Curriculum and Syllabi

M.Tech Degree Programme

ENVIRONMENTAL GEOTECHNOLOGY

(with effect from Academic Year 2010-2011)

DEPARTMENT OF CIVIL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY
CALICUT
M.Tech.(Environmental Geotechnology)

Programme Educational Objectives

1. To produce students with excellent academic qualities and related skills who will contribute to the ever increasing academic and research requirements of the country.
2. To impart to the students, in-depth knowledge of the modern skills and tools related to Environmental Geotechnical engineering so as to enable them to address the environmental aspects and sustainable issues related to infrastructure development of the country.
3. Provide a strong foundation in basic and advanced knowledge in geotechnical engineering and environmental engineering enabling the students to excel in the various careers in the related areas.
4. Provide expert training in laboratory and experimental work.
5. Train the students to attain various programming and software skills.
6. Enable the students to develop strong communication and technical writing skills.
7. Train the students to develop teaching skills through regular teaching assistance.
8. Prepare the students to be industry ready by encouraging interaction with industry, carrying out industry based projects, involving them in consultancy projects etc.

Programme Outcomes

1. Post-Graduates will develop confidence for taking up research and teaching as a profession.
2. Post-Graduates will attain an ability to identify, formulate and solve complex Environmental Geotechnical / Geotechnical engineering problems
3. Post-Graduates will be able to conduct investigations of complex problems in their domain using research based knowledge and tests/experiments
4. Post-Graduates will exhibit skills to use modern engineering tools, software and equipment to analyse various problems in their area of specialisation.
5. Post-Graduates will develop a strong research mind so as to carry out relevant and needy research in Environmental Geotechnical / Geotechnical engineering fields leading to significant contributions in the domain.
6. Post-Graduates will understand the impact of engineering solutions on the society.

7. Post-Graduates will be aware of the environmental aspects and sustainable issues related to infrastructure development of the country.
8. Post-Graduates will be able to communicate effectively in both verbal and written forms.
9. Post-Graduates will develop confidence to face newer challenges in Industry.
10. Post-Graduates will develop confidence for self-education and ability for life-long learning.
11. Post-Graduates will have an understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects.
12. Post- Graduates will be aware of their professional and ethical responsibilities.

Department of Civil Engineering

Curriculum for M.Tech in Environmental Geotechnology (CED)

Semester 1

S.No.	Code	Title	L	T	P/S	C
1	CE6401	Ground Improvement		3	0	3
2	CE6402	Fundamentals of Soil Behaviour		3	0	3
3	CE6101	Theory of Elasticity		3	0	3
4	CE6491	Environmental Geotechnical Laboratory		0	2	1
5	CE6492	Computational Geomechanics Laboratory		0	2	1
6		Elective		3	0	3
7		Elective		3	0	3
8		Elective		3	0	3
		Total credits				20

Semester 2

S.No.	Code	Title	L	T	P/S	C
1	CE6411	Waste Disposal Methods and Management		3	0	3
2	CE6412	Reinforced Earth and Geotextiles		3	0	3
3	CE6414	Groundwater Hydrology				
4	CE6493	Foundation Engineering Design studio		0	2	1
5	CE6497	Seminar		0	2	1
6		Elective		0	2	1
7		Elective		3	0	3
		Elective		3	0	3
		Total credits				15

Semester 3

S.No.	Code	Title	L	T	P/S	C
1	CE7498	Project				8
2		Elective		3	0	3
3		Elective		3	0	3
		Total credits				14

Semester 4

S.No.	Code	Title	L	T	P/S	C
1	CE7499	Project word and Viva voce				12
2		Total credits				12

Minimum requirements:

1. A minimum of 60 credits have to be earned for the award of M.Tech degree in this programme.
2. Students to register for six electives in three semesters together with two or three electives each in the first two semesters and a maximum of two in the third semester. Fourth semester is reserved for project work only.
3. Industrial Training (1 credits) during summer term is optional

LIST OF ELECTIVES

S.No.	Code	Title	Credits
1	CE 6421	Advanced Design of Foundations	3
2	CE 6422	Design of Engineered Landfills	3
3	CE 6423	Foundation Engineering for Difficult and Contaminated Grounds	3
4	CE 6424	Wastewater Engineering	3
5	CE 6425	Analysis and Design of Earth Retaining Structures	3
6	CE 6426	Landslide Mitigation Methods	3
7	CE 6427	Groundwater Contamination	3
8	CE 6428	Earthquake Geotechnical Engineering	3
9	CE 6429	Bioremediation Technologies	3
10	CE 6411	Finite Element Method	3
11	CE 6203	Pavement Materials, Design, and Construction	3
12	CE 6213	Pavement Evaluation and Management	3
13	CE 6225	Geographic Information System and its Applications	3
14	CE 6312	Marine Foundations	3

COURSE ASSESSMENT METHODS

Assessment is carried out as per the Rules & Regulations formulated by the Institute, the relevant portions of which are given below.

Lecture based courses

Continuous Assessment is based on:

- A minimum of two mandatory tests (of minimum one hour each).
- Assignments/tutorials/presentations/course projects/reports etc as decided by the course faculty.
- Weightage: Normally between 40-60%, as decided by the course faculty.

End Semester Assessment is based on:

- One end semester examination of minimum three hours duration.
- Weightage: Normally between 40-60%, as decided by the course faculty.

Laboratory/practical /drawing courses

- Assessment shall be based on tests and the performance of students in the regular laboratory/practical/ drawing classes and will be decided by the course faculty.
- End semester examination is not mandatory.
- If end semester examination is planned, it shall be conducted before the last instructional day and the weightage for it should not exceed 40%.

Continuous Assessment : 50 Marks
(Test 1: 15/20; Test 2: 25/20; Assignments/Tutorials etc: 10)
End Semester Examination : 50 Marks

BRIEF SYLLABUS

CE 6401: Ground Improvement

L	T	P	C
0	3	0	3

Prerequisite: - Nil

Vibration techniques, dynamic compaction, Classification of stabilizing agents, stabilizing agents, stabilization process, drainage and compaction, lime-sand columns, stone columns, Grouting techniques, , jet grouting, Soil fracturing techniques for terminating settlements and restoring, in situ soil mixing techniques, construction techniques, testing procedures

Total Hours : < 42 Hrs.>

CE 6402: Fundamentals of Soil Behaviour

L	T	P	C
3	0	0	3

Prerequisite: - Nil

Nature and distribution of soil, description of individual particle, clay mineralogy,Effective stress principle, steady state flow in soil, effect of flow on effective stress, determination .consolidation ,one, two, three and radial direction, variation of effective stress during consolidation,Stress path, tri-axial and direct shear tests, shear behaviour of granular soils, factors affecting shear behaviour,factors affecting shear strength, , thixotropy ,creep, determination of in situ undrained strength, Introduction models and soil mechanics, use of models in engineering, elasticity, soil elasticity, elastic-plastic model for soil, elastic volumetric strains, a particular elastic-plastic model

Total Hours : < 42 Hrs.>

CE6411: Waste Disposal Methods and Management

L	T	P	C
3	0	0	3

Prerequisite: - Nil

Disposal on Land - Disposal by Irrigation - Sewage Farming - Disposal by Infiltration - preparation of land for Infiltration . Pretreatment of Industrial waste before disposal on land - Disposal on Surface Waters-Disposal on streams-stream sanitation-Hydrological and climatological factors of stream sanitation--Microbial self purification.Disposal of Sewage Sludge.Composting-Fundamentals of microbial degradation -Operational sequences and technical equipment in facilities.Sanitary Land Fill . Long-term behaviour of landfills -Recultivation and aftercare of landfill sites. Other methods for solid waste disposalDisposal of Hazardous and Special Wastes.Waste Recycling-wastewater recycling-resource recovery from waste

Total Hours : < 42 Hrs.>

CE 6412: Reinforced Earth and Geotextiles

L	T	P	C
3	0	0	3

Pre-requisite: -Nil

Geosynthetics and Reinforced soil structures, Testing of Geosynthetics. Types and functions, Materials and manufacturing process, Testing and valuations, Principles of soil reinforcement, codal provision,Bearing capacity improvement. Geosynthetics in pavements, Embankments on soft soils, Geosynthetics in roads and railways, separators, drainage and filtering in road pavements, railway tracks, overlay design and constructions, trench drains.

Total Hours : < 42 Hrs.>

CE 6414: Groundwater Hydrology

L	T	P	C
3	0	0	3

Pre-requisite: -Nil

Occurrence of ground water: origin -rock properties affecting ground water vertical distribution - aquifers -permeable regions - ground water balance -ground water flow -Darcy's law - laplace equation -potential flow lines - Ground water and well hydraulics. steady unidirectional flow -steady radial flow in to a well -well in uniform flow - steady flow with uniform discharge - characteristics well losses –pumping tests -non equilibrium equation for pumping tests -Thies' method -Jacob method -Chow's method -Tube wells: design -screened wells -gravel packed wells - - deep wells - gravity wells - drilling in rocks - screen installation -well completion well development -testing wells for yield -collector -or radial wells –infiltration galleries well point system -failure of tube wells

Quality of ground water: ground water samples – measurement of water quality- - quality for agricultural use pumps - shallow well pumps - ground water investigation - -sewage recharge -recharge through pits, shafts and wells

Total Hours : < 42 Hrs.>

CE 6421: ADVANCED DESIGN OF FOUNDATIONS

L	T	P	C
3	0	0	3

Pre-requisite :- Nil

Soil -Structure interaction problems -Contact pressure distribution – contact pressure distribution beneath rafts - Modulus of up grade reaction – Determination of modulus of sub grade reaction .Introduction to pile foundations– Estimation of pile capacity by static and dynamic formulae – Wave equation method of analysis of pile resistance – Load -Transfer method of estimating pile capacity – Settlement of single pile .Laterally loaded piles Pile Groups–Settlement of pile groups Pile caps –Pile load tests . Introduction -nature of dynamic loads -stress conditions on soil elements under earthquake loading -dynamic loads .imposed by simple crank mechanism - Design of Machine Foundations. Vertical, sliding, rocking and yawing vibrations of a block foundation -simultaneous rocking, sliding and vertical.vibrations of a block foundation -foundation of reciprocating machines -design criteria - calculation of induced.forces and moments -multi-cylinder engines -numerical example (IS code method).
Foundations subjected to impact loads - design of hammer foundations (IS code method) - vibration isolation

Total Hours : < 42 Hrs.>

CE 6422: Design of Engineered Landfills

L	T	P	C
3	0	0	3

Pre-requisite :- Nil

Environmental-geotechnical application., soil structure , structural soil interaction , soil foundation structure interactions, load factor of safety, bearing capacity of granular soil, friction forces and angle between two materials.Liners, different types, properties of liners, clay liners, geo-synthetic liners, composite liners, design aspects.Reclaiming sites potential tests, Land fill gases , principal gases and their properties, Gas monitoring ,Data assessment and remedial Solutions .Establishment of new landscapes, Introduction, plant requirements, soil cover, soil fertility

Total Hours : < 42 Hrs.>

CE 6423: Fountation Engineering for Difficult and Contaminated Grounds

L	T	P	C
3	0	0	3

Prerequisite: -Nil

Site investigations, geophysical methods, electrical resistivity and seismic refraction methods, methods of investigations direct methods, semi direct, Methods and indirect methods, drilling methods, in situ permeability tests, SPT,DCPT,SCPT, in-situ vane shear test, pressure meter test, plate load test, Codal provisions. Shallow foundation, , safety, allowable settlements, bearing capacity theories, layered soils, choice of shear strength parameters, bearing capacity from N values, static cone tests, and plate load tests

Deep foundations , types of soils , construction methods, Axial capacity of single piles , Capacity, Negative skin friction, pile load test, pile integrity tests, Caissons, Foundation in difficult soils, expansive soils, chemically aggressive environment, soft soils, fill, regions of subsidence

Total Hours : < 42 Hrs.>

CE 6424: Wastewater Engineering

L	T	P	C
3	0	0	3

Pre-requisite: - Nil

Waste water treatment-objectives, methods-Effluent and sludge disposal and reuse. Waste water characteristics-waste water composition-variation in concentration of waste -Flow rates-Analysis of wastewater flow rate - Waste water Treatment-methods and design classification and application of waste water treatment methods, elements of plant analysis and design, other important considerations. Fundamentals of process analysis-Reactions and reaction kinetics. Physical Unit Operations-Screening flow measurement, Grit removal, Flow equalization, mixing, plain sedimentation, flocculation, (sedimentation aided with coagulation), Floation, Granular medium filtration, chemical Unit processes-Chemical precipitation, Gas transfer, absorption, disinfection-by various methods-odour control.

Design facilities for physical chemical treatment of wastewater, Biological waste water treatment-Microbial metabolism, Kinetics of biological growth, suspended growth biological treatment, attached growth biological treatment, Design facilities for the biological treatment of waste water.

Total Hours : < 42 Hrs.>

CE6425: Analysis and Design of Earth and Earth Retaining Structures

L	T	P	C
3	0	0	3

Prerequisite: -Nil

Earth pressure, Types, at rest, active, passive, Rankine's theory, Back fill features, Soil type, surface inclination, loads on surface, soil layers, water level, Coulomb's theory, Rigid retaining structures, , stability analysis Flexible Retaining structures, , Cantilever sheet piles, Anchored bulkheads, free earth method, fixed earth method, moment reduction factors, anchorages, Cofferdams, diaphragm walls. Braced excavation, Types, Construction methods, Pressure distributions, bottom heave,, ground deformation Reinforced soil walls, Elements, construction methods, External stability, and internal stability,.Laterally loaded piles, short and long piles, free head and fixed head piles, lateral load capacity of single piles, Lateral deflection, Elastic analysis, Group effect, Lateral load test, Codal provision, underground structures in soils, pipes, conduits, Trench less technology, Tunnelling techni ques, cut and cover method, shield tunneling

Total Hours : < 42 Hrs.>

CE6426: LANDSLIDE MITIGATION METHODS

Pre-requisite: - Nil

L	T	P	C
3	0	0	3

Natural and manmade disasters, Description of development by disasters, factors affecting disasters, characteristics of particular hazards and disasters, earthquakes, Tsunamis, Tropical cyclones, floods, droughts, Environmental pollution, Deforestation. Environmental hazards, Typology, Assessment and response, Environmental Hazards Revisited issues, Disasters, Human induced Hazards, responses, the strategies and the scale of disaster,. Risk assessment and Management, objectives of assessment, Evolving objectives of assessment, Assessment of different disaster types, Destructive capacity, Disaster due to hydrological and meteorological phenomena. Targeting mitigation where it has most effect, Actions of reduced risk, Classification measures, Disaster mitigation as a development theme, Disaster risk appraisal, Disaster risk reduction planning, Appraisal of disaster mitigation needs, Disaster mitigation needs, Disaster risk reduction planning.

Total Hours : < 42 Hrs.>

CE 6427: Groundwater Contamination

L	T	P	C
3	0	0	3

Prerequisite: -Nil.

Introduction, Capillarity, Capillary measurements, Hydraulic conductivity, conductivity, Factors affecting conductivity results. Infiltration, Percolation and retention, Mass transport phenomenon in moist fine grained soils, creeping flow, nature, pore fluid in soil, soil energy conductivity, osmosis and reverse osmosis phenomena, Soil water suction and diffusivity, moisture migration, Diffusion phenomena.

Radiation effects on water, characteristics of radioactivity, radioactive decay process, Environmental geotechnical aspects of radiation, Flow through porous media, wet lands, saltwater intrusions, Liquid waste control, Relationship between solid and liquid wastes, Landfill design technology, Laboratory tests for compacted garbage and hydraulic conductivity of compacted garbage, Design of waste control systems, factors effecting the stability of waste control system, Dynamic load effects on waste control systems.

Total Hours : <42 Hrs.>

CE6428: Earthquake Geotechnical Engineering

Pre-requisite: - Nil

L	T	P	C
3	0	0	3

Fundamentals of vibration, system with a single degree of freedom, system with two degree of freedom, dynamic properties of soil, laboratory tests and results, field test measurements. Internal structures of earth, continental drifts and plate tectonics, elastic rebound theory, ground motion parameters, estimation of ground motion parameters, seismic hazard analysis, local site effects and design of Ground motions, Liquefaction, liquefaction related phenomena, evaluation of liquefaction hazards, liquefaction susceptibility, Initiation of liquefaction, Effects of liquefaction. Dynamic ultimate bearing capacity, seismic design considerations of sub structures, shallow foundations, deep foundations.

Total Hours : < 42 Hrs.>

CE 6429: BIOREMEDIATION TECHNOLGIES

L	T	P	C
3	0	0	3

Pre- requisite: - Nil

Pollution and Biomonitoring, chemical and biological pollution monitoring, Toxicity testing of hazardous wastes terrestrial bioassays, traditional approaches and limitations, soil and sediment leaching media, diatoms indicators of water quality, bioindicators of environmental monitoring and pollution control. Bio drainage – land and water use for sustainable development, salts in soil and water, plant mechanism of absorbing and transporting water, mineral absorption by plants, Biotechnical and soil bioengineering - stabilization – bioengineering stabilization methods, biotechnical Stabilization methods.

CE6491: Environmental Geotechnical Laboratory

L	T	P	C
0	0	2	1

Pre-requisite: -Nil

1. Permeability tests – constant and variable head
2. Swell and shrinkage test for soils
3. Test for compressibility
4. Test for determination of shear strength
5. Introduction to testing of geotextiles
6. Determination of total soluble solids, Organic matter
7. Determination of calcium carbonate, PH, soluble sulphates in soil.
8. Chemical tests for determination of cation exchange capacity
9. Chemical tests for leachate analysis, Iron, Manganese, chloride
10. Introductory tests for determination of surface area

Total Hours : < 26 Hrs.>

CE 6492: Computational Geomechanics Laboratory

L	T	P	C
0	0	2	1

Prerequisite :-Nil

To familiarize and give hands on training to students in the following areas of Civil Engineering Application software

1. Drafting and documentation
2. Surveying – terrain mapping, computation of areas & volumes
3. Structural Analysis and Design
4. Water resources
5. Geotechnical Engineering
6. Road/Railway system
7. Environmental Engineering
8. Estimation and costing
9. Project management

Recommended packages:

- Auto CAD
- MicroStation

- MS Office
- Matlab
- Grapher/Sigma plot
- Moss
- AutoCivil
- Intergraph
- ASAP
- STAAD
- Water CAD
- Flow master
- Win log
- Geoslope
- Beurcap MS – Project

Total Hours : < 26 Hrs.>

CE6493: FOUNDATION ENGINEERING DESIGN STUDIO

Prerequisite: -Nil

L	T	P	C
3	0	0	3

Design Principles shallow foundations, Bearing capacity calculations from laboratory and field studies-settlement of footings—tilt and horizontal displacement- design of isolated, combined, centric footings – different types of rafts. Design of pile foundations- bearing capacity calculations design of bored, pre cast, driven piles – pile settlement calculations – piles subjected to lateral loads grouping of piles. Design of various ground improvement techniques- soil nailing- stone columns – vibrofloatation- preloading- geo drains sand columns- reinforced earth Design of well foundations – retaining walls –sheet pile designs

Total Hours : < 26 Hrs.>

CE 6497: SEMINAR

The students are expected to give a seminar on relevant topic related to environmental Geotechnology either a research or a case study, covering various aspects like scope of the problem, methodology used for the study conclusions arrived at etc.

L	T	P	C
0	0	0	1

Total Hours : < 26 Hrs.>

CE 7498 : PROJECT (S3)

The subject of study should be based on the latest works ongoing in the field of geotechnical and or environmental engineering.

L	T	P	C
			8

CE 7499 : PROJECT (S4)

The subject of study should be based on the latest works ongoing in the field of geotechnical and or environmental engineering.

L	T	P	C
			12

CE 6401: Ground Improvement

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Total hours : < 42 Hours>

Course Objectives:

To acquire knowledge about

1. Various methods of stabilization
2. Various methods of improving geotechnical properties of soils
3. Techniques to accelerate rate of consolidation
4. Retro fitting technique and arresting failure of foundation

Total hours : < 42 Hours> :

Module 1: (10 Hours)

Vibration techniques, dynamic compaction, depth of treatment, environmental considerations, practical application of vibrotechniques and dynamic compaction

Module 2: (10 Hours)

Classification of stabilizing agents, stabilizing agents, stabilization process, drainage and compaction, deleterious effects of organic substances and sulphates on inorganic stabilization, lime stabilization , lime column method, bearing capacity and settlement of lime columns, slope stability, stability of trenches, laboratory and field investigations, lime-sand columns, stone columns

Module 3: (12 Hours)

Grouting techniques, chemical grouting, principles of injection, grout systems, grouting operations, applications, design methods, jet grouting, the jet grouting process, geometry and properties of soil used, properties of treated ground, application of jet grouting

Module 4: (13 Hours)

Soil fracturing techniques for terminating settlements and restoring levels of buildings and structures, injection technology and its effects, typical examples, in situ soil mixing techniques, construction techniques, testing procedures

References:

1 Moscly, M.P. "A Text book on Ground Improvement", Blackie Academic and Professional, 1994.
2 Raj, P. Purushothama, "Ground Improvement Techniques", Laxmi Publications, New Delhi, 2005

Course Outcomes :

On completion of the course the students will be able to

1. Acquire about various techniques of ground improvement
2. Techniques to utilise native soil for construction activities
3. Technique to accelerate rate of construction projects
4. Various technique to rectify settlements, restoration etc.

CE 6402: Fundamentals of Soil Behaviour

L	T	P	C
3	0	0	3

Pre-requisite: Nil
Total hours : < 42 Hours>

Course Objectives:

1. To study about the Soil formation, depositional and post depositional soil characteristics,
2. To have a deep understanding of soil fabric, different fabric types, their characteristics, methods of fabric evaluation
3. To study the soil water interaction in an in depth level
4. To understand the compressibility behaviour of soils
5. To have a thorough understanding of the shear strength characteristics

Total hours : < 42 Hours> :

Module 1: (9 Hours)

Origin, nature and distribution of soil, description of individual particle, clay mineralogy, clay-water electrolytes, soil fabric and structure

Module 2: (12 Hours)

Effective stress principle, steady state flow in soil, effect of flow on effective stress, determination of coefficient of permeability, consolidation ,one, two, three and radial direction, variation of effective stress during consolidation, consolidation tests and determination of consolidation parameters

Module 3: (12 Hours)

Stress path, tri-axial and direct shear tests, shear behaviour of granular soils, factors affecting shear behaviour, determination of shear strength parameters, shear behaviour of fine grained soils, pore pressure parameters, UU,CU,CD tests, total and effective shear strength parameters, total and effective stress paths, water content contours, factors affecting shear strength-stress history, rate of loading, structure and temperature, anisotropy of strength, thixotropy ,creep, determination of in situ undrained strength.

Module 4: (12 Hours)

Critical state model

Introduction models and soil mechanics, use of models in engineering, elasticity, soil elasticity, plasticity and yielding, yielding of metal tubes in combined tension and torsion, elastic-plastic model for soil, elastic volumetric strains, a particular elastic-plastic model

References:

1 Mitchell, J. K., "Text book in Fundamentals of Soil Behaviour", 2Ed, John Wiley &Sons, New York, 1993
2 Holtg,R.D and Kovacs W.D., "An Introduction to Geotechnical Engineering" , Prentice hall CO, N.J. 1981
3 Hough, B. K, "Basic Soil Engineering" The Ronald Press Co, New York., 1957

Course Outcomes :

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

1. Identify the probable soil formation history
2. They will be able to evaluate the soil fabric by indirect and direct methods
3. Identify and solve soil water interaction problems

4. Properly evaluate the soil compressibility aspects and estimate probable settlements.
5. Asses the shear strength characteristics by conducting the most appropriate tests

CE6411: Waste Disposal Methods and Management

L	T	P	C
3	0	0	3

Pre-requisite: Nil
Total hours : < 42 Hours>

Course Objectives:

1. To familiarize the methods of disposing wastes- solid, liquid and gaseous
2. To learn the impacts of disposing wastes on human health and ecosystem
3. To learn the methods of managing waste disposal to reduce the impacts
4. To learn the alternatives to disposal

Module 1: (12 Hours)

Wastewater Disposal

Disposal on Land - Disposal by Irrigation - Sewage Farming - Disposal by Infiltration - preparation of land for Infiltration - regulation of infiltration - Pretreatment of Industrial waste before disposal on land - Wider aspects of wastewater disposal on land- prevention of water pollution, Enhancement of agricultural production, Augmentation of water resources, Prevention of saltwater intrusion

Module2: (12 Hours)

Wastewater Disposal

Disposal on Surface Waters-Disposal on streams-stream sanitation-Hydrological and climatological factors of stream sanitation-Organic self purification-Microbial self purification-Efficient use of self assimilative capacity of streams-Disposal of waste water on lakes-Disposal of waste water on Sea

Disposal of Sewage Sludge-sludge digestion-biogas generation-agricultural applications of digested sludge

Module 3: (12 Hours)

Composting-Fundamentals of microbial degradation -Operational sequences and technical equipment in facilities for composting - Quality and application of compost

Sanitary Land Fill - Methods and fundamentals for waste pretreatment prior land filling -Landfill technology - Long-term behaviour of landfills -Recultivation and aftercare of landfill sites

Module 3: (9 Hours)

Other methods for solid waste disposal-Incineration-technology description-air emission and public perception issues-Open Dumping of waste-Ocean Dumping

Disposal of Hazardous and Special Wastes - Containment Technologies - Vapour Extraction - Bioremediation- Medical waste-treatment and disposal options

Waste Recycling-wastewater recycling-resource recovery from waste

References:

1 U. N. Mahida, "Water Pollution and Disposal of Wastewater on Land", TMH
2 Clarence J. Velz, "Applied Stream Sanitation", Wiley-Interscience
3 Metcalf and Eddy, "Wastewater Engineering-Treatment, Disposal and Reuse", TMH
4 Subijoy Dutta, "Environmental Treatment Technologies for Hazardous and Medical Wastes-Remedial Scope and Efficacy",TMH
5 Frank Kreith, "Hand Book of Solid Waste Management", Mc Graw Hill, New York, 1994

Course Outcomes :

After the completion of the course, the student will be able to

1. Decide the method of disposal suitable for a given waste under a given circumstance.
2. Quantify and evaluate the impacts of disposing wastes to human health and ecosystem.
3. Implement suitable management measures to reduce the impacts of waste disposal.

CE 6412: Reinforced Earth and Geotextiles

L	T	P	C
3	0	0	3

Pre-requisite: Nil
Total hours : < 42 Hours>

Course Objectives:

To acquire knowledge about

1. Types and functions of various geosynthetics and its manufacturing process
2. Testing and valuation of various properties of geosynthetics used in soil structures
3. Principle of soil reinforcement and design of reinforced soil retaining structures
4. Bearing capacity improvement and embankment s on soft soils
5. Use of geosynthetics in pavement, geotechnical and environmental engineering to fulfil the various functional applications

Module 1: (11 Hours)

Geosynthetics and Reinforced soil structures, Testing of Geosynthetics

Module 2: (12 Hours)

Types and functions, Materials and manufacturing process, Testing and valuations, Principles of soil reinforcement, Design and construction of geosynthetics , reinforced soil retaining structures, walls and slopes, Codal provision,Bearing capacity improvement.

Module 3: (12 Hours)

Geosynthetics in pavements, Embankments on soft soils, Geosynthetics in roads and railways, separators, drainage and filtering in road pavements, railway tracks, overlay design and constructions, trench drains.

Module 4: (10 Hours)

Geosynthetics in Environmental control, liners for ponds and canals, covers and liners for landfills, material aspects and stability considerations, landfills, occurrences and methods of mitigation, Erosion causes and techniques for control.

References

1 Robert M. Koerner, "Designing with Geosynthetics", Prentice Hall, Englewood Cliffs, 1990
2 G Venkatappa Rao, GVS Surry Narayana Raju, "Engineering with Geosynthetics",Tata Mc Graw, 1990 Hill Publishing Company Ltd, New Delhi
3 T.S Ingold , "Reinforced Earth",Thomas Telford Ltd, London, 1982.
4 J.N Mandal , "Reinforced Soil and Geotextiles", Oxford and IBH Publishers Co. Pvt. Ltd, New Delhi, 1988.

Course Outcomes :

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

1. Familiar with the functional applications of various geosynthetics

2. Understand the design and construction of geosynthetics in soil retaining structures

3. Analyse the various properties after testing the geosynthetics along with/without soil

CE 6414: Groundwater Hydrology

L	T	P	C
3	0	0	3

Pre-requisite: Nil

Total hours : < 42 Hours>

Course Objectives:

To acquire knowledge about :

1. Groundwater Sources, aquifers, basic governing principles.
2. Groundwater and Well Hydraulics –
3. Tube wells and basic components
4. Ground water Quality Control aspects

Module 1: (10 Hours)

Occurrence of ground water: origin -rock properties affecting ground water vertical distribution –geologic formations as aquifers - types of aquifers -aquifer parameters-ground water basins -springs -ground water in permeable regions -ground water balance - ground water flow -Darcy's law -laplace equation -potential flow lines - flow net -steady radial flow into a well -well in uniform flow -steady flow in leaky aquifer -aquifer with percolation -seepage under a dam-unsteady flow –general equation –confined and unconfined aquifers.

Module 2: (13 Hours)

Ground water and well hydraulics: steady unidirectional flow -steady radial flow in to a well -well in uniform flow - steady flow with uniform discharge -unsteady radial flow in to a well -confined, unconfined and leaky aquifers - well near aquifer boundaries - multiple well system -partially penetrating wells -characteristics well losses –pumping tests -non equilibrium equation for pumping tests -Thies' method –Jacob method, Chow's method

Module 3: (13Hours)

Tube wells: design -screened wells -gravel packed wells -well loss-selection of screen size yield of a well -test holes -well logs -

methods of construction -dug wells - shallow tube wells - deep wells - gravity wells - drilling in rocks - screen installation -well completion well development -testing wells for yield -collector -or radial wells –infiltration galleries well point system -failure of tube wells .

Module 4: (9Hours)

Quality of ground water: ground water samples – measurement of water quality- chemical, physical and bacterial analysis - quality for domestic use - quality for agricultural use pumps - shallow well pumps - ground water investigation - geographical investigation electrical resistivity method - seismic refraction method - gravity and magnetic method - test drilling – resistivity logging – potential logging – artificial recharge - recharge by water spreading -sewage recharge -recharge through pits, shafts and wells

References

1 Todd D.K., " Ground Water Hydrology", John Wiley
2 Garg S.P., "Ground Water & Tube wells", Oxford & IBH
3 Raghunath H.M., "Ground Water Hydrology", Wiley
4 Raghunath H.M., "Hydrology", Wiley Eastern

Course Outcomes :

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

1. Identify the groundwater sources
2. Compute the Well capacities
3. Design and implement Tube wells
4. Estimate the groundwater quality

CE 6421: Advanced Design of Foundations

L	T	P	C
3	0	0	3

Pre-requisite: Nil

Total hours : < 42 Hours>

Course Objectives:

To acquire knowledge about
1. Soil structure interaction models
2. Theories of pile design
3. Determination of dynamic properties of soils
4. Designs of foundations subjected to vibrations of different models
5. To understand various vibration isolation techniques

Module 1: (10 Hours)

Soil -Structure Interaction

Introduction to Soil -Structure interaction problems -Contact pressure distribution – factors influencing Contact pressure distribution beneath rigid and flexible footings – concentrically and eccentrically loaded cases – contact pressure distribution beneath rafts - Modulus of up grade reaction – Determination of modulus of sub grade reaction – Factors influencing modulus of subgrade reaction

Module 2: (10 Hours)

Pile Foundations

Introduction – Estimation of pile capacity by static and dynamic formulae – Wave equation method of analysis of pile resistance – Load -Transfer method of estimating pile capacity – Settlement of single pile – Elastic methods. Laterally loaded piles – Modulus of sub grade reaction method – ultimate lateral resistance of piles. Pile Groups – Consideration regarding spacing – Efficiency of pile groups – Stresses on underlying soil strata – Approximate analysis of pile groups –Settlement of pile groups Pile caps –Pile load tests – Negative skin friction.

Module 3: (12 Hours)

Introduction to Machine Foundations

Introduction -nature of dynamic loads -stress conditions on soil elements under earthquake loading -dynamic loads imposed by simple crank mechanism -type of machine foundations special considerations for design of machine foundations – Criteria for a satisfactory machine foundation -permissible amplitude of vibration for different type of machines -methods of analysis of machine foundations -methods based on linear elastic weightless springs methods based on linear theory of elasticity (elastic half space theory) -degrees of freedom of a block foundation –definition of soil spring constants -nature of damping -geometric and internal damping -determination of soil constants – methods of determination of soil constants in laboratory and field based on IS code provisions.

Module 4: (13 Hours)

Design of Machine Foundations

Vertical, sliding, rocking and yawing vibrations of a block foundation -simultaneous rocking, sliding and vertical vibrations of a block foundation -foundation of reciprocating machines -design criteria -calculation of induced forces and moments -multi-cylinder engines -numerical example (IS code method).

Foundations subjected to impact loads - design criteria - analysis of vertical vibrations computation of dynamic forces - design of hammer foundations (IS code method) - vibration isolation – active and passive isolation - transmissibility -methods of isolation in machine foundations.

References

1 Lambe and Whitman, “Soil Mechanics”, Wiley Eastern., 1976.
2 Das B.M., “Advanced Soil Mechanics”, Mc. Graw-Hill, NY, 1985.
3 Winterkorn H.F. and Fang H.Y. Ed., “Foundation Engineering Hand Book”, Van-Nostrand Reinhold, 1975.
4 Bowles J.E., “Foundation Analysis and Design” (4Ed.), Mc.Graw –Hill, NY, 1996
5 Poulose H.G. and Davis E.H., “Pile foundation Analysis and Design”, John-Wiley & Sons, NY, 1980.
6 Leonards G. Ed., “Foundation Engineering”, Mc.Graw-Hill,NY, 1962.
7 Bowles J.E., “Analytical and Computer Methods in Engineering “Mc.Graw-Hill,NY, 1974.
8 Shamsher Prakash, “Soil Dynamics”, McGraw Hill.
9 Alexander Major, “Dynamics in Soil Engineering”
10 Sreenivasalu & Varadarajan, “Handbook of Machine Foundations”, Tata McGraw Hill
11 IS 2974 -Part I and II, “Design Considerations for Machine Foundations”
12 IS 5249: “Method of Test for Determination of Dynamic Properties of Soils”

Course Outcomes :

One completion of course, the student will be able to

1. Acquire knowledge of soil structure interaction and various models

2. Familiarize with design of pile foundation and pile testing

3. To analyses and design of foundation subjected to vibrations

4. To utilize vibration isolation technique for design of foundations.

5. Design of deep foundation subjected various types of loads.

CE 6423: Fountation Engineering for Difficult and Contaminated Grounds

CE 6422: Design of Engineered Landfills

L	T	P	C
3	0	0	3

Pre-requisite: Nil

Total hours : < 42 Hours>

Course Objectives:

To acquire knowledge about

1. To understand various methods of waste disposal methods
2. To characterize, analyses chemical constitutions of waste
3. To understand design methodologies of various land fill techniques
4. To design various components of engineered land fills
5. To study slope stability of land fill improvements

Module 1: (10 Hours)

Environmental-geotechnical application , introduction ,basic considerations of ground improvement systems ,load environmental factor design criteria, load factor design criteria and approaches , environmental load factor design criteria, soil structure , structural soil interaction , soil foundation structure interactions, load factor of safety and allowable condition, bearing capacity of granular soil, friction forces and angle between two materials.

Module 2: (12 Hours)

Liners, different types, properties of liners, clay liners, geo-synthetic liners, composite liners, design aspects

Module 3: (12 Hours)

Reclaiming potentially combustible sites , Introduction to combustion process, combustion tests , use of combustion potential tests, Land fill gases , principal gases and their properties, Gas monitoring ,Data assessment and remedial solutions.

Module 4:(11 Hours)

Establishment of new landscapes, Introduction, plant requirements, soil cover, soil fertility, site preparation, establishing grass cover, Establishing trees and shrubs, Maintenance.

References

1 Hsai –yang Fang., "Introduction to Environmental Geotechenology" CRC press Newyork, 1997

2 Cairmey .T. , "Contominated land problems and solutions", Blackie Academic & Professional, New York, 1993.

Course Outcomes :

One completion of course, the student will be able to :

1. Acquired knowledge about various techniques of land fill

2. To design of liners and various components of waste disposal units

3. To understand analysis of chemical constituents of leachate

4. To design cover systems of waste disposal units

Pre-requisite: Nil

Total hours : < 42 Hours>

L	T	P	C
3	0	0	3

Course Objectives:

To acquire knowledge about

1. Site investigation including in-situ tests, sampling and geophysical methods
2. Bearing capacity and settlement criterion for shallow foundations in layered soils and design considerations
3. Construction methods of deep foundations in contaminated soils and evaluation on load carrying capacity of foundations
4. Caissons and special foundations in expansive soils with design criteria
5. Essential requirements of foundations in chemically aggressive environments

Module 1: (12 Hours)

Site investigations, planning of investigation programmes, geophysical methods, electrical resistivity and seismic refraction methods, methods of investigations direct methods, semi direct, Methods and indirect methods, drilling methods, measurement of water table, field tests, in situ permeability tests, SPT,DCPT,SCPT, insitu vane shear test, pressure meter test, plate load test, Codal provisions.

Module 2: (12 Hours)

Shallow foundation, Design consideration, factors of safety, allowable settlements, bearing capacity theories, layered soils, choice of shear strength parameters, bearing capacity from N values, static cone tests, and plate load tests.

Module 3: (12 Hours)

Deep foundations , types of soils , construction methods, Axial capacity of single piles , dynamic formulae, skin friction and end bearing in sands and clays ,Axial capacity of groups, settlement of single piles and groups, uplift Capacity, Negative skin friction, pile load test, pile integrity tests.

Module 4: (9 Hours)

Caissons, Foundation in difficult soils, expansive soils, chemically aggressive environment, soft soils, fill, regions of subsidence

References

1 Joseph E. Bowles, "Foundation Analysis and Design", McGraw Hill Companies, Inc. New York, 1996.
2 Ninan P Kurian, "Design of foundation System", Narosa Publishing House, New Delhi, 1992.
3 Swami Saran, "Analysis and Design of Substructures", oxford & IBH publishing Co Pvt. Ltd, New Delhi, 1996
4 M.J Tomlinson, "Foundation Design and construction", Pitman Publishing Limited, London, 1975

Course Outcomes :

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

1. Understand the role of site investigation including field tests in making the sub-soil investigation report
2. Identify the methods of exploration and types of samplers to obtain quality samples
3. Determination of bearing capacity and settlement of shallow foundations in layered soils using the field and laboratory test data
4. Design of various deep foundations in contaminated soils
5. Understand the design features of caissons and special foundations in soils with chemically aggressive environment

CE 6424: WASTEWATER ENGINEERING

L	T	P	C
3	0	0	3

Pre-requisite: Nil

Total hours: < 42 Hours>

Course Objectives:

1. To learn the various characteristics of wastewater important in treatment
2. To learn the methods of estimating wastewater flow
3. To learn the various operations and processes in wastewater treatment
4. To learn the design of selected wastewater treatment operations and processes

Module 1: (10 Hours)

Waste water treatment-objectives, methods-An overview-Effluent and sludge disposal and reuse. Waste water characteristics-(Physical, Chemical and biological)-waste water composition-variation in concentration of waste - Water loading Data-Flow rates-Analysis of wastewater flow rate Data.

Module 2: (12 Hours)

Waste water Treatment-methods and design classification and application of waste water treatment methods, elements of plant analysis and design, other important considerations. Fundamentals of process analysis-Reactions and reaction kinetics.

Module 3: (12 Hours)

Physical Unit Operations-Screening flow measurement, Grit removal, Flow equalization, mixing, plain sedimentation, flocculation, (sedimentation aided with coagulation), Floation, Granular medium filtration, chemical Unit processes-Chemical precipitation, Gastransfer, absorption, disinfection-by various methods-odour control. Design facilities for physical chemical treatment of wastewater

.

Module 4: (11Hours)

Biological waste water treatment-Microbial metabolism, Kinetics of biological growth, suspended growth biological treatment, attached growth biological treatment, Design facilities for the biological treatment of waste water.

References:

1 Metcalf and Eddy, "Text book on Wastewater Engineering", Tata Mc Graw hill publishing and co.1994

2. Syed.R Qasim "Wastewater Treatment Plants-planning, Design and Operation", CBS College Publishing,.1998.

3. "New Processes of Wastewater Treatment and Recovery", Edited by G.Mattock by Ellishorwood Ltd., 1996.

Course Outcomes :

1. Analyze for the various characteristics of wastewater important in treatment and decide on the method of treatment to be adopted

2. Design the various units of the conventional wastewater treatment system.

3. Design wastewater treatment systems for specific requirements.

CE6425: Analysis and Design of Earth and Earth Retaining Structures

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Total hours: < 42 Hours>

Course Objectives:

To acquire knowledge about

1. Earth pressure theory and influence of various factors on earth pressure
2. Implementing the earth pressure theory to analyse the stability and design of various types of earth retaining structures
3. Stability of the braced excavations and preventive measures of bottom heave and ground deformation
4. Load carrying capacity of various laterally loaded single and group piles including deflection and moment patterns
5. Underground structures in soils and tunnelling techniques

Module 1: (10Hours)

Earth pressure, Types, at rest, active, passive, Rankine's theory, Backfill features, Soil type, surface inclination, loads on surface, soil layers, water level, Coulomb's theory, Effect due to wall friction and wall inclination, Graphical methods, Earthquake effects.

Module 2: (12 Hours)

Rigid retaining structures, Types, Empirical methods, stability analysis Flexible Retaining structures, Types, Material, Cantilever sheet piles, Anchored bulkheads, free earth method, fixed earth method, moment reduction factors, anchorages, Cofferdams, diaphragm walls.

Module 3: (13 Hours)

Braced excavation, Types, Construction methods, Pressure distribution in sands and clays, stability, bottom heave, seepage, ground deformation Reinforced soil walls, Elements, construction methods, External stability, and internal stability.

Module IV (10 Hours)

Laterally loaded piles, short and long piles, free head and fixed head piles, lateral load capacity of single piles, Lateral deflection, Elastic analysis, Group effect, Lateral load test, Codal provision, underground structures in soils, pipes, conduits, Trench less technology, Tunnelling techniques, cut and cover method, shield tunneling

References:

1 Gregory. P. Tschebotarioff, "Foundations, Retaining and Earth Structures", Mc Graw-Hill Kogakusha, 1978

2 Shamsher prakash, Gopl & Ranjan, Swami Saran, "Analysis and design of foundations and retaining structures", Sarita Prakashan New Delhi, 1979

3 W.C. Huntington, "Earth pressure and retaining walls", John Wiley & Sons, Inc, London., 1957.

Course Outcomes :

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

1. Familiar with graphical and analytical methods to determine the lateral earth pressure under various influencing factors

2. Analyse all types of earth retaining structures for the stability against sliding, overturning and bearing failure

3. Analyse the stability of braced excavations and develop the pressure distribution diagrams along the various braced cuts in different types of soils

4. Determine the load carrying capacity and lateral deflection along the various types of laterally loaded piles

5. Understand the design and executional procedures in tunneling using different methods

CE6426: Landslide Mitigation Methods

L	T	P	C
3	0	0	3

Pre-requisite: Nil

Total hours: < 42 Hours>

Course Objectives:

To acquire knowledge about

1. To have sufficient knowledge in all forms of natural and manmade disasters, their causative factors, characters and their influence on others.
2. Regional level and site specific identification and stabilization of possible landslide prone zones.
3. Anthropogenic activities and environmental friendly stabilization techniques.
4. Risk assessment and management with special emphasis on geological conditions and increase of groundwater and surface water in existing and post project situations.
5. Authoritative evolution of Landslide Mitigation strategy in micro and macro levels.

Module 1: (10 Hours)

Natural and manmade disasters, Description of development by disasters, factors affecting disasters, characteristics of particular hazards and disasters, earthquakes, Tsunamis, Tropical cyclones, floods, droughts, Environmental pollution, Deforestation.

Module 2: (12 Hours)

Environmental hazards, Typology, Assessment and response, Environmental Hazards Revisited issues, Natural trends, Disasters, Human induced Hazards, responses, the strategies and the scale of disaster.

Module 3:(12 Hours)

Risk assessment and Management, objectives of assessment, Evolving objectives of assessment, Assessment of different disaster types, Destructive capacity, Disaster due to hydrological and meteorological phenomena.

Module 4: (11 Hours)

Targeting mitigation where it has most effect, Actions of reduced risk, Classification measures, Disaster mitigation as a development theme, Disaster risk appraisal, Disaster risk reduction planning, Appraisal of disaster mitigation needs, Disaster mitigation needs, Disaster risk reduction planning.

References:

1 Gregory.P.Tschebotraioff, "Foundations, Retaining and Earth Structures", McGraw-Hill, Kogakusha., 1978

2 M & A. ReimberT, "Retaining Walls, Anchorages and Sheet Piling", Transtech Publications,1974

Switzerland.
3 Shamser Prakash, Gopla Rangen, Swami Saran, "Analysis and Design Of Foundations and Retaining Structures", Saritha Prakashan Newdelhi, 1979
4 W.C Huntington , "Earth Pressure and retaining walls", John Wiley & Sons, Inc, London, 1957.

Course Outcomes :

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

1. Understand the existing natural and manmade problems in landslide perspective.
2. Bringing in new projects without landslide occurrence.
3. Evolve and execute Landslide Mitigation Strategy for a place or region.

CE 6427: Groundwater Contamination

L	T	P	C
3	0	0	3

Pre-requisite: Nil

Total hours: < 42 Hours>

Course Objectives:

To acquire knowledge about

1. Capillarity, Capillary measurements, Hydraulic conductivity etc.
2. Basics of Infiltration, Percolation and Retention
3. Radiation effects on water
4. Liquid Waste Control

Module 1: (11 Hours)

Introduction, Capillarity, Capillary measurements, Hydraulic conductivity, measurements of Hydraulic conductivity, Factors affecting conductivity results.

Module 2: (12 Hours)

Infiltration, Percolation and retention, Mass transport phenomenon in moist fine grained soils, creeping flow, nature of pore fluid in soil, soil energy conductivity, osmosis and reverse osmosis phenomena, Soil water suction and diffusivity, moisture migration, Diffusion phenomena.

Module 3: (12 Hours)

Radiation effects on water, characteristics of radioactivity, radioactive decay process, Environmental geotechnical aspects of radiation, Flow through porous media, wet lands, saltwater intrusions, Estuaries

Module 4: (10 Hours)

Liquid waste control, Relationship between solid and liquid wastes, Landfill design technology, Laboratory tests for compacted garbage and hydraulic conductivity of compacted garbage, Design of waste control systems, factors effecting the stability of waste control system, Dynamic load effects on waste control systems.

References

1. Hsai-Yang Fang, " Introduction to Environmental Geotechnology" – CRC Press, New York, 1997

Course Outcomes :

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

1. Compute Capillarity, Capillary measurements, Hydraulic conductivity etc.
2. Calculate the mass transport
3. Asses the effects of radiation on ground water
4. Design systems for Liquid waste disposals and control.

CE6428: Earthquake Geotechnical Engineering

L	T	P	C
3	0	0	3

Pre-requisite: Nil

Total hours: < 42 Hours>

Course Objectives:

To acquire knowledge about

1. The sources of earthquakes and seismic hazards
2. The internal structure of earth system and its behaviour relate to earthquake phenomena
3. Strong ground motion parameters to characterise the earthquake motion and GRA
4. Determination of dynamic properties of soils and evaluating the liquefaction susceptibility of different soil deposits and its mitigation
5. Seismic design aspects of foundations and geotechnical structures like slopes, embankments, reservoirs and bridges etc.

Module 1: (10 Hours)

Fundamentals of vibration, system with a single degree of freedom, system with two degree of freedom, dynamic properties of soil, laboratory tests and results, field test measurements, correlation between the properties.

Module 2: (12 Hours)

Internal structures of earth, continental drifts and plate tectonics, elastic rebound theory, ground motion parameters, estimation of ground motion parameters, seismic hazard analysis, local site effects and design of Ground motions

Module 3: (13 Hours)

Liquefaction, liquefaction related phenomena, evaluation of liquefaction hazards, liquefaction susceptibility, Initiation of liquefaction, Effects of liquefaction.

Module 4: (10 Hours)

Dynamic ultimate bearing capacity, seismic design considerations of sub structures, shallow foundations, deep foundations

References:

1 Steven . C. Kramer, "A text Book on Geotechnical Earthquake Engineering" (2004) . Prentice hall International series, 2004
2 B . M. Das, "A text Book on principles of soil Dynamics", Brooks, Code, 1993
3 S Prakash, "A text Book on soil Dynamics" , Tata McGraw Hill., 1981

Course Outcomes :

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

1. Identify the sources of earthquakes and hazards
2. Familiarise on determination of ground motion parameters and perform the GRA using analytical software's
3. Analyse the dynamic properties of soils from both the field and laboratory tests data
4. Evaluate the liquefaction susceptibility of soil deposits and prepare the maps
5. Determine dynamic bearing capacity and perform the seismic design of sub structures

CE 6429: BIOREMEDIATION TECHNOLGIES

L	T	P	C
3	0	0	3

Pre-requisite: Nil

Total hours: < 42 Hours>

Course Objectives:

1. To learn the theory and practice of bio-monitoring
2. To learn methods of bioremediation
3. To learn the fundamentals of bio-drainage
4. To learn the methods for biological stabilization of soil

Module 1: (10 Hours)

Pollution and Biomonitoring, chemical and biological pollution monitoring, the necessity of combining Biological and chemical monitoring, Algal assay approaches to pollution studies in aquatic systems.

Module 2:(13 Hours)

Toxicity testing of hazardous wastes by aquatic and terrestrial bioassays, traditional approaches and limitations, soil and sediment leaching media, diatoms indicators of water quality, bioindicators of environmental monitoring and pollution control.

Module 3: (13 Hours)

Bio drainage – land and water use for sustainable development, salts in soil and water, plant mechanism of absorbing and transporting water, mineral absorption by plants, principles of bio drainage planning and design, bio drainage management aspects.

Module 4: (9 Hours)

Biotechnical and soil bioengineering - stabilization – bioengineering stabilization methods, biotechnical stabilization methods.

References:

1 Rana B.C , “Pollution and Bio Monitoring”, Tata McGraw Hill Publishing Co., 1995.
2 Kapoor A.S , “Bio Drainage”, Tata McGraw Hill Publishing Co. SP 69, Special publication, ASCE., 1999.

Course Outcomes :

After the completion of the course, the student will be able to

1. Design bio-monitoring programmes
2. Carryout onsite bioremediation programmes
3. Decide on the suitability of biological soil stabilization techniques in the field

CE6221 Geographic Information System and Its Applications

Pre-requisite: Nil
Total Hours: 42

L	T	P	Cr
3	0	0	3

Module I: (9 Hours)

Introduction: Definitions of GIS - Components of GIS - Geographic data presentation: maps - mapping process - coordinate systems - transformations - map projections - geo referencing - data acquisition.

Module II: (11 Hours)

Geographic Data Representation, Storage, Quality and Standards: Storage - Digital representation of data - Data structures and database management systems - Raster data representation - Vector data representation - Concepts and definitions of data quality - Components of data quality - Assessment of data quality - Managing data errors - Geographic data standards.

Module III: (12 Hours)

GIS Data Processing, Analysis and Modeling: Raster based GIS data processing - Vector based GIS data processing - Queries - Spatial analysis - Descriptive statistics - Spatial autocorrelation - Quadrant counts and nearest neighbour analysis - Network analysis - Surface modeling - DTM.

Module IV: (10 Hours)

GIS Applications: (in one of the following areas)

Applications of GIS in Environment monitoring - Natural hazard management - Natural resources management urban planning - utility management - Land information - Business development

References

1. Lo, C.P. & Yeung A.K.W., Concepts and Techniques of Geographic Information Systems, Prentice Hall of India, New Delhi, 2006.
2. Anji Reddy, M., Remote Sensing and Geographical Information Systems, B.S.Publications, Hyderabad, 2001.
3. Burrough, P.A., Principles of Geographical Information Systems, Oxford Publication, 1998.
4. Clarke, K., Getting Started with Geographic Information Systems, Prentice Hall, New Jersy, 2010.
5. DeMers, M.N., Fundamentals of Geographic Information Systems, John Wiley & Sons, New York, 2002.
6. Geo Information Systems - Applications of GIS and Related Spatial Information Technologies, ASTER Publication Co., Chestern (England), 1992
7. Jeffrey, S. & John E., Geographical Information System - An Introduction, Prentice-Hall, 1990
8. Marble, D.F., Galkhs HW & Pequest, Basic Readings in Geographic Information Systems, Sped System Ltd., New York, 1984.

Course Outcomes :

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

1 Identify the GIS components and reference systems for mapping and data acquisition
2 Select suitable data representation tools and methods for analysis
3 Process the data to derive meaningful inferences for decision making
4 Apply the tools and techniques for the selected practical applications

CE6203 Pavement Materials, Design and Construction

Total hours : < 42 hours>

L	T	P	C
3	0	0	3

Course Objectives:

1. To provide the knowledge about various types of materials used for pavement construction
2. To understand uses of materials in each layer based on their properties
3. To get familiarized with various tests on pavement materials
4. To compare the physical, chemical and mechanical properties of pavement materials with respect traffic and environmental conditions
5. To acquire knowledge about various types and components of pavements
6. To understand the stresses and their distribution based on the crust properties
7. To distinguish between highway and airfield pavements
8. To familiarize with various methods of analysis of flexible and rigid pavements

Module I: (10 Hours)

Pavement Materials: Types and Component parts of Pavements - A brief study on aggregates, bitumen and modified bitumen like cutback, emulsion, polymer modified bitumen - Bituminous mix design methods, specifications and testing - Superpave.
Factors affecting Design and Performance of Pavements: Comparison between Highway and Airport pavements - Functions and Significance of Subgrade properties, Various Methods of Assessment of Subgrade Soil Strength for Pavement Design - Causes and Effects of variation in Moisture Content and Temperature - Depth of Frost Penetration

Module II: (12 Hours)

Analysis & Design of Flexible Pavement: Stresses and Deflections in Homogeneous Masses - Burmister's 2- layer, 3- layer Theories - Wheel Load Stresses - ESWL of Multiple Wheels - Repeated Loads and EWL factors - Sustained Loads and Pavement behaviour under Traffic Loads - Empirical, Semi-empirical and Theoretical Approaches - Development, Principle, Design steps, Advantages and Applications of different Pavement Design Methods - Mechanistic Empirical Pavement Design

Module III: (10 Hours)

Analysis & Design of Rigid pavements: Types of Stresses and Causes, Factors influencing the Stresses; General conditions in Rigid Pavement Analysis, ESWL, Wheel Load Stresses, Warping Stresses, Friction Stresses, Combined Stresses - Types of Joints in Cement Concrete Pavements and their Functions, Joint Spacings, Design of Slab Thickness, Design of Joint Details for Longitudinal Joints, Contraction Joints and Expansion Joints, IRC Method of Design - - Mechanistic Empirical Pavement Design.

Module IV: (10 Hours)

Pavement Construction: Earthwork - roadway excavation, embankment construction; Drainage -surface/subsurface, different types of drains; Subbase - Construction of gravel and stabilised bases; Base - WBM base, wet mix macadam; Bituminous pavements - preparation & laying of tack coat, bituminous macadam, mixed seal surfacing, bituminous concrete; Cement concrete pavements - construction methods of cement concrete roads, joints in plain and reinforced cement concrete pavements - Pavement Recycling.

References:

1. Yoder and Witezak, Principles of Pavement Design, John Wiley and sons, 1975.
2. Yang, Design of functional pavements, McGraw-Hill, 1973.
3. Harold N. Atkins, Highway Materials, Soils, and Concrete, Prentice Hall, 2002.
4. Robert D. Krebs, Highway Materials, McGraw Hill Text, 1971
5. Asphalt Institute, The Asphalt Handbook, 2007
6. IRC: 37-2001, Guidelines for the Design of Flexible Pavements.
7. IRC: 58-2002, Guidelines for the Design of Rigid Pavements.

8. RRL, DSIR, Concrete Roads, HMSO, IRC Publications
9. Lavin P G, Asphalt Pavements, Spon Press, 2003.
10. MORTH Specifications for Road and Bridge Works, Indian roads Congress
11. Kett I, Asphalt Materials & Mix Design Manual, Noyes Publications, 1999.
12. Kim Y R, Modelling of asphalt Concrete, ASCE Press, 2008
13. Mechanistic Empirical Pavement Design Guide, NCHRP, TRB, 2008.

Course Outcomes:

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

1. suggest suitable materials for different types of pavements
2. asses the properties of pavement materials with their suitability
3. interpret the material test results with respect to the field conditions
4. apply the material properties for analysis of pavements under traffic
5. understand the variation in specification for pavement materials used in other countries
6. identify the pavement types based on their behaviour under traffic
7. analyse the pavement components with respect to their material composition
8. estimate the stresses induced due to wheel load and temperature
9. design the pavement, flexible or rigid, for the conditions prevailing at site
10. provide feedback to update the design guidelines.

CE6101: Theory of Elasticity and Plasticity

L	T	P	C
3	0	0	3

Prerequisite: - Nil

Total Hours : 42 Hrs.

Course Objectives:

1. To understand the basis of mechanics of deformable solids with adequate mathematical vigour and thus appreciate the simplifying assumptions of *strength of materials theory*
2. To get familiarised with the index notation, a *language* extensively used in modern technical literature
3. To understand idealisations of elasticity as idealisations. The plane-stress, plane-strain, axisymmetric problems and their solutions based on the idealisations enable course registrants to comprehend the importance and necessity of such idealisations.
4. To understand energy theorems and variational formulations that provide an alternative problem formulation and that leads to a variety of numerical methods
5. To understand the behaviour of a non-circular prismatic bar subjected to torsion, thus appreciate the elementary torsion problem and its simple solution.
6. To get familiarised with the basic ingredients of theory of plasticity.

Module 1: (12 hours)

Introduction to the mathematical theory of elasticity: Elasticity, stress, strain, Hooke's law, two- dimensional idealisations, plane stress and plane strain problems, equations of equilibrium, strain- displacement relations, constitutive relations, compatibility conditions, displacement and traction boundary conditions.Two-dimensional problems in rectangular coordinates: Stress function, solution by polynomials, Saint Venant's principle, bending of a cantilever, determination of displacements. Two-dimensional problems in polar coordinates: General equations, problems of axisymmetric stress distribution, pure bending of curved bars, effect of circular hole on stress distribution in plates, concentrated force at a point on a straight boundary.

Module 2: (10 hours)

Introduction to Cartesian Tensors: Transformation laws of cartesian tensors, special tensors and tensor operations, the Kronecker's delta, the permutation tensor, the *e-S* identity, symmetry and skew- symmetry, contraction, derivatives and the comma notation, Gauss' theorem, the base vectors and some special vector operations, eigenvalue problem of a symmetric second order tensor, equations of elasticity using index notation.

Stress and strain problems in three dimensions: Principal stresses, principal strains, three-dimensional problems.

Module 3: (12 hours)

Energy Theorems and Variational Principles of Elasticity: Strain energy and complementary energy, Clapeyron's theorem, virtual work and potential energy principles, principle of complementary potential energy, Betti's reciprocal theorem, principle of linear superposition, uniqueness of elasticity solution. Torsion of straight bars: Elliptic and equilateral triangular cross-section, membrane analogy, narrow rectangular cross-section, torsion of rectangular bars, torsion of rolled profile sections, hollow shafts and thin tubes.

Module 4: (8 hours)

Introduction to plasticity: One-dimensional elastic-plastic relations, isotropic and kinematic hardening, yield function, flow rule, hardening rule, incremental stress-strain relationship, governing equations of elastoplasticity.

References

1. Timoshenko, S.P. and Goodier, J.N., Theory of Elasticity, Mc Graw Hill, Singapore, 1982.
2. Srinath, L.S., Advanced Mechanics of Solids, Second Edition, Tata McGraw Hill, India, 2003.
3. Ameen, M., Computational Elasticity—Theory of Elasticity, Finite and Boundary Element Methods, Narosa Publishing House, 2004.
4. Leipholz, H., Theory of Elasticity, Noordhoff International Publishing, Layden, 1974.
5. Sokolnikoff, I.S., Mathematical Theory of Elasticity, Tata Mc Graw Hill, India, 1974.
6. Xu, Z., Applied Elasticity, Wiley Eastern Ltd, India, 1992.
7. Chakrabarty, J, Theory of Plasticity, Elsevier, London, 2006.
8. Hill, R., Mathematical Theory of Plasticity, Oxford University Press, 1998.

9. Chen, W.F., and Han, D.J., Plasticity for Structural Engineers, Springer Verlag, 1998.

Course Outcomes:
The student will be able to

1. Mathematically formulate elasticity problems as a well posed boundary value problem
2. Solve simple engineering problems with mathematical rigour. Such solutions can act as bench-mark solutions for testing computational methods and software.
3. Appreciate the Cartesian Tensor notation, thereby understand modern technical literature, which otherwise would have appeared intricate.
4. Develop simple approximate methods based on variational formulations

CE6213 Pavement Evaluation & Management

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Total hours : < 42 hours>

Course Objectives:

1. To familiarize the various aspects of surface characteristics and their levels of influence in performance of pavement
2. To get exposure on various techniques for pavement distress evaluation
3. To assess the various pavement distresses in the field
4. To acquire knowledge on cost analysis of pavement maintenance and management
5. To analyse the various maintenance alternatives based on their suitability
6. To design and suggest best alternatives for optimised pavement performance

Module I: (11 Hours)
Pavement Surface Condition & Its Evaluation: Various Aspects of Surface and their Importance; Causes, Factors Affecting, Deterioration and Measures to Reduce: i) Pavement Slipperiness ii) Unevenness iii) Ruts, Pot holes, and Cracks; Methods of Measurement of Skid Resistance, Unevenness, Ruts and Cracks. Pavement Surface Condition Evaluation by Physical Measurements, by Riding Comfort and Other Methods; their Applications.

Module II: (11 Hours)
Pavement Structure & Its Evaluation: Factors affecting Structural Condition of Flexible and Rigid Pavements; Effects of Subgrade Soil, Moisture, Pavement Layers, Temperature, Environment and Traffic on Structural Stability, Pavement Deterioration; Evaluation by Non-Destructive Tests such as FWD, Benkelman Beam Rebound Deflection, Plate Load Test, Wave Propogation and other methods of Load Tests; Evaluation by Destructive Test Methods, and Specimen Testing

Module III: (9 Hours)
Pavement Overlays & Design: Pavement Overlays, Design of Flexible Overlay over Flexible Pavement by Benkelman Beam Deflection and other Methods, Flexible Overlays and Rigid Overlays over Rigid Pavements, Use of Geosynthetics inPavement Overlays.

Module IV: (10 Hours)
Pavement Management System: Concepts of pavement management systems, pavement performance prediction - concepts, modeling techniques, structural conditional deterioration models, mechanistic & empirical models, functional condition deterioration models, unevenness deterioration models and other models, ranking and optimization methodologies.

References
1. Yoder E.J. and Witezak, Principles of Pavement Design, II Ed., John Wiley and Sons, 1975.
2. Woods, K.B., Highway Engineering Hand Book, McGraw Hill Book Co.
3. David Croney, The Design and Performance of Road Pavements, HMSO Publications, 2008.
4. Haas and Hudson, Pavement Management System, McGraw Hill Book Co., New York, 1982.
5. Per Ullidtz, Pavement Analysis, Elsevier, Amsterdam, 1998.
6. HRB/TRB/IRC/International Conference on Structural Design of Asphalt Pavements, 1988.
7. SHAHIN, M Y, Pavement management for airport, roads and parking lots, Chapman and hall 2005.

8. Yang H. Huang, Pavement Analysis and Design, Prentice Hall, 2003.

Course Outcomes:

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

1. identify the causes of pavement surface distresses and suggest suitable remedial measures
2. suggest suitable remedial measures for various distresses to improve the pavement surface condition
3. interpret the field evaluation data and pavement design data with respect to present and future traffic condition
4. optimize the maintenance alternatives based on the benefit and cost ratio of the project alternative
5. adopt new technology for pavement evaluation and maintenance with respect to field performance and funds available
6. provide the feedback data for updating the pavement performance monitoring system

CE6491: Environmental Geotechnical Laboratory

L	T	P	C
0	0	2	1

Pre-requisite: Nil

Total hours : < 26 hours>

Course Objectives:

To acquire knowledge about

1. To familiarize tests for identification, classification and determination of engineering properties
2. To familiarize with chemical tests to evaluate leachate characteristics
3. To familiarize with various testes on water
4. To understand various tests for chemical constituents of soils

1	Permeability tests – constant and variable head
2	Swell and shrinkage test for soils
3	Test for compressibility
4	Test for determination of shear strength
5	Introduction to testing of geotextiles
6	Determination of total soluble solids, Organic matter
7	Determination of calcium carbonate, PH, soluble sulphates in soil.
8	Chemical tests for determination of cation exchange capacity
9	Chemical tests for leachate analysis, Iron, Manganese, chloride
10	Introductory tests for determination of surface area

Reference

IS 2720 : “Method of Test for Soil (relevant parts)”

Course Outcomes :

After the completion of the course, the student will be able to:

1. To get experience in testing for determination of engineering properties of soils
2. To get expose in various tests for identification and quantification of chemical constituents
3. To study and analyse chemical constituents of soils
4. To get exposure to geotextile testing facilities

CE 6492: Computational Geomechanics Laboratory

L	T	P	C
0	0	2	1

Pre-requisite: Nil

Total hours : < 26 hours>

Course Objectives :

The major course objectives are :

1. Familiarise the students with the basic drafting and documentation techniques.
2. Expose the students to various algorithmic techniques.
3. Familiarise the students with various application softwares in Civil engineering.
4. Give them hands on training on Geotehnical Engineering packages
5. Expose them to FEM software like PLAXIS, MIDAS etc.

To familiarize and give hands on training to students in the following areas of Civil Engineering Application software

1 Drafting and documentation
2 Surveying – terrain mapping, computation of areas & volumes
3 Structural Analysis and Design
4 Water resources
5 Geotechnical Engineering
6 Road/Railway system
7 Environmental Engineering
8 Estimation and costing
9 Project management

Recommended packages:

- Auto CAD
- MicroStation
- MS Office
- Matlab
- Grapher/Sigma plot
- Moss
- AutoCivil
- Intergraph
- ASAP
- STAAD
- Water CAD
- Flow master
- Win log

- Geoslope
- Beurcap MS – Project

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

1. Carry out scientific documentation and drafting.
2. Use various graph plotting softwares.
3. Write programs for the various geotechnical engineering problems.
4. Develop and implement user-friendly front engines for programs
5. Make use of the standard GE packages like Borelog, Geoslope, BearCap etc.

CE6493: Foundation Engineering Design Studio

L	T	P	C
0	0	2	1

Pre-requisite: Nil

Total hours : < 26 hours>

Course Objectives:

To acquire knowledge about

1. To get familiarise with design of shallow foundations

2. To get familiarise with design of deep foundations

3. To get exposure to various ground improvement technique

4. To familiarise with design of well foundation

5. To get exposure to retaining structure

Total hours: < 40 hours>

Module 1: (10 Hours)

Design Principles shallow foundations, Bearing capacity calculations from laboratory and field studies-settlement of footings—tilt and horizontal displacement- design of isolated, combined, centric footings – different types of rafts

Module 2: (10 Hours)

Design of pile foundations- bearing capacity calculations design of bored, pre cast, driven piles – pile settlement calculations – piles subjected to lateral loads grouping of piles

Module 3: (8Hours)

Design of various ground improvement techniques- soil nailing- stone columns –vibrofloatation- preloading- geo drains sand columns- reinforced earth

Module 4: (12 Hours)

Design of well foundations – retaining walls –sheet pile designs

References

1. Swami Saran, "A text book on Analysis and design of substructures" Oxford and IBH Publishing Co-856pp, 1996
2. Bowles.J.E, "Foundation Analysis and Design" . Mc GRAW-Hill International Book co , New Delhi, 1990

Course Outcomes :

After the completion of the course, the student will be able to:

1. Experience in design of different type of shallow foundation
2. To get experience in design of different type deep foundation
3. Experience in various ground improvement technique in section design
4. To familiarize the design of caission
5. To get exposure to sheet pile and retaining wall design

CE 6497: SEMINAR

L	T	P	C
0	0	0	1

Course Objectives :

The major course objectives are :

1. To introduce the students to various sub fields in Geotechnical / Environmental Geotechnical Engineering.
2. To expose them to current developments / research activities in the above areas.
3. To train the students to gather in depth information on any specific area / topic.
4. To train the students to make proper technical documentation on any selected topic.
5. To train the students to give effective technical presentations.

The students are expected to give a seminar on relevant topic related to environmental geotechnology either a research or a case study, covering various aspects like scope of the problem, methodology used for the study conclusions arrived at etc.

Course Outcomes :

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

1. Identify the current research trends / needs in any specific GE / EGE area.
2. Gather relevant information on any specific topic.
3. Technical documentation of the collected information.
4. Proper technical presentation of the collected information.

CE 7498 : PROJECT (S3)

L	T	P	C
			8

Course Objectives:

The major course objectives are :

1. To introduce the students to various sub fields in Geotechnical / Environmental Geotechnical Engineering.
2. To expose them to current developments / research activities in the above areas.
3. To train the students to gather in depth information on any specific area / topic.

4. To train the students to make proper technical documentation on any selected topic.
5. To train the students to give effective technical presentations.

The subject of study should be based on the latest works ongoing in the field of geotechnical and or environmental engineering.

Course Outcomes

On Completion of the course the students will be able to:

1. Develop the essential personal, organisational, management, theoretical and research skills to become independent researchers.
2. Demonstrate a degree of analysis and a degree of originality in advanced investigations.
3. Develop understanding of research philosophies, design and terminology as well as personal transferable skills.
4. Describe a process that has previously been unexplained, difficult or poorly/ partially understood and to conduct an active, systematic process of inquiry.
5. To prepare professional documentation of research work carried out.

CED 799 : PROJECT (S4)

L	T	P	C
			8

Course Objectives:

The major course objectives are :

1. To introduce the students to various sub fields in Geotechnical / Environmental Geotechnical Engineering.
2. To expose them to current developments / research activities in the above areas.
3. To train the students to gather in depth information on any specific area / topic.
4. To train the students to make proper technical documentation on any selected topic.
5. To train the students to give effective technical presentations.

The subject of study should be based on the latest works ongoing in the field of geotechnical and or environmental engineering.

Course Outcomes

On Completion of the course the students will be able to:

1. Develop the essential personal, organisational, management, theoretical and research skills to become independent researchers.
2. Demonstrate a degree of analysis and a degree of originality in advanced investigations.
3. Develop understanding of research philosophies, design and terminology as well as personal transferable skills.
4. Describe a process that has previously been unexplained, difficult or poorly/ partially understood and to conduct an active, systematic process of inquiry.
5. To prepare professional documentation of research work carried out.