DEPARTMENT OF CIVIL ENGINEERING

COURSE STRUCTURE & SYLLABUS

R25

MTech in

GEOTECHNICAL ENGINEERING

(Course Code:20)

I YEAR I – SEMESTER

S.No	Course Code	Course Name	L	T	P	C
1.	Professional Core – I **M252001**	Advanced Soil Mechanics	3	1	0	4
2.	Professional Core – II **M252002**	Soil Investigation/ Soil Exploration	3	1	0	4
3.	Professional Core – III **M252003**	Landfill Engineering	3	1	0	4
4.	**Professional Elective -I M252004A**	a) Ground Improvement Techniques	3	1	0	4
	M252004B	b) Soil-Foundation Interaction				
	M252004C	c) Critical State Soil Mechanics				
	M252004D	d) Computational Methods in Geotechnical Engineering				
5.	**Professional Elective -II M252005A**	a) Design with Geo-synthetics	3	1	0	4
	M252005B	b) Rock Mechanics				
	M252005C	c) Remote Sensing & Geographical Information Systems				
	M252005D	d) Tunnelling Technology				
6.	Lab – I **M252006**	Geotechnical Engineering Lab-I	0	1	2	2
7.	Lab – II **M252007**	Geotechnical Engineering Lab-II	0	1	2	2
8.	**M252008**	Seminar-I	0	0	2	1
		Total	**15**	**7**	**6**	**25**

I YEAR II – SEMESTER

S.No.	Course Code	Course Name	L	T	P	C
1.	Professional Core – IV **N252001**	Advanced Foundation Engineering	3	1	0	4
2.	Professional Core – V **N252002**	Earth Retaining Structures	3	1	0	4
3.	Professional Core – VI **N252003**	Geosynthetics Engineering	3	1	0	4
4.		Professional Elective -III	3	1	0	4
	N252004A	a) Pavement Analysis Design & Evaluation				
	N252004B	b) Construction Planning & Methods				
	N252004C	c) Geotechnical Earthquake Engineering				
	N252004D	d) Unsaturated soil mechanics				
5.		Professional Elective -IV	3	1	0	4
	N252005A	a) Earth Dams				
	M252005B	b) Construction in Expansive Soils				
	M252005C	c) Numerical Methods in Geotechnical Engineering				
	M252005D	d) Finite Element Method				
6.	Lab – III **N252006**	Geotechnical Engineering Lab-III	0	1	2	2
7.	Lab – IV **N252007**	Software Design Lab	0	1	2	2
8.	**N252008**	Seminar-II	0	0	2	1
		Total	**15**	**7**	**6**	**25**

II YEAR I – SEMESTER

Sl. No.	Course Code	Course Title	L	T	P	Credits
1	O252001	Research Methodology and IPR Swayam 12 weeks MOOC course-RM&IPR	2	0	0	2
2	O252002	Summer Internship/ Industrial training (8-10 weeks)*	0	0	0	2
4	O252003	Dissertation Part-A$	0	0	20	10
	Total		**2**	**0**	**20**	**14**

*Student attended during summer/ year break and assessment will be done in 3rd Semester.
Comprehensive viva can be conducted courses completed upto 2nd Semester.
$ Dissertation -Part A, Internal assessment.

II YEAR II - SEMESTER

Course Code	Course Title	L	T	P	Credits
Dissertation P252001	Dissertation Part-B%	0	0	32	16
Total		**0**	**0**	**32**	**16**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY GURAJADA VIZAIANAGARAM M.TECH.- I YEAR- I SEMESTER

GEOTECHNICAL ENGINEERING

ADVANCED SOIL MECHANICS

Course objectives:

1. To Analyze the field loading conditions and predict the behavior of soil under loading and unloading condition in drained and untrained conditions of soil
2. To predict the probable seepage from the reservoir and for checking the stability of the structure under hydro dynamic conditions
3. To determine various application-based parameters of consolidation for safe design of structures on clay soils

Course Outcomes: At the end of the course, student will be able to;

1. Understand the behavior of soils stress paths and to determine the shear parameters under different load and drainage condition
2. Estimate Seepage and numerical modeling of Steady and transient flow condition
3. Determine Compressibility characteristics of NCC and OCC soils

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

Flow through soils: Permeability, seepage, mathematical analysis – Finite difference formulae for steady state and transient flows – flow nets – computation of seepage – uplift pressure, and critical hydraulic gradient.

UNIT- III

Compressibility and Consolidation: One dimensional compression, Oedometer test, parameters – coefficient of volume change, constrained modulus, compression index, swell or unloading, maximum past consolidation stress, Over consolidation ratio, Primary and secondary compression, consolidation - One, two- and three-dimensional problems, Consolidation of partially saturated soils, Creep/Secondary Compression in soils.

UNIT- IV

Stress-Strain-Strength Behaviour of soils: Shear strength of soils; Failure criteria, drained and undrained shear strength of soils. Significance of pore pressure parameters; Determination of shear

strength; Drained, Consolidated Undrained and Undrained tests; Interpretation of triaxial test results. Behaviour of sands; Critical void ratio; dilation in soils;

UNIT- V

Critical State Soil Mechanics: Critical state parameters; Critical state for normally consolidated and over consolidated soil; Significance of Roscoe and Hvorslev state boundary surfaces; Yielding, Bounding Surfaces.

REFERENCE:

1. Das, B. M.- Advanced Soil Mechanics, Taylor and Francis. 7 edition (2008)
2. Mitchell J.K. - Fundamentals of soil behaviour - John Wiley and Sons, Inc., New York. (third edition) 2005
3. Craig, R. F.- Soil Mechanics, Van Nostrand Reinhold Co. Ltd. (1987)
4. Lambe, T. W. and Whitman, R. V.- Soil Mechanics SI version , John Wiley & Sons.(2011) Muniram Budhu.- Soil Mechanics and Foundations, John Wiley & Sons, Inc.(2007)
5. Atkinson J. H. - An Introduction to the Mechanics of Soils and Foundation - through critical state soil mechanics, McGraw- Hill Co. (1993)
6. Wood, D.M.- Soil Behavior and Critical State Soil Mechanics. Cambridge university press (1991)

I Year - I Semester		L	T	P	C
		3	0	0	3
SOIL EXPLORATION					

Unit: 1

Soil Exploration – Importance, Terminology, - Planning of Ground Investigations -Geophysical methods.

Unit: 2

Borings - drilling – Probing and Trail pits -Location, spacing and depth, Methods of Boring including Drilling, Stabilization of Boreholes, – Planning of exploration.

Unit: 3

Sampling and Sample Disturbance: Methods of sampling -Types of Samples and Samplers- Cleaning of Bore holes, Preservation, Labeling and Shipment of Samples - Design Considerations of Open Drive Samplers. –Bore log, -Preparation of Soil Report.

Unit: 4

Field tests - The Standard Penetration Test – its limitations and Corrections – Cone Penetration Test – Field Vane Shear Test – Bore Hole Shear Test – Dilatometer Test – Pressure Meter test – Field Permeability Test –Plate load test – Monotonic and Cyclic Pile load test

Unit: 5

Design of Geotechnical Structures Based on the data from Field TestsThe Standard Penetration Test – its limitations and Corrections – Cone Penetration Test – Field Vane Shear Test – Bore–Hole Shear Test – Dilatometer Test – Pressure Meter test – field Permeability Test

REFERENCES

1.Site Investigation by C.R.I.Clayton, M.C. Matthews and N.E,Simons, University of Surrey, UK.

2. Geotechnical Investigation methods: A filed Guide for Geotechnical Engineers – Roy. E. Hunt, CRC Press.

3.Hvorslev, M. J., Sub-Surface Exploration and Sampling of Soils for Civil Engineering Purposes, US Waterways Experiment Station, Vicksburg, 1949.

4. Soil Mechanics in Engineering Practice by Terzagi and Peck

5.Foundation Analysis and Design by J.E. Bowles McGraw Hill Publishing Co.,

6.Foundation Design and Construction by MJ Tomlinson – Longman Scientific

7. Relevant IS Codes

I Year - I Semester		L	T	P	C
		3	0	0	3
LANDFILL ENGINEERING					

Unit :1

Geotechnical Characterization of Landfills: Physical Characterization of landfill material (Size distribution,Porosity, Moisture content, Field capacity, Wilting point, Unit weight, Hydraulic conductivity, Shear strength,Compressibility), Dynamic Properties; Landfill regulations (USEPA, RCRA).

Unit :2

Landfill.configurations:-Landfillsitingmethodology;linersystemsandproperties;Recommended DesignProcedure; Geomembranes, Geosynthetic Clay Liners (GCL's); Soil Drainage Layer and various materialsused for providing drainage, Interface effect among various liner components; Liner system performance,estimation of leakage, Rate of flow through composite liner.

Unit :3

Stability of Landfills Slopes: Sliding Failure of Leachate Collection System and Final CoverSystem;Rotational Failure of Landfill Waste, Liner, and Subsoil; Translational Failure along the Liner System; TwoPart Wedge Failure Mechanism; Vertical expansion of MSW landfills,

Unit: 4

Geosynthetics for Reinforcement, Three Part Wedge Failure Mechanism, Stability under seismic conditions.Analysis and Design of Veneer Cover Soils: Seismic Analysis of Veneer Cover Soil, GeosyntheticReinforced Veneer Slopes, Seepage Induced Veneer Slope Instability: Horizontal seepage build-up and Parallel-to-slope seepage build-up.

Unit: 5

Hydraulic and Structural Design Criteria for Drainage Layer Material, stresses due to liner selfweight ,temperature, expansion and contraction. Anchor Trenches; Design of Final Cover Systems; Alternate CoverSystems and Materials. End Uses of Closed Landfills, Typical Landfill failures and mitigation measures. Learning Resources

Text Books:

1. Rao, G. V. and Sasidhar, R. S., Solid Waste Management and Engineered Landfills, Sai Master Geo environmental Services Pvt. Ltd., Hyderabad, 2009.
2. Xuede Qian, Robert M. Koerner, Donald H. Gray, Geotechnical Aspects of Landfill Design and Construction, Prentice Hall, 2002.

Reference Books:

1. Claudio Cameselle, Jeffrey A. Adams, and Krishna R. Reddy, Sustainable Engineering: Drivers, Metrics, Tools, and Applications, Wiley, 2019.
2. Hari D Sharma, Krishna R Reddy, Geoenvironmental Engineering, Published by John Wiley, NY, 2004.
3. Manoj Datta, Waste Disposal in Engineered Landfills, Narosa Publishing House, New Delhi, 1997

Other Suggested Readings:

1. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1 -34-waste-containmentandremediation-technology-spring-2004/lecture-notes/
2. https://onlinecourses.nptel.ac.in/noc21_ce57/preview
3. https://www.epa.gov/landfills

I Year - I Semester		L	T	P	C
		3	0	0	3

GROUND IMPROVEMENT TECHNIQUES

Unit: 1

Introduction – Need for Engineering Ground – Classifications of Ground ModificationTechniques – Suitability, Feasibility and Desirability.Densification of cohesionless soils –Deep Compaction – Vibroflobation – Vibro Composer method - Blasting – Densification at Ground. -Vibrocompaction- Heavy Tamping

Unit: 2

Improvement of Cohesive soils – Preloading - Soil Replacement – Radial Consolidation Vertical and Radial Consolidation - Vertical Drains – Sand Drains – Effect of Smear – Sandwicks – Band drains – Dynamic Compaction.

Unit: 3

Stabilisation- Mechanical Stabilisation, Lime Stabilisation, Cement Stabilisation, Bitumen Stabilisation, Thermal Stabilisation, Chemical Stabilistion and Stabilisation with Different Admixtures

Unit: 4

Dewatering :- Dewatering methods – open sumps and ditches – gravity flow wells – Vacuum dewatering – Electro – kinetic dewatering – ElectrosmosisGrouting: Overview of grouting - Suspension grouts – Solution grouts – Emulsion grouts-Categories of grouting – Grouting Techniques – ascending stage, descending stage and stage grouting – Grouting Plant - Grout control - Grouting applications – Dams, Tunnels, Shafts and drifts, excavations.

Unit: 5

Stone Columns – Methods of installation of Stone Columns – Load shared by stone columns and the stabilized ground – uses of stone columns Lime columns and granular trenches – Installation– In situ ground reinforcement – ground anchors – types – Components and applications – uplift capability-Stability of foundation trenches and surrounding structures through soil Nailing, tie backs.

REFERENCE:

1.Construction and Geotechnical Methods in Foundation Engineering By R.M. Koerner, McGraw – Hill Book Co.

2.Current Practices in Geotechnical Engineering Vol.1, Alam Singh and Joshi, International Book Traders, Delhi, & Geo-Environ Academia.

3.Foundation Analysis and Design (1V Ed.) By J.E. Bowles, McGraw – Hill Book Co.,

4.Ground Improvement Techniques by P. Purushotham Raj, Laxmi Publications (P) Ltd., New Delhi.

5.Ground Improvement – Edited by M.P. Moseley, Blackie Academic & Professional.

6.Soil Mechanics for Road Engineers, H.M.S.O, Londan.

7.Ground Improvement Techniques by Bergado et al.

I Year - I Semester		L	T	P	C
		3	0	0	3

SOIL FOUNDATION INTERACTIONS

Unit: 1

Introduction to Soil – Foundation Interaction Problems – Contact Pressure Distribution – Idealized Soil Behaviour, Foundation Behaviour, Interface Behaviour, Analytical techniques.

Unit: 2

Idealized Soil Response Models for the Analysis of Soil – Foundation Interaction – Elastic Models for Soil Behaviour, Cointler model, Elastic Continuous Model, Two –Parametric Elastic Models – Elastic – Plastic and Time Dependent Behaviour of Soil Masses.

Unit: 3

Plane Strain Analysis of an Infinite plate and an Infinitely Long. Beam; Bernoulli – Euler Beam Theory and its Modifications – Effect of Shear Deformations.

Unit: 4

Finite Beams on a Winkler Medium – Method of Initial Parameters – Method of Super Position – Strain Energy Method.

Unit: 5

Analysis of finite plats – Axi Symmetric Leading of a Circular Plate – Circular Plate Resting on a Winkler Medium – Circular Plate Resting on a Two – parameter elastic

REFERENCE:

1.Analytical and computer methods in foundation engineering, JE Bowles, McGraw Hill publications.
2. Foundation analysis and design, JE Bowles, McGraw Hill Publications.
3.Foundation analysis by RF Scott, Printice Hall
4.Hytenyi, Beams on Elastic Foundations – university of Michigan Press.
5.Elastic Analysis of soil – Foundation Interaction. APS Selvadurai – Elsevier

I Year - I Semester		L	T	P	C
		3	0	0	3
CRITICAL STATE SOIL MECHANICS					

Unit: 1

Stress and strain – Stress and Strain Paths and Invariants – Critical State line – families of Undrained and Drained tests – Undrained and Drained planes – The Roscoe surface – Rosco surface as a state boundary surface.

Unit: 2

Behaviour of Over Consolidated Samples – Hvorslev Surface – Critical State Line – Complete State Boundary surface – Volume Changes and Pore Pressure changes – Behaviour of Sands – Effect of Dilation.

Unit: 3

Soil behaviour Before failure – Plasticity of Soils – Cam clay - Power in Cam – Clay – Critical States and Yielding of Cam – clay, Compression of Cam – Clay.

Unit: 4

Routine Soil Tests and the Critical State Model – Mohr – Coulomb Failure Criterion – One – dimensional compression – Undrained Shear Strength – General states of stress – Pore pressure Parameters – Interpretation of Index Test Data.

Unit: 5

Test paths in consolidation and shear testing -- Soil Parameters for Design – Choice of Analysis – Methods – Choice of Strength Parameters.

REFERENCES:

1.The Mechanics of Soils by J.H. Atkinson and P.L. Bransby& ELBS McGraw – Hill Book Co.,

2.Critical State Soil Mechanics – A. Sehofield and P. Wroth McGraw Hill Book Co.

3.Guide to soil Mechanics – Bolton seed, Mac millan Press Ltd., London.

I Year - I Semester		L	T	P	C
		3	0	0	3

COMPUTATIONAL METHODS IN GEOTECHNICAL ENGINEERING

Unit:1
Solution of Non-linear and Linear Equations: Bisection, False Position, Newton-Raphson, Jacobi'smethod, Gauss Seidel method

Unit:2
Solution of ODE using numerical techniques: Initial value problems and boundary value problems;Taylor series method, Picard's method, Euler's method, Runge-Kutta method.

Unit:3
Finite Difference Method: Boundary value and Initial value problems - Dirichlet conditions, Neumann conditions; Ordinary and partial differential equations; Non-linear problems

Unit:4
Introduction to Finite Element Method: Formulation of weak form, interpolation functions

Unit:5
Constitutive modelling of soil: Critical state soil mechanics: Elastic-plastic constitutive models; Cam Learning Resources:

Text Books:
1. Jain M K, Iyengar SRK and Jain R K,Numerical Methods for Scientific and Engineering computations, New Age International (P) Ltd. Publishers, New Delhi, 2012, 3rd edition.
2. Naylor D J and Pande G N, Finite Elements in Geotechnical Engineering, Pineridge Press Ltd., UK,1981.

Reference Books:
1. C S Desai and JT Christian, Mc Numerical Methods in Geotechnical Engineering. Graw Hill, 1977.
2. Y. M. Cheng, J. H. Wang, Li Liang, W. H. Fung, W. H. Fung Ivan, Numerical Methods and Implementation in Geotechnical Engineering, 2020.

I Year - I Semester		L	T	P	C
		3	0	0	3

DESIGNING WITH GEOSYNTHETICS

UNIT:1

Types, Applications and Functions of Geosynthetics: Introduction – Types of Geosynthetics – Function: Reinforcement, separation, drainage, filtration and barrier – Uses and Applications.

UNIT:2

Manufacture, Properties and Testing Methods of Geosynthetics: Raw materials – manufacturing process of various types of geosynthetics--

UNIT:3

Design of reinforced earth retaining Walls: -Types of soil reinforced structures like wrap-around walls -full-height panel walls -discrete-facing panel walls -modular block walls, Construction aspects -Usage of BS 8006 -FHWA design codes -Internal and External stability analyses-Seismic loads.

UNIT:4

Design of reinforced earth slopes: Basal reinforcement for construction on soft clay soils, construction of steep slopes with reinforcement layers on stable foundation soil, different slope stability analysis, erosion control on slopes using geosynthetics.

UNIT:5

Design of Filters, Drains, Prefabricated vertical drains and Erosion Control Measures using Geosynthetics: Different filtration requirements- Criteria for selection of geotextiles for filtration- Erosion control techniques for slopes and coastal regions, Designing of PVD for stabilizing soft and marine soils

REFERENCE:

1."Designing with Geosynthetics" by Robert M. KoernerPrantice Hall, Eaglewood Cliffs, NJ 07632.
2."Construction and Geotechnical Engineering using Synthetic Fabries" by Robert
M. Koerner and Josoph P. Welsh. John Willey and Sons, New York.
3."Engineering with Geosynthetics", by G. Venkatappa Rao and GVS Suryanarayana
Raju – Tata McGraw Hill Publishing Company Limited, New Delhi.
4."Foundation Analysis and Design" by J.E. Bowles McGraw Hill Publications.
5.FHWA code
6.BS 8006 code

I Year - I Semester		L	T	P	C
		3	0	0	3
ROCK MECHANICS					

Unit: 1

Introduction and Classification of Rocks: Development of Rock Mechanics:Applications of Rock Mechanics – Rock Vs. Soil: Engineering Classification of intact rock and fissured rocks: Classification based on Structural features – Rock quality Designation Number and Velocity Ratio Methods.

Unit: 2

Strength and Deformation Behaviour of Rocks and Failure Theories: Typical Stress– Strain Curves – Static and Creep Test; Strength of rock – Unconfined Shear Strength and Triaxial Shear Strength of Rocks; Creep behaviour of Rocks; rock fracture and friction; Coulomb – Navier; Mohr's and Griffith Theory and its Modification (General discussion only – derivation of equation not included.)

Unit: 3

Laboratory Testing of Rock Samples – Factors affecting test results sampling procedure and preparation of specimens; Tensile Tests – Direct, Indirect and Flexural tests; Uniaxial compression test; Unconfined andTriaxial shear tests; Determination of Elastic constants – Pulse generation and Resonant Frequency of a vibrating bar methods.

Unit: 4

In-Situ Testing of Rock masses Plate –bearing test, Pressure Tunnel test; Flat Jack Test; Permeability of Rock and rock masses; Pore water pressure in rocks.

Unit: 5

Methods of Improving the Properties of Rock Masses – Pressure Grouting and Rock bolting. -- Design of simple – Openings in competent rocks; laminated rocks and rocks containing planes of weakness. (Distribution of stresses around simple openings suction only without derivation)

REFERENCE:

1.Jaegar, J.C., and Cook, N.G.W. – Fundamentals of Rock Mechanics
2.Stagg, K.C. and Zienkiewicz., O.C – Rock Mechanics in Engineering Practice.
3.Obert, L & Duvall, W.L. – Rock Mechanics and the Design of Structures in Rock.

I Year - I Semester		L	T	P	C
		3	0	0	3
REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM					

UNIT-1

Remote Sensing : Definition, Elements involved in Remote Sensing, Ideal Vs Real Remote Sensing, Characteristics of Real Remote Sensing System, Nature of Electromagnetic Radiation. The Electromagnetic Spectrum, Remote Sensing Terminology and Units, Energy Interaction with Earth Features, Vegetation, Soils and Water bodies, Energy interaction in the atmosphere. Spatial Resolution, Spectral Resolution and Radiometric Resolution, Characteristics of Various sensors and satellites: LANDSAT, SPOT, IRS, ERS.

Unit: 2

Introduction to GIS: What is GIS , Components of GIS, Overview of GIS, Examples of GIS application for civil engineering, Using a GIS for Decision making under uncertainty, Geo-referenced data.
Data Input/Output: Keyboard entry, Manual Digitizing, Scanning, remotely sensed data, Existing Digital data – Cartographic database, Natural resources data sets, Digital elevation data and census related data sets, Data output devices.

Unit: 3

Data Quality: Components of data Quality, Sources of error. Data management: Data Base approach, Three classic data models (Hierarchical network Relational data models), Query languages, Nature of Geographic data.Spatial data models: Raster and Vector data models. Data bases for GIS managing Spatial and attribute data together – Organizing Geographic Information within a DBMS, Limitations and Practical Approaches.

Unit: 4

GIS Analysis functions : Organizing data for analysis, Classification of GIS Analysis function, Maintenance and Analysis of Spatial data – Transformations, Edge matching and editing, Maintenance and analysis of non-spatial attribute data – Editing and query functions.

Unit: 5

GIS analysis functions for Integrated analysis of spatial and attribute data: Retrieval and Classification functions, Overlay operations, Neighborhood operations, Connectivity function, Output, Formatting – Map annotation, Text pattern and line styles, Graphic symbols, Cartographic modeling by GIS, analysis procedure with an example.

TEXT BOOKS:

1.Principles of Geographic Information Systems by Peter A. Burrough and Rachael A.McDonnell – Oxford University Press.
2.Principles of Remote Sensing by Paul J Curran Geographic Information Systems, - A Management

Perspective by STAN ARONOFF, Published by WDL Publications, Ottawa, Canada.
3.Michael Hord. Remote Sensing Methods and Applications, John Wiley.
4.Remote Sensing and Geographical Information Systems – 2nd Edition by M. Anji Reddy.

REFERENCE BOOKS:

1.Remote sensing and Image Interpretation by LILESAND and KIEFER, Published by John Wiley and Sons.
2.Fundamentals of GIS by MICHAEL N DEMERS, Published by John Wiley & Sons, Inc.

I Year - I Semester		L	T	P	C
		0	0	4	2
GEOTECHNICAL ENGINEERING LAB -1					

List of Experiments:

1.Determination of moisture content and specific gravity of soil
2.Grain size distribution analysis and hydrometer analysis
3.Atterberg limits (liquid limit, plastic limit, shrinkage limit)
4.Field identification tests
5.Vibration test for relative density of sand
6.Standard and modified proctor compaction tests
7.Falling head permeability test and constant head permeability test
8.CBR

I Year - I Semester		L	T	P	C
		0	0	4	2
GEOTECHNICAL ENGINEERING LAB-II					

List of Experiments:

1.Unconfined compression test
2.Direct shear test
3.Tri-axial compression test-UU,CU,CD tests.
4.Laboratory vane shear test
5.Free swell index test
6.Swell pressure test
7.Consolidation test
8.Field density test (core cutter and sand replacement methods)
9.PH, electrical conductivity, chloride and sulphate in soils

I Year - II Semester		L	T	P	C
		3	0	0	3
ADVANCED FOUNDATION ENGINEERING					

Unit: 1

Shallow Foundations –Bearing capacity – Terzaghi, Meyerhof's, Hansen's and Vesic's Bearing Capacity Theories – IS method of Bearing Capacity - Factors - Bearing Capacity of Stratified Soils- Bearing Capacity Based on Penetration Resistances - Safe Bearing Capacity and Allowable Bearing Pressure.

Unit: 2

Types and choice of type. Design Considerations including Location and Depth, Proportioning of Shallow Foundations- Isolated and Combined Footings and Mats - Design Procedure for Mats. Floating Foundation- Fundamentals of Beams on Elastic Foundations –Introduction to Drilled pier and Caisson Foundations

Unit: 3

Settlement Analysis – Elastic settlement in granular soils – Meyerhof's, De Beer and Marten's and Schemertmann'sequations-Elastic settlements of surface and subsurface footing in clays-Skempton and Bjerrum's pseudo threedimensional approach to consolidation settlement, settlement from in-situ tests. Tolerable settlements.

Unit: 4

Pile Foundation -Classification of Piles-Factors influencing - Choice- Load Carrying Capacity of Single Piles in Clays and Sands Using Static Pile Formulae- α - β - and λ - Methods –Dynamic Pile Formulations Pull-out resistance of piles -Meyerhof's, Vesic's equations and Coyle and Castello correlations for piles in sands (Elastic settlement of piles)- Pull out Resistance of piles - Negative skin friction in piles – Typical field situations – Estimation of downdrag- Neutral point – Methods of minimizing downdrag.

Unit: 5

Pile Groups: -- -Efficiency of Pile Groups- Different Formulae-Load Carrying Capacity of Pile Groups in Clays and Sands – Settlement of Pile Groups in Clays and Sands – Computation of Load on each Pile in a Group. Laterally loaded vertical piles - Modulus of subgrade reaction – Piles in granular soils and cohesive soils subjected to lateral loading - Matlock & Reese analysis for piles in sands - Davisson & Gill analysis for piles in clays, Broms' Analysis for piles in sands and clays.

REFERENCE

1.Principles of Foundation Engineering -Braja M. Das
2.Foundation Analysis and Design – J.E. bowles, McGraw – Hill Publishing Co.,
3.Analysis and design of foundations and Earth Retaining Structures. –S. Prakash,
Gopal Rajan and Swami Saran – SaritaPrakasan, Merut.
4.Foundation Design and Construction – M.J. Tomlinson, Pitman
5.Soil Mechanics and Foundation Engineering, Vol. II, Foundation Engg., - VNS Murthy
6.Pile Foundation Analysis & Design by Poulos and Davis.

I Year - II Semester		L	T	P	C
		3	0	0	3
EARTH RETAINING STRUCTURES					

Unit: 1

Earth pressures – Different types and their coefficients- Classical Theories of Earth pressure – Rankine's and Coulomb's Theories for Active and Passive earth pressure- Computation of Lateral Earth Pressure in Homogeneous and Layered soils- Graphical solutions for Coulomb's Theory in active and passive pressures.

Unit: 2

Retaining walls – different types - Type of Failures of Retaining Walls – Stability requirements – Drainage behind Retaining walls – Provision of Joints – Relief Shells.

Unit: 3

Sheet Pile Structures – Types of Sheet piles – Cantilever sheet piles in sands and clays – Anchored sheet piles – Free earth and Fixed earth support methods – Rowe's moment reduction method – Location of anchors and Design of Anchorage system.

Unit: 4

Braced cuts and Cofferdams: Lateral Pressure in Braced cuts – Design of Various Components of a Braced cut – Stability of Braced cuts – Bottom Heave in cuts. – types of cofferdam, suitability, merits and demerits – Design of single – wall cofferdams and their stability aspects – TVA method and Cummins' methods.

Unit: 5

Pseudo static analysis of Earth Retaining Structures using Mononobe& Okabe Solution :

REFERENCES:

1.Principles of Foundation Engineering by Braja M. Das.
2.Foundation analysis and design – Bowles, JE – McGraw Hill
3.Soil Mechanics in Engineering Practice – Terzaghi, K and Rolph, B. peck 2nd Edn. – John Wiley & Co.,
4.Analysis and Design of Foundations and Retaining Structures, Prakash, S – SarithaPrakashan, Mearut.

I Year - II Semester		L	T	P	C
		3	0	0	3
GEOSYNTHETICS ENGINEERING					

Unit -I

Introduction: An overview on the development, functions and applications of various geosynthetics - thegeotextiles, geogrids, geonets, geomembranes, geocomposites and other products.Designing with geotextiles: Manufacture of geotextiles, Geotextile properties and test methods –functions - Designing geotextiles for separation, reinforcement, stabilization, filtration and drainage applications.

Unit -II

Designing with geogrids: Manufacture of geogrids, Types of geogrids, Geogrid properties and test methods – physical properties, mechanical properties, endurance properties and environmentalproperties– Designing geogrid for reinforcement in pavements, retaining walls and bearing capacity.

Unit -III

Designing with geonets: Manufacture of geonets, Geonet properties and test methods – Physical properties, mechanical properties, hydraulic properties, endurance properties and environmental properties-Designing geonet for drainage purposes.

Unit -IV

Designing with geomembranes: Manufacture of geomembranes-Geomembrane properties and testmethods – physical properties, mechanical properties, chemical properties and biological hazard - Applications of geomembranes and the relevant designs.

Unit -V

Designing with geocomposites: Geocomposites in seperation, reinforcement applications– Reinforcedgeotextile composites – reinforced geomembrane composites – reinforced soil Composites using discontinuous fibres and meshes, continuous fibres and three –dimensional cell -Designing for bearing capacity, drainage and filtration purposes.

Learning Resources:

Text Books:

1.Koerner, R.M., Designing with geosynthetics", Pearson Education Inc., 2012, 6th edition,

2.Mandal, J.N., "Geosynthetics Engineering: in Theory and Practice", Research Publishing,

Singapore, 2018, 1st edition.

Reference Books:

1. Swami Saran, I.K., Reinforced Soil and its Engineering Applications" International Publishing

House Pvt. Ltd., 2019, 1st edition

2. Mazenn Alshaaer and Han-Yong Jeon “Geopolymers and other Geosynthetics”, IntechOpen. 2020.

3. “ICE Handbook of Geosynthetic Engineering: Geosynthetics and their Applications, ICE Publications, 2021

Other Suggested Readings:

1. https://nptel.ac.in

2. https://freevideolectures.com › course › 3352 › geosynthetics.

3. https://www.swayamprabha.gov.in

I Year - II Semester		L	T	P	C
		3	0	0	3

PAVEMENT ANALYSIS, DESIGN AND EVALUATION

Unit: 1

Pavement Types, Wheel Loads and Design Factors: Definition of Pavement Types, Comparison of Highway pavements, Wheel Loads, Tyre pressure, Contact pressure, Design Factors: Traffic and Loading, Environment, Materials, Failure criteria, Reliability.

Unit: 2

Stresses in Pavements: Layered System Concepts: One Layer System: Boussinesq's Theory. Two Layer Theory: Burmister's Theory. Three Layer System. Stresses in Rigid Pavements. Relative Stiffness of Slabs, Modulus of Subgrade Reaction, Stresses due to Warping, Stresses due to Friction, Stresses due to Load, IRC Recommendations.

Unit: 3

Pavement Design: IRC Method of Flexible Pavement Design, AASHTO Method of Flexible Pavement Design, IRC Method for Rigid Pavements, use of Geosynthatics in pavements.

Unit: 4

Pavement Inventories: Serviceability Concepts, Visual Rating, Pavement Serviceability Index, Roughness Measurements, Measurement of Distress Modes Cracking, Rutting, Rebound Deflection using Benkleman Beam Deflection Method, Load Man Concept, Skid Resistance Measurement.

Unit: 5

Pavement Evaluation: Functional Pavement Performance Evaluation: AASHTO Method, Psycho Physical and Psycho Metric Scaling Techniques, Deduct Value Method.Structural Conditional Evaluation Technique: Benkelman Beam Deflection Method, Pavement Distress Rating Technique. Design of Overlays by Benkelmen Beam Deflection Methods as per IRC – 81 - 1997 – pavements on problematic soils.

REFERENCES:

1.Yoder and Witzorack, "Principles of Pavement Design", John Willey and Sons.
2.Yang, H. Huang, "Pavement Analysis and Design", Prentice Hall Publication, Englewood Cliffs, New Jersy.
3.Sargious, M.A. Pavements and Surfacings for Highways and Airports – Applied science Publishers limited
4.Ralps Hass and Hudson, W.R. " Pavement Management System" Mc-Graw Hill Book Company.
5.IRC codes of practice.

I Year - II Semester		L	T	P	C
		3	0	0	3

CONSTRUCTION PLANNING AND METHODS

Unit: 1

Project Management: Planning – Scheduling – Control – Bar chart – Milestone charts – Development of CPM and Pert networks – Time Estimates – Evaluation of Project duration – Cost Analysis – Updating – Crashing and Resource Allocation.

Unit: 2

Equipment: Equipment Economics – Cost of Owning and operating – Earth moving equipment – Dozers – Scrapers – graders – shovels – hoes – loaders – clamshell buckets – Draglines – Cranes

Unit: 3

Trucks and Handling Equipment: Rear dump trucks – Capacities of trucks and handling equipment – calculation of truck production – compaction equipment – types of compaction rollers – quality control – soil stabilization

Unit: 4

Aggregate production: Crushers – Jaw Crushers – Gyratory crushers – impact crushers – selection of crushing equipment – screening of aggregate – concrete mixers – mixing and placing concrete – consolidating and finishing.

Unit: 5

Project Budgeting: Introduction – Project costs – types of costs – Accuracy and timing of cost estimates – methods of crushing costs – cost control – cost inflation – escalation and contingencies.

References:

1.Peurifoy and Schexnayder, " Construction Planning, Equipement and Methods", Tata McGraw Hill Edition, New Delhi.

2.Kraig Knutson, Clifford, J.S, Christine Flori and Rishard E. Mayo, "Construction Management Fundamentals". Tata McGraw Hill Edition, New Delhi.

3.Chitkara, "Construction Project Management", Tata McGraw Hill Edition, New Delhi.

Timothy.J. Kopprnborg, "Contemporary Project Management", CenageLerraning.

I Year - II Semester		L	T	P	C
		3	0	0	3
GEOTECHNICAL EARTH QUAKE ENGINEERING					

Unit: 1

Earthquake Seismology: Introduction -- Seismic waves - Causes of earth quake - Continual drift and Plate tectonics – Earthquake fault sources – Faults, fault geometry, fault movement - Elastic Rebound Theory – Location of Earth Quakes - Quantification of Earthquakes – Intensity and magnitude – Earthquake Energy.

Unit: 2

Earthquake ground motion: Seismograph - Characteristics of Ground motion: - Ground motion parameters – Amplitude Parameters – peak acceleration, peak velocity, peak displacement other amplitude parameters – Frequency content parameters – ground response spectra, Fourier spectra, Power spectra, response spectra – spectral parameters – duration. Local site Specification and Code based design

Unit: 3

Dynamic Soil Properties: Representation of Stress conditions by the Mohr Circle – Measurement of Dynamic properties – field, laboratory, interpretation of observed ground response -- One dimensional response analysis - linear approach, E quivalent linear approach.

Unit: 4

Liquefaction and Lateral Spreading – Liquefaction Related phenomena - Liquefaction susceptibility – Initiation of Liquefaction – Effects of Liquefaction – Remedies on Seismic hazards – Densification – Reinforcement – Grouting and mixing Techniques – Drainage Techniques

Unit: 5

Seismic Design of Foundation, Slopes and Retaining Structures: Seismic Design requirements for Foundation – Seismic Bearing capacity - Seismic Settlement -- Internal stability and weakened instability of slopes - Seismic design of retaining walls: Dynamic Response of Retaining walls - Seismic Displacement of Retaining walls - Seismic Design Considerations.

REFERENCES:

1.“Geotechnical Earth Quake Engineering” by SL Kramer, Pearson Education.
2.“Earth Quake” W.H. Freeman, New York

I Year - II Semester		L	T	P	C
		3	0	0	3
UNSATURATED SOIL MECHANICS					

Unit:1

Introduction: Unsaturated soil, Gravimetric and Volumetric water content, Pore water pressure, Matric andOsmotic suction, Soil Water Characteristic Curve (SWCC), Hysteresis in SWCC, Methods to determineSWCC

Unit:2

Seepage in unsaturated soil: Permeability and Hydraulic Conductivity, Hydraulic Conductivity Function(HCF), One-dimensional steady state flow, Darcy's and Gardner's Principles, Transient Flow, Infiltration,Numerical Modelling, Capillary Barriers.

Unit:3

Strength characteristics of unsaturated soil: Extended Mohr Coulomb's criterion, Shear strength and pore pressure parameters, Measurements of unsaturated shear strength parameters.

Unit:4

Unsaturated shear strength models, Applications in Bearing Capacity, Lateral Earth Pressure, and Slope stability in Unsaturated soils.

Unit:5

Volume Change behavior of soils: Stress state variables for unsaturated soils, StressDeformation Behavior, Volumetric continuity, Volume-Mass Constitutive Relations, Swelling and Collapse behavior.

Learning Resources:

Text Books:

1. Murray E. J. and Shivakumar V., Unsaturated Soils: A fundamental interpretation of soil behaviour,Wiley-Blackwell, 2010, 1st edition.

2. Ning Lu and William J. Likos, Unsaturated Soil Mechanics, John Wiley & Sons Inc., 2004

Reference Books:

1. Charles W. W. Ng, and Menzies B., Advanced Unsaturated Soil Mechanics and Engineering, CRCPress, 2007, 1 st edition (Reprint 2019)
2. Fredlund D. G. and Rahardjo H., Soil Mechanics for Unsaturated Soils, John Wiley & Sons Inc.,1993, 1st edition
3. https://nptel.ac.in/courses/105/103/105103139/
4. https://nptel.ac.in/courses/105/101/105101200/

I Year - II Semester		L	T	P	C
		3	0	0	3
EARTH DAMS					

Unit: 1

BASIC CONCEPTS AND MISCELLANEOUS TOPICS.: Evolution – Types of Dams –Earthfill Dams – Rockfill Dams – Selection of Type of Dam SiteTopography – Foundation Conditions – Basic Design Requirements – Causes of Failure and Deterioration of Dams – Design Investigations – Fill Material – Foundations – Design Studies .

Unit: 2

SEEPAGE THROUGH DAM SECTION AND ITS CONTROL: Estimation of Seepagethrough Dam Section and foundation – Considerations in selection and design of core and determination of shell material Drains: – Pervious Downstream Shell – Chimney Drains – Rock Toe and Drains – Use of Geo-textiles as Filter Material.

Unit: 3

CONTROL OF SEEPAGE THROUGH FOUNDATIONS: General Considerations – different types of cutoff walls – Provision of d/s aprons – relief wellsSLOPE PROTECTION – Necessity with respect to u/s and d/s slopes – u/s slope protection by Dumped Riprap- Hand-placed Riprap – Soil -Cement Slope Protection – Downstream Slope Protection by providing berms - grass turfing.

Unit: 4

STABILITY ANALYSIS OF SLOPES OF EARTH DAMS: Slope stability analysis techniques –Methods of Slices, Fellinious Method, Simplified Bishop method, Taylor's method, Simplified Janbu's Method; Stability of earth dam slopes – u/s slope during sudden drawdown, d/s slope during steady seepage, stability of u/s and d/s slopes during and after construction.

Unit: 5

INSTRUMENTATION: – Purpose - Types of Instruments and Brief Description – Installation – piezometers --Casagrande and Vibration wire -- Settlement gauges – Inclinometers.

REFERENCE:

1.Earth Dams by HD Sharma
2.Earth and Rockfill Dams HD Sharma & Bharat Singh

I Year - I Semester		L	T	P	C
		3	0	0	3
CONSTRUCTION IN EXPANSIVE SOILS					

Unit: 1

Clay mineralogy-Nature of soils-clay mineral structures-cation exchange-soil water-soil structure-soil water interaction.

Unit: 2

Swelling characteristics: swelling-factors effecting swelling-swell potential-swell pressure-methods of determination – factors affecting swelling potential and swell pressure – Heave ---factors affecting heave- methods of determination of heave.

Unit: 3

Foundation Practices in Expansive Clays – Sand cushion – Belled Piers – CNS layer technique – Under – reamed pile foundations – Construction techniques – design specifications – Load - carrying capacity in compression and uplift of single and multi – under reamed piles in clays and sands – granular pile Anchors.

Unit: 4

Lime soil columns and Lime slurry pressure injection – Stabilization with admixtures – Preponding – Vertical and Horizontal Moisture Barriers .

Unit: 5

Shear strength of expansive soils-Kattis concept of bilinear strength envelope-Stress state variables in partly saturated soils-fredlunds strength parameters-determination of matrix suction by axis translation technique-field suction measurement

References:

1.F.H.Chen, Foundations on Expansive Soils, Eleveir Scientific Publishing Company, Newyork.
2.J.D.Nelson and D.I. Miller, Expansive soils- Problems and Practice in Foundation and Pavement Engineering by, John Wiley & Sons, Inc.
3.D.G. Fredlund and H.Rahardjo, Soil Mechanics for Unsaturated Soils, WILEY Inter science Publication, John Wiley & Sons, Inc
4.D.R. Katti, AR Katti, Behaviour of Saturated Expansive Soils and Control methods, Taylor and Francis Gopal Ranjan and AS Rao, Basic and Applied Soil Mechanics, New Age International Publishers,NewDelhi. Hand Book on Under reamed and Bored Compaction Pile Foundations – CBRI, Roorkee. IS: 2720(Part XLI) – 1977 Measurement of Swelling Pressure of Soils.

I Year - II Semester		L	T	P	C
		3	0	0	3

NUMERICAL METHODS IN GEOTECHNICAL ENGINEERING

Unit: 1

Introduction: Categories of Problems in Geo-technical Engineering, Finite Difference Method, Boundary Corrections for Grids. Accuracy, Convergence and Stability. Idealization of soil behaviour; Linear, Bilinear and multi-linear, Hyperbolic, Spline function, Ramberg – Osgood's Model, Polynomials, Higher order elastic models, perfect plasticity, frictional. Elastic models of soil behaviour – The winkler – Filenenko-boroditch – Pasternak – Ressiener models.

Unit: 2

Seepage: Finite Difference Solution to Laplace equation for Homogeneous and Layered Soils.

Unit: 3

Consolidation: Finite Difference Solution for One Dimensional, Two and three dimensional consolidations.Multi layered systems. Consolidation of Ground for Construction Load and Static Load.

Unit: 4

Shallow Foundations: Beams on Elastic foundations, solution by Finite Difference and – Finite Element Method (Direct Approach) Limit analysis, Lower Bound and Upperbound theories Method of Finite difference solution of Raft foundations.

Unit: 5

Pile Foundation: Pile Stresses – Static loading – Finite Element Method Solution (Direct approach) of the pile static pile capacity- wave equation -- Lateral piles by Finite Element Method (Direct Approach) and Finite Difference method.

REFERENCE:

1.Numerical methods in Geotechnical Engineering by C.S. Desai and J.T. Christian McGraw Hill publications.

2.Analytical and computer methods in foundation engineering, JE Bowles, McGraw Hill publications.
3.Foundation analysis and design, JE Bowles, McGraw Hill publications
4.Foundation analysis by RF Scott, Printice Hall
5.Hytenyi, Beams on Elastic Foundations – university of Michigan Press.
6.Elastic Analysis of Soil – Foundation Interaction, APS Selvadurai – Elsevier
7.Pile Foundation Analalysis& Design by Poulos and Davis.

I Year - II Semester		L	T	P	C
		0	0	4	2
GEOTECHNICAL ENGINEERING LAB-III					

List of Experiments:

1.Auger boring
2.Standard penetration test
3.Dynamic cone penetration test
4.Plate load test
5.Field CBR test
6.Pile load test
7.Electrical resistivity of soil

I Year - II Semester		L	T	P	C
		0	0	4	2
SOFTWARE DESIGN LAB					

1.Ultimate, Net and Safe Bearing Capacity Using Terzaghi and IS Code Methods.
2.Net Settlement Pressure
3.Hyperbolic Curve Fitting of Tri-axial Compression Data
4.Terzaghi One dimensional consolidation solution by FDM (perform analysis of substructures by packages)
5.Beam on Elastic Foundation by FDM
6.FDM Solution for Raft Foundation
7.Axial Loaded Piles by Direct FEM
8.Laterally Loaded Piles by FDM & FEM
9.Stability Analysis by Bishop theory
10.Stability Analysis by Method of Slices.

The Student is able to write at least Eight Programs listed above.

III Semester		L	T	P	C
		3	0	0	3
GEO – ENVIRONMENTAL ENGINEERING					

Unit: 1

Introduction- Ground water contamination, pollutant transport and ground water remediation. Sources and Types of ground water contamination – underground storage tanks, Land fills, surface impoundments, waste disposal injection wells, Septic system, Agricultural wastes, Land application, radioactive contamination, other sources of contamination.

Unit: 2

Clay Mineralogy, -Clay-water interaction, Electric Charges on Surfaces, Electric Double Layer, Diffuse Double-Layer (DDL) Models, Stern and Grahame Models, Interaction Energies, DLVO Model and Interaction Energies, Swelling Clays, Soil-Water Characteristics, Soil-Water Potentials, Measurement of Soil-Water Potentials, Soil water Characteristics Curves, Evaluation of Measured Soil-Water Potentials, Potentials and Swelling Soils, -Cation exchange capacity, Specific surface area measurements.

Unit: 3

Contaminant Transport Mechanisms: Introduction – Advection process – Diffusion – Dispersion process – Diffusion – Mass transport Equations : Derivation of advection dispersion equation for solute transport; One Dimensional Models – Continuous source in one dimension – Instantaneous source in one dimension – Adsorption effects – Transport in one dimensional with first order decay – Sorption: The concept of sorption.Factors influencing sorption – Contaminant characteristics, Soil characteristics, Fluid media characteristics. Sorption Isotherm: Linear sorption Isotherm – Freundlich Sorption isotherm – Langmuir Sorption Isotherm, Sorption effects on fate and transport of pollutants.

Unit: 4

-Soil-pollutant interactions, Soil-Water Characteristics, Soil-Water Potentials, Measurement of Soil-Water Potentials, Soil-water Characteristics Curves, Unsaturated Hydraulic conductivity, Governing equation for unsaturated flow, Evaluation of Measured Soil-Water Potentials, Potentials and Swelling Soils, -Cation exchange capacity, Specific surface area measurements.

Unit: 5

-Remediation and Pollution Mitigation, Pollutants and Site Contamination, Pollution Mitigation, Elimination, and Management, In situ and ex situ Remedial Treatment, Physico-chemical Techniques, Contaminated Soil Removal and Treatment, Vacuum Extraction: Water and Vapour, Electrokinetic Application, Solidification and Stabilization, - Inorganic Pollutants, Permeable reactive barriers, Organic Chemical Pollutants, Biological Techniques

TEXT BOOKS:

1.Ground water Contamination (Transport and Remediation) By Philip. B. Bedient, Hanadi, S. Rifai& Charles. J. Newell, Prentice Hall PTR, Upper Saddle River, NJ07458.

2.Geoenvironmental Engineering by Raymond N. Yong, CRC Press.

3.Barrier Systems for Waste Disposal Facilities by Rowe, R. K., Quigley, R. M., Brachman, R. W.I. and Booker, J. R. (2004), Taylor & Francis, London, UK.

4.Geotechnical and Geoenvironmental Engineering HandBook by R. K. Rowe, Springer

REFERENCES:

1.Geoenvironmental Engineering by R. Krishna Reddy - John Wiley & Sons, Inc.

2.Geoenvironmental engineering by Reddy, L.N and Inyang, I.H. – Marcel Drekker, 2000.

3.Environmental geotechniques by Sarsby, R. – Thompson Telford, 2000.Geotechnical Practices for Waste Disposal by Daniel, D.E., 1993

III Semester		L	T	P	C
		3	0	0	3
SOIL DYNAMICS & MACHINE FOUNDATIONS					

Unit: 1

Introduction: Types of motion- SHM- Fundamental definitions- SDOF systems- Free and forced vibration with and without damping- Types of damping-Equivalent stiffness of springs in series and parallel- Principles of vibration measuring devices- Introduction to two and multi degree freedom systems

Unit: 2

Theories of Vibration Analysis- EHS Theory and lumped parameter model- Different modes of vibration- Natural frequency of foundation soil system – Barkan and IS methods – Pressure bulb concept – Reisner Theory – Limitations of Reisner theory – Sung's solutions --Pauw's Analogy – Heigh's Theory.

Unit: 3

Dynamic properties of soils, Determination of E, G and Poisons ratio from field and laboratory tests, recommendations of Indian codes- Stress waves in bounded elastic medium- Use of wave theory in the determination of elastic properties, Elastic coefficients of soils and their determination- damping factor from free and forced vibration tests.

Unit: 4

Machine Foundations: Classification based on the type of dynamic force and structural form, design data, design criteria, foundations for reciprocating, impact and high speed machined like turbo generators- IS code provisions for the design of the same

Unit: 5

Vibration Isolation and Special Topics: Transmissibility, Principles of isolation- Methods of isolation- Vibration isolators- Types and their characterizes - Liquefaction of soils, Dynamic bearing capacity, Earth retaining structures under dynamic loads-Pile foundations with dynamic loads

REFERENCES:

1.Vibrations of Soils and Foundations – Richart Hall and Woods
2.Vibration Analysis and Foundation Dynamics, NSV Kameswara Rao, Wheeler Publishing, New Delhi.
3.Foundations of Machines- Analysis and Design- Prakash and Puri
4.Analysis and design of Foundations for Vibrations- P J Moore
5.Fundamentals of Soil Dynamics- B M Das
6.Dynamics of bases and Foundations- D DBarkar

III Semester		L	T	P	C
		3	0	0	3
FINITE ELEMENT METHOD					

Unit-1

Introduction: Review of stiffness method- Principle of Stationary potential energy-Potential energy of an elastic body- Rayleigh-Ritz method of functional approximation -variational approaches -weighted residual methods

Unit: 2

Finite Element formulation of truss element: Stiffness matrix- properties of stiffness matrix – Selection of approximate displacement functions- solution of a plane truss- transformation matrix and stiffness matrix for a 3 -D truss- Inclined and skewed supports-Galerkin's method for 1-D truss – Computation of stress in a truss element.

Unit: 3

Finite element formulation of Beam elements: Beam stiffness- assemblage of beam stiffness matrix- Examples of beam analysis for concentrated and distributed loading-Galerkin's method - 2-D Arbitrarily oriented beam element – inclined and skewed supports –rigid plane frame examples

Unit: 4

Finite element formulation for plane stress, plane strain and axi-symmetric problems- Derivation of CST and LST stiffness matrix and equations-treatment of body and surface forces-Finite Element solution for plane stress and axi-symmetric problems- comparison of CST and LST elements – convergence of solution- interpretation of stresses.

Unit: 5

Iso-parametric Formulation: An iso-parametric bar element- plane bilinear iso-parametric element – quadratic plane element - shape functions, evaluation of stiffness matrix, consistent nodal load vector - Gauss quadrature- appropriate order of quadrature – element and mesh instabilities – spurious zero energy modes, stress computation- patch test.

REFERENCES:

1.Concepts and applications of Finite Element Analysis – Robert D. Cook, Michael E Plesha, John Wiley & sons Publications

2.A first course in the Finite Element Method – Daryl L. Logan, Thomson Publications.

3.Introduction to Finite Elements in Engineering-Tirupati R. Chandrupatla, Ashok D. Belgunda, PHI publication.

III Semester		L	T	P	C
		0	0	4	2
RESERCH METHODOLOGY AND IPR					

Unit 1 :

RESEARCH PROBLEM AND SCOPE FOR SOLUTION Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit 2 :

FORMAT Effective literature studies approaches, analysis, Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 3 :

PROCESS AND DEVELOPMENT Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

Unit 4 : PATENT RIGHTS

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit 5 : NEW DEVELOPMENTS IN IPR

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Textbooks :

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3. Ranjit Kumar, 2nd Edn, “Research Methodology: A Step by Step Guide for beginners”

References :

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

6. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

II Year - I Semester		L	T	P	C
		0	0	3	3
SUMMER INTERNSHIP/ INDUSTRIAL TRAINING					

II Year - I Semester		L	T	P	C
		0	0	20	10
DISSERTATION -PartA					

II Year - II Semester		L	T	P	C
		0	0	32	16
DISSERTATION / THESIS-PartB					