SYLLABUS M.TECH. (CIVIL ENGINEERING)

(SOIL MECHANICS)

AUTONOMOUS REGULATIONS 2023

(Effective for the batches admitted in 2023-24 onwards)

DEPARTMENT OF CIVIL ENGINEERING

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES (A)

(Affiliated to AU, Approved by AICTE & Accredited by NBA)

SANGIVALASA, Bheemunipatnam Mandal, Visakhapatnam District-531162

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES (AUTONOMOUS)
DEPARTMENT OF CIVIL ENGINEERING

M.TECH. 2 YEAR DEGREE COURSE STRUCTURE

(Effective for the M.Tech. students admitted into first year from the academic year 2023-24)

M.TECH. I Year - I Semester

Code	*Subject*	*Periods*				*Sessional Marks*	*End Exam*	*Total Marks*	*Credits*
		L	*T*	*P*	**Total**				
23SM111	Advanced Soil Mechanics	3	1	-	4	40	60	100	3
23SM112	Soil Science	3	1	-	4	40	60	100	3
23SM113	Ground Improvement Techniques	3	1	-	4	40	60	100	3
23SM114	Reinforced Soil Structures	3	1	-	4	40	60	100	3
23SM115	Professional Elective – I	3	1	-	4	40	60	100	3
23SM116	Soil Engineering Lab	-	-	3	3	50	50	100	1.5
23SM117	Technical Seminar	-	-	3	3	50	-	50	1.5
23SM118	Research Methodology & IPR	2	-	-	2	40	60	100	2
23SM119	Universal Human Values and Professional Ethics	2	-	-	2	50	-	50	MNC
Total		**19**	**5**	**6**	**30**	**390**	**410**	**800**	**20**

M.TECH. I Year – II Semester

Code	*Subject*	*Periods*				*Sessional Marks*	*End Exam*	*Total Marks*	*Credits*
		L	*T*	*P*	**Total**				
23SM121	Analysis and Design of Substructures	3	1	-	4	40	60	100	3
23SM122	Pavement Analysis & Design and Rock Mechanics	3	1	-	4	40	60	100	3
23SM123	Professional Elective – II	3	1	-	4	40	60	100	3
23SM124	Professional Elective – III	3	1	-	4	40	60	100	3
23SM125	Professional Elective – IV	3	1	-	4	40	60	100	3
23SM126	Computational Geotechnical Engineering Lab	-	-	3	3	50	50	100	1.5
23SM127	GeoSynthetics & Rock Mechanics Lab	-	-	3	3	50	50	100	1.5
23SM128	English for Research Paper Writing	2	-	-	2	50	-	50	MNC
Total		**18**	**5**	**6**	**29**	**350**	**400**	**750**	**18**

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES (AUTONOMOUS)
DEPARTMENT OF CIVIL ENGINEERING

M.TECH. 2 YEAR DEGREE COURSE STRUCTURE

(Effective for the M.Tech. students admitted into first year from the academic year 2023-24)

M.TECH. II Year – I Semester

Code	***Subject***	***Periods / Week***	***Sessional Marks***	***End Exam Marks***	***Total Marks***	***Credits***
23SM211	MOOCS-1	-	100			3
23SM212	MOOCS-2	-	100			3
23SM213	Project Phase - 1	8	100	-	100	8
Total		**12**	**100**	**-**	**100**	**14**

M.TECH. II Year – II Semester

Code	***Subject***	***Periods / Week***	***Sessional Marks***	***End Exam Marks***	***Total Marks***	***Credits***
23SM221	Project Phase - 2	16	-	100	100	16
Total		**16**	**-**	**100**	**100**	**16**

***** *Massive Open Online Course: Method of evaluation will be decided by a Departmental Committee constituted for this purpose and students are graded accordingly.*

The student has to do at least Two MOOC course. All Courses arecompulsory

List of Professional Electives

PE - I

1. Soil Dynamics and Machine Foundations
2. Remote Sensing and GIS Applications in Geotechnical Engineering
3. Geotechnical Exploration & Instrumentation

PE – II

1. Finite Element Methods in Geotechnical Engineering
2. Geotechnics of Problematic Soils
3. Reliability Analysis and Design

PE – III

1. Soil Structure Interaction
2. Computational Methods in Geotechnical Engineering
3. Geo-Environmental Engineering

PE – IV

1. Earth and Earth Retaining Structures
2. Offshore Geotechnical Engineering
3. Forensic Geotechnical Engineering

ADVANCED SOIL MECHANICS

23SM111	**Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week	Sessional marks: 40
End Exam: 3 hours	End Exam Marks: 60

Course Objective:

The course contents enable the students to know the engineering properties of soils and determine the shear strength of cohesive and granular soils.

Course outcomes:

By the end of the course the students will be able to

1. Know the engineering properties of soils.
2. Understand the shrinkage and consolidation behaviour of soils.
3. Determine the shear strength of cohesive and granular soils.
4. Understand the deformation characteristics of soils.

SYLLABUS

UNIT – I

Engineering properties of soils: Physical properties of soil - Engineering properties of soils - Plasticity characteristics - Index properties of soil - IS Soil Classification - Permeability and Seepage

UNIT - II

Principle of effective stress: force distribution in a particulate system, inter particle forces, inter granular pressure.

Shear strength of Granular soils: Introduction, Friction Properties, Apparent friction Parameters, Sliding and interlocking friction, Laboratory measurement of Granular soil strength, measurement of friction angle, stress and strain, intrinsic friction angle, Volumetric strain.

UNIT – III

Cohesive soil strength: Analytical and physical strength parameters, Porewater pressure, Components of Pore water pressure for fully saturated soil, Pore pressures in partially saturated clay, Pore water measurements, Skempton's Parameters, Pore pressure coefficients

- laboratory determination – Stress Paths for various loading conditions – Undrained shear strength of anisotropic clay.

UNIT – IV

Compaction: IS Light Compaction - Zero Air void line

Consolidation: Review of theory of one dimensional consolidation, laboratory consolidation tests, Estimation of total compression, Time and load deformation curves,

load increment ratio, Soil structure in consolidation and compression – Sand drains – effect smear zone.

UNIT - V

Sub-Surface Exploration: Introduction – Planning and stages in sub-surface exploration – Methods of exploration – Test pit – Trenches – Seismic refraction and Electrical resistivity method – Methods of Boring – Types of soil sample – Design Features of soil sampler – standard penetration test – static and dynamic cone penetration test – Pressuremeter test – Rock exploration – Core boring – Core Recovery – RQD - bore log – preparation of sub-soil investigation report.

TEXT BOOKS

1. Mitchell, J. K. (2005), "Fundamentals of Soil Behaviour", John Wiley& sons, New Jersey, 3rd edition.
2. Yong, R. N. and Warkentin, B. P. (1975), "Soil Properties and Behaviour", Elsevier, New York.

REFERENCES

1. Das, B.M. (2008), "Advanced Soil Mechanics", Taylor & Francis, New York, 3rd edition.
2. Terzaghi, K. (1966), "Theoretical Soil Mechanics", John Wiley, New York.
3. Terzaghi, K. (1960), From Theory to Practice in Soil Mechanics. New York, NY: John Wiley and Sons Inc.
4. Davis, R.O. and Selvadurai, A.P.S. (1996), "Elasticity and Geomechanics", Cambridge University Press, Cambridge.
5. Scott, R.F. (1965), "Principles of Soil Mechanics", Addison –Wesley, London.
6. Wood, D.M (2007), "Soil Behaviour and Critical State Soil Mechanics", Cambridge university press, Cambridge.
7. Lambe, T. W. and Whitman, R. V. (2012), "Soil Mechanics-SI version", John Wiley &Sons, New York, 2nd edition.
8. Atkinson, J.H. and Bransby, P.L. (2000), "The mechanics of soils: An introduction to critical state soil mechanics", McGraw-Hill, New York.
9. Budhu, M. (2007), "Soil Mechanics and Foundations", Wiley-India edition, New Delhi.
10. Relevant NPTEL Courses

SOIL SCIENCE

23SM112 **Credits: 3**

Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40

End Exam: 3 hours End Exam Marks: 60

Course Objectives:

The course enables to understand the formation of soils, their mineralogy and various **mechanisms** involved in soil water interaction.

Course Outcomes:

At the end of the course the student will be able to:

1. Understand the Formation, Nature and Mineralogy soils
2. Gain knowledge about the Soil Fabric Structure and its characterisation
3. Apply concepts of water movement in Saturated and Unsaturated soils to measure unsaturated hydraulic conductivity.

SYLLABUS

UNIT – I

Soil Formation: Introduction: Weathering: Origin of clay minerals and clay genesis – soil profiles and their development. Sediment erosion – transport and deposition.

Nature of Soil: Particle size composition – Measurement of Pore size distribution – Principles of sedimentation analysis – Interpretation of accumulation Curves.

UNIT – II

Soil Mineralogy: Silicate Crystals - Surfaces – Gravel, Sand and Silt particles – Biogenic and Geochemical processes – Non-clay Mineral Characteristics.

Structural units of layer silicates – classification of clay minerals – Intersheet and InterLayer bonding – The 1:1 Minerals – Smectite Minerals – Mica like clay minerals – other clay minerals.

UNIT – III

Soil Fabric and Structure: Introduction – Structure and Fabric – Granular Soil packing – clay soil Fabric – Fabric classification – Particle arrangement in fabric units – First and Second order fabric characterization – Pore spaces and fabric – Techniques for direct fabric viewing – Quantification of fabric – Fabric characteristics from sedimentation.

UNIT – IV

Mechanism of Soil Water interactions – structures properties of adsorbed water – clay water electrolyte system. Ion distribution in clay water system - elements of double layer theory –

Influence of system variables on double layer theory – Limitations of Gouy-Chopman diffused double layer model – Energy and force of repulsions – long range attraction – Cation exchange.

UNIT – V

Flow through Soils: Soil water – capillarity - saturated flow: darcy's equations, determination of permeability in the field, Kozeny-Carmen Relationship – layered soils – factors effecting saturated flow – seepage force – Quicksand condition – Two dimensional flow - flownets and their characteristics – phreatic line for earthdams - uplift pressure – exit gradient – piping – filter criteria

Unsaturated flow: unsaturated flow equations for no volume change; for volume change cases Measurement of unsaturated hydraulic conductivity.

TEXT BOOKS

1. Mitchell, J. K. (1976), "Fundamentals of Soil Behaviour", John Wiley & Sons Inc.
2. Yong, R.N. and Warkentin B.P., (1975), "Soil Properties & Behaviour", Elsevier Scientific Publishing Company.

REFERENCES

1. Das, B.M. (2008), "Advanced Soil Mechanics", Taylor & Francis, New York, 3rd edition.
2. Lambe, T. W. and Whitman, R. V. (2012), "Soil Mechanics-SI version", John Wiley &Sons, New York, 2nd edition.
3. Atkinson, J.H. and Bransby, P.L. (2000), "The mechanics of soils: An introduction to critical state soil mechanics", McGraw-Hill, New York.
4. Relevant NPTEL Courses

GROUND IMPROVEMENT TECHNIQUES

23SM123 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional Marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Learning Objectives

1. To summarize the engineering properties of soil and problems associatedwith weak deposit.
2. To familiarize with the need for ground improvements.
3. To define the concept of soil stabilization.
4. To recall soil reinforcement techniques and geo-synthetics.

Course outcomes
At the end of the course students will be able

- To understand the engineering properties of soil and problems associatedwith weak deposit.
- To reason the need for the implementation of ground improvementtechniques.
- To be understand the concept of soil stabilization.
- To be utilize soil reinforcement techniques and geo-synthetics

SYLLABUS

UNIT I DEWATERING

Introduction - Scope and necessity of ground improvement in Geotechnical engineering- basic concepts and philosophy. Drainage - Ground Water lowering by well points deep wells, vacuum and electro-osmotic methods. Stabilization by thermal and freezing techniques.

UNIT II COMPACTION AND SAND DRAINS
Insitu compaction of granular and cohesive soils, Shallow and Deep compaction sand piles – concept, design, factors influencing compaction Blasting and dynamic consolidation – Preloading with sand drains, fabric drains, wick drains etc. – theories of sand drain – design and relative merits.

UNIT III STONE COLUMN, LIME PILES AND SOIL NAILING

Stone column, lime piles – Functions – Methods of installation – design, estimation of load carrying capacity and settlement-slope stability-stability of trenches-lime-sand columns-Root piles, soil nailing – Applications.

UNIT IV EARTH REINFORCEMENT

Earth reinforcement – Principles and basis mechanism of reinforced earth-reinforced soil retaining structures-simple design, Synthetic and natural fibre based Geotextiles and their applications. Filtration, drainage, separation, erosion control – case studies.

UNIT V. GROUTING
Grouting techniques – Types of grout – Suspension and solution grouts – Basic requirements of grout. Grouting equipment – principle of injection-injection methods – properties of treated ground-

application of jet grouting-grout monitoring – Electro – chemical stabilization – Stabilization with cement, lime etc. – Stabilization of expansive clays.

References

1. Hausmann, M. R., Engineering Principles of Ground Modification, McGraw – Hill International Editions, 1990.
2. Purushotham Raj, Ground Improvement Techniques, Laxmi Publications,New Delhi, 1996.
3. Klaus Krisch, Alan Bell, Ground Improvement (3rd Edition), CRC Press,London, 2012.
4. Jones C. J. F. P, Earth Reinforcement and Soil Structures, Butterworths,London, 1988.
5. Moseley M. P., Ground Improvement, Blockie Academic and Professional,Chapman and Hall, Glassgow, 1993.

GEOSYNTHETICS AND REINFORCED SOIL STRUCTURES

23SM114 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective:

The course content enables students to learn the use of Geosynthetics in Civil Engineering, modern concepts of Soil Reinforcement, design principles and ease of their applicability to construction practices.

Course Outcomes:

At the end of the course the student will be able to;

1. Explain the significance of Geosynthetics, Properties of Geotextiles and its application.
2. Design with Geotextiles.
3. Learn the Concept of Reinforced Earth.
4. Design the Reinforced Earth Retaining Walls, Reinforced Pavements, and Landfills.

SYLLABUS

UNIT – I

Geosynthetics-Types, Functions, Applications, Raw materials, Manufacturing methods.

UNIT – II

Properties of Geotextiles- Physical Properties, Mechanical Properties, Hydraulic Properties, Survivability and Durability.

Tests on Geotextiles- Mass per unit area, Nominal Thickness, Apparent Opening Size, Characteristic Opening Size, Tensile Strength-Strip Tensile Strength, Wide Width Tensile Strength, Grab Tensile Strength, Seam strength, Static Puncture test- CBR push through test, Rod Puncture Test, Dynamic Puncture Test- Cone Drop test, Permittivity, Transmittivity.

UNIT – III

Designing with Geosynthetics: Designing with Geotextiles-Design Methods, Designing for separation, Designing for Highway Reinforcement, Designing for Filtration, Designing for drainage, Designing for Multiple functions, Construction Methods and Techniques using Geotextiles. Designing with Geogrid, Geonets, Geomembranes, Geocomposites

UNIT – IV

Reinforced Earth: Concept, Effects of Reinforcement on soils – Equal Confining and Pseudo Cohesion Concepts, Materials, Friction Coefficient – Definition, Laboratory determination, Factors affecting fiction coefficient; Telescope and Hitex Methods of construction, Application of Reinforced Earth – Binquet & Lee's Approach for analysis of foundations with reinforcement layers.

UNIT – V

Reinforced Earth Retaining Walls: Introduction, Stability Mechanisms, Design of Reinforced Earth Retaining Wall, Advantages over conventional Retaining Walls
Reinforced Pavements: Benefits of placing reinforcement in flexible pavement layers, design of reinforced pavements by Giroud and Noiray approach and modified CBR Method.
Landfills: Geosynthetic applications for land fill liners, covers and other components

TEXT BOOKS

1. Venkatappa Rao, G. and Suryanarayana Raju, G.V.S. (1990), "Engineering with Geosynthetics", Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. Koerner, R. M., (2012) "Designing with Geosynthetics", Xlibris Corp, New York, 6th Edition.

REFERENCES

1. Siva Kumar Babu, G.L. (2006), "An Introduction to Soil Reinforcement and Geosynthetics", Universities Press, Hyderabad.
2. Robert M. Koerner (1991), "Construction and Geotechnical Methods in Foundation Engineering", McGraw Hill, New York.
3. Hausmann, M. R. (1990), "Engineering Principles of Ground Modifications", McGraw Hill Pub Co., New York.
4. BS 8006:2010, "Code of practice for strengthened/reinforced soils and other fills".
5. FHWA-NH1-00-043, (2014) "Mechanically stabilized earth walls and reinforced soil slopes design and construction guidelines".
6. John, N.W.M. (1999), "Geotextiles", Blackie, New York, 2nd Edition.
7. Relevant NPTEL Courses

Professional Elective – I

SOIL DYNAMICS AND MACHINE FOUNDATIONS

23SM115 A **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:

The course enables to understand the theory of vibrations, dynamic properties of soil and apply them in design foundations for machines.

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

1. Understand the concept of vibrations in soil-structure medium.
2. Know the dynamic properties of soil and their importance
3. Gain knowledge about the importance of designing machine foundations.
4. Demonstrate the ability to design machine foundations

SYLLABUS

UNIT – I

Theory of Vibrations: Free and forced vibrations with and without damping for single mass system with single degree freedom, Logarithmic Decrement and Damping Ratio, Principles of Design of Vibration measuring Devices, Transmissibility of force, vibrations of Two degree freedom system, vibrations of Systems under transient loads.

UNIT – II

Natural frequency of foundation soil system- Barkan's Method, Pressure Bulb Concept, Pauw's Analogy, Tschebetorioff's concept of reduced natural Frequency

UNIT – III

Dynamic Soil Properties: Tests for determination of dynamic soil properties - Cyclic Plate load test, Block vibration test, Up Hole, down Hole and Cross Hole wave Propagation tests, Hammer Test, Resonant Column Test, Seismic Reflection and Refraction tests.

UNIT – IV

Design of Machine Foundation: Types of Machine Foundations, design criteria, Degrees of Freedom of Block foundation, Analysis of Block foundations under sliding, rocking, yawing and Coupled motions, Design Aspects and Construction details of foundations for reciprocating and Impact,

UNIT – V

Vibration Isolation - Passive and active isolation - use of springs and damping materials construction aspects of machine foundations.

TEXT BOOKS

1. Swami Saran, (1999),"Soil Dynamics and Machine Foundations", Galgotia Publications Private Ltd, New Delhi, 2nd Edition.
2. N. S. V. Kameswara Rao, (1998),"Vibration Analysis and Foundation Dynamics", Wiley New Delhi, 1st Edition

REFERENCES

1. Das, B. M. and Ramana, G.V. (2010),"Principles of Soil Dynamics", CL Engineering, Punjab, 2nd Edition.
2. Narasinga Rao, B.N.D. (2015), "Soil Mechanics and Foundation Engineering", Wiley Publishers, New Delhi, 1st Edition.

REMOTE SENSING AND GIS APPLICATIONS IN GEOTECHNICAL ENGINEERING

23SM115 B **Credits: 3**

Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40

End Exam: 3 hours End Exam Marks: 60

Course Objective

The course content enables students to learn Remote sensing & GIS Applications in Geotechnical Engineering

Course Outcomes

At the end of the course the student will be able to;

1. Classify the rocks and defects in rocks.
2. Learn the different properties of rocks.
3. Learn the different tests on rocks.
4. Outline the Creep behaviour, strength and failure of rock.

SYLLABUS

Unit - I

Introduction - Definition- Principle of Remote Sensing- History of Development of Remote Sensing- Stages in Remote Sensing- Electromagnetic Radiation and the Electromagnetic Spectrum- Interactions With the Atmosphere- Atmospheric Scattering- Atmospheric Absorption- Atmospheric Windows- Refraction- Interaction of EMR with the Earth's Surface- Reflection- Transmission- Spectral Signature.

Unit-II

Platforms & Sensors- Remote Sensing Systems- Remote Sensing From Space- Remote Sensing Sensors- Resolution- Imaging Sensors- Optical Infrared (OIR) Imagers- Optical Sensors- Thermal Sensors- Microwave Sensors- Active Microwave Sensors- Data Preprocessing- Remote Sensing in India.

Unit-III

Introduction to Image Interpretation- Basic Principles of Image Interpretation- Elements of Image Interpretation- Techniques of Image Interpretation- Interpretation Keys- Introduction to Digital Image Processing- Digital Image- Image Rectification and Registration- Geometric Correction- Image Enhancement Techniques (Only Concepts)- Image Classification -Unsupervised Classification and Supervised Classification- Digital Photogrammetry - Stereo Images from Satellites - Data Merging .

Unit-IV

Geographic Information Systems (GIS)- Definitions and Related Technology- GIS Operations- GIS Elements- GIS Concepts and Practice- Map Projection and Coordinate System.Vector Data Model- Introduction- Vector Data Representation- Geometric Objects- Topology.

Unit-V

Vector Data Analysis- Introduction- Buffering- Applications of Buffering- Map Overlay- Feature

Type and Map Overlay- Map Overlay Methods- Slivers- Error Propagation in Map - Overlay- Distance Measurement- Map Manipulation-Raster Data Analysis- Introduction- Analysis Environment- Local Operations- Local Operations With a Single Grid- Local Operations With Multiple Grids- Neighborhood Operations- Zonal Operations.

Text Books

1. Fundamentals of Remote Sensing 2nd Ed by George Joseph- University Press- New Delhi.
2. Introduction to Geographic Information Systems by Kang Tsung Chang- Tata Mc.G.H. Publications- New Delhi.
3. Remote Sensing and Image Interpretation by Lillesand- T.M. and Kieffer- Joh Wiley and Sons- New York- 1987.

Reference Books

1. Remote Sensing of the Environment – An Earth Resource Prespective by John R. Jensen- Pearson Education- New Delhi.
2. Geographic Information Systems: A Management Perspective by Aronoff- S. Ottawa: Wdl Publications- 1989.

GEOTECHNICAL EXPLORATION & INSTRUMENTATION

23SM115 C **Credits: 3**

Instruction: 3 Lectures & 1 Tutorial / week Sessional Marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives

1. To recall the various soil investigation techniques.
2. To identify the appropriate technique for soil exploration.
3. To classify soil strata using direct and in direct methods.
4. To interpret the investigated data to design suitable foundation system.

Course Outcomes

At the end of the course students will be able

1. To understand the significance of understanding the soil properties at a site conduct a sequential soil exploration according to the site.
2. To extract samples as per requirement and perform field and laboratorytests.
3. To understand the practical significance of the results obtained from field and laboratory tests.
4. To clearly report the conclusions based on the conducted soil explorationand tests.

SYLLABUS

UNIT I:

Introduction: Soil Formation, types of soils, physical and biological weathering, soil transport, deposition and stratification phenomena and Soil Classification.
Soil Exploration: Soil Exploration Programme for different Civil Engineering Projects

UNIT II:
Exploration Methods: Methods of Boring, Augering and Drilling. Machinery used for drilling, types of augers and their usage for various projects.

UNIT III:
Soil Sampling: sampling methods, types of samples, storage of samples and their transport. Sample preparation, sample sizes, types of samplers specifications for testing.
Borehole Logging: Logging of Boreholes-logging methods- Ground water observations – water table fluctuations and effects - Preparation of soil profiles - calculations

UNIT IV:

Field testing of soils: methods and specifications – visual identification tests, vane shear test, penetration tests, analysis of test results.

UNIT V:
Report writing: Soil exploration Reports- identification, calculations and preparation.
Field Instrumentation: Rollers, Pressure meters, Piezometer, Pressure cells, Sensors, Inclinometers, Strain gauges etc.

References

1. Scott R F, “Principles of Soil Mechanics”, Addition Wesley Publishing Co.Inc., 1988.
2. Bowles, J.E, Physical and Geotechnical Properties of Soil, McGraw-Hill Book Company,1985.
3. Terzaghi , Peck .and Mesri “ Soil Mechanics in Engineering Practice “1996.
4. Gopal Ranjan and Rao, A.S.R, Basic and Applied Soil Mechanics, Wiley Eastern Limited,1991.
5. Richard Handy and Merlin Spangler. “Geotechnical Engineering: Soil and Foundation Principles and Practice (5^{th} Edition)”, McGraw-Hill, 2007.

SOIL ENGINEERING LAB

23SM116 **Credits: 1.5**

Instruction: 3 Practical / week Sessional marks: 50

End Exam: 3 hours End Exam Marks: 50

Course Objectives:

To enable a student to understand the various index and engineering properties of soil by experimentation

Course Outcomes:

By the end of the course, student will be able to:

1. Determine index and engineering properties of different soils and understand their behaviour.
2. Gain basic knowledge towards geophysical testing techniques.

SYLLABUS

Soil Laboratory

1. Determination of hygroscopic content, specific gravity and gradation characteristics of soils.
2. Determination of Atterberg Limits of soils.
3. Determination of compaction characteristics of soils.
4. Determination of permeability of soils by using constant head method.
5. Determination of permeability of soils by using variable head method.
6. Determination of consolidation characteristics of soils.
7. Determination of shear strength parameters of soils using direct shear test.
8. Determination of shear strength parameters of soils using unconfined compression strength test.
9. Determination of shear strength parameters of soils using triaxial compression test (UU).
10. Determination of Swell Pressure using Swell-Consolidation test/Constant volume method.

TECHNICAL SEMINAR

23SM117 **Credits: 1.5**

Instruction: 3 Tutorial / week Sessional marks: 50

End Exam: - End Exam Marks: -

Course Objectives:

The objective of this course is

1. To develop an overview of geotechnical engineering and its importance.
2. To promote teamwork and lifelong learning among the students.

Course Outcomes:

At the end of the course the students will be able to

2. Improve the communication skills and cultivate lifelong learning.
3. Broaden their knowledge about Geotechnical Engineering and its significance
4. Update their knowledge on the latest developments in geotechincal engineering.
5. Understand the environmental, safety, economical and sustainability aspects of any geotechnical engineering structure.

SYLLABUS

Each student has to select a topic and collect about 10 papers with at least 5 journal papers and prepare a report and give a seminar at the end the semester.

Research Methodology and IPR

23SM118	**Credits: 2**
Instruction: 2 Lectures / week	Sessional marks: 40
End Exam: 3 hours	End Exam Marks: 60

Course Outcomes: At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasise the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

SYLLABUS:

Unit-I: 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-II: 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-III: 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-IV: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit-V: 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.

REFERENCES:

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 Edition, "Research Methodology: A Step by Step Guide for beginners"*
4. *Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.*
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*

Universal Human Values and Professional Ethics

23SM119 **Credits: -**

Instruction: 3 Lectures / week Sessional Marks: 50
End Exam: - End Exam Marks:

Course Objectives:

1. To create an awareness on Engineering Ethics and Human Values.
2. To instill Moral and Social Values and Loyalty
3. To appreciate the rights of others.
4. To create awareness on assessment of safety and risk

Course outcomes: By the end of the semester, the student will be able to:

CO1	Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field
CO2	Identify the multiple ethical interests at stake in a real-world situation or practice
CO3	Articulate what makes a particular course of action ethically defensible
CO4	Assess their own ethical values and the social context of problems
CO5	Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
CO6	Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research

SYLLABUS

Unit I: HUMAN VALUES

Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others – Living Peacefully –Caring –Sharing –Honesty -Courage-Cooperation–Commitment – Empathy –Self Confidence -Character –Spirituality-Case Study.

LEARNING OUTCOMES:

1. learn about morals, values & work ethics.
2. learn to respect others and develop civic virtue.
3. develop commitment
4. learn how to live peacefully

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 –Case Study.

LEARNING OUTCOMES:

1. learn about the ethical responsibilities of the engineers.
2. create awareness about the customs and religions.
3. learn time management
4. learn about the different professional roles.

Unit III: ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as Social Experimentation –Similarities between standard and social Experimentations-Framing the problem –Determining the facts –Codes of Ethics – Clarifying Concepts –Application issues –Common Ground -General Principles –Utilitarian thinking respect for persons-Case study.

LEARNING OUTCOMES:

1. Demonstrate knowledge to become a social experimenter.
2. Provide depth knowledge on framing of the problem and determining the facts.
3. Provide depth knowledge on codes of ethics.

4. Develop utilitarian thinking

UNIT IV: ENGINEERS RESPONSIBILITY FOR SAFETY AND RISK

Safety and risk –Assessment of safety and risk –Risk benefit analysis and reducing risk-Safety and the Engineer-Designing for the safety-Intellectual Property rights(IPR).

LEARNING OUTCOMES:

1. create awareness about safety, risk & risk benefit analysis.
2. engineer's design practices for providing safety.
3. provide knowledge on Intellectual Property Rights.

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 and Research –Analyzing Ethical Problems in research- Case Study.

LEARNING OUTCOMES:

1. Develop knowledge about global issues.
2. Create awareness on computer and environmental ethics.
3. Analyze ethical problems in research.
4. Give a picture on weapons development.

Text Books:

1. *M.Govindarajan, S.Natarajananad, V.S.SenthilKumar "Engineering Ethics includes Human Values" -PHI Learning Pvt. Ltd-2009*
2. *Harris, Pritchard and Rabins "Engineering Ethics", CENGAGE Learning, India Edition, 2009.*
3. *Mike W. Martin and Roland Schinzinger "Ethics in Engineering" Tata McGraw-Hill–2003.*
4. *Prof.A.R.Aryasri, DharanikotaSuyodhana "Professional Ethics and Morals" Maruthi Publications.*
5. *A.Alavudeen, R.KalilRahman and M.Jayakumaran "Professional Ethics and Human Values" – Laxmi Publications.*
6. *Prof.D.R.Kiran "Professional Ethics and Human Values"*
7. *PSR Murthy "Indian Culture, Values and Professional Ethics" BS Publication*

I M.tech II Semester
ANALYSIS AND DESIGN OF SUBSTRUCTURES

23SM121 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective:
The course contents enable the students to learn the basic aspects of geotechnical engineering, analysis and structural design of foundations and retaining structures.

Course outcomes:
By the end of the course the students will be able to
1. Understand the basic concepts of foundation design.
2. Analyze the settlement of footings.
3. Understand the design and construction procedure of deep foundations
4. Design the foundations for transmission line towers.

SYLLABUS

UNIT – I

Foundation Design-general Principles: Types of Foundations, Basic requirement of a foundation, computation of loads, Design steps.

Shallow Foundations-I: Introduction, location and depth of foundation, Bearing Capacity of footings, Local and Punching shear failure, Skempton's Bearing capacity factor, footings on layered soils, Bearing capacity from penetration tests, Bearing capacity from Plate load test, factor of safety, soil pressure for structural design in normal and swelling soils.

UNIT – II

Shallow Foundations-II: Settlement of footings: Settlement from penetration tests, Stress path method for Settlement calculation, Settlement of footings on slope, Allowable Bearing Pressure, Allowable Bearing pressure of Raft foundation, Floating Raft, Uplift capacity of footings, Modulus of sub grade reaction. Beams on elastic foundation, design of circular and annular rafts.

UNIT – III

Deep Foundations: Introduction, Classification of piles, Bearing capacity of piles, Pile load test, Negative skin friction, Vertical pile subjected to lateral load, lateral load capacity of single pile, Batter piles under lateral loads, uplift capacity of piles, pile groups, Bearing capacity of a pile group, settlement of pile group, Negative skin friction in a pile group, uplift capacity of a pile group, Lateral pile load test, ultimate lateral load resistance of pile group,

Hrennikoff's method, proportioning and design of pile foundations, bored piles – secant piles, tangent piles, intermittent piles, V – piles, Static installation, Box Jacking, piled raft.

UNIT – IV

Bridge substructures: Introduction, Elements of bridge substructures, determination of maximum flood discharge, determination of maximum depth of scour, depth of foundation, allowable bearing pressure, lateral stability of well foundation. Well foundations, Types of well foundations, sinking stresses in wells, tilts and shifts, sinking of wells, Design aspects of components of well foundations, Lateral stability of Well foundation.

UNIT – V

Foundations of Transmission Line Towers: Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

TEXT BOOKS

1. Swami Saran (2006), "Analysis and Design of Substructures", Taylor& Francis, London, 2nd edition.
2. Teng, W.C. (1983), "Foundation Design", John Wiley, New York.

REFERENCES

1. Bowles, J.E. (2007), "Foundation Analysis and Design", McGraw-Hill, New York, 5th edition.
2. Vargheese, P.C. (2005), "Foundation Engineering", Prentice Hall of India, New Delhi.
3. Gopal Ranjan and Rao, A.S.R. (2007), "Basic and Applied Soil Mechanics", New Age International, New Delhi.
4. Poulos, H. G. and Davis, E. H. (1980), "Pile Foundation Analysis and Design", John wiley & sons, New York.
5. Tomlinson, M. J. (2001), "Foundation Design and Construction" , Prentice Hall, England, 7th edition.
6. Salgado, R. (2008), "The Engineering of Foundations", McGraw-Hill, Boston
7. Relevant I.S. Codes
8. Relevant NPTEL Courses

PAVEMENT ANALYSIS & DESIGN AND ROCK MECHANICS

23SM122 **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective

The course content enables students to learn the design of pavements and pavement management systems and Rock structure, properties, strengthand failures.

Course Outcomes

At the end of the course the student will be able to;

1. Categorize the types of pavements and design the flexible and rigid pavements and Design the heavy duty pavements.
2. Learn the Concept of pavement evaluation and type of pavement distress and Learn environment effects and pavement maintenance.
3. Classify the rocks and defects in rocks and Learn the different properties of rocks.
4. Learn the different tests on rocks and Outline the Creep behaviour, strength and failure of rock.

Syllabus

UNIT I
Introduction-Factors affecting structural design of pavement. Analysis of single, two and multi-layer flexible pavement. **Methods of flexible pavement design**- applications of CBR, Burmister, AASHTO and IRC methods.

UNIT II
Load and temperature stresses in rigid pavements- Westergaard's, Bradburry's and Picket's concepts. **Design of rigid pavements** by PCA, AASHTO and IRC methods; Design of joints in rigid pavements; Design of airport pavements and Design aspects of flexible and rigid overlays.

UNIT III
Introduction: Formation of rocks, Physical properties, Classification of rocks and rock masses, Static and Dynamic Elastics constants of rock.
Rock Testing: **Laboratory** (Sampling, Sample Preparation, Specimen, Uniaxial Compressive Strength test, Tensile strength test, Brazillian test, flexure strength Test, Flexural strength Test, Shear Strength Test, Test for Elastic Constants); **Field tests** (Deformability- Cable Jacking Test, Pressure Tunnel Test, Bore hole Test, Shear Tests- Single Jack Test, Dilatometer Test, Stress Relief Techniques, Insitu Stress, Hydro fracturing technique, Flat Jack Techniques, Indirect Methods.).

UNIT IV
Discontinuities in Rock Masses: Discontinuity orientation, Effect of discontinuities on strength of rock. Strength Behaviour: Compression, Tension, and Shear, Stress-Strain relationship, Rheological behavior.

UNIT V
Strength/Failure Criterion: Coulomb, Mohr, Griffith's theory of brittle strength and other strength criteria. Stresses in the rock near underground openings. **Application of rock mechanics in Civil Engineering:** Rock tunnelling, rock slope stability, bolting, blasting, grouting, and rock foundation design.

TEXT BOOKS

1. Narasinga Rao, B.N.D. (2015), "Soil Mechanics and Foundation Engineering", Chapter - 24, Foundations on Expansive Soils, pp. 1039-1080, Wiley Publishers, New Delhi, 1st Edition.
2. Verma, B. P. (2006), "Rock Mechanics for Engineers", Khanna Publishers, New Delhi, 3 rd Edition.
3. Ramamurthy, T. (2007), "Engineering in Rocks for Slopes, Foundations and Tunnels", PHI Learning Private Limited, New Delhi, 2nd Edition
4.

REFERENCES

1. Ola, S.A. "Tropical soils in engineering practice", Balkema publications.
2. Metcaff, J. B., Butterworth,(1972), "Soil stabilization principles and practice",
3. Relevant NPTEL Courses

Professional Elective - II
FINITE ELEMENT METHODS IN GEOTECHNICAL ENGINEERING

23SM123 A **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:

1. The basic concepts of Finite Element methods and its applications to complex engineering problems. The characteristics and selection of different finite elements used in finite element methods.
2. The equilibrium equations and stress-strain relations for different boundary conditions encountered in structural and heat transfer continuum problems.
3. The application of the FEM technique to dynamic problems and validate the solutions through simulation software for real time applications.

Course Outcomes:

- Ability to explain the concept of finite element methods
- Ability to identify element properties and Isoparametric elements
- Ability to determine internal stresses in simple beam by direct stiffness method

SYLLABUS

UNIT-1

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics- Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship in matrix form, plane stress & plane strain and axisymmetric bodies of revolution with axis-symmetric loading, Energy principles - Raleigh - Ritz method of functional approximation.

UNIT-II

Theory relating to the formulation of the finite element method, Coordinate system (local and global), generalized coordinates, Concept of the element, Various element shapes, Discretisation of a structure, Mesh refinement Vs. Higher order element, Interconnections at nodes of displacement models, inter element compatibility, -shape functions.

UNIT-III

Basic component – One dimensional FEM single bar element, Beam element : Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions, shape functions for 1 D elements, Initial strain and temperature effects, and trusses under axial forces.

UNIT-IV

Two-dimensional FEM**:** Different types of elements for plane stress and plane strain analysis – Displacement models Generation of element stiffness and nodal load matrices – staticcondensation.

UNIT-V

Isoparametric representation and its formulation for 2d analysis. Formulation of 4-noded and 8- noded isoparametric quadrilateral elements – Lagrangian elements-serendipity elements.

Text Books

1. Finite Element Analysis by C.S.Krishnamoorthy, (2002), Tata McGraw Hill Publishing Co. Ltd.
2. Introduction to Finite Element Method by Desai,C.S.and Abel, J.F.,Van Nostrand,1972.

Reference Books

1. Introduction to Finite element Method by Tirupathi chandra Patla and Belugundu
2. The Finite Element Method in Engineering Science" by Zienkiewicz, P., McGraw Hill,1971.

GEOTECHNICS OF PROBLEMATIC SOILS

23SM123 B **Credits: 3**

Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40

End Exam: 3 hours End Exam Marks: 60

Course Objectives:

To identify and classify various problematic soils and adopt foundation techniques for different problematic soils

Course Outcomes:

At the end of this course, the students will be able to:

1. Learn about the behaviour of expansive soil under various moisture conditions.
2. Identify expansive soils based upon various swell properties.
3. Understand about properties of soft clays and organic soils.

SYLLABUS

Unit – I

Introduction: Type of Damages and Heave, seasonal moisture variation, active zone, mechanism of swelling. Factors influencing heave, estimation of heave.

Unit – II

Identification and classification of expansive soil: swell potential, differential swell pressure. Free swell ratio, swelling pressure, Determination of swelling pressure, early methods-free swell ratio method, effective plasticity index.

Unit – III

Foundation techniques in expansive soils: foundation isolation, rigid foundations-underreamed pile foundation, Reinforced Slab-on-Grade Foundations.

Unit - IV

Control of soil moisture fluctuations, surface grading, subsurface drains, moisture barriers. Altering soil properties-controlled soil excavation and backfill, prewetting. Lime stabilization.

Unit – V

Soft clays: Geology of soft marine clays, mineralogy, physical properties, shear strength and compressibility, foundation types.

Organic and peaty soils, **Collapsible soils:** Geotechnical properties, foundation types.

Filled up Soils: Characterization, Methods for Strengthening Filled up material for supporting structures, Foundation practices in Filled up areas.

TEXT BOOKS

1. Narasinga Rao, B.N.D. (2015), "Soil Mechanics and Foundation Engineering", Chapter - 24, Foundations on Expansive Soils, pp. 1039-1080, Wiley Publishers, New Delhi, 1st Edition.

REFERENCES

1. Ola, S.A. “Tropical soils in engineering practice”, Balkema publications.
2. Metcaff, J. B., Butterworth,(1972), “Soil stabilization principles and practice”,
3. Relevant NPTEL Courses

RELIABILITY ANALYSIS

23SM123 C **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:

The course enables to enlighten the concepts of reliability based design in geotechnical engineering.

Course Outcomes:

At the end of the course the student will be able to

1. Basic understanding of the principles of reliability
2. Gain knowledge in Basic statistics like Data reduction techniques, Histograms, etc.
3. Design geotechnical structures on the principle of reliability based design with enhanced and optimal partial factors of safety.

SYLLABUS

UNIT – I

Concepts of Structural Safety: General, Design methods.
Basic Statistics: Introduction, Data reduction, Histograms, Sample correlation.

UNIT – II

Probability Theory: Introduction, Random events, Random variables, Functions of random variables, Moments and expectation, Common probability distribution, Extremal distribution.

UNIT – III

Resistance Distributions and Parameters: Introduction, Statistics of properties of concrete, Statistics of properties of steel, Statistics of strength of bricks and mortar, Dimensional variations, Characterization of variables, Allowable stresses based on specified reliability.
Probabilistic Analysis of Loads: Gravity loads, Wind load.

UNIT – IV

Basic Structural Reliability: Introduction, Computation of structural reliability. Monte Carlo Study of Structural Safety: General, Monte Carlo method, Applications.
Level 2 Reliability Methods: Introduction, Basic variables and failure surface, First-order second-moment methods (FOSM).

UNIT – V

Reliability Based Design: Introduction, Determination of partial safety factors, Safety checking formats, Development of reliability based design criteria, Optimal safety factors, Summary of results of study for Indian standard – RCC design. Reliability of Structural Systems: Preliminary concepts as applied to simple structures.

TEXTBOOKS

1. Ranganatham. R. (2006), "Structural Reliability Analysis and Design", Jaico Publishing House.
2. Melchers, R.E. (1999), "Structural Reliability", Wiley – Blackwell Publisher, 2nd Edition.

PROFESSIONAL ELECTIVE - III
SOIL STRUCTURE INTERACTION

23SM124 A **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:

At the end of the course students will be able

1. To analyse the behaviour of marine soil deposits under repetitive loading conditions.
2. To understand the suitable offshore investigation techniques in theproposed project.
3. To perform foundation analysis for gravity structures, jacket and jack-upkind of offshore structures.
4. To analyse suitable anchor system for mooring structures and foundationsystem for offshore pipeline

Course Outcomes:

At the end of the course students will be able

1. To make students understand soil foundation interaction and itsimportance.
2. To familiarize students with model analysis, Winkler model for soilstructure interaction analysis.
3. To expose students to beams and plates on elastic foundation.
4. To enable students to carry out elastic analysis of pile, soil-pile interactionanalysis, dynamic soil-pile interaction.
5. To make students understand the concepts of laterally loaded pile.

Mapping of course outcomes with program outcomes:

		PO												PSO		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO	**1**	1	2	1	2	1	2	3	1	1	1	-	1	2	1	2
	2	1	2	1	2	1	2	3	1	-	1	-	1	1	2	1
	3	2	2	2	2	1	2	3	1	-	1	1	1	2	2	2

UNIT I SOIL-FOUNDATION INTERACTION

Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, two parameter elastic models, Elastic plastic behaviour and Time dependent behaviour.

UNIT II BEAM ON ELASTIC FOUNDATION - SOIL MODELS

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.

UNIT III PLATE ON ELASTIC MEDIUM

Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.

UNIT IV ELASTIC ANALYSIS OF PILE

Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid

cap.

UNIT V LATERALLY LOADED PILE

Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts - An introduction to soil-foundation interaction under dynamic loads.

Text Books

1. Kameswara Rao N.S.V., Foundation Design – Theory and Practice, JohnWiley & Sons (Asia), 2011.
2. Poulos H.G, Tall Building Foundation Design (1st Edition), CRC Press, London, 2017.
3. J. E. Bowles, "Foundation Analysis and Design", McGraw Hill, 1996.
4. J. W. Bull, Soil-Structure Interaction: Numerical Analysis and Modelling, CRC Press, 1st Edition, 1994.
5. Chandrakant S. Desai, Musharraf Zaman, Advanced Geotechnical Engineering: Soil-Structure Interaction using Computer and Material Models, CRC Press, 2013.

References:

1. Hemsley, J.A, Elastic Analysis of Raft Foundations, Thomas Telford, 1998.
2. McCarthy, D.F. Essentials of Soil Mechanics and Foundations, basic geotechnics (6thEdition), Prentice Hall, 2002.
3. Selvadurai, A.P.S., Elastic Analysis of Soil Foundation Interaction, Elsevier, 1979.
4. Poulos, H.G., and Davis, E.H., Pile Foundation Analysis and Design, John Wiley, 1980.
5. Scott, R.F. Foundation Analysis, Prentice Hall, 1981.
6. Structure Soil Interaction - State of Art Report, Institution of structural Engineers, 1978.

COMPUTATIONAL METHODS IN GEOTECHNICAL ENGINEERING

23SM124 B **Credits: 3**

Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40

End Exam: 3 hours End Exam Marks: 60

Course Objective:

1. Understand the theory, assumptions, and approximations of finite element method as it is used in geotechnical engineering and geomechanics
2. Understand critical aspects of commonly encountered problems in geotechnical engineering
3. Apply a commercial finite element code for geotechnical analysis
4. Critically analyze numerical results, being mindful of the possibilities and limitations of the finite element method for solving problems in geotechnical engineering and geomechanics

Course Outcomes:

At the end of the course the student will be able to:

1. Solve linear and non-linear equations using numerical techniques.
2. Apply finite difference and finite element method for analysing behaviour of geotechnical structures.
3. Apply correlation and regression analysis for the geotechnical data.
4. Solve problem of consolidation and flow through porous media using numerical technique.

SYLLABUS

Unit – I

Solution of Non-linear Equations: Bisection, False Position, Newton-Raphson, Successive approximation method, Iterative methods. Solution of Linear Equations: Jacobi's method, Gauss Seidel method, Successive over relaxation method.

Unit - II

Finite Difference Method: Two-point Boundary value problems – Disichlet conditions, Neumann conditions; ordinary and partial differential equations.

Unit - III

Finite Element Method: Fundamentals, Constitutive finite element models for soils. Correlation and Regression Analysis: Correlation - Scatter diagram, Karl Pearson coefficient of correlation, Limits of correlation coefficient; Regression –Lines of regression, Regression curves, Regression coefficient, Differences between correlation and regression analysis

Unit - IV

One-dimensional Consolidation - Theory of consolidation, Analytical procedures, Finite difference solution procedure for multilayered systems, Finite element formulation Flow Through Porous Media - Geotechnical aspects, Numerical methods, Applications and Design analysis, Flow in jointed media.

Unit - V

Risk assessment in Geotechnical Engg. - Probabilistic site characterisation and design of foundations .

Text Books:

1. S. Chandrakant., Desai and John T. Christian, "Numerical Methods in Geotechnical Engineering", Mc. Graw Hill Book Company, 1977.

2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering

computations", Third edition, New Age International (P) Ltd. Publishers, New Delhi.

References

1. D.J. Naylor and G.N. Pande, "Finite Elements in Geotechnical Engineering", Pineridge Press Ltd., UK.
2. Sam Helwany, "Applied soil mechanics", John Wiley & sons, Inc, USA

GEOENVIRONMENTAL ENGINEERING

23SM124 C **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective:
From this course students will learn the following

To characterize waste based upon its source and safe transport and disposal of waste without any contamination.

Course outcomes:

By the end of the course the students will be able to
1. Learn about various sources and characteristics of site.
2. Understand about classification of waste and environmental concerns of waste.
3. Know about the safe transport and disposal methods of hazardous waste.

SYLLABUS

UNIT-1

Basic concepts related to soil pollution - Sources of pollution- industrial, mining, agricultural, and municipal; types of contaminants - Impact of contamination - physical and chemical properties of soil - Retention behaviour - governing factors, sorption characteristics - isotherms.

UNIT-II
Contaminant transport- saturated and unsaturated flow, pore size distribution characteristics - Site investigation - Soil sampling - sample handling, transportation, characterization, preservation and storage.

UNIT-III
Non-destructive techniques - electromagnetic, thermal and seismic, Soil remediation - need and approach, Techniques - soil washing, permeable reactive barriers, solidification, vacuum extraction, electro-kinetic remediation,thermal desorption.

UNIT-IV
Bioremediation – phytoremediation - soil fracturing - Case studies on polluted sites and issues related to environment. Containment systems and basic principles – carbon dioxide sequestration, Grout curtains, Ground freezing, Compacted soil liners, Geosynthetic clay liners.

UNIT -V

Soil erosion and conservation: Causes of soil erosions, Factors contributing to erosion – climatic factors, Topographical factors, Vegetation factors. Erosion control – Cropping systems, Gullies, Check dams, Contouring, Wind striping, Ridging, Bank protection, Erosion control withvegetation mats and Silt fence

TEXT BOOKS

1. Sharma, H. D. and Reddy, K. R. (2004), "Geoenvironmental Engineering", John Wiley & Sons

2. Geoenvironmental Engineering – principles and applications by L.N. Reddiand H.F. Inyang, Marcel Dekker, 2000

REFERENCES

2. Rowe, R. K. (2001), "Geotechnical & Geoenvironmental Engineering Handbook", Kluwer Academic
3. Reddi, L. N. and Inyang, H. I. (2000), "Geoenvironmental Engineering Principles and Applications", Marcel. Dekker, Inc., New York .
4. LaGrega, M. D., Buckingham, P. L. and Evans, J. C. (2001), "Hazardous Waste Management", McGraw-Hill, New York.
5. Daniel, D. E. (1993), "Geotechnical practice for waste disposal", Chapman and Hall,London.
6. Oweis, I.S. and Khera, R.P. (1998), "Geotechnology of Waste Management", PWS Publishing Co., New York, 2nd Edition.
7. Bagchi, A. (2004), "Design of Landfills and Integrated Solid Waste Management", John Wiley & Sons, New Jersey, 3rd Edition.
8. Relevant NPTEL

PROFESSIONAL ELECTIVE - IV
EARTH AND EARTH RETAINING STRUCTURES

23SM125 A **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objective:

The course contents enable the students to understand the earth pressure concepts and design principles of retaining structures.

Course outcomes:

By the end of the course the students will be able to

1. Understand the basic concepts of earth pressure theories.
2. Learn the design procedure of sheet pile walls
3. Know the types of bracing systems and cellular cofferdams.
4. Understand the construction techniques and design criteria of earth and rock fill dams.

SYLLABUS

UNIT – I

Earth Pressure: Basic concepts, Rankine and Coulomb earth pressure theories, Determination of active and passive pressures: Culmann's Graphical method, logarithmic spiral methods, friction circle method. Consideration of surcharge, seepage, earth quack, wave effect, stratification, type of backfill, wall friction and adhesion.

UNIT – II

Rigid Retaining Walls: Uses, types, stability and design principles of retaining walls, backfill drainage, settlement and tilting.

Sheet Pile Walls: Types, Design of cantilever sheet pile walls in granular and Cohesive soils; Design of anchored sheet pile walls by free and fixed earth support methods, Rowe's theory of moment Reduction, Design of anchors, Diaphragm Walls – construction, trench cutter.

UNIT – III

Braced excavations: Types of sheeting and Bracing systems, lateral earth pressure on sheeting in sand and clay, Design components of braced cuts. Cellular cofferdams: Types – Diaphragm and Circular type, Design by TVA method. Stability of cellular cofferdams, cellular cofferdams in rocks and soils.

UNIT – IV

Earth and Rock fill dams: Earth dams : Selection of Site, types of earthen dams, design criteria, stability analysis: upstream and down stream for steady seepage, rapid draw down, end of construction; Seepage, Uplift Control, filters and drains.

UNIT – V

Construction and Causes of Failure of earth dams: Construction - Hydraulic, Seepage and Structural Failure; Instrumentation and performance observations in earth dams. Rock Fill Dams: Types, Design parameters, Advantages over other types of dams

TEXT BOOKS

1. Arora, K.R. (2014), "Soil Mechanics and Foundation Engineering", Standard Publishers, New Delhi, 7th edition.
2. Bharat Singh and Sharma, H. D. (1976), "Earth and Rockfill Dams", Sarita Prakashan, India.

REFERENCES

1. Rowe, R.K. (2001), "Geotechnical and Geoenvironmental Engineering Handbook", Springer, New York.
2. Narasinga Rao, B.N.D. (2015), "Soil Mechanics and Foundation Engineering", Wiley Publishers, New Delhi, 1st Edition.
3. Taylor, D.W. (1967), "Fundamentals of Soil Mechanics", John Wiley, New York.
4. Das, B. M. (2016), "Principles of Foundation Engineering", Cengage learning, Boston, 8th edition.
5. Purushothama Raj, P. (1995), "Geotechnical Engineering", Tata McGraw Hill, New Delhi.
6. Hsai-Yang Fang (2004), "Foundation Engineering Handbook", CBS publishers & distributors, New Delhi, 2nd edition.
7. Clayton, C.R.I., Rick, I.W. and Andrew, J.B. (2014), "Earth pressure and earth-retaining structures", CRC press, Florida, 3rd edition.
8. Relevant NPTEL Courses

OFFSHORE GEOTECHNICAL ENGINEERING

23SM125 B **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:
1. To analyse index and engineering properties of marine clays.
2. To adopt suitable investigation method and sampling techniques for thesemarine deposits
3. To analyse loads on offshore structures and select appropriate foundationfor these structures.
4. To implement required ground improvement technique for these structures

Course Outcomes:
At the end of the course students will be able
1. To analyse index and engineering properties of marine clays.
2. To adopt suitable investigation method and sampling techniques for themarine deposits.
3. To analyse loads on offshore structures and select appropriate foundationsfor those.
4. To implement required ground improvement techniques for offshorestructures.

SYLLABUS

Unit – I
Identify and describe key challenges of offshore engineering design - describethe aspects of the marine environment that feed into offshore engineering design.
Describe the main components of an offshore site investigation; Interpret selected geotechnical site investigation data - Identify the main types of offshore foundation systems and describe the drivers during foundation design, perform selected foundation design calculations to illustrate the interplaying mechanisms.

Unit - II
Identify key aspects of geotechnical pipeline design and perform selected design calculations to illustrate the interplaying mechanisms - determine the loads acting on the offshore structures. Offshore soil investigation: General characteristics of offshore soil exploration – sampling using free corer, gravity corer, tethered systems and manned submersibles – deep penetration sampling using wire line techniques – sampling disturbances – mechanical and environmental - In-situ determination of strength of submarine soils – penetrometer, piezocone, vane and pressure meter techniques – penetration tests from tethered submersible platforms, manned submersibles and using wire line techniques.

Unit – III
Classification of marine soils – relative distribution of marine soils in the different marine regions – general characteristics of marine deposits in some specific locations and in the Indian sub-continent. Foundations for gravity structures: Types of gravity structures – Installation techniques – movement of gravity structures – settlement of soil beneath gravity structures – stress distribution beneath gravity structures – stability of gravity structures under static and cyclic loads. Foundation for jacket type structures: Types – installation techniques.

Unit - IV

Design considerations – axial and lateral load capacity of piles – lateral load deformation behaviour of piles – calculation of bearing capacity of piles- design of piles subjected to lateral loads – Reese-Matlock method and p-y curves method.

Unit - V

Foundations for jack up platforms: Types of jack up platforms – piles and mat supported – spud cans – different types – installation techniques – techniques for removal of jack ups – stability of jack up platforms –determination of penetration of supports – stability under lateral loads – stability under static and cyclic load effects. Sea bed anchors, submarine pipe lines: General introduction to sea bed anchors, moorings, submarine pipe line etc., - general design considerations (brief outline only) – geotechnical aspects in the design and installation of sea bed anchors, moorings, submarine pipelines etc.

Text Books

1. Randolph M and Gourvene S, Offshore Geotechnical Engineering, CRCPress,2017.
2. Ben C. Gerwick, "Construction of Marine and Offshore Structures", CRCPress, 1999.
3. B. Gou, S. Song, J. Chacko and A. Ghalambor, "Offshore Pipelines", GPPPublishers, 2006.
4. S. K. Hakrabarti, "Handook of Offshore Engineering", Elsevier, 2005.
5. M. J. Tomlinson, "Pile Design and Construction", E and F Spon, 1994

References

1. Arous, D.A. (Ed.), Offshore Site Investigation, Graham Trotman
2. Chaney, R.C and Demars, K.R , Strength Testing of Marine Sediments –Laboratory and In-situ Measurements, ASTM, STP-883
3. George P. and Wood D., Offshore Soil Mechanics, Cambridge UniversityPress.
4. Le Tirant, Sea Bed Reconnaissance and offshore Soil Mechanics for theInstallation of Petroleum Structures, Gulf Publ. Company
5. Poulos, H.G and Davis, E.H, Pile Foundation Analysis Design, JohnWiley, New York

FORENSIC GEOTECHNICAL ENGINEERING

23SM125 C **Credits: 3**
Instruction: 3 Lectures & 1 Tutorial / week Sessional marks: 40
End Exam: 3 hours End Exam Marks: 60

Course Objectives:

1. To understand the roles and responsibilities of a forensic geotechnicalengineer.
2. To understand the types of damages and investigation methods that can beadopted.
3. To understand and apply reverse-engineering of design and analysis toidentify the cause of failure.
4. To inculcate the ability to write reports of the faults as deduced and suggestrepair and rehabilitation measures.

Course Outcomes:

At the end of the course students will be able

1. To understand the roles of a Forensic Engineer.
2. To classify the types of damage and plan the investigation accordinglybased on the knowledge obtained from case studies and relatable issues.
3. To apply design and analysis principles to investigate the cause of failure.
4. To suggest mitigation or rehabilitation measures according to the siteconditions.

SYLLABUS

UNIT-1

Concept of Forensic Investigation, Necessity, Objectives of Forensic Geotechnical Investigation, Methods of Forensic Investigation. Project reconnaissance and characterization of the distress, including document search such as plans, codes, and other technical specifications followed in the original design.

UNIT-II

Types of Damage - Planning the Investigation - Investigation methodology, Collection of Data - Distress Characterization - Development of Failure, Hypothesis - Diagnostic Tests - Back Analysis - Technical Shortcomings, LegalIssues - Reliability Aspects.

UNIT-III

Observation Method of Performance Evaluation - Case Histories related to settlement of Structures - lateral movement - backfill settlements - causes due to soil types such as collapsible soil, expansive soil, soluble soils, slope failures and landslides, debris flow, slope softening and creep, trench collapses, dam failures.

UNIT-IV

Foundation due to earthquakes, erosion, deterioration, tree roots, groundwater and moisture problems, groundwater problems, retaining failures problems, pavement failures and issues, failures in soil reinforcement and geosynthetics.

UNIT-V

Development of codal provisions and performance-based analysis procedures

Text Book

1. Forensic Geotechnical and Foundation Engineering by Robert W. Day, Mc Graw Hill

Reference Book

1. Malcolm D. Bolton, “A Guide to Soil Mechanics “Universities Press.
2. Saxena, D.S., "Technical, Ethical, and Legal Issues with Forensic Geotechnical Engineering - A Case History", Proceedings, 13th Asian Regional Conference on SoilMechanics and Geotechnical Engineering, Kolkata, India, 11 December 2007.
3. Bolton M, A Guide to Soil Mechanics, Universities Press,1991.
4. Robert W. Day (2011) Forensic Geotechnical and Foundation Engineering, Second Edition, McGraw-Hill Companies, Inc.
5. Rao, V.V.S. and Sivakumar Babu, G.L (2016) Forensic Geotechnical Engineering, Springer Nature.

COMPUTATIONAL GEOTECHNICAL ENGINEERING LAB

23SM126 **Credits: 1.5**

Instruction: 3 Lectures / week Sessional Marks: 50
End Exam: 3 hours End Exam Marks: 50

Course Objectives

1. To understand the concept of software based numerical modelling.
2. To learn and carry out basic numerical modelling on PLAXIS 2D, 3D,FLAC3D v7.0 and OASYS Geotechnical software.

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

- Process and present the data appropriately using MS EXCEL and ACCESS or open source software's.
- Write programs using MATLAB and apply them for engineering applications.
- Use software SPSS/equivalent open source software for statistical purposes.
- Prepare drawings and detailing for geotechnical structures using AUTOCAD.

Course Content

Engineering aspect of finite element method - Basic tools of the designsoftware – Different soil models – modelling of substructure and loading conditions – analysis of the response of the foundation under different loadingconditions

Data processing and graphical presentation using MS EXCEL and ACCESS Mathematical and statistical packages (MATLAB and SPSS)

Basics of AUTOCAD and CAD

Finite Element Analysis: shallow and deep foundations, slope stability analysis

Retaining walls, reinforced earth structures, tunnelling using geotechnical software packages

Reading:

1. R. V. Hogg, A. Craig, and J. W., McKean, "Introduction to Mathematical statistics", 6th edition, Pearson Education, 2004.
2. S. P. Washington, M. G. Karlaftis, F. L. Mannering, "Statistical and Econometric Methods for Transportation Data Analysis", 2nd Edition, CRC Press, 2010.

GEOSYNTHETICS AND ROCK MECHANICS LAB

23SM127 **Credits: 1.5**

Instruction: 3 Practical / week Sessional marks: 50

End Exam: 3 hours End Exam Marks: 50

Course Objectives:

To enable a student to understand the various physical properties of Geosynthetics by experimentation.

Course outcomes:

By the end of the course, student will be able to:

1. Determine physical properties of different types of Geosynthetics.
2. Gain basic knowledge towards rock specimen preparation and testing.

SYLLABUS

Geosynthetics Laboratory

1. Determination of physical properties of Geotextiles, Geogrids and Geomembranes
2. Determination of A.O.S of geotextiles
3. Determination of Grab and wide width tensile strengths of geotextiles
4. Determination of Interfacial frictional characteristics of Geotexiles with Fillmaterial using modified direct shear test.
5. Determination of CBR Puncture Resistance of geotextiles
6. Determination of in plane and cross plane permeability of geotextiles

Demonstration

7. Evaluation of long term flow ability of geotextiles by Gradient ratio test
8. Cone Drop Test on geotextiles

Rock Mechanics Laboratory

1. Water absorption test for rock specimens
2. Point Load Test
3. Unconfined Compression Test on Rock specimens
4. Split Tensile Strength of Rock using Brazilian

ENGLISH FOR RESEARCH PAPER WRITING

23SM128 **Credits: -**

Instruction: 3 Lectures / week Sessional Marks: 50
End Exam: End Exam Marks:

Course Objectives:

Students will be able to:

1. Understand how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
4. Ensure the good quality of paper at very first-time submission

COURSE OUTCOMES:

By the end of the course, the student will be able to:

1. Develop writing skills and level of readability.
2. Critically analyse the content and draft an outline of the abstract.
3. Review the literature, discuss and learn methodology, write effective results, and conclusions.
4. Demonstrate good writing skills and draft good quality paper using appropriate vocabulary

and grammatically correct sentences.

SYLLABUS

UNIT I: PLANNING AND PREPARATION

Reading: Reading the content, understanding the key words and theme.

Grammar: Arranging the word order in sentences, breaking up long sentences, structuring paragraphs and sentences, concision of content, removing redundancy, avoiding ambiguity and vagueness.

Learning Outcomes

At the end of the module, the learners will be able to

- Learn how to understand the text content
- Structure the sentences
- Concise the sentences and write well structured paragraphs on specific topics

UNIT-II: ABSTRACT PREPARATION

Analysing the content- getting clarity on who did what, highlighting the findings, hedging and criticising the material. Drafting- Writing abstracts and introductions of paper, learning Paraphrasing and checking Plagiarism.

Learning Outcomes

- At the end of the module, the learners will be able to
- Learn how to Analyse and high light the findings.

- Write abstracts and introductions of paper

- Paraphrase the paper content
- Check Plagiarism

UNIT-III: DISCUSSION AND CONCLUSIONS

Review of the Literature- Using methods to find results. Participating in discussions and bring out effective, conclusions. Learn the tips to draft the appropriate title of a paper. Define the purpose and scope and its contribution to the field of research.

Learning Outcomes

At the end of the module, the learners will be able to

- Review the literature
- Discuss the work to bring out effective conclusions.
- Draft a title of a paper
- Identify the scope and its contribution to the field of research

UNIT-IV: WRITING SKILLS AND QUALITY

Vocabulary- Use of appropriate vocabulary; nouns, synonyms and phrases to write methods, results, discussion and Conclusions. Grammar- Using grammatically correct sentences, using correct form of verbs- subject verb agreement, noun pronoun agreement and punctuations. Proof reading the research paper and submitting the quality work on time.

Learning Outcomes

At the end of the module, the learners will be able to

- Use appropriate vocabulary to write methods, results, discussion and Conclusions.
- Use grammatically correct sentences
- Proof read the research paper
- Submit the quality research paper on time

Reference Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011