JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
Course Structure and syllabi for
M.Tech-Geo Technical Engineering
for affiliated Engineering Colleges 2017-18

I YEAR I Semester

S. No	Course Code	Subject	L	T	P	C
1.	17D12101	Numerical Methods	4	---	---	4
2.	17D12102	Advanced Soil Mechanics	4	---	---	4
3.	17D12103	Theoretical Soil Mechanics	4	---	---	4
4.	17D12104	Design of Shallow Foundations	4	---	---	4
5.	17D12105 17D12106 17D12107	**Elective – 1** 1. Geo-Technical Earth Quake Engineering 2. Remote Sensing and Its Application in Geotechnical Engineering 3. Unsaturated Soil Mechanics	4	---	---	4
6.	17D12108 17D12109 17D12110 17D12111	**Elective – 2** 1. Geo-Environmental Engineering 2. Soil Dynamics and Machine Foundations 3. Soil Structure Interaction 4. Foundation Engineering for Problematic Soils	4	---	---	4
7.	17D12112	Advanced Geotechnical Engineering Lab-1	--	---	4	2
		Total	**24**		**4**	**26**

I YEAR II Semester

S. No	Course Code	Subject	L	T	P	C
1.	17D12201	Design of Deep foundations	4	---	---	4
2.	17D12202	Ground Improvement Techniques	4	---	---	4
3.	17D12203	Geo-Synthetics and applications in Geo Technical Engineering	4	---	---	4
4.	17D12204	Finite Element Method for Geo-Technical Applications	4	---	---	4
5.	17D12205 17D12206 17D12207 17D12208	**Elective – 3** 1. Earth and Earth Retaining Structures 2. Pavement Analysis and Design 3. Off shore Geo technical Engineering 4. Reinforced soil structures	4	---	---	4
6.	17D12209 17D12210 17D12211 17D12212	**Elective – 4** 1. Experimental Geo-Mechanics 2. Rock Mechanics 3. Optimization techniques in Geo Technical Engineering 4. Forensic Geo Technical Engineering	4	---	---	4
7.	17D12213	Advanced Geotechnical Engineering Lab-2	--	---	4	2
		Total	**24**		**4**	**26**

M.Tech. II YEAR   (III Semester)

S. No	Course Code	Subject	L	T	P	C
1.	17D20301 17D20302 17D20303	Elective – V (Open Elective) 1. Research Methodology 2. Human Values & Professional Ethics 3. Intellectual Property Rights	4	---	---	4
2.	17D12301	ELECTIVE – VI (MOOCs)	--	---	---	--
3.	17D12302	Comprehensive Viva Voce	--	---	---	2
4.	17D12303	Seminar	--	---	---	2
5.	17D12304	Teaching Assignment	--	---	---	2
6.	17D12305	Project Work Phase I	--	---	---	4
		Total	**4**			**14**

M.Tech. II YEAR   (IV Semester)

S. No	Course Code	Subject	L	T	P	C
1.	17D12401	Project Work Phase II	--	---	---	12
		Total				**12**

Project Viva Voce Grades:

A: Very Good
B: Good

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(17D12101) NUMERICAL METHODS

UNIT – I
THE CALCULUS OF THE FINITE DIFFERENCES:
Differences Formulae, Difference Table, Properties of the Operators E and Δ, Leibnitz Rule- Interpolation with Equal Intervals, Unequal Intervals, Central Difference Interpolation Formulae – Inverse Interpolation

Unit – II
NUMERICAL DIFFERENTIATION AND INTEGRATION:
First Order and Second Order Derivatives – Maximum and Minimum Values of a Tabulated Function- Newton Cote's Quadrature Formula- Trapezoidal Rule, Simpson's Rules, Romberg's Method – Gaussian Quadrature Formulae

Unit – III
SIMULTANEOUS LINEAR ALGEBRAIC EQUATIONS:
Methods of Solution Using the Inverse of the Matrix, Method of Successive Elimination- Iterative Methods – Gauss - Siedel Method and Relaxation Method

Unit – IV
NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS:
Picard's Method of Successive Approximations –Euler's Modified Method -Runge-Kutta Method of Fourth Order – Predictor – Corrector Methods - Milne's Method and Adam's Moulton Method

Unit – V
INTRODUCTION TO FINITE ELEMENT ANALYSIS:
Various Steps in Solving a Problem by Finite Element Method(Displacement Approach) - Two Dimensional Method Elements - Formulation of The Finite Element Method Using (I)Principle of Virtual Work(II) Minimization of Total Potential Energy of a System - Discrete Element Method

Text Books/Reference Books
1. Introductory Methods Of Numerical Analysis by S.S.Sastry, PHI
2. Numerical Methods For Engineers & Scientists by Chapra, Tata McGraw Hill
3. Calculus Of Finite Difference Method & Numerical Analysis by Gupta Malik
4. Analytical & Computer Methods In Finite Difference Methods by Bonles
5. Elastic Analysis Of Soil Foundation Interaction by SelvaDurai
6. Applied Numerical Analysis By Curtis F. Gerald, Partick.O.Wheatly, Addison – Wesley, 1989

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(17D12102) ADVANCED SOIL MECHANICS

Course Objectives: This Course Will Enable Students:
- To Explore The Scientific Principles Used To Describe The Major Engineering Properties Of Soil, And The Engineering Testing Methods Used To Quantify These Properties
- To Explain Role Of Water In Soil Behavior With Change In Soil Stresses, Permeability And Quantity Of Seepage Including Flow Net Are Estimated
- To Determine Shear Parameters And Stress Changes In Soil Due To Foundation Loads
- To Estimate The Magnitude And Time-Rate Of Settlement Due To Consolidation

UNIT I
GEOSTATIC STRESSES &STRESS PATHS:
Stresses Within A Soil Mass: Concept of Stress for a Particulate System, Effective Stress Principle, Geostatic Stresses, Soil Water Hydraulics: Principal Stresses and Mohr's Circle of Stress, Stress Paths; at Rest Earth Pressure, Stress Paths for Different Practical Situations

UNIT II
COMPRESSIBILITY AND CONSOLIDATION:
One Dimensional Consolidation, Odometer Test, Coefficient of Volume Change, Constrained Modulus, Compression Index, Swell for Loading and Unloading, Pre Consolidation Stress, Over-Consolidation Ratio, Primary and Secondary Compression, Consolidation One Dimensional Problems, Consolidation of Partially Saturated Soils, Creep/Secondary Consolidation

UNIT III
STRESS-STRAIN BEHAVIOR OF SOILS:
Shear Strength of Soils; Failure Criteria : Coulomb's Failure Criterion, Taylor's Failure Criterion, Mohr–Coulomb Failure Criterion, Tresca Failure Criterion, Practical Implications of Failure Criteria, Drained and Un-drained Shear Strength of Soils. Significance of Pore Pressure Parameters; Determination of Shear Strength; Drained, Consolidated Un-drained and Un-drained Tests; Interpretation of Triaxial Test Results.

UNIT IV
STABILITY ANALYSIS OF SLOPES:
Effective and Total Stress Approach, Shape of Slip Surface, Methods of Slices, Graphical Methods, and Location of Critical Slip Circle, Friction Circle Method, and Stability During Critical Conditions.

UNIT V
EARTH PRESSURE THEORIES
Rankin's earth pressure – Coulomb`s wedge theory – Cullman`s graphical method – Rebhan`s Graphical Method – Stability of Retaining walls: Gravity and Cantilever – Terzaghi`s simplified method for stability analysis.

Course Outcomes:
During This Course, Students Will Be Trained:
 ➢ Analyze The Soil Stresses, Permeability And Seepage For The Existing Field Conditions
 ➢ To Understand The Compressibility Behavior of Soil And Consolidation Settlement Along With Time Rate Of Settlement
 ➢ To Develop Suitable Method For Analyzing The Slope Stability.
 ➢ To understand the stability considerations of retaining walls.

Text Books/Reference Books:

1. Geotechnical Engineering- Donold P Coduto Phi Learning Private Limited, New Delhi
2. Das, B. M. &SobhanK, - Principles of Geotechnical Engineering, Cengage Learning, Edition (2015).
3. Mitchell J.K. - Fundamentals of soil behavior - John Wiley and Sons, Inc., New York. (Third edition) 2005
4. Soil Mechanics And Foundation Engg.- Muni Budhu(2010), 3rd Edition, John Wiely&Sons
5. Soil Mechanics- J A Knappett and R F Craig Eighth Edition (2012), Spon Press Taylor &Francis.
6. Analysis and Design Foundations by Joseph Bowles, McGraw Hill Publications.

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(17D12103) THEORETICAL SOIL MECHANICS

Course Objectives: This Course Will Enable Students To
- To Impart The Knowledge For Computation Of Settlements And Stress In Semi infinite Elastic Soil Medium
- Settlements And Stress In Anisotropic Medium And Layered Deposits Due To Foundation Loads
- Concept on Plastic Collapse.

UNIT I
Introduction – Elasticity and Stability Problems, Concept of Stress and Strain – Plane Stress, Plane Strain and Axi-symmetric Problems– Equation of Equilibrium and Compatibility – Stress Functions.

UNIT II
Stresses In Elastic Half-Space Medium By External Loads –Fundamental Solutions – Boussinesq's and Mindlin Solution – Anisotropic and Non-Homogeneous Linear Continuum – Influence Charts – Elastic Displacement-Layered Soil-Burmister Method

UNIT III
Limit Equilibrium Analysis – Stress –Strain Relationship – Elasto Plastic Response, – Perfectly Plastic Material, Filed applications – Slip-Line Solutions for Undrained and Drained Loading.

UNIT IV
Limit Analysis – Principles of Virtual Work – Theorems of Plastic Collapse – Mechanism for Plane Plastic Collapse – Simple Solutions for Drained and Un-drained Loading –Stability of Slopes, Cuts and Retaining Structures. Introduction to Centrifuge Modeling.

UNIT V
Flow Through Porous Media – Darcy's Law – General Equation of Flow– Steady State Condition – Solution by Flow Net – Fully Saturated Conditions.

Course Outcomes:
During This Course, Students Will Be Trained :
- To Evaluate The Theoretical Aspects Like Stresses, Limiting Stresses Etc
- To Understand The Stability Aspects Collapse Mechanisms, Centrifuge Modeling, Estimate The Stresses In Soils, Flow Net And Related Problems

Text Books/Reference Books
1. Foundations of Theoretical Soil Mechanics, Harr, M.E (1966) McGraw-Hill.
2. Foundation Engineering Handbook, Winterkorn, H.F., And Fang, H.Y(2000) Galgotia, Book source, 2000
3. Theoretical Soil Mechanics- Karl Terzaghi (1943), John Wiley &Sons.
4. Soil Mechanics and Foundations, Muniram Budhu (2007), John Wiley &Sons, Inc.
5. Soil Mechanics, T.W. Lambe and R.V. Whitman (1969). John Wiley &Sons
6. Foundations And Slopes- Attikinson(1981), McGraw-Hill, New Delhi
7. Seepage, Drainage And Flow nets– Cedergren H R(1997).-, John Wiely&Sons

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(17D12104) DESIGN OF SHALLOW FOUNDATIONS

Course objectives: This course will enable students to
- Understanding the capacity of the soil under different field conditions
- Design of shallow foundations under different loading condition and different environment
- Design of footings for uniform settlement of all shallow foundations.

UNIT I:
Developments - Need Of Foundation Engineering – Consideration for depth of foundations – Classification of foundations and their applicability - General Requirements - Selection of Type of Foundation – Structural Safety and Economy, Foundation Drainage Control.

UNIT II:
Bearing Capacity of Shallow Foundations - Homogeneous – Layered Soils - Soft and Hard Rocks, Effect of Ground Water Table and Eccentricity of Foundations. Evaluation of Bearing Capacity from In-Situ Tests: Plate Load test, Standard penetration test - Codal - Recommendations.

UNIT III
Foundations on Sanitary Landfill Site, Residual Soils, Permafrost and Adjoining To the River Bed. Contact Pressure under Footings: Flexible and Rigid. Principles of Footing Design:

UNIT IV
Proportionating of Shallow Footings, Introduction to Special Foundations - Design of Foundation for Seismic Forces - Introduction to Theory of Vibration - Design of Block Foundation - Codal Recommendations.

UNIT V
Settlement Analysis-Immediate-Consolidation Settlement-Layered Soils. Construction Period Correction-Evaluation from In-Situ Tests – Codal Recommendations.

Course Outcomes:
During This Course, Students Will Be Trained To:
- Analyze The Bearing Capacity Of The Soil For Shallow Foundations
- Design Aspects Of Raft Foundations For Achieving Uniform Settlement For Special Structures Like Water Tanks
- Structural Design Of Shallow Foundations In All Conditions Like Land-Fills, Pavements Etc In Varying Conditions Including Seismic Areas
- Proper Communication With Structural And Other Engineers

Reference Books:
1. Basic Soil Mechanics by Gopal Ranjan and ASR Rao
2. Foundation Engineering, Varghese P C. (2011)– Phi, India
3. Foundation Engineering, Bajra M Das.(2012), Cengage Learning India
4. Foundation Analysis and Design, J E Bowles (2012), McGraw Hill, Inc.
5. Foundation Engineering, Peck Hanson &Thornburg (1974). John Wiley &Sons,

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(17D12105) GEO-TECHNICAL EARTH QUAKE ENGINEERING
(Elective – 1)

UNIT I
ELEMENTS OF EARTHQUAKE SEISMOLOGY AND DYNAMICS:
Theory Of Vibration - Basic Definition - Governing Equation For Single Degree Freedom System - Forced Vibrations - Rotating Mass Type Excitation - Base Excitation - Isolation Vibration Measuring Instruments. Mechanism Of Earthquakes - Causes Of Earthquake - Earthquake Fault Sources.

UNIT II
GROUND MOTION CHARACTERISTICS:
Elastic Rebound Theory - Seismic Wave in Earthquake Shaking - Definition of Earthquake Terms - Locating an Earthquake - Quantification of Earthquakes. Strong Motion Records -Characteristics of Ground Motion - Factors Influencing Ground Motion - Estimation of Frequency Content Parameters.

UNIT III
GROUND RESPONSE ANALYSIS - LOCAL SITE EFFECTS AND DESIGN GROUND MOTION
Wave Propagation Analysis - Site Amplification - Need For Ground Response Analysis - Method Of Analysis - One Dimensional Analysis - Equipment for Linear Analysis for Site Effects.

UNIT IV
SEISMIC STABILITY ANALYSIS
Earthquake Response Of Slopes - Evaluation Of Slope Stability - Pseudo static Analysis - Newmark's Study Of Block Analysis - Dynamic Analysis - Earth Pressure Due To Ground Shaking Evaluation. Liquefaction-Susceptibility.

UNIT V
EARTHQUAKE HAZARD MITIGATION
Seismic Risk Vulnerability And Hazard - Percept Of Risk - Risk Mapping - Hazard Assessment - Maintenance And Modifications To Improve Hazard Resistance - Different Type Of Foundation And Its Impact On Safety.

References
1. Kameswararao, N.S.V., Dynamics Soil Tests and Applications, Wheeler Publishing - New Delhi, 2000.
2. Krammers.L. Geotechnical Earthquake Engineering, Prentice Hall, International Series, Pearson Education (Singapore) Pvt. Ltd., 2004.
3. Kameswararao, Vibration Analysis and Foundation Dynamics, Wheeler Publishing, New Delhi, 1998.

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(17D12106) REMOTE SENSING AND ITS APPLICATION IN GEOTECHNICAL ENGINEERING (Elective – 1)

UNIT – I

Definitions And Introduction To Remote Sensing, Components Of Remote Sensing System, Active And Passive Remote Sensing, Electromagnetic Radiations And Their Interactions With The Earth Features And Atmosphere. Remote Sensing Satellite Orbits, Image Acquisition Process, Receptivity, Row/Path and Ground Swath and Coverage.

UNIT – II

Various Remote Sensing Platforms Like Ground Based, Air Borne And Satellite Based. Passive and Active Remote Sensors: Return Beam Videocon (RBV), Multi-Spectral Scanners (MSS), Thematic Mapper (TM), Push Broom Scanners, Linear Imaging Self Scanner (LISS), Thermal Infrared Scanning Systems, Radiometers, Radar, Lidar and SAR. Different Types Of Remotely Sensed Data Products.

UNIT – III

Geometry, Radiometry And Pre-Processing Of Remotely Sensed Imagery. Ground Truth Collection and Geo-Referencing Of Imagery. Characteristics of Photographic Images. Colour, Tone and Texture, Photo-Interpretation Keys, Techniques of Photo-Interpretation. Digital Image Classification Techniques and Extraction of Thematic Information.

UNIT – IV

Global Positioning System *(GPS)* : Introduction & Components Of GPS, Space Segment, Control Segment And User Segment, Elements Of Satellite Based Surveys – Map Datum's, GPS Receivers, GPS Observation Methods And Their Advantages Over Conventional Methods. Geographic Information System (GIS) - Definition of GIS, Geographical Concepts and Terminology, Components of GIS, Data Acquisition, Raster and Vector Formats, Scanners and Digitizers.

UNIT – V

Role of Remote Sensing and GIS in Terrain Investigation and Advantages over Conventional Mapping Techniques. Extraction of Topographic Information from Remotely Sensed Data and Generation of Digital Terrain Model from Stereo Pairs of Images. Geological Mapping for the Geotechnical Investigations of Soil Strata. Monitoring Of Areas Prone To Landslides Using Remote Sensing, Digital Model and GIS. Application of Visible, Infra-Red and Microwave Remote Sensing For the Identification of Soil Types, Grain Size and Moisture Studies.

Text Books/References:-

1. Remote Sensing and Image Interpretation by Lillesandt.M. And Kiefer R.W. John Wiley and Sons. New York.
2. M. Anji Reddy, Textbook of Remote Sensing and Geographical Information systems, BS Publications, Hyderabad. 2011. ISBN: 81- 7800-112-8
3. George Joseph , Fundamentals of Remote Sensing Universities Press, Hyderabad 2005
4. Remote Sensing and GIS by B.Bhatta, Oxford University Press,New Delhi
5. Introduction to Remote Sensing By J.B. Campbell, Taylor & Francis, London.
6. Introductory Digital Image Processing By J.R. Jensen, Prentice Hall International Ltd., London.
7. Remote Sensing and its applications by LRA Narayana University Press 1999.
8. Remote Sensing In Civil Engineering, By Kennie, T.J.M. And Matthews M.C. Surrey University Press, Glasgow.

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(17D12107) UNSATURATED SOIL MECHANICS
(ELECTIVE-I

Course objectives: This course will enable students to
- ➢ Understand concept of shear stress and its importance
- ➢ Know the behavior hydraulic conductivity of the soil
- ➢ Know the importance of soil-water interaction in applied soil engineering

UNIT – I:
INTRODUCTION TO UNSATURATED SOIL MECHANICS:
Types of Problems, Typical Profiles of Unsaturated, Tropical and Residual Soil, Expansive and Collapsing Type of Soils. Origin and Formation, Identification and Classification of Expansive and Collapsing Soils.
Collapse and Heave: Collapse Potential and Swell Potential, their importance and Determination by Different Laboratory Methods. Heave Prediction Based On Odometer Tests, Suction Tests and Empirical Procedures, Heave, Collapse and Settlement

UNIT – II:
SOIL SUCTION:
Matric And Osmotic Suction, Total Suction, Theory Of Soil Suction, Measurement By Direct And Indirect Methods –Tensiometers, Axis Translation Technique, Pressure Plate Apparatus,Filter Paper Method, Psychrometers, Squeezing Technique Of Measuring Osmotic Suction
Flow Through Unsaturated Soils – Flow Laws, Darcy's Law for Unsaturated Soils, Coefficient of Permeability With respect To Water Phase and Air Phase, Air Diffusion, Measurement of Permeability and Air Coefficient of Permeability.

UNIT – III:
PHASE PROPERTIES AND RELATIONS FOR UNSATURATED SOILS:
Properties Of Individual Phases, Interaction Of Air And Water, Volume-Mass Relations, Changes In Volume-Mass Properties, Densities Of Mixtures Subjected To Compression Of The Air Phase, Piston Porous Stone Analogy, Effective Stress Concepts And Stress State Variables For Unsaturated Soils, Equilibrium Analysis For Unsaturated Soils: Total Or Overall Equilibrium, Independent Phase Equilibrium – Water Phase, Air Phase, Contractile Skin(Meniscus).

UNIT – IV:
DESIGN ALTERNATIVES FOR STRUCTURES ON EXPANSIVE SOILS:
Structural Foundation Alternatives, Treatment Of Expansive Soils – General Considerations And Guidelines, Surcharge Loading, Prewetting, Use Of Admixtures, Electrochemical Soil Treatment, Moisture Control And Soil Stabilization, Treatment Alternatives For Highways And Airfield
Pavements.

UNIT – V:

SHEAR STRENGTH:

History Of Shear Strength, Failure Envelope For Unsaturated Soils, Use Of Effective Stress Parameters To Define Shear Strength, Mohr-Coulomb And Stress Points Envelopes, Triaxial Tests On Unsaturated Soils, Cd Tests, Constant Water Content Tests, CuTests With Pore Pressure Measurements, Undrained Tests, Multistage Testing, Measurement Of Shear Strength Parameters

Course outcomes:

During this course, students will be trained:

> ➢ To understand the concept of unsaturated soils and change in the behavior of the soil properties.
> ➢ To understand the contractual skin mechanism of partially saturate sols in the design of foundations by knowing the soil water interaction i.e., soil as a four phase system. Comparative study of basic properties in case of three and four phase system in soils.
> ➢ To design the effective methods for foundations and structures

Text Books/References:

1. Soil Mechanics For Unsaturated Soils – Dg Fredlund And H Rahardjo, Wiley Interscience Publication, John Wiley & Sons, NY
2. Unsaturated Soil Mechanics – Ning Lu And William J Likos, John Wiley & Sons, Inc
3. Ng Charles, W.W., Menzies Bruce, Advanced unsaturated Soil Mechanism and Engineering, Taylor & Francis Group, 2007.
4. Mechanics Of Residual Soils – G E Blight, A ABalkema Publishers, USA
5. Expansive Soils – Problems & Practice In Foundations And Pavement Engineering – John D Nelson And Debora J Miller, John Wiley & Sons, Ny

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(17D12108) GEO-ENVIRONMENTAL ENGINEERING
ELECTIVE – II

UNIT I
SOIL – POLLUTANT INTERACTION
Introduction To Geo Environmental Engineering – Environmental Cycle – Sources, Production And Classification Of Waste – Causes Of Soil Pollution – Factors Governing Soil-Pollutant Interaction – Failures Of Foundations Due To Pollutants – Case Studies.

UNIT II
SITE SELECTION AND SAFE DISPOSAL OF WASTE
Safe Disposal of Waste – Site Selection for Land Fills – Characterization of Land Fill Sites – Waste Characterization – Stability of Land Fills – Current Practice of Waste Disposal – Passive Containment System – Application of Geo Synthetics in Solid Waste Management – Rigid or Flexible Liners

UNIT III
TRANSPORT OF CONTAMINANTS
Contaminant Transport In Sub Surface – Advection – Diffusion – Dispersion – Governing Equations – Contaminant Transformation – Sorption – Biodegradation – Ion Exchange – Precipitation – Hydrological Consideration In Land Fill Design – Ground Water Pollution . Pollution of Aquifers by Mixing Of Liquid Waste – Protecting Aquifers.

UNIT IV
WASTE STABILIZATION AND DISPOSAL
Hazardous Waste Control And Storage System – Stabilization/ Solidification Of Wastes – Micro And Macro Encapsulation – Absorption, Adsorption, Advection, Precipitation-Detoxification – Mechanism Of Stabilization – Organic And Inorganic Stabilization – Utilization Of Solid Waste For Soil Improvement.

UNIT V
REMEDIATION OF CONTAMINATED SOILS
Rational Approach To Evaluate And Remediate Contaminated Sites – Monitored Natural Attenuation – Ex-situ And In-situ Remediation – Solidification, Bio – Remediation, Incineration, Soil Washing, Electro Kinetics, Soil Heating.

Text Books/References:

1. Wentz, C.A., Hazardous Waste Management, McGraw Hill, Singapore, 1989.
2. Daniel, B.E., Geotechnical Practice for Waste Disposal, Chapman and Hall, London, 1993.
3. Proceedings of the International Symposium of Environmental Geotechnology (Vol.I and Ii), Environmental Publishing Company, 1986 And 1989.

4. Ott, W.R., Environmental Indices, Theory and Practice, Ann. Arbor, 1978.
5. Fried, J.J., Ground Water Pollution, Elsevier, 1975.
6. ASTM Special Technical Publication 874, Hydraulic Barrier in Soil and Rock, 1985.
7. Westlake, K., (1995), Landfill Waste Pollution and Control, Albion Publishing Ltd., England, 1995.
8. Lagrega, M.D., Buckingham, P.L., and Evans, J.C., Hazardous Waste Management, McGraw Hill, Inc. Singapore, 1994.

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(17D12109) SOIL DYNAMICS AND MACHINE FOUNDATIONS
ELECTIVE – II

Course objectives: This course will enable students to
 ➢ To study vibration concepts in soils like damping, wave propagation, resonance and effect of modes of vibrations.
 ➢ To study dynamic soil properties. Determination of dynamic properties by field and laboratory tests
 ➢ Effect of liquefaction and ant liquefaction measures
 ➢ To study vibration isolation, machine foundation design

UNIT – I:
FUNDAMENTALS OF VIBRATION:
Definitions, Simple Harmonic Motion, Response Of Single Degree of freedom Systems Of Free And Forced Vibrations With And Without Viscous Damping, Frequency Dependent Excitation, Systems Under Transient Loads, Rayleigh's Method Of Fundamental Frequency, Logarithmic Decrement, Determination Of Viscous Damping, Transmissibility, Systems With Two And Multiple Degrees Of Freedom, Vibration Measuring Instruments.

UNIT – II:
WAVE PROPAGATION AND DYNAMIC SOIL PROPERTIES:
Propagation Of Seismic Waves In Soil Deposits - Attenuation Of Stress Waves, Stress Strain Behavior Of Cyclically Loaded Soils, Strength Of Cyclically Loaded Soils, Dynamic Soil Properties - Laboratory And Field Testing Techniques, Elastic Constants Of Soils, Correlations For Shear Modulus And Damping Ratio In Sand, Gravels, Clays And Lightly Cemented Sand.

UNIT – III:
VIBRATION ANALYSES:
Types of vibration analysis, General Requirements, Permissible Amplitude, Allowable Soil Pressure, Modes of Vibration of a Rigid Foundation Block, Methods of Analysis, Lumped Mass Models, Elastic Half Space Method. Vibration Isolation

UNIT – IV:
DESIGN OF MACHINE FOUNDATIONS:
Analysis and Design of Block Foundations for Reciprocating Engines, Dynamic Analysis and Design Procedure for A Hammer Foundation, IS Code of Practice Design Procedure for Foundations of Reciprocating and Impact Type Machines. Vibration Isolation and Absorption Techniques

UNIT – V:
MACHINE FOUNDATIONS ON PILES:
Introduction, Analysis of Piles under Vertical Vibrations, Analysis of Piles under Translation and Rocking, Analysis of Piles under Torsion, Design Procedure for A Pile Supported Machine Foundation

Course outcomes:
During this course, students will be trained:
- ➤ To develop a mechanism to design the foundations for resisting vibrations and achieve static equilibrium conditions of structures.
- ➤ To understand the classical geotechnical failures due to liquefaction and mitigate the same.
- ➤ Design of foundations in large structures like power plants, other industrial buildings etc., for analyzing the vibrating waves which can be isolated and
- ➤ measures for achieving safety of the adjacent foundations

Text Books/References:

1. Soil Dynamics and Machine Foundation (2010), Swami Saran, Galgotia Publications Pvt. Ltd.
2. Soil Dynamics(1981)- Prakash, S. McGraw Hill Book Company
3. Foundation for Machines (1998) Prakash, S. And Puri, V. K.: Analysis AndDesign, John Wiley & Sons,
4. Vibration Analysis And Foundation Dynamics(1998)-Kameswara Rao, N. S. V., Wheeler Publication Ltd.,
5. Vibrations Of Soils And Foundations(1970) Richart, F. E. Hall J. R And Woods R. D., Prentice Hall Inc.,
6. Principles of Soil Dynamics (2002) Das, B. M., Pws Kent Publishing Company, Boston.

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(17D12110) SOIL STRUCTURE INTERACTION
ELECTIVE – II

Course objectives: This course will enable students to
- ➢ Make students understand soil structure
- ➢ understand stress-strain characteristics of soils, the mechanism of failure, the factors that affects the shear strength structural behavior with soils

UNIT – I:
SOIL-FOUNDATION INTERACTION:
Introduction To Soil-Foundation Interaction Problems, Soil Behavior, Foundation Behavior, Interface Behavior, Scope Of Soil Foundation Interaction Analysis, Soil Response Models, Winkler, Elastic Continuum, Two Parameter Elastic Models, Elastic Plastic Behavior.

UNIT – II:
BEAM ON ELASTIC FOUNDATION- SOIL MODELS:
Infinite Beam, Two Parameters, Isotropic Elastic Half Space, Analysis Of Beams Of Finite Length, Classification Of Finite Beams In Relation To Their Stiffness. Plate on Elastic Medium: Thin and Thick Plates, Analysis of Finite Plates, Numerical Analysis of Finite Plates, Simple Solutions.

UNIT – III:
PLATES ON ELASTIC CONTINUUM:
Thin and Thick Rafts, Analysis of Finite Plates, Numerical Analysis of Finite Plates.

UNIT – IV:
ELASTIC ANALYSIS OF PILE:
Elastic Analysis of a Single Pile, Theoretical Solutions for Settlement and Load Distributions, Analysis Of Pile Group, Interaction Analysis, Load Distribution In Groups With Rigid Cap.

UNIT – V:
LATERALLY LOADED PILE:
Load Deflection Prediction for Laterally Loaded Piles, Sub-grade Reaction and Elastic Analysis, Interaction Analysis, Pile-Raft System, Solutions through Influence Charts. An Introduction to Soil-Foundation Interaction under Dynamic Loads.

Course outcomes:
During this course, students will be trained to:
- ➢ Analyze the behavior of the soil under elastic and plastic condition
- ➢ Predict the behavior of the pile under static and dynamic loads.
- ➢ Understand analysis and design of Rafts & Piles.
- ➢ Analyze the laterally load pile and prediction of its behavior

Text Books/References:

1. Foundation Analysis And Design - J E Bowles, McGraw Hill, Ny
2. Soil Mechanics In Engineering Practice – Karl Terzaghi And R B Peck (1967),John Wiley And Sons, Ny
3. Analysis And Design Of Foundations And Retaining Structures – S.Prakash(1979), Sarita Prakashana, Meerut
4. Soil Mechanics And Foundation Engineering – S K Garg, Khanna Publications
5. Geotechnical Engineering – C Venkataramaiah, New Age International Publishers

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(17D12111) FOUNDATION ENGINEERING FOR PROBLEMATIC SOILS ELECTIVE – II

Course objectives: This course will enable students to
- ➢ In-situ testing in difficult grounds
- ➢ Design the foundations in earth movement conditions
- ➢ Improve the ground conditions

UNIT –I :
INTRODUCTION:
Classification, Swelling and Shrinkage, Sensitivity, Settlement and Bearing Capacity of Clays, Fissures in Clay, Glacial Deposits and Difficult Rocks.
Site Investigation in Difficult Ground: Objectives, Difficulties in Determining the Characteristics of the Ground, Remedial Measures.

UNIT – II:
IN-SITU TESTING AND GEOPHYSICAL SURVEYING:
Introduction, Penetrometers, SPT, CPT, Plate Bearing Tests, Pressure Meters, Seismic and Resistivity surveying, Methods of ground identification.
Ground Water And Foundations: Introduction, Effective Stress Theory, Oil Tanks On Poor Ground, Effect Of Raising The Ground Water Level – Reclaimed Land, Foundation On The Sea Bed.

UNIT – III:
FOUNDATIONS AND EARTH MOVEMENTS:
Introduction, Creep of Rock Masses, Landslides, Earthquake – Primary and Secondary Effects.
Design Of Foundations: Introduction, General Principles, Strip And Raft Foundations, Building On Shrinkable Soil, Building On Fill, Raft Foundation – Variable Soil And Make Up Ground, Pile Foundation – Choice, Types; Construction Problems.

UNIT – IV:
STABILITY OF SLOPES IN DIFFICULT GROUND:
Introduction, Mechanism of Stability, Strength of Distorted Clay, Factor of Safety, Analysis, Remedial Measures.

UNIT – V:
GROUND TREATMENT:
Introduction, Ground Water Lowering Techniques, Electro-Osmosis And Electro-Chemical Stabilization, Thermal Techniques, Grouts And Grouting, Reinforcements, Other Stabilization Techniques, Dynamic Consolidation, Pre Loading,
Vibro flotation, Stone Columns.

Course outcomes:

During this course, students will be trained to:

> ➢ Develop the in-situ methods to evaluate the bearing capacity under different criteria.
> ➢ Analyze and design the grounds in shrinking areas
> ➢ Overcome the construction problems by adopting suitable methods

Text Books/References:

1. Foundation In Difficult Ground – F G Bell, Butterworths & Co
2. Foundation Analysis And Design – J E Bowles, Tata McGraw Hill
3. Foundation Engineering – (2001) M J Tomlinson - Phi

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(17D12112) ADVANCED GEOTECHNICAL ENGINEERING LAB-1

Course Objectives: To obtain index and engineering properties of locally available soils, to understand the behavior of these soils under various loads and subsoil conditions.

List of Experiments/Projects
1. Classification of a given Soil
2. Determining the void ratio of a deposit
3. Effect of compactive effort on compaction properties of a given soil
4. In-Situ Unit Weight (Core Cutter & Sand Replacement)
5. Permeability of Clay Soils.
6. Free Swell, Swell Potential, Swell Pressure Test
7. Odometer Test (For Determination Of CC & CV)
8. Direct Shear Test
9. Triaxial Tests- UU
10. Triaxial Tests- CU
11. CBR Test

Course Outcomes: Possible to classify and evaluate the behavior of the soil subjected to various loads and subsoil conditions.

Reference Books:
1. Head, K.H. – Manual Of Soil Laboratory Testing, Volumes I – Soil Classification And Compaction Tests, 3rd Edition, Crc Press, Taylor And Francis Group, 2006.
2. Head, K.H. – Manual Of Soil Laboratory Testing, Volumes Ii – Permeability, Shear Strength And Compressibility Tests, 3rd Revised Edition, Ingram International Inc, 2011.
3. Head, K.H. And Epps, R.J. – Manual Of Soil Laboratory Testing, Volumes III – Effective Stress Tests, 3rd Edition, Whittle Publishing, 2014.

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(17D12201) DESIGN OF DEEP FOUNDATIONS

Course objectives: This course will enable students to
- ➢ Know the design of deep foundation
- ➢ Type of deep foundations will be provided for different structures
- ➢ Understand the special foundations.

UNIT – I:
SINGLE PILE:
Vertically Loaded Piles, Static Capacity, Dynamic Formulae; Wave Equation Analyses; Point Bearing Resistance With SPT and CPT Results; Bearing Resistance of Piles on Rock; Pile Load Test; Uplift Resistance; Laterally Loaded Piles -Ultimate Lateral Resistance; Negative Skin Friction;

UNIT – II:
BUCKLING OF FULLY AND PARTIALLY EMBEDDED PILES:
Ultimate Capacity of Pile Groups in Compression, Pullout & Lateral Load; Efficiency; Settlements of Pile Groups; Interaction of Axially & Laterally Loaded Pile Groups.

UNIT – III:
PILE RAFT FOUNDATION:
Design Criteria-Design of Sheet Pile Foundations: Analysis of Anchored Sheet Piles and Cantilever Sheet Piles Lateral Supports In Open Cuts Numerical Problems

UNIT – IV:
WELL FOUNDATION:
Design And Construction of well foundations. Bearing Capacity, Settlement and Lateral Resistance. Tilts and Shifts. Drilled Shaft: Construction Procedures, Design Considerations, Load Carrying Capacity And Settlement Analysis.

UNIT – V:
DEEP FOUNDATIONS IN EXPANSIVE SOILS:
Origin And Occurrence, Identification, Sampling And Testing, Preventive And Remedial Measures. Foundations on Expansive Soils: The Nature, Origin and Occurrence, Identifying, Testing and Evaluating Expansive Soils, Typical Structural Distress Patterns and Preventive Design &Construction Measures.

Course outcomes:
During this course, students will be trained:
- ➢ To analyze and adopt design skills of vertical and batter piles for various types of loading and soil conditions
- ➢ To design the sheet piles and under reamed piles in expansive soils.
- ➢ To design the well foundations (caissons)
- ➢ To design the deep foundations in expansive soils.

Text Books/References:
1. Analysis And Design Of Substructures (2009), Swami Saran, Oxford &Ibh Publications Pvt. Ltd.
2. Foundation Design in Practices (2010) - Kaurna Moy Ghosh. Phi
3. Foundation Engineering (2012)- J E Bowles, McGraw Hill
4. Pile Foundation Analysis And Design H.G. Poulos, And E.H.Davis, John Wiley
   And Sons, New York.
3. Design Of Foundation Systems (1992)N.P. Kurien: Principles & Practices, Narosa, New Delhi
4. Foundation Engineering Hand Book (1990), H. F. Winterkorn And H Y Fang Galgotia Booksource

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(17D12202) GROUND IMPROVEMENT TECHNIQUES

Course objectives: This course will enable students to
  - Identify the soil type of soil from a job site or in a professional setting, determine that soil's properties based on type and evaluate design decisions from your understanding of that soil's properties.
  - To explore the scientific principles used to describe the major engineering properties of soil, and the engineering testing methods used to quantify these properties
  - To explore the site improvement techniques

UNIT – I:
SITE INVESTIGATION:
Planning Of Exploration And Experimental Programmed, Investigations, Exploration For Preliminary Design, Exploration For Detailed Designee-Physical Explorations (Soundings, Probing, Boring, Boring Methods), Excavation Methods For Explorations, Ground Water Investigations, Rock Boring, Miscellaneous Exploratory Techniques

UNIT – II:
SAMPLING AND IN-SITU FIELD TESTS:
Types Of Samples, Samplers, Preservation, Shipment And Storage Of Samples, Bore Log, Pore Pressure Measurements, Core Recovery, Rock Strength, Rock Quality Designation In-Situ Field Testing And Laboratory Investigation Of Soils And Rock(Including Advanced Equipment), Instrumentation, Data Acquisition And Measurement Techniques: SPT, SCPT, DCPT, Pressure Meter.

UNIT – III:
DATA INTERPRETATION:
Data Interpretation for Determination of Engineering Properties of Soils and Their Application to Geotechnical Design, Preparation of Site Investigation Reports

UNIT – IV:
SITE IMPROVEMENT:
General Methods Of Stabilization – Shallow And Deep, Factors Governing Suitable Method, Compaction, Drainage: Soil And Filter Permeability, Filter Criteria, Drainage Layout And Pumping System,Pre-Compression And Consolidation: Principles, Sand Drains, Pore Pressure Distribution, Electro-Osmotic And Chemical Osmotic Consolidation.

UNIT – V:
STABILIZATION:
Mechanical Stabilization, Lime, Cement, Bitumen, and Chemical Etc.Grouting: Injection Principles, Grouting Pressure Criteria, Grouting Equipment, Injection of Chemicals, Thermal Methods: Heating and Cooling Effects on Soils.

Course outcomes:

During this course, students will be trained:

➢ To explore and understanding the behavior of soils using index, compaction and engineering properties for the design of foundations.

➢ To adopt suitable ground improvement techniques

➢ To alter the geotechnical properties to suit any type of foundations based on the load coming from the super structure on to the foundation and soil

➢ To understand the dewatering mechanics mechanism.

Text Books/References Books:

1. Engineering Principles of Ground Modifications – Haussmann, McGraw Hill.
2. Foundation Analysis and Design – J E Bowles, Tata McGraw Hill.
1. Subsurface Exploration and Sampling of Soils for Civil Engg. Purposes – Hvorslev M J,
2. Geotechnical Engineering- Donold P Coduto Phi Learning Private Limited, New Delhi
3. Geotechnical Engineering- Shashi K. Gulathi&Manoj Datta. (2009), "Tata Mc Graw Hill.
3. Soil Mechanics And Foundation Engg.- Muni Budhu (2010), 3rd Edition, John Wiley& Sons
4. Soil Mechanics For Road Engineers –Hmso

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(17D12203) DESIGN WITH GEO-SYNTHETICS AND APPLICATIONS IN GEO TECHNICAL ENGINEERING

UNIT I
INTRODUCTION:
Historical Development – Types Of Geo-synthetics – Geotextiles – Geogrids- Geonets – Geomembranes – Geocomposites – Functions – Reinforcement – Separation – Filtration – Drainage – Barrier Functions.

UNIT II
RAW MATERIALS AND MANUFACTURING METHODS:
Methods – Polyamide – Polyster – Polyethylene – Polypropylene – Poly Vinyl Chloride – Woven – Monofilament – Multifilament – Slit Filament – Non-Woven – Mechanically Bonded- Chemically Bonded – Thermally Bonded.

UNIT III
PHYSICAL AND HYDRAULIC PROPERTIES:
Physical Properties: Mass Per Unit Area – Thickness – Specific Gravity; Hydraulic Properties: Apparent Open Size – Permittivity – Transmissivity.

UNIT IV
MECHANICALLY PROPERTIES AND DURABILITY:
Mechanical Properties: Uniaxial Tensile Strength – Burst And Puncture Strength – Soil Geosynthetic Friction Tests; Durability: Abrasion Resistance – Ultraviolet Resistance.

UNIT V
APPLICATIONS OF GEOSYNTHETICS:
Use Of Geosynthetics For Filtration And Drainage – Use Of Geosynthetics In Roads – Use Of Reinforced Soil In Retaining Walls – Improvement Of Bearing Capacity – Geosynthetics In Land Fills.

Text Books/Reference Books:

1. Engineering With Geosynthetics by G.Venkatapparao and G.V.Ssuryanarayanaraju – Tata McGraw Hill, New Delhi, 1990.
2. Construction and Geotechnical Methods in Foundation Engineering By Robert M. Koerner – McGraw Hill, New York, 1985.
3. Designing With Geosynthetics by Robert M. Koerner, Prentice Hall, New Jersey, UAS, 1989.
4. Engineering with Geosynthetics (1990), G.V.Rao and G.V.S.S,Raju (Eds), Tata McGraw Hill, New Delhi
5. G.Venkatappa Rao (2007).Geosynthetics – An Introduction, SAGES, Hyderabad

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(17D12204) FINITE ELEMENT METHOD FOR GEO-TECHNICAL APPLICATIONS

Course objectives: This course will enable students to

- ➢ Understand in general how finite elements obtain approximate solutions to differential equations.
- ➢ Appreciate the structure of a typical finite element program.
- ➢ Gain experience of finite element analysis applied to classical geotechnical problems (e.g. settlement, seepage, consolidation, slope stability)
- ➢ Gain insight into the soil properties needed for finite element Analysis

UNIT – I:
INTRODUCTION:
Concepts of FEM, Steps Involved In Finite Element Analysis Procedure, Merits and Demerits. Principles of Elasticity: Stress Equations, Strain-Displacement Relationships in Matrix Form, Plane Stress, Plane Strain and Axi-Symmetric Bodies of Revolution with Axi-Symmetric Loading.

UNIT – II:
ELEMENT PROPERTIES:
Concept Of An Element, Various Element Shapes, Displacement Models, Generalized Coordinates, Shape Functions, Convergent And Compatibility Requirements, Geometric Invariance, Natural Coordinate System - Area And Volume Coordinates Generation Of Element Stiffness And Nodal Load Matrices, Isoparametric Formulation: Concept, Different Isoparametric Elements For 2d Analysis.

UNIT – III:
Discretization Of A Structure, Numbering Systems, Aspect Ratio Its Effects, Assemblage, Direct Stiffness Method Strain Laws: Introduction, Bilinear Elastic Model, Hyperbolic Model, Comparison Of Models.
UNIT – IV:
GEOTECHNICAL APPLICATIONS:
Geotechnical Applications Sequential Construction, Excavations and Embankments, Bearing Capacity and Settlement Analysis.

UNIT – V:
SEEPAGE ANALYSIS:
Finite Element Discretization of Seepage Equation, Computation of Velocities and Flows, Treatment of Free Surface Boundary, Analysis of Jointed Rock Mass: Characters and Discontinuity of Rock.

Course outcomes:

During this course, students will be trained:

➢ To understand the basic concepts of finite element analysis in general and the transition from structural engineering aspects to geotechnical engineering aspects.
➢ To understand the finite element techniques for seepage analysis and joint rock masses
➢ In Finite element applications in design and Analysis of bearing capacity of the soil for shallow foundations
➢ To understand elastic model, hyperbolic model and stress- strain response.

Text Books/Reference Books:

1. Introduction to the Finite Element Method (1972), Desai, C. S. And J.F. , Abel.Van Nostrand Reinhold Company
2. Finite Element Analysis In Geotechnical Engineering Vol 1&2, (1999) - D M Potts& L Zdravkovic, Thomas Telford Publishing, London
3. Finite Element Analysis In Geotechnical Engineering, D J Naylor & G N Pande(2012)
4. Introduction To The Finite Element Method(1993) J. N. Reddy - McGraw-Hill Publishers,
5. Finite Element Analysis - Theory And Programming(1994) Krishna Murthy, C. S -Tata McGraw-Hill,
6. Finite Element Methods(1971) Zienkiewicz, O. C. -, McGraw-Hill Publishers,

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(17D12205) EARTH AND EARTH RETAINING STRUCTURES
ELECTIVE – III

Course objectives: This course will enable students to
- ➢ To study the geostatic stresses, shear strength of soils.
- ➢ To study the static earth pressure for retaining walls, slope stabilities

UNIT – I:
GEOSTATIC STRESSES: Total, Neutral and Effective Stress in Homogeneous Soils, Stress Diagrams, Stresses Affected By Capillary Water and Direction of Flow of Water. **Shear Strength Of Soils:** Introduction, Concept of Stresses, Principal Stresses, Principal Planes, Mohr's Construction, Location of Pole, Basic Concept of Shearing Resistance, Coulomb's Theory, and Mohr-Coulomb's Theory. Numerical Problems

UNIT – II:
Determination Of Shear Strength Parameters, Stress Controlled And Strain Controlled Tests, Classification Of Shear Tests Based On Drainage Conditions, Stress-Strain Relationship Of Clays And Sands, Concept Of Critical Void Ratio. Pore pressure parameters and their relevance.

UNIT – III:
EARTH PRESSURE:
Introduction, Active And Passive Earth Pressures, Earth Pressure At Rest, Rankin's Theory For Determination Of Active And Passive Earth Pressure, Coefficient Of Earth Pressure At Rest, Earth Pressure Distribution, Total Earth Pressure And Its Point Of Application, Determination Of Tension Cracks And Critical Height For Unsupported Excavation, Effect Of Water Table On Earth Pressure, Coulomb's Theory Of Active And Passive Earth Pressure, Cullman's And Ruthann's Graphical Methods For Determination Of Active And Passive Earth Pressures.

UNIT – IV:
STABILITY OF SLOPES:
Introduction, Factor Of Safety, Slope Failure, Toe And Base Failure Of Finite Slopes, Analysis Of Stability By Method Of Slices, Taylor's Stability Number, Effect Of Water Table On Slopes, Tension Cracks

UNIT – V:
SEEPAGE ANALYSIS:
Laplace's Equation For Two Dimensional Flow Of Water Through Soils, Flow nets, Properties And Uses Of Flownets, Phreatic Line, Graphical And Analytical Procedures For Determination Of Quantity Of Seepage, Prevailing Hydraulic Head And Exit Gradient In Homogeneous Earth Dam, Uplift Pressure, Sketching Of Flow nets For Typical Hydraulic Structures – Weirs, Dams, Sheet Pile Walls

Course outcomes:

During this course, students will be trained:

➤ To analyze the field problems and encountering various failures due to shear geostatic stress etc
➤ To design the and analyze the retaining structures for earth pressures
➤ To design and analyze suitable slope stability, understand the seepage in soils for design of complicated structures

Text Books/Reference Books:

1. Foundation Analysis And Design - J E Bowles, McGraw Hill, NY
2. Soil Mechanics In Engineering Practice – Karl Terzaghi And R B Peck (1967),
   John Wiley and Sons, NY
3. Analysis And Design Of Foundations And Retaining Structures –Prakash (1979), Sarita Prakashana, Meerut
4. Soil Mechanics And Foundation Engineering – S K Garg, Khanna Publications
5. Geotechnical Engineering – C Venkataramaiah, New Age International Publishers

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(17D12206) PAVEMENT ANALYSIS AND DESIGN
ELECTIVE – III

Course objectives: This course will enable students to
➢ Identify the type of pavement and to know the stress distribution
➢ Learn the deflection criteria in soils for different pavements
➢ To know the characteristics of the rigid pavements and flexible pavements

UNIT – I:
INTRODUCTION:
Types and Component Parts of Pavements, Factors Affecting Design and Performance of Pavements, Highway and Airport Pavements.

UNIT – II:
STRESSES AND DEFLECTION IN FLEXIBLE PAVEMENTS:
Stresses And Deflections In Homogeneous Masses, Two, Three And Multi-Layer Theories, Wheel Load Stresses, Various Factors In Traffic Wheel Loads, ESWL Of Multiple Wheels, Repeated Loads And EWL Factors, Sustained Loads, Pavement Behavior Under Transient Traffic Loads.

UNIT – III:
FLEXIBLE PAVEMENT DESIGN METHODS FOR HIGHWAYS AND AIRPORTS:
Empirical, Semi-Empirical and Theoretical Approaches, Development, Principle, Design Steps, Advantages and Application OofThe Different Pavement Design Methods Including IRC, AASHTO and Asphalt Institute Methods.

UNIT – IV:
STRESSES AND DEFLECTIONS IN RIGID PAVEMENTS:
Types Of Stresses And Causes, Factors Influencing The Stresses, General Considerations In Rigid Pavement Analysis, EWL, Wheel Load Stresses, Warping Stresses, Frictional Stresses, Combined Stresses.

UNIT – V:
RIGID PAVEMENT DESIGN:
Types of Joints in Cement Concrete Pavements and Their Functions, Joint Spacing, Design Of Cc Pavement For Roads And Runways, Design Of Joint Details For Longitudinal Joints, Contraction Joints and Expansion Joints.

Course outcomes:
During this course, students will be trained:
➢ For the design of flexible and rigid pavements at different soil conditions
➢ To understand the behavior of the stresses and deflections at different loading and soil conditions

Text Books/Reference Books:

1. Principles of Pavement Design – Yoder E J, Witczak, John Wiley and Sons
2. Soil Mechanics for Road Engineers – RRL and DSIR, HMSO Publication
3. Design of Functional Pavements – Huang, McGraw Hill Book Co.
4. Development in Highway Engineering – Pell Peter S, Applied Science Publishers, London
5. Pavement Analysis – Huang, Elsevier Publications

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(17D12207) OFF SHORE GEO TECHNICAL ENGINEERING
ELECTIVE – III

Course objectives: This course will enable students to
- ➢ Understand the type of soil strata available in offshore
- ➢ Develop a structure under different environmental condition
- ➢ Design the anchors in the sea
- ➢ Design the pipelines and cable structures

UNIT – I:
DESIGN OF OFFSHORE PLATFORMS:
Introduction, Fixed And Floating Platforms, Case Studies And General Features, Elements Of Hydrodynamics And Wave Theory, Fluid Structure Interaction, Steel Concrete And Hybrid Platforms Consolidation And Shear Strength Characteristics Of Marine Sediments.

UNIT – II:
DESIGN CRITERIA:
Environmental Loading, Wind, Wave and Current Loads after Installation, Stability during Towing Foundations: Site Investigations, Piled Foundation, Foundations for Gravity Structures, Pile-Supported Structures

UNIT – III:
Behavior under Dynamic Loading, Static and Dynamic Analysis of Platforms and Components

UNIT – IV:
Dynamic Response in Deterministic and in deterministic Environment, Codes of Practice, Analysis of Fixed Platform and Semisubmersible Related Topics

UNIT – V:
Anchor Design, Breakout Resistance Analysis and Geotechnical Aspects of Offshore Pipeline and Cable Design

Course outcomes:
During this course, students will be trained to:
- ➢ Design the structure for wind, wave loads and dynamic loads
- ➢ Design the structure for overturning
- ➢ Design the pipeline and cable structures

Text Books:
1. Offshore Geotechnical Engineering – Mark Radolph and Susan Gourvenec, Crc Press.
2. Construction Of Marine And Offshore Structures – Ben C Gerwick, CRC Press.

3. Offshore Geotechnical Engineering – Etr Dean
4. Frontiers In Offshore Geotechnics II – Susan Gourvenec And David White, Crc Press.
5. Frontiers in Offshore Geotechnics Ii – Vaughan Meyer, Crc Press
6. Geotechnical Aspects of Coastal and Offshore Structures: Proceedings Of The Symposium, Bangkok – AN S Balasubramaniam, Crc Press

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(17D12208) REINFORCED SOIL STRUCTURES
ELECTIVE – III

Course objectives: This course will enable students to
➢ Identify the soil suitable for reinforced earth
➢ Identify the type of reinforcing material suitable for the project
➢ Design the reinforced earth

Unit – I:
Historical Background: Introduction to Reinforced Soil Structures, Comparison with Reinforced Cement Concrete Structures. **Reinforced Earth:** Principles, Concepts and Mechanisms of Reinforced Earth

UNIT – II:
Materials Used, Properties, Laboratory Testing and Constructional Details, Metallic Strips, Metallic Grids, Geotextiles, Geogrids, Geomembranes AndGeocomposites, Their Functions and Design Principles

UNIT – III:
Geotextiles: Introduction, Design Methods, Function and Mechanism, Geotextiles Properties and Test Methods – Physical, Mechanical and Hydraulic Properties, Construction Methods and Techniques Using Geotextiles

UNIT – IV:
Design Applications Of Reinforced Soil Structures In Pavements, Embankments, Slopes, Retaining Walls And Foundations, Reinforced Soil Structures For Soil Erosion Control Problems, Geosynthetic Clay Liners

UNIT – V:
Performance Studies of Reinforced Dams, Embankments, Pavements, Railroads, Foundations and Underground Structure.

Course outcomes:
During this course, students will be trained to:
➢ Design and incorporate the reinforced earth for the sites at weak soil sites
➢ Design the pavements, embankments using reinforced earth to enhance the engineering properties of the soils
➢ To understand the properties of the geo textiles
➢ To conduct the performance studies on reinforced dams

Text Books/Reference Books:
1. Jewell, R.A., Soil Reinforcement with Geotextiles, Ciria, London, 1996.
2. John, N.W.M., Geotextiles, John Blackie and Sons Ltd., London, 1987.
3. Jones, C.J.F.P., Earth Reinforcement and Soil Structures, Earthworks, London, 1982.

4. Koerner, R.M., Designing With Geosynthetics, (Third Edition), Prentice Hell, 1997.
5. Proc. Conference on Polymer and Reinforcement, Thomas Telford Co., London, 1984.
6. John S. Horvath, Geofoamgeosynthetic, Horvath Engineering P.C. Scarsdale, New York, U.S.A, 1998.
7. Gray, D.H., and Sotir, R.B., Biotechnical and Soil Engineering Slope Stabilization: A Practical Guide for Erosion Control, John Wiley & Son Inc., New York, 1996.
8. Ramanathaayyar ,T.S., Ramachandran Nair, C.G. And Balakrishna Nair, N., Comprehensive Reference Book On Coir Geotextiles, Centre For Development For Coir Technology, 2002.

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(17D12209) EXPERIMENTAL GEO-MECHANICS
ELECTIVE – IV

UNIT – I:
INTRODUCTION:
Scopes And Objectives Of Explorations – Planning A Subsurface Exploration – Stages In Sub Surface Exploration – Explorations For Preliminary And Detailed Design – Spacing And Depth Of Exploration.

UNIT II
OPEN EXCAVATION AND BORINGS OF EXPLORATION
Pits And Trenches – Drifts And Shafts – Methods Of Boring – Auger Borings – Wash Borings –Rotary Drilling –Percussion Drilling – Core Drilling.

UNIT III
SOIL SAMPLES AND SAMPLERS:
Types Of Soil Samples – Disturbed Samples –Undisturbed Samples – Design Features Affecting The Sample Disturbance –Split Spoon Samplers – Scraper Bucket Samplers –Shell By Tubes And Thin Walled Samplers – Piston Samplers – Denis Samplers – Preservation And Handling Of Samples.

UNIT IV
IN-SITU TESTING:
Field Tests – Standard Penetration Tests – Cone Penetration Tests – In-Situ Vane Shear Test–Plate Load Test – Monotonic And Cyclic –Field Permeability Tests – In-Situ Tests Using Pressure Meter – Observation Of Ground Water Table. -Instrumentation in Soil Engineering, Strain Gauges, Resistance and Inductance Type

UNIT V
GEOPHYSICAL METHODS:
Geophysical Methods-Types-Seismic Methods – Electrical Resistivity Methods – Electrical Profiling Method –Electrical Sounding Method – Seismic Refraction Method – Sub-Soil Investigation Report.

Text Books/Reference Books:
1. Sub Surface Exploration and Sampling of Soils for Civil Engineering Purpose by Hvorslev, M.J. Waterways Station, Vicksburg, Mississippi, 1949.
2. Foundation Engineering By S.P. Brahma, Tata McGraw Hill Publishing Company Limited, New Delhi, 1985.
3. Analysis And Design of Foundations and Retaining Structures by Shamsherprakash, Gopalranjan and Swami Saran, Sarita prakasham, Meerut.1979.
4. Soil Mechanics & Foundation Engineering, Vol. 2 by V.N.S. Murthy, Saikripa Technical Consultants, Bangalore.
5. Geotechnical Engineering by C. Venkataramaiah, Wiley Eastern Ltd., New Delhi.

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(17D12210) ROCK MECHANICS
ELECTIVE – IV

Course objectives: This course will enable students to
- ➢ Identify the type of the rock
- ➢ Analyze the rock quality designation and also evaluate its strength
- ➢ Determine the methods of tunneling and mining

UNIT – I:
INTRODUCTION:
Classification of Rocks, Geological Petro Graphic and Engineering. Index Properties of Rocks- Porosity, Density, Permeability, Durability and Slake. Core Recovery, Rqd And Its Importance In Engineering Stress-Strain Behavior, Factors Influencing The Strength Of Rock, Temperature, Confining Pressure, Strain Rates, Modes Of Failures Of Rocks.

UNIT – II:
FAILURE THEORIES OF ROCKS:
Mohr's Hypothesis, Griffith's Criteria, Muller's Extension Of Griffith's Theory, Elementary Theory Of Crack Propagation, Failure Of Rock By Crack Propagation, Effects Of Cracks Of Elastic Properties. Testing Of Rocks: Laboratory and Field Test, Assessment of In-Situ Strength

UNIT – III
ROCK FOUNDATION:
Shallow and Deep Investigation for Foundation Design and Construction Aspect, Slope Stability Analysis, Mode of Failures in Rock. Design of Slopes, Excavation in Rock and Stabilization Concepts

UNIT – IV:
STRENGTHENING OF ROCKS:
Foundation Treatment for Dams and Heavy Structures by Grouting and Rock Reinforcement. Methods and Principles of Grouting, Principles of Design of Rock Bolts

UNIT – V:
TUNNELS:
Basic Terminology And Application, Site Investigations, Methods Of Excavation Of Tunnels Supports And Stabilization, Construction Control And Maintenance, Tunnel Ventilation, Control Of Ground Water And Gas Underground Mining; Mining Methods.

Course outcomes:
During this course, students will be trained to:
- ➢ Identify the type of rock and to evaluate the bearing capacity of the rock,
- ➢ Design and analyze the foundations and improvement techniques for the
- ➢ foundations on in-situ rocks
- ➢ Design methodologies for mining and tunneling where rock is encountered
- ➢ To understand the principles of gravity.

Text Books/Reference Books:
1. Introduction To Rock Mechanics – Goodman (1976), John Wiley And Sons, Ny
2. Fundamentals Of Rock Mechanics – J C Jeager And N G W Cook (1976), Chapman and Hall, London
3. Principles Of Engineering Geology And Geotechniques – Krynine And Judd
4. Rock Engineering – John A Franklin And Maurice B Dusseault, McGraw Hill
5. Rock Mechanics For Engineers: Varma, B.P, Khanna Publishers
6. Rock Mechanics & Design Of Structures: Obert, L & Duvall, W.I., John Wiley &Sons

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(17D12211) OPTIMIZATION TECHNIQUES IN GEO TECHNICAL
ENGINEERING
ELECTIVE – IV

Course objectives: This course will enable students to
  ➢ The graduates are expected to adopt various numerical method and Mathematical tools for analysis of research data
  ➢ Learning the numerical methods in applied soil mechanics
  ➢ Learning the bivariate data and Lagrangae's equation for the problems
  ➢ Application of queuing theory

UNIT – I
RECURRENCE RELATION AND GENERATING FUNCTIONS:
Formation Of Recurrence Relation, Solution Of Linear And Nonlinear Recurrence Relation, Properties Of Generating Function And Solve The Recurrence Relation Using The Generating Function And Related Problems. Scatter Diagram; Karl Pearson's Coefficient of Linear Correlation. , Linear Regression, Properties of Regression and Related Problem.

UNIT – II:
NUMERICAL ANALYSIS:
Introduction to Interpolation, Newton's Forward and Backward Interpolation (Statement Only), Lagrange Interpolation (Statement Only). Numerical Differentiation for Equal and Unequal Interval. Matrix Eigen Value and Eigen Vector by Power Methods. Curve Fitting and Problems. Statistics: Analysis of Bivariate Data. Correlation Analysis – Meaning Of Correlation.

UNIT – III
OPTIMIZATION TECHNIQUE:
Linear Programming Problem (LPP) Formation of LPP, Graphical Method and Related Problems. Transportation Problems, Assignment Problem. Queuing Theory-Basic Structure, Exponential Distribution, Birth-And-Death Model,

UNIT – IV:
Tucker Condition, Penalty Function Method, Augmented Lagrangian Method, Sequential Unconstrained Minimization, Cutting Plane Method; Introduction to Evolutionary Algorithms: Need for Evolutionary Algorithms, Type of Evolutionary Methods.

UNIT – V:
ARTIFICIAL INTELLIGENCE:
Introduction- Classification of Artificial Intelligence- Expert Systems-Artificial Neural Networks Basic Concepts-Uses in Functional Approximation and

Optimization Applications in the Design and Analysis, Building Construction. Fuzzy Logic-Basic Concepts-Problem Formulation Using Fuzzy Logic-Applications

Course outcomes:
During this course, students will be trained to:
- Analyze the data obtained from the field
- Develop appropriate methods to solve logically and optimize the test or field Results
- To understand the important techniques of curve fitting and correlation.

Text Books/Reference Books:

1. Introduction to Optimum Design J.S. Arora (2004), Elsevier, 2nd Edition.
2. Optimization for Engineering. Design: Algorithms & Examples K. Deb (2006),Prentice Hall India, ,
3. Engineering Optimization: Theory & Practice, S.S. Rao (2008) New Age International (P) Ltd, 3rd Edition,
4. Multi - Objective Optimization Using Evolutionary Algorithms, K. Deb(2003) John Wiley
5. Applied Statistics & Probability For Engineers: Montgomery, Douglas C. & Runger, George C. (2007), 3/E,Wiley India.
6. Fuzzy Logic Implementation and Applications (1996), Patyra, M.J. And MlynekWiley,.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
M.Tech II semester (GE)

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(17D12212) FORENSIC GEO TECHNICAL ENGINEERING
ELECTIVE – IV

Course objectives: This course will enable students to
  - ➢ Learning the soil properties for causing failures
  - ➢ Identification of failure phenomenon
  - ➢ New approach in the design aspects
  - ➢ Improvisation of legal aspects in geotechnical engineering

UNIT – I:
INTRODUCTION:
Historical Failures Of Geotechnical Structures (Finite And Infinite Slopes, High Embankments Such As Earthen Dams, Tunnels, Excavations, Foundations-Shallow And Deep, Retaining Structures Etc.), Characterization Of Failures, Inadequateness Of Limit State Design, Principles And Advantages Of Mobilizeable Strength Design. Numerical Problems

UNIT – II:
TECHNICAL FORENSIC INVESTIGATION:
Collection Of Data, Problem Characterization, Development Of Failure Hypotheses, A Realistic Backanalysis,Field Observations And Performance Monitoring, Modeling Of Failure Hypothesis And Quality Control Of Formal And Technical Aspects of The Work. Numerical Problems.

UNIT – III:
GUIDELINES FOR FORENSIC INVESTIGATION OF GEOTECHNICAL:
Types of Distress, Diagnostic Tests: Field and Laboratory Tests, Analysis, Legal Issues Such As Facts, Interpretations, Opinions, Negligence
Technical Issues Related To Geotechnical Failures:
Primary Shortcomings Causing Failures, Shortcomings in Design, Inadequate Site Investigations, Unforeseen Occurrences and Phenomena, Shortcomings in Construction; Recommendations to Limit Future Occurrence of Failures.

UNIT – IV:
CASE HISTORIES:
Construction Of Historic Monuments, Destruction Due To Environmental Changes And Survival Of Monuments Among Them, Such As Leaning Tower Of Pisa, Egyptian Pyramids, Tall Structural Foundations.

UNIT – V:

GEOTECHNICAL ENGINEERING AND LEGAL SYSTEM:
Legal Conflict Of Geotechnical Failures, Sanctions In The Legal Code Of Construction, Geotechnical Work For Documentation Of Forensic Cases; Case Studies Of Legal Conflict Of Prominent Structures .

Course outcomes:
During this course, students will be trained:
- ➢ To predict the failure modes in geotechnical engineering before construction of structures
- ➢ To understand the case histories for employing remedial techniques in the design
- ➢ To design the structures to overcome the failure in geotechnical engineering by understanding the behavior of soils
- ➢ To frame the guidelines for avoiding the legal aspects of geotechnical failures by predicting and understanding the failure mechanism, their remedial measures before the construction of the foundations.

Text Books/Reference Books:
1. Forensic Geotechnical And Foundation Engineering – Robert W Day (2011)
2. Forensic Geotechnical Engineering – V V S Rao And G L Sivakumar Babu (2013), Springer India.
3. Indo-Us Forensic Practices: Investigation Techniques and Technology – Shen EnChen, R Janardhanan, C Natarajan, Ryan Schmidt (2010), American Society of Civil Engineers

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(17D12213) ADVANCED GEOTECHNICAL ENGINEERING LAB-2

Course objectives: This course will enable students to
  ➢ The objective of this course is to make students to learn principles and design of experiments.
  ➢ To investigate the performance of various Soils

  1. Determination Of Shear Strength Parameters By Vane Shear Test
  2. Determination Of Shear Strength Parameters By CD And CU Test
  3. To Evaluate The Bearing Capacity And Settlement Of Soils From
      a. By Plate Load Test
      b. By Cone Penetration Test (Static And Dynamic)
      c. Standard Penetration Test

  4. To Determine The Ground Water Table
      a. Using Electrical Resistivity Method
      b. Seismic Refraction Method
  5. Determination Of Shear Modulus, Damping Ratio And Liquefaction Of Soils By Resonant Column Method
  6. Determination of Ph and Organic Solids.
  7. Determination Of Chemical Properties Of Soil Such As Chloride, Phosphorous, Potassium, Magnesium, Calcium, Sodium Etc.,

Course outcomes:
During this course, students will be trained:
  ➢ Achieve Knowledge of Design and development of experimental skills.
  ➢ Understand the principles of design of experiments.

Text Books /Reference Books:
  1. Shams her Prakash, (1979) "Engineering Soil Testing", Nemichand, New Delhi.
  2. Joesph E Bowles, "Engineering Properties of Soil and Their Measurements", McGraw Hill
  3. John T. Germaine, Amy V. Germaine, (2009) "Geotechnical Laboratory Measurements", John Wiley
  4. William Lambe, (2003) "Soil Testing For Engineers", MIT.

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M.Tech III semester (GE)

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(17D20301) RESEARCH METHODOLOGY
(Elective V-OPEN ELECTIVE)

UNIT I
Meaning of Research – Objectives of Research – Types of Research – Research Approaches – Guidelines for Selecting and Defining Research Problem – research Design – Concepts related to Research Design – Basic Principles of Experimental Design.

UNIT II
Sampling Design – steps in Sampling Design –Characteristics of a Good Sample Design – Random Sampling Design.
Measurement and Scaling Techniques-Errors in Measurement – Tests of Sound Measurement – Scaling and Scale Construction Techniques – Time Series Analysis – Interpolation and Extrapolation.
Data Collection Methods – Primary Data – Secondary data – Questionnaire Survey and Interviews.

UNIT III
Correlation and Regression Analysis – Method of Least Squares – Regression vs. Correlation – Correlation vs. Determination – Types of Correlations and Their Applications

UNIT IV
Statistical Inference: Tests of Hypothesis – Parametric vs. Non-parametric Tests – Hypothesis Testing Procedure – Sampling Theory – Sampling Distribution – Chi-square Test – Analysis of variance and Co-variance – Multi-variate Analysis.

UNIT V
Report Writing and Professional Ethics: Interpretation of Data – Report Writing – Layout of a Research Paper – Techniques of Interpretation- Making Scientific Presentations in Conferences and Seminars – Professional Ethics in Research.

Text Books:
1. Research Methodology: Methods And Techniques – C.R.Kothari, 2ndEdition,New Age International Publishers.
2. Research Methodology: A Step By Step Guide For Beginners- Ranjit Kumar, Sage Publications (Available As Pdf On Internet)
3. Research Methodology and Statistical Tools – P.Narayana Reddy and G.V.R.K.Acharyulu, 1stEdition, ExcelBooks, New Delhi.

REFERENCES:

1. Scientists Must Write - Robert Barrass (Available As Pdf on Internet)
2. Crafting Your Research Future –Charles X. Ling AndQuiang Yang (Available As Pdf On Internet)

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
M.Tech III semester (GE)

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(17D20302) INTELLECTUAL PROPERTY RIGHTS
(Elective V-OPEN ELECTIVE)

UNIT – I
Introduction To Intellectual Property: Introduction, Types Of Intellectual Property, International Organizations, Agencies And Treaties, Importance Of Intellectual Property Rights.

UNIT – II
Trade Marks : Purpose And Function Of Trade Marks, Acquisition Of Trade Mark Rights, Protectable Matter, Selecting And Evaluating Trade Mark, Trade Mark Registration Processes.

UNIT – III
Law Of Copy Rights : Fundamental Of Copy Right Law, Originality Of Material, Rights Of Reproduction, Rights To Perform The Work Publicly, Copy Right Ownership Issues, Copy Right Registration, Notice Of Copy Right, International Copy Right Law.
Law Of Patents : Foundation Of Patent Law, Patent Searching Process, Ownership Rights And Transfer

UNIT – IV
Trade Secrets : Trade Secrete Law, Determination Of Trade Secrete Status, Liability For Misappropriations Of Trade Secrets, Protection For Submission, Trade Secrete Litigation.
Unfair Competition : Misappropriation Right Of Publicity, False Advertising.

UNIT – V
New Development Of Intellectual Property: New Developments In Trade Mark Law ; Copy Right Law, Patent Law, Intellectual Property Audits.
International Overview On Intellectual Property, International – Trade Mark Law, Copy Right Law, International Patent Law, International Development In Trade Secrets Law.

TEXT BOOKS & REFERENCES:

1. Intellectual Property Right, Deborah. E. Bouchoux, Cengage Learing.
2. Intellectual Property Right – Nleashmy The Knowledge Economy, Prabuddha Ganguli,
Tate Mc Graw Hill Publishing Company Ltd.,

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M.Tech III semester (GE)

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(17D20303) HUMAN VALUES AND PROFESSIONAL ETHICS
(Elective V-OPEN ELECTIVE)

Unit I:
HUMAN VALUES:Morals, Values and Ethics-Integrity-Work Ethic-Service
learning – Civic Virtue – Respect for others – Living Peacefully – Caring – Sharing –
Honesty - Courage- Co Operation – Commitment – Empathy –Self Confidence
Character – Spirituality.

Unit II:
ENGINEERING ETHICS: Senses of Engineering Ethics- Variety of moral issues –
Types of inquiry – Moral dilemmas – Moral autonomy –Kohlberg‟s theory-
Gilligan‟s theory- Consensus and controversy – Models of professional roles-
Theories about right action- Self interest - Customs and religion –Uses of Ethical
theories – Valuing time –Co operation – Commitment.

Unit III :
ENGINEERING AS SOCIAL EXPERIMENTATION: Engineering As Social
Experimentation – Framing the problem – Determining the facts – Codes of Ethics –
Clarifying Concepts – Application issues – Common Ground - General Principles –
Utilitarian thinking respect for persons.

UNIT IV:
ENGINEERS RESPONSIBILITY FOR SAFETY AND RISK: Safety and risk –
Assessment of safety and risk – Risk benefit analysis and reducing riskSafety and the
Engineer- Designing for the safety- Intellectual Property rights(IPR).

UINIT V:
GLOBAL ISSUES: Globalization – Cross culture issues- Environmental Ethics –
Computer Ethics – Computers as the instrument of Unethical behavior – Computers
as the object of Unethical acts – Autonomous Computers- Computer codes of Ethics –
Weapons Development - Ethics .

Text Books :
1. "Engineering Ethics includes Human Values" by M.Govindarajan, S.Natarajan and
    V.S.SenthilKumar-PHI Learning Pvt. Ltd-2009.
 2.. "Engineering Ethics" by Harris, Pritchard and Rabins, CENGAGE Learning, India
    Edition, 2009.
3."Ethics in Engineering" by Mike W. Martin and Roland Schinzinger – Tata
    McGrawHill– 2003.
4. "Professional Ethics and Morals" by Prof.A.R.Aryasri, DharanikotaSuyodhana-
    Maruthi Publications.
 5. "Professional Ethics and Human Values" by A.Alavudeen, R.Kalil Rahman and
    M.Jayakumaran , Laxmi Publications.