to
- CO1 Differentiate different type of shallow foundations, their selection, design principles for different ground conditions
- CO2 Apply appropriate bearing capacity theory and factors for different type of loading and ground conditions
- CO3 Decide the design bearing pressure based on settlement, mode of loading and ground conditions
- CO4 Perform interactive analysis for different types of shallow foundation and ground conditions
- CO5 Perform analysis for different types of special foundation and special ground conditions

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1-low, 2-medium, 3-high

SF3211 SOIL MECHANICS LABORATORY

UNIT I SHEAR STRENGTH TESTS
Direct shear – Triaxial compression (UU, CU, and CD) test – Unconfined compression test – Vane shear test.

UNIT II SUCTION TESTS
Soil water characteristic curves of soil by Pressure Plate apparatus – Filter paper technique.

UNIT III TEST ON GEOSYNTHETICS
Opening size of Geotextiles – Tensile strength of Geosynthetic materials – Interfacial friction – Permeability

UNIT IV TEST ON ROCKS
Point load index – Brazilian test – Direct shear test – Uniaxial compressive strength test

UNIT V MODEL AND FIELD TESTS (demonstration only)
Model test on foundation elements - strain gauges - load cells. Field tests - Plate load test – static cone penetration test – standard penetration test – pressure meter test - Block vibration test – Cyclic triaxial test.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
- On successful completion of the course, the students will be able to
- CO1 assess the shear strength of soils by conducting appropriate tests
- CO2 analyse the soil water characteristic curves of different soils
- CO3 analyse and assess the characteristics of soils using the geosynthetics
- CO4 evaluate the strength characteristics of rocks
- CO5 Understand the concept of conducting model tests and use data acquisition system for conducting model test in laboratory

REFERENCES:
11. I.S. Code of Practice (2720): Relevant Parts, as amended from time to time.

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SF3311

PRACTICAL TRAINING (4 WEEKS)

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SYLLABUS:
- Students individually undertake training in reputed Soil Mechanics and Foundation Engineering Companies during the summer vacation for a specified period of four weeks.
- Students allowed to get field exposure and effectively interact with geotechnical engineers.
- At the end of training, a detailed report on the work done should be submitted to the course coordinator.
- Students will be evaluated through a viva-voice examination by a team of internal staff.

TOTAL: 4 WEEKS

COURSE OUTCOMES:
- On completion of the course, the student is expected to be able to
  - CO1: Understand the real field problem and compare the theoretical knowledge with field data.
  - CO2: Solve Soil Mechanics and Foundation engineering problems in the field either individually or in team.
  - CO3: Understand the professional ethics.
  - CO4: Work in a team to obtain the solution for various field problems.

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SF3312

PROJECT WORK I

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SYLLABUS:
The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voice examination by a panel of examiners including one external examiner.

TOTAL: 180 PERIODS

COURSE OUTCOMES:
• On completion of the course, the student will be able to
  CO1 Recognize the importance of literature review
  CO2 Develop a clear outline and methodology for the project
  CO3 Identify the potential research gap and list parameters to work with filling the gap
  CO4 Report and present the findings of the work conducted.

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SF3411

PROJECT WORK II

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SYLLABUS:
The student should continue the Project Work I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 360 PERIODS

COURSE OUTCOMES:
• On completion of the course, the student will be able to
  CO1 Apply the knowledge gained from theoretical and practical courses in solving problems
  CO2 Represent data acquired in graphical and reader-friendly formats
  CO3 Derive detailed conclusions from work carried out
  CO4 Write thesis and present the findings of the work conducted
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PROFESSIONAL ELECTIVE COURSES

SF3001  
GEOENVIRONMENTAL ENGINEERING  

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UNIT I  
SOIL – WASTE INTERACTION  

UNIT II  
CONTAMINANT TRANSPORT AND SITE CHARACTERISATION  

UNIT III  
WASTE CONTAINMENT AND REMEDIATION OF CONTAMINATED SITES  

UNIT IV  
LANDFILLS AND SURFACE IMPOUNDMENTS  

UNIT V  
STABILISATION OF WASTE  

TOTAL: 45 PERIODS
COURSE OUTCOMES:

- On successful completion of the course, the students will be able to
  
  **CO1** Understand the various causes and consequences of waste interaction with soil and their modification.
  
  **CO2** Understand the various mechanism of transport of contaminants into the subsurface and characterization of contaminated sites and their risk analysis.
  
  **CO3** Understand on how to decontaminate the site so as to reuse the site for human settlement
  
  **CO4** Understand how to safely dispose the waste through different containment process.
  
  **CO5** Expose on how to convert the waste into a resource material through soil waste stabilization techniques with or without chemical stabilization.

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SF3002  
GEOLOGY FOR GEOTECHNICAL APPLICATIONS  
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UNIT I  ENGINEERING PROPERTIES OF ROCKS AND MINERALS  

UNIT II  SURFACE AND SUBSURFACE GEOLOGICAL INVESTIGATIONS  
Surface investigations: Bed rock attitudes - Strike and dip of rocks-Field mapping- thickness, calculation of True thickness and vertical thickness of bed rock-pitting and trenching-Subsurface
investigations: electrical and seismic geophysical methods in subsurface geological investigations for foundation engineering- applications of GPR in subsurface strata studies.

UNIT III  CORE SAMPLING AND LOGGING TECHNIQUES
Rocks and soil sampling methods- Drilled core sections - Bore hole logging methods, Core logging techniques – Resistivity log, Neutron log, Sonic log, Gamma log etc., and interpretation. Description of discontinuities-Fence diagrams, RQD and RMR.

UNIT IV  GEOLOGICAL INVESTIGATIONS FOR FOUNDATION SITES
Ground stability studies - Scour and erosion studies-stability of slopes: Geological information for slope stabilization and geological solution for slope stability in landslides areas-Overview of rocks of Tamil Nadu.

UNIT V  GEOLOGICAL CONSIDERATIONS FOR ENGINEERING STRUCTURES AND GEOHAZARDS
Geological conditions necessary for design of major engineering structures. Geological hazards-causes and mitigation- Case studies from India – Earthquake – Seismic zones of India.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
• On successful completion of the course, the students will be able to
  CO1 Identify various rock types and understand the strength and durability of different rock types.
  CO2 Map the surface and subsurface geological formations using geological and geophysical exploration techniques.
  CO3 Explore and analyse the subsurface rocks and their discontinuities for design and construction of major Civil engineering structures.
  CO4 Analyse the suitable methods for improving slope stability and manage unstable slopes efficiently.
  CO5 Understanding the various geological conditions necessary for design of major engineering structures.

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1-low, 2-medium, 3-high

24
UNIT I BASIC CONCEPTS
Historical development of pavements – types, classification, components, and principle of load transfer – Approaches to pavement design – vehicle and traffic considerations – behaviour of road materials under repeated loading – Stresses and deflections in layered systems.

UNIT II FLEXIBLE PAVEMENT
Factors affecting flexible pavements – material characterization for analytical pavement design – AASHO, CBR, group index methods – Importance of Resilient modulus – Fatigue subsystem – failure criteria for bituminous pavements – IRC design guidelines.

UNIT III RIGID PAVEMENT
Factors affecting rigid pavements - Design procedures for rigid pavement – Slab thickness, dowel bar, tie bar, spacing of joints – IRC guidelines – Airfield pavements – Comparison of highway and airfield pavements.

UNIT IV PAVEMENT EVALUATION AND REHABILITATION
Pavement evaluation – surface and structural - causes and types of failures in flexible and rigid pavements – Presents serviceability index of roads – Overlay design - pavements maintenance, management and construction – Drainage and its importance in pavements.

UNIT V STABILIZATION OF SOILS FOR ROAD CONSTRUCTIONS
Need for a stabilized soil – Design criteria – Mechanisms - factors influencing choice of stabilizers - Testing and field control – Applications of Geosynthetics in road construction - Case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On successful completion of the course, the students will be able to
  CO1 Explain different types of pavements, wheel load, serviceability and design strategies of pavement.
  CO2 Design flexible pavements based on different guidelines.
  CO3 Design rigid pavements based on different guidelines.
  CO4 Explain the various types of failure in different components of pavement and assess the pavement conditions and rehabilitation.
  CO5 Select suitable stabilizers based on mechanism and requirements for construction with quality control in the field.

REFERENCES:
SF3004  EARTHQUAKE RESISTANT DESIGN OF FOUNDATIONS  L  T  P  C 3 0 0 3

UNIT I  BASIC DESIGN PARAMETERS  9
Dynamic properties of soils and its evaluation, strength, and deformation characteristics of soils under earthquake loading, liquefaction hazard evaluations and remedial measures, geotechnical failure of foundations during earthquake, provision of IS 1893 and IS 13920

UNIT II  SHALLOW FOUNDATION  9

UNIT III  DEEP FOUNDATION  10

UNIT IV  SEISMIC DESIGN OF RETAINING WALL  9
Seismic passive lateral earth pressure, behaviour of retaining wall during earthquakes, modification of Coulomb’s Theory, Modified Culmann’s Theory, displacement analysis, Indian standard code of practice.

UNIT V  STRUCTURAL DESIGN OF FOUNDATION  8
Loads acting on foundations during earthquake – fundamental failure mechanisms of foundations – essential criteria for design of foundations in liquefiable soils – structural design of foundations subjected to earthquake loading

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On successful completion of the course, the students will be able to
  CO1 Evaluate the dynamic properties of soils and relevant design parameters
  CO2 Design the shallow foundation subjected to earthquake loading by including the effect of soil liquefaction
  CO3 Analyse and design the deep foundation by considering various earthquake forces
  CO4 Analyse and design the retaining wall by incorporating earthquake force
  CO5 Perform structural design of foundations subjected to both static and dynamic loading
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SF3005 GROUND IMPROVEMENT TECHNIQUES

UNIT I HYDRAULIC MODIFICATIONS
9
Scope and necessity of ground improvement in Geotechnical engineering basic concepts. Drainage – Ground Water lowering by well points, deep wells, vacuum, and electro-osmotic methods. Stabilization by thermal and freezing techniques - Applications.

UNIT II MECHANICAL MODIFICATIONS
9
In situ compaction of granular and cohesive soils, Shallow and Deep compaction methods – Sand piles – Concept, design, factors influencing compaction. Blasting and dynamic consolidation - design and relative merits of various methods – Soil liquefaction mitigation methods - Case studies.

UNIT III PHYSICAL MODIFICATION
9

UNIT IV MODIFICATION BY INCLUSIONS
9
Reinforcement – Principles and basic mechanism of reinforced earth, simple design: Synthetic and natural fiber-based Geotextiles and their applications. Filtration, drainage, separation, erosion control – case studies.

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Director
UNIT V  CHEMICAL MODIFICATION

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On successful completion of the course, the students will be able to
  CO1 identify and evaluate the deficiencies in the deposits of the given project area and improve its characteristics by hydraulic modifications
  CO2 improve the ground characteristics by mechanical modifications using various method and design the system
  CO3 improve the ground characteristics by physical modifications using various method and design the system
  CO4 improve the characteristics of soils by various reinforcement techniques and design
  CO5 Analyse the ground and decide the suitable chemical method for improving its characteristics

REFERENCES:
1. Puppala, A.J., Huang, J., Han, J., and Hoyos, L.R., Ground Improvement and Geosynthetics; Geotechnical special publication No. 207, Geo Institute, ASCE, 2010
11. Han, J., Principles and Practice of Ground Improvement, John Wiley and Sons, New Jersey, Canada 2015.

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1-low, 2-medium, 3-high
UNIT I  SOIL RESPONSE MODELS OF INTERACTION ANALYSIS  

UNIT II  INFINITE AND FINITE BEAMS ON ELASTIC FOUNDATIONS  
Infinite beam, General solution of the elastic line – concentrated and distributed loads on beams – Idealization of semi-infinite and finite beams. Classification of finite beams, different end conditions and loads – solutions - General method.

UNIT III  PLATE ON ELASTIC MEDIUM  

UNIT IV  ANALYSIS OF PILE AND PILE GROUPS  
Elastic analysis of single pile – Solutions for settlement and load distribution – Simplified method for constructing load settlement curve to failure – Analysis of group settlement – Two pile interaction Analysis, Analysis of general groups – Theoretical solutions for free standing groups – Settlement of groups caused by compressible underlying strata – Use of design charts – Surface settlement around a group – Observed and predicted group behaviour.

UNIT V  LATERALLY LOADED PILE  
Load - deflection prediction for laterally loaded piles, subgrade reaction and elastic analysis, Analysis of pile group, pile raft system, solutions through influence charts.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On successful completion of the course, the students will be able to

CO1  Select appropriate soil response model for interactive analysis.
CO2  Differentiate and perform interactive analysis for different beams.
CO3  Differentiate and perform interactive analysis for different plates.
CO4  Perform interactive analysis for single pile, two pile and multiple groups subjected to vertical loading.
CO5  Perform interactive analysis for single pile and multiple groups subjected to lateral loading.

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SF3007 DYNAMICS OF SOILS AND FOUNDATIONS

UNIT I THEORY OF VIBRATION

UNIT II DYNAMIC SOIL PROPERTIES AND BEHAVIOUR

UNIT III FOUNDATIONS FOR RECIPROCATING MACHINES

UNIT IV FOUNDATION FOR IMPACT AND ROTARY MACHINES

UNIT V INFLUENCE OF VIBRATION AND REMEDIATION

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On successful completion of the course, the students will be able to
- CO1 Differentiate different type of dynamic loads and theory of vibration of different systems
- CO2 Select different dynamic properties from different testing principles and applications
- CO3 Perform analysis and design of reciprocating machines based on different methods.
- CO4 Perform analysis and design of impact and rotary machines based on different
- CO5 Assess influence of vibration from different dynamic source and design suitable remediation
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SF3008 GEOTECHNICAL EARTHQUAKE ENGINEERING  L  T  P  C  3  0  0  3

UNIT I ELEMENTS OF EARTHQUAKE SEISMOLOGY 6

UNIT II THEORY OF VIBRATION 9

UNIT III GROUND MOTION CHARACTERISTICS 10
Strong Motion Records -characteristics of ground motion - Factors influencing ground motion - Estimation of frequency content parameters - Seismic site investigations - Evaluation of Dynamic soil properties.

UNIT IV DESIGN GROUND MOTION 10

UNIT V SEISMIC STABILITY ANALYSIS 10

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On successful completion of the course, the students will be able to
  
  CO1 Explain interior structure of earth, different causes, location and quantification of earthquake
  
  CO2 Differentiate different type of dynamic loads and theory of vibration of different systems
  
  CO3 Evaluate dynamic properties of soils and ground motion characteristics
  
  CO4 Estimate the design ground motion based on the ground response analysis
  
  CO5 Analyze and design different types of foundations, slopes and retaining walls for seismic loading and assess liquefaction potential and mitigation of liquefaction induced damage.

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SF3009 MECHANICS OF UNSATURATED SOILS

UNIT I STATE OF UNSATURATED SOIL


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DIRECTOR

Centre for Academic Courses
Anna University, Chennai-600 025
UNIT II

PHYSICS OF SOIL WATER SYSTEM


UNIT III

STRESS STATE VARIABLES AND SHEAR STRENGTH


UNIT IV

STEADY AND TRANSIENT FLOWS


UNIT V

MATERIAL VARIABLE MEASUREMENT AND MODELLING


TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On completion of the course, the students is expected to be able to

  CO1 Explain stress state variables, material variables and constitutive law of unsaturated soil
  CO2 Explain the physics of soil-water mechanism, relationship of models.
  CO3 Explain and determine the soil-water characteristic curve and the shear strength of unsaturated soil
  CO4 Explain the principles of vapour flow, air diffusion, pore liquid flow and rate of infiltration in unsaturated soil.
  CO5 Measure the material variables and select the suitable soil models.

REFERENCES:

SF3010  GEOSYNTHETICS AND REINFORCED SOIL STRUCTURES  

UNIT I  PRINCIPLES AND MECHANISMS OF SOIL REINFORCEMENT  

UNIT II  REINFORCING MATERIALS AND THEIR PROPERTIES  

UNIT III  DESIGN FOR SOIL REINFORCEMENT AND SEPARATION  

UNIT IV  DESIGN FOR FILTRATION, DRAINAGE AND CONTAINMENT  

UNIT V  DESIGN OF SLOPES  

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On successful completion of the course, the students will be able to
  - CO1 Explain various principles and mechanism of soil reinforcement.
  - CO2 Select different reinforcing materials based on functions to determine their properties
  - CO3 Design geosynthetics as a reinforcement and/or a separator for different reinforced structures.
  - CO4 Design geosynthetics as a filter, drainer and as a containment for different reinforced structures.
  - CO5 Analyze and design reinforced slopes for static and seismic loading.

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Centre for Academic Courses
Anna University, Chennai-600 025
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SF3011 ROCK MECHANICS AND APPLICATIONS

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UNIT I CLASSIFICATION OF ROCKS
Types of Rocks - Index properties and classification of rock masses, competent and incompetent rock - value of RMR and ratings in field estimations.

UNIT II STRENGTH CRITERIA OF ROCKS
Behaviour of rock under hydrostatic compression and deviatomic loading - Modes of rock failure - planes of weakness and joint characteristics - joint testing, Mohr - Coulomb failure criterion and tension cut-off.Hoek and Brown Strength criteria for rocks with discontinuity sets.

UNIT III INSITU STRESSES IN ROCKS
Insitu stresses and their measurements, Hydraulic fracturing, flat jack, over coring and under coring methods - stress around underground excavations – Design aspects of openings in rocks - case studies.

UNIT IV SLOPE STABILITY AND BEARING CAPACITY OF ROCKS
Rock slopes - role of discontinuities in slop failure, slope analysis and factor of safety - remedial measures for critical slopes – Bearing capacity of foundations on rocks – case studies.
UNIT V  ROCK REINFORCEMENT

Reinforcement of fractured and joined rocks - shotcreting, bolting, anchoring, installation methods - case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On successful completion of the course, the students will be able to
  
  **CO1** Classify the Rock mass and rate the quality of rock for tunnelling and foundations works and suggest the safer length of tunnelling and stand-up time.
  
  **CO2** Apply the knowledge of engineering and understand the stress – strain characteristics and failure criteria of rock and apply them to arrive at the shear strength parameters of rocks to be used for the design of structures resting on rock and for the design of underground excavation in rocks.
  
  **CO3** Apply the knowledge of engineering and assess the influence of insitu stress in the stability of various underground excavations and also acquire the knowledge of design of opening in rocks.
  
  **CO4** Apply the knowledge on rock mechanics and analyse the stability of rock slopes and arrive at the bearing capacity of shallow and deep foundations resting on rocks considering the presence of joints, design the foundations resting on rocks. Able to carry out suitable foundation for the structure resting on rock.
  
  **CO5** Improve the insitu strength of rocks by various methods such as rock reinforcement and rock support. Able to select suitable support system considering the interaction between rock and support. Also capable of executing the same in the field.

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UNIT I DESIGN CONSIDERATION
Design consideration, Factors influencing design, Types of earth and rock fill dams, Design
details, Provisions to control pore pressure.

UNIT II SLOPE STABILITY AND SEEPAGE ANALYSIS
Stability of infinite and finite slopes, Method of Slices, Bishop’s method, Flow nets, Stability
conditions during construction, Full reservoir and drawdown – cut off walls – Trenches –
Importance of drainage and filters.

UNIT III HYDRAULIC FRACTURING
Sampling Techniques – quality of samples – factors influencing sample quality - disturbed and
undisturbed soil sampling advanced sampling techniques, offshore sampling, shallow
penetration samplers, preservation and handling of samples.

UNIT IV FIELD TESTING IN SOIL EXPLORATION
Introduction, Conditions and mechanisms for hydraulic fracturing, Failure criterion for hydraulic
fracturing – cubic specimen with a crack – core with a transverse crack – core with a vertical
crack, strike–dip of easiest crack spreading; factors affecting hydraulic fracturing, self-healing of
a core crack.

UNIT V SLOPE PROTECTION MEASURES
Special design problems, Slope protection, Filter design, Foundation treatment, Earth dams on
pervious soil foundation, Application of Geosynthetic materials in filtration. Treatment of rock
foundation, Construction Techniques, Quality control and performance measurement.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- On successful completion of the course, the students will be able to
  - Assess the causes of failure and damage of embankments and slopes.
  - Apply the knowledge of engineering and analyse the stability of slopes for various seepage
    conditions and apply the concept in the design of earth and rock fill dams.
  - Apply the knowledge of engineering and assess the stability of dam against hydraulic
    fracturing and suggest suitable remedial measure.
  - Understand the nature of failures and damages in earth and rock fill dams and apply the
    concept in field to avoid distress.
  - Recommend suitable remedial measures to protect the slopes and implement quality control
    and monitor its performance.

REFERENCES:
1. Rowe, R.K., Geotechnical and Geoenvironmental Engineering Handbook, Kulwer Academic
   Glasgow, 1986.
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SF3013 GEOTECHNICS OF UNDERGROUND STRUCTURES

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UNIT I GROUND MOVEMENTS AND ITS EFFECTS
Understanding of the ground – Building response to ground movements – concept of limiting tensile strain – strains in simple rectangular beams – ground movement due to tunneling and excavation - lateral supporting systems – retaining walls – factors influencing on the selection of the retaining system – case history.

UNIT II ANALYSIS OF UNDERGROUND SUPPORTING SYSTEMS

UNIT III DESIGN OF UNDERGROUND SUPPORTING SYSTEMS
Principles of retaining wall design – types of wall support systems - design of structural elements – Permanent situations – bottom-up/top-down construction sequences – Props – Tied systems – Soil berms – Design of ground anchors – Retaining wall as part of complete underground structure – resistance to vertical and lateral actions

UNIT IV DESIGN OF TUNNEL
Longitudinal and transverse profile of tunnel structure - tunnel protection against fire - advanced systems of anti-water insulation of underground structures - loading types of shallow and deep tunnels, rock mass classification - mining technologies of deep excavation - shield technology, execution technology of shallow underground structures, sewerage objects - trenchless technologies.

UNIT V PROTECTION OF ADJACENT BUILDINGS
Protection of building using the behaviour of excavation and tunneling induced deformation – building protection by auxiliary methods – construction defects and remedial measures – building rectification methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On successful completion of the course, the students will be able to

CO1 Understand various types of supporting systems used for excavations and analyse ground movement due to various activities like excavations

CO2 Analyse underground supporting system using mathematical, analytical and numerical methods
CO3 Design various underground supporting systems using mathematical and numerical approach

CO4 Understand the concept of tunnelling, analyse, and design the tunnel in different ground conditions

CO5 Protect the adjacent building due to underground construction using various methods

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SF3014 MARINE GEOTECHNIQUES

UNIT I MARINE SOIL DEPOSITS
Offshore environment, Offshore structures and foundations, Specific problems related to marine soil deposits, Physical and engineering properties of marine soils

UNIT II BEHAVIOR OF SOILS SUBJECT 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

Attested

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Centre for Academic Courses
Anna University, Chennai-600 025
UNIT III   SITE INVESTIGATION IN THE CASE OF MARINE SOIL DEPOSITS  
Challenges of site investigation in marine environment, Different site investigation techniques, sampling techniques, Geophysical methods, Recent advancements in site investigation and sampling used for marine soil deposits

UNIT IV   FOUNDATIONS IN MARINE SOIL DEPOSITS  
Different offshore and nearshore foundations, Gravity platforms, Jack-up rigs, pile foundations, cessions, spudcans

UNIT V   MARINE FOUNDATIONS SUBJECTED TO WAVE LOADING  
Cyclic behavior of soils, empirical models, elastic-plastic models, FEM analysis of marine foundations subjected to wave loading

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- On completion of the course, the students are expected to be able to
  CO1 Understand the physical and engineering properties of marine soil deposits
  CO2 explain the effect of wave loading on physical and engineering properties of marine soil deposits
  CO3 execute investigation program for marine soil deposits
  CO4 design suitable marine foundation as per project requirement
  CO5 develop numerical model and design marine foundation subjected to wave loading

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