DEPARTMENT OF CIVIL ENGINEERING

Scheme of Instruction and Syllabus of
M.E. (Civil Engineering)
Specialization: Geo Technical Engineering

Full Time
(2017-2018)

UNIVERSITY COLLEGE OF ENGINEERING
(Autonomous) Osmania University
Hyderabad – 500 007, TS, INDIA

(With effect from the Academic Year 2017-2018)

INSTITUTE

Vision

The Vision of the institute is to generate and disseminate knowledge through harmonious blending of science, engineering and technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research
- To generate , disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services to the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programmes
- Technology transfer and incubation

DEPARTMENT

Vision

To be as a leading academic department on pace with global standards and contribute to the development of economic, technically viable and useful to societal problems and challenges of civil engineering profession and also contribute to the regional and country's developmental activities.

Mission

- To train the human resources with knowledge base in the field of

Civil Engineering so that they can face the challenges of civil and infrastructural engineering problems to provide viable solutions.

- To integrate their understanding and attainable knowledge on the specializations for effective functioning in their profession and useful to the welfare and safety of mankind.
- To enhance the technical knowledge and research aptitude in the domains of various Civil Engineering specializations to serve the society in highly professional manner.
- Produce highly competent and capable professionals and motivated young academicians to provide solutions to real life problems of Engineering and Technology and has apt for continuous learning and dedication towards societal issues.

Programme Educational Objectives (PEO):

PEO-1: Impart theoretical concepts and fundamentals including appraisal of the principles involved, assumptions made, limitations and validity of the theories

PEO-2: Provide adequate scope to understand the mechanisms through laboratory experimentation.

PEO-3: Inculcate application of theoretical concepts to solve field challenges through illustration of Case Studies and Field visits.

PEO-4: Develop skill to transform the in-situ behavior in to a physical / analytical model, to analyze and to find solutions leading to a meaningful research outcome.

PEO-5: Prepare to deal with the professional challenges, demonstrate leadership, exhibit ethics contribute to the sustainable development of the society and to excel at global standards.

Programme Outcomes (PO):

PO-1: Acquisition of Strong theoretical base which enhance analytical capabilities

PO-2: Greater capability for laboratory experimentation and field evaluation of geotechnical behavior of soils / Rocks

PO-3 Ability to apply engineering knowledge, analyse, design and develop solution to complex geotechnical engineering problems

PO-4 Competence to take up research in a systematic and organized manner to obtain meaningful Outcome

PO-5 Development of comprehension, presentation / communication skills, adoption to modern tools and inclination for continued learning

PO-6 Preparation of Professionals who can understand field challenges in geotechnical engineering and provide an ideal/ethical solution towards sustainable development of society

MAPPING OF PEO'S WITH PO'S

PROGRAMME EDUCATIONAL OBJECTIVES						
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
PEO-1	YES	--	--	--	--	YES
PEO-2	--	YES	--	YES	---	YES
PEO-3	YES	YES	YES	YES	---	YES
PEO-4	----	----	YES	YES	YES	YES
PEO-5	YES	YES	YES	YES	YES	YES

SCHEME OF INSTRUCTION
for
ME-CIVIL-GEOTECHNICAL ENGINEERING- REGULAR COURSE

Syllabus Ref. No. / Code	Subject Title	Contact hours per week	Scheme of Examination		Credits
			CIE	SEE	
CORE SUBJECTS					
CE 1301	Theoretical Soil Mechanics	3	30	70	3
CE 1302	Advanced Soil Mechanics	3	30	70	3
CE 1303	Foundation Engineering-I	3	30	70	3
CE 1304	Foundation Engineering-II	3	30	70	3
CE 1305	Soil Dynamics & Machine Foundations	3	30	70	3
CE 1306	Expansive Soil Engineering	3	30	70	3
ELECTIVE SUBJECTS					
CE 1311	Sub-soil Exploration Methods	3	30	70	3
CE 1312	Ground Improvement Techniques	3	30	70	3
CE 1313	Instrumentation in Geotechnical Engineering	3	30	70	3
CE 1314	Designing with Geosynthetics	3	30	70	3
CE 1315	Design of Offshore Foundations	3	30	70	3
CE 1316	Geo-Environmental Engineering	3	30	70	3
CE 1317	Geotechnics in Tunnel Engineering	3	30	70	3
CE 1318	Advanced Engineering Geology	3	30	70	3
CE 1319	Rock Mechanics	3	30	70	3
CE 1105	Finite Element Methods	3	30	70	3
CE 1124	Neural Fuzzy & Expert Systems	3	30	70	3
CE 1320	Geospatial Technology	3	30	70	3
CE 1116	Advanced Concrete Technology	3	30	70	3
CE 1404	Statistical Techniques	3	30	70	3
DEPARTMENTAL REQUIREMENTS					
CE 1331	Geotechnical /Engineering Laboratory - I	2	50		2
CE 1332	Geotechnical /Engineering Laboratory – II	2	50		2
CE 1333	General Seminar –I	2	50		2
CE 1334	General Seminar –II	2	50		2
CE 1335	Project Seminar	4	100		8
CE 1336	ME Dissertation	6	GRADE		12

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Department of Civil Engineering
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CE 1301

THEORETICAL SOIL MECHANICS

Pre-requisite : Basic Soil Mechanics of BE/B.Tech-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understand theory of elasticity and its application to soils
- To learn application of theory of plasticity to describe engineering behavior of soils
- To describe engineering behavior of soils in terms of rheological models

Course Outcomes

- Competence in Theory of Elasticity, Plasticity and Rheological modeling
- Ability to apply theory of elasticity / plasticity / rheological modeling to analyse and obtain solution to challenges involving engineering behavior of soils
- Capacity building in research related to theoretical soil mechanics

UNIT- I

Theory of elasticity: Basic concepts, definitions and notations of stress strain components -Hooke's Law generalized equilibrium and compatible conditions in Cartesian, polar coordinates - principal stresses and strains - Octahedral stress-stain invariants.

UNIT- II

Stress and Strain Tensors: Stress in soil mass due to surface loads - Boussinesq's equations - elasticity problems in soil mechanics.

UNIT- III

Theory of plasticity: Ideal Plastic substance - strain hardening- yield criteria- Tressca, & Moses theory - Mohr's & Coulomb's yield surfaces- applications to soil mechanics problems.

UNIT- IV

Rheological Equations: Visco-Elasticity - Ideal viscous substances, Rheological models consisting more than two elements. Principle of superposition.

UNIT- V

Fundamental Applications of Theory of Elasticity and Plasticity in Soil Mechanics: One - dimensional consolidation, shear strength , long - term slope stability- creep and relaxation effects on earth pressure theories etc.

Suggested Reading:

1. Suklje, L, *Rheological Aspects of Soil Mechanics,* Wiley Interscience - John Wiley and Sons, 1969.
2. Salencon, J., *Applications of Theory of Plasticity in Soil Mechanincs,* John Wiley and Sons, 1974.
3. Foulis, G.T., *Sress-Strain Behavior of Soils,* Proceedings of Roscoe Memorial Symposium - Oxford Shire.

Department of Civil Engineering
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CE 1302

ADVANCED SOIL MECHANICS

Pre-requisite : Basic Soil Mechanics of BE/B.Tech-Civil Engg. programme
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understand the Seepage analysis and related applications
- To learn the mechanisms contributing to shear strength of soils, factors affecting and procedures for determination of shear parameters in laboratory
- To gain knowledge in the settlement analysis, earth pressure computation.
- To understand the soil mechanics associated with analysis, design and construction of Embankments and Earthen Dams

Course Outcomes

CO-1	Competence in understanding the Seepage / Shear Strength / Compressibility Characteristics of Soil
CO-2	Ability to compute earth pressure
CO-3	Core competence in analysis & design of Embankments and Earthen Dams
CO-4	Ability to analyse a field challenge and to recognize the soil mechanics involved in it and to provide a solution

UNIT-I

Soil water hydraulics: Seepage mathematical Analysis-finite difference formulae of study state and transient flow water soils- construction of flow nets in homogenous soils by graphical methods- computation of seepage for

ground water- embankments earth uplift pressures critical hydraulics- safety factors.

UNIT-II

Shear strength properties of soils: Review of conventional shear stress factors affecting shear strength of soils – pore pressure in soils- pore pressure measurements in triaxial compression test and field measurements- total and effective shear stress parameters- stress path – Hvorslave shear parameters – shear strength, thixotrophy and liquefaction of soils.

UNIT-III

Consolidation of properties: one, two and three dimensional consolidation theories – primary, secondary, consolidation process finite difference formulations of consolidation equations – radial consolidation – sand rain and other techniques to accelerate consolidation process- estimation of settlements.

UNIT-IV

Limiting equilibrium conditions: review of (Rankine, coulomb) Earth pressure theories computation of earth pressure using theory of plasticity for cohesive and cohesionless soils- soil tension effects- rupture zones- reliability of solutions- Earth pressure computations- soil properties to be used- graphical and computer solutions- Earth pressure theories by elasticity- pressure in soils- green elevators, coal bunkers etc.

UNIT-V

Earth dams and highway embankments- type of embankments, factors influencing design of embankments- control of pore pressure, slope stability analysis of embankments – critical study of failures- embankments settlements seepage analysis- seepage control methods- grade filters and their use- impervious zones cut of walls- slopes protection methods- swelling and shrinkage characteristics of soils- identifications- estimation of swell and swell potentials.

Suggested reading:

1. Scott, R.F., *Principles of Soil Mechanics*, Eastern Willey Publications.
2. Lambe, T.W. and Whitman, R.V., *Soil Mechanics*, John Wiley and Sons, 1969.
3. Alam Singh, *Soil Engineering in Theory and Practice*, Asia Publishing House,1981.
4. Sherard, J.E., *Earth and Rock Filled Dams*, John Wiley and Sons.

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Department of Civil Engineering
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CE 1303

FOUNDATION ENGINEERING-I

Pre-requisite : Basic Foundation Engineering of BE/B.Tech-Civil Engg.
Instructions :(L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To learn computation of stress in soils due to applied loads by application of elastic theories
- To understand the mechanism of bearing capacity of shallow foundations and learn to estimate the bearing capacity incorporating different ground conditions
- To learn the mechanics governing the stability of deep excavations
- To learn different methods of geotechnical investigations required for selection and design of shallow foundations.

Course Outcomes

CO-1 Ability to understand the Elastic theories and their application to compute increment in vertical pressure due to applied loads
CO-2 To gain comprehensive understanding about bearing capacity of shallow foundations (Isolated & Spread footings) and the analysis and design associated with it
CO-3 Competence in geotechnical aspects of deep excavations
CO-4 Capacity building for practice of shallow foundations

UNIT-I

General: Review of sub- soil exploration methods- including the rock properties- review of foundation design principles.

UNIT-II

Determination of bearing capacity of soils for foundations- review of existing methods- additional considerations for development of bearing capacity of equations (Terzaghi, Meyerhoff, Vesic, Brich Hansen etc.) - effect of water table, layered soils, foundation on slopes, uplift pressure- consideration from field test (S.P.T, C.P.T, K_S , E_S ETC.)- bearing capacity for rocks, safety factors in foundation design.

UNIT-III

Review of methods for stress distribution in elastic half space (Westguard, Newmark- Mendlin, Burmister, Boussieque etc.) – contact pressure distribution – conventional and finite element methods – determination of immediate , elastic, consolidation, creep settlements- size depth effects- settlement of rocky strata- reliability of settlement computations, structural tolerance differential settlements.

UNIT-IV

Spread footing foundations: principles of design- spread foundations for various structures- determination of ultimate bearing capacity for shallow, mat, special footing with case studies settlement analysis- introduction to finite element method of design. Design considerations of foundations on expansive soils.

UNIT-V

Walls for deep excavations of foundations: Necessity for deep excavation (>6m deep) various methods and techniques adopted- braced type wall supports- estimation of soil pressures – ground loss around excavations- instability due to heave and piping of bottom of excavations and other causes of instability- review of conventional and finite element methods for design of various members- slurry wall or trench excavations- consideration of safety factors. Estimation of earth pressure on deep buried pipes and conduits.

Suggested reading:

1. "Foundation Design and Analysis",-Fifth edition, by Joseph Bowles, Mc Graw Hills.
2. "Foundation Engineering Hand Book" by H.Y. Fang, CBS Pub., 1997.
3. "Foundations Design and Construction" by Tomlinson M.J.,Longman and technical scientific.

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Department of Civil Engineering

ME-CIVIL-Geotechnical Engineering

CE 1304

FOUNDATION ENGINEERING-II

Pre-requisite :Basic Foundation Engineering of BE/B.Tech-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understand the differentiation between shallow and deep foundations
- To learn the analysis and design of deep foundations
- To gain knowledge of aspects related to construction of foundations

Course Outcomes

CO-1 Comprehensive understanding about the necessity, types, suitability, installation, analysis and design of Deep Foundations (Pile / Pier / Caissons)
CO-2 Understanding the installation, analysis & Design of Sheet Piles, Cofferdams
CO-3 Core Competence in the practice of Deep foundations

UNIT- I

General : Types of piles- necessity and use of pile foundation - review of principles of design by conventional and finite element methods determination of pile capacities for vertical and horizontal loads - single pile and group of pile - for loads - tension piles - batter piles and anchor piles - settlement of pile foundations - negative skin fiction, design of pile caps - polygon of forces - pile load tests.

UNIT – II

Drelled pier foundation - types - their necessity - construction methods - determination of ultimate load capacity for vertical and lateral loads- settlement - pier inspection methods.

UNIT- III

Well foundations (Caissons) types of caissons - their necessity- principles of design by elastic and ultimate soil resistant methods (IRC-45) determination of grip length in cohesive and cohesionaless soils - setelements - scour depths - thickness of straining - case studies.

UNIT- IV

Sheet piles - necessity of using the piles - types of piles - principles of design consideration of sheet piles and their components - cantilevered, anchored, - review of convensional design methods and finite elements methods - stability number - sloping dredge line - overall stability safety factors.

UNIT–V

Coffer dams - different types and their utility- principles of design and construction of methods - review of convensional menthods.

Suggested Reading

1. "Foundation and analysis" - fifth edition, by Joseph Bowels, Mc Graw Hills.
2. "Foundations Engineering Hand Book" by H.Y.Fang , CBS Pub, 1997
3. "Foundation Design and construction" by Tomlinson M.J. Longman and technical scientific.

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Department of Civil Engineering

ME-CIVIL-Geotechnical Engineering

CE 1305

SOIL DYNAMICS AND MACHINE FOUNDATIONS

Pre-requisite :Basic Foundation Engineering of BE/B.Tech-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understand Theory of Vibrations and its application to the design of machine foundations
- To learn the laboratory and field test procedures for determination of dynamic properties of soils
- To gain knowledge of the dynamic earth pressure, dynamic bearing capacity of soils
- To learn the essentials of design of machine foundations

Course Outcomes

CO-1 Competence in application of theory of vibrations in modeling and analysis of machine foundations
CO-2 Competence in determination of dynamic properties of soils
CO-3 Ability to compute the dynamic earth pressure, dynamic bearing capacity of soils
CO-4 Comprehensive understanding about Liquefaction and its remediation
CO-5 Competence in the design of Machine foundations & Provisions of Earth quake resistant design of structures

UNIT-I

Theory of vibration, wave propagation in elastic, homogenous and isotropic medium - single degree of freedom - spring - dashpot, free and forced vibration and damping - description and methods of use of vibration measuring equipment.

UNIT-II

Determination of dynamics soil properties - field and laboratory methods.

UNIT-III

Determination of dynamic earth pressure- bearing capacities and liquefaction of soils

UNIT-IV

General principles of machine foundation design for reciprocating and impact type - vibration isolation and screening methods.

UNIT-V

Earthquake resistant design of structures - stipulation of IS Code 1893 case studies

Suggested Reading :

1. "Foundation Design and analysis" - fifth edition by Jospeh Bowels, Mc Graw Hills.
2. "Foundation Engg. Hand book" by H.Y.Fang, CBS Pub.1997
3. "Soil dynamics and machine foundations" by swami saran, Galgotia pub,1999

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Department of Civil Engineering

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CE 1306

EXPANSIVE SOIL ENGINEERING

Pre-requisit: Basic Clay Mineralogy & SM, FE of BE/B.Tech-Civil Engg.

Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)

Duration of University Examination : 3 Hours

University Examination : 70 Marks

Sessionals through continuous evaluation

(Two midterm assessments) : 30 Marks

Course Objectives

- To gain comprehensive understanding about identification and characterization of expansive soils
- To learn the laboratory test procedures for evaluation of expansiveness
- To learn the swell control measures

Course Outcomes

CO-1 Ability to understand the Engineering behavior of Expansive Soils, their presence, identification

CO-2 Competence in laboratory evaluation of swell potential of expansive soils

CO-3 Core competence in the analysis, design and construction of foundations / excavations in Expansive Soils and competence in providing remediation

UNIT-I

General: Necessity of study and importance. Spread of expansive soils in India and other countries. Various problems encountered for structural safety of structures, remedial measures.

UNIT-II

Clay mineralogy: study of physic- chemical properties of clay mineral including their micro structures, their identification by thermal, x-ray diffraction, Electron Microscopic methods engineering properties.

UNIT-III

Determination of swell and swell potential of soil water systems- laboratory and field estimates of heave. Study of moisture movements- swelling and shrinkage behaviors- cyclic swells- multidimensional swells. Shear strength, consolidation and earth pressure (Characteristic) properties of swelling clays.

UNIT-IV

Problems and remedial measures: Problems encounterd in shallow, deep foundations in swelling sub- soil strata- design considerations- study of case histories, methods of alteration or modification of swell properties. Use of under reamed piles and their design criteria – Reliability analysis of foundations on expansive soils- settlement characteristics- hysteresis of deformations of swelling soils- Inter swelling. Safety factors.

UNIT-V

Open and underground excavations in swelling and shrinkage soils- construction techniques to be adopted. Remedial measures- stabilization methods use of chemical grouts etc.

Suggested Reading:

1. Proceedings of 2nd Int conf on expansive soils research and engg. Texas, 1963.
2. Proceedings of 3rd Int conf on expansive soils Haifa Israel, 1978.

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CE 1311

SUB-SOIL EXPLORATION METHODS

Pre-requisite : Foundation Engineering of BE/B.Tech-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understand the objectives, necessity and scope of sub-soil exploration methods
- To learn the field and laboratory components of a geotechnical investigation
- To gain competence in interpretation of the investigation data
- To learn the methods of reporting including the recommendations

Course Outcomes

CO-1 Ability to understand the requirement of geotechnical investigations of project, select suitable method of investigation and planning
CO-2 Competence in the investigation methods including collection of samples, performing laboratory and field tests
CO-3 Competence to prepare Geotechnical Investigation report to suit the requirements of a project including necessary recommendations

UNIT – I

General considerations – Delineation of objectives of site investigation, reconnaissance, preliminary and detail investigations - methods and types of

investigations – spacing of bore holes – geophysical methods – planning of exploration methods.

UNIT – II

Methods of direct investigations, review of existing methods including for marine conditions, drilling in soils and rock, description of soils and rock during exploration, methods of sampling and preservations - ground water observations.

UNIT – III

Insitu tests(field) : static and dynamic tests – SPT, CPT, Dutch cone, shear vane, PMT, DMT, BST, permeability, KO, Plate load test, deformation modulus, tests on rocks RQD, chemical tests on water - recording of the tests and their interpretation – determination of dynamic properties of soils and rock for machine foundation designs – C_u, shear G, natural frequency, resonance, amplitude and damping ,etc.

UNIT – IV

Preparation of geotechnical investigation reports – geotechnical documentation – preparation of geotechnical features – generalized characteristics properties of soils – statistics methods, graphical correlations and factor of safety values. Final recommendation to evaluate the bearing capacities and settlement characteristics of soils and for use of proper selection of type of foundations.

UNIT – V

Preparation of monograms for determining the properties of soils, accuracy of results and storing the data for future use.

Suggested Reading:

1. J.E. Bowles – Foundation Design & Analysis.McGraw-Hill Edition 1995.
2. Soil Mechanics in Foundation Engg., Z Wilum and K.Starzewist, Survey University Press, 1975.

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CE 1312

GROUND IMPROVEMENT TECHNIQUES

Pre-requisite : Soil Mechanics of BE / B.Tech-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understand the objectives, necessity and scope of ground improvement techniques
- To learn different methods of insitu densification of cohesive, cohesionless soils
- To learn the classification, functions and applications of Geosynthetics in ground improvement
- To learn the process of identification of necessity for ground improvement, finding alternative methods and recommendation of the ideal technique through case studies

Course Outcomes

CO-1 Ability to understand the necessity of ground improvement and potential of a ground for improvement

CO-2 To gain comprehensive understanding about the improvement of in-situ cohesive soils as well as Cohesion less soils

CO-3 Competence to analyse an in-situ ground, identification of ground improvement techniques feasible, selection of the ideal method, its planning , design, implementation and evaluation of improvement level

UNIT – I

General : Formation of rock, soils and soil profiles, soil distribution in India and other countries - marine, black cotton soils (expansive)., lateritic, alluvial, desert soils peat etc., factors affecting the alteration of ground after formation – natural and man-made – reclaimed soils – methods of geotechnical processes.

UNIT – II

Compaction methods: moisture density relations – compactive efforts – field methods – surface compaction, deep compactions- vigor compaction methods, vibro-probes, stone columns, sand compaction, stone column piles, selection of methods – quality control – specifications for compaction process for solving field problems.

UNIT – III

Drainage methods: seepage, ground water seepage control – filter requirements methods of dewatering – well point methods of discharge computations – design of steps for dewatering – design of well screens – selection of pumps and accessories – deep bored wells.

Precompression methods: compressibility and consolidation properties of soils estimation of rate of consolidation settlements – accelerating methods – monitoring compressions – design of vertical drains – consolidation by electro osmosis and vacuum compression methods.

UNIT – IV

Grouting and injection methods: principles, design methods, selection of methods and requirements. Aspects of grouts, types of grouts and chemical applications, seepage control, solidification and stabilization – equipment and accessories used – quality control – specifications for achieving satisfactory results.

UNIT – V

Stabilization methods: mechanical, cement, lime, chemical methods of stabilization of soils – use of admixtures – polymers – geosynthesis – reinforcements thermal slurry trenches, void filling – prewetting – improving rock stability methods – exercise quality control to achieve desired results.

Suggested Reading:

1. J.E. Bowles – Foundation Design & Analysis.McGraw-Hill Edition 1995.
2. Ground improvement techniques by P. Purushottam Raj, Laxmi Pub., 1999.
3. F. S. Fang Handbook of Foundation Engg. CBS Pub., 1985.

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Department of Civil Engineering

ME-CIVIL-Geotechnical Engineering

CE 1313

INSTRUMENTATION IN GEOTECHNICAL ENGINEERING

Pre-requisite : Engineering Physics of BE / B.Tech-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understand the necessity and scope of Instrumentation in Geotechnical Engineering applications
- To gain comprehensive understanding about different types of Instrumentation, their principle, application and suitability
- To learnt the principles of instrumentation based on method of radiation

Course Outcomes

CO-1 Ability to understand the principles of working of different types of instrumentation

CO-2 Ability to place, data log and monitor functioning of the instruments

CO-3 Competence for identification of necessity, selection of the ideal type, its planning , design, implementation and evaluation of data acquired in any given Geotechnical Engineering Application

UNIT – I

General: Necessity and use of instrumentation – structural performance. Various methods of instrumentation techniques. Review of existing technique.

UNIT – II

Displacement measuring techniques (Horizontal and Vertical): Principles of designs of the equipments and measuring techniques – mechanical, electrical, mercury and hydraulic gauges(USBR, Maihak, SILRRL, BRS, RDO CRRI) – Composite settlement, tilt and crack measuring – settlement gauges.

UNIT – III

Prorepressure measuring devices: Well point, Casagrande, Geonor – electrical prunematic and hydraulic Piezometers – Manufacturing and installation and installation monitoring techniques. Limitations of these techniques. Monitoring on long term basis.

UNIT – IV

Stress – strain methods: Principles of design and use of methods – manufacturing, installation and monitoring methods – Auxiliary equipments required for monitoring. Their use and limitations. Earth pressure measuring cells, OYO monocello, Menard pressure cell.

UNIT – V

Instrumentation by radiation methods: Nuclear, infrared, neutron moderation methods different probes for measuring density, moisture content and components of soil and rock-stress and strain behaviors.

Suggested Reading:

1. "Soil Engineering" Vol. 2 by Alam Singh, CBS Pub., 1992.
2. "Foundation Instrumentations" by Hanna T.W., Transtech Pub., Switzerland.
3. USBR – Earth Manual, dennes, Colorado.

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CE 1314

DESIGNING WITH GEOSYNTHETICS

Pre-requisite : Soil Mechanics of BE / B.Tech-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understanding the necessity and scope of Geosynthetics in Ground Improvement
- To gain comprehensive understanding about different types of Geosynthetic Products their functions, application and suitability
- To learn the analysis and design of Reinforced Soil Walls

Course Outcomes

CO-1 Competence in identification of ideal geosynthetic function and ability to select the ideal product to serve the function
CO-2 Ability to analyse and design the application of geosynthetics
CO-3 Competence construction practices and evaluation of post construction improvement.

UNIT – I

An overview of Geosythetics : Introduction – Classification & basic description of Geosythetics – manufacturing process – Over view of Geotextiles, Geogrids, Geonets, Geomembranes and Geocomposites.
Design methods – Design by cost & availability – Design by specification – Design by function.

UNIT – II

Geotextile Properties and Test methods – Physical, Mechanical, Hydraulic, Endurance and Degradation properties.

Designing with Geotextiles : Geotextile functions and mechanisms – Designing for separation – Designing for reinforcement – Designing for stabilization – Designing for filtration – Designing for drainage – designing for multi functions.

UNIT – III

Geogrid Properties and Test methods – Physical, Mechanical, Endurance and Environmental properties.

Designing with Geogrids : Designing for geogrid reinforcement

Geonets Properties and Test methods – Physical, Mechanical, Hydraulic, Endurance and Environmental properties.

Designing with Geonets : Designing for geonet drainage

UNIT – IV

Geomembrane Properties and Test methods – Physical, Mechanical, chemical, biological, thermal and Identification properties.

Designing with Geomembranes – Liquid containment liners – Covers for reservoirs – Canal liners – Landfill liners – Caps & closures – Underground storage tanks etc.

UNIT – V

Designing with Geocomposites – Geocomposites for separation – reinforcement – filtration – drainage – liquid/ vapour barriers.

Construction methods & techniques using Geosynthetics.

Suggested Reading:

1. Hausman, M. R. (1990). " *Engineering Principles of Ground Modification*" McGraw-Hills
2. Moseley, M.P. (1193), "*Ground Improvemen*." Champman and Hall.
3. Koener, R.M. (2012), "*Designing with Geosynthetics, Vol.1 & 2*, Xlibriss Corporation LLC.
4. Rao, G.V. and Raju, G.V.S.S. (1995). " *Engineering with Geosynthetics*", Tata McGraw Hills.
5. Purushothama Raj, P. (2014). "*Ground Improvement Techniques*". Lami Publishers (P), Ltd. New Delhi
6. Fang, H.Y. (1191). "*Foundation Engineering Hand Book*", Second Edition, CBS Publications, New Delhi.

w.e.f. 2017-18

Department of Civil Engineering
ME-CIVIL-Geotechnical Engineering

CE 1315

DESIGN OF OFFSHORE FOUNDATIONS

Pre-requisite : Foundation Engineering of BE / B.Tech-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To learn the soil mechanics of seabed and the forces acting on an offshore structure foundation.
- To gain comprehensive understanding about Dynamics of Offshore structures and the geotechnical response of offshore structure foundations
- To learn the geotechnical analysis and design of offshore structure foundations.

Course Outcomes

CO-1 Knowledge of the forces acting on an offshore structure and ability to understand the Soil Mechanics of Seabed
CO-2 Comprehensive understanding about Dynamics of Offshore structures and the geotechnical response of offshore structure foundations
CO-3 Competence for analysis and design of Offshore structure foundations and ability to evaluate the risk associated.

UNIT – I

General: Nature of magnitude of loads on foundation of offshore structures – design consideration in relation to environment wave action on large offshore structures.

UNIT – II

Soil mechanics of seabed: Geotechnical studies of sea floor sediments – stability – bearing – capacity – features of foundation of gravity structures – bearing capacity and settlement under dynamic loads – immediate and long term behavior liquefaction under cyclic loads.

UNIT – III

Concrete structures and buried structures: dynamic stresses in pile driving – pile behavior, p-y curves – analysis of single and pile groups – long term performance of concrete in marine environment – general appraisal offshore structure – sea bed foundation considerations for gravity structures – finite element methods for inter active analysis using linear, nonlinear foundation response – geotechnical aspects of anchor and submarine pipe lines – coastal structures – ports and harbors.

UNIT – IV

Dynamics of offshore structures – Waves and wave action – wave induced loading on dynamic structures, offshore platform.

UNIT – V

Risk factors – assessment of the accuracy of design process – problems areas in design calculation and classified offshore structures – general research problems – state of art for long term experience and maintenance and operations of the offshore structure drilling and production platforms for the oil industry.

Suggested Reading:

1. Geotechnical and Ocean Engineering – Civil Engineering Practice, Edited by Paul N.C. Lancaster V Basel, 1998.
2. Numerical Methods in offshore piling – Institution of Civil Engineers, London, 1980.

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Department of Civil Engineering
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CE 1316

GEO-ENVIRONMENTAL ENGINEERING

Pre-requisite :Soil Mechanics / Env. Engg of BE / B.Tech-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understand the necessity and scope of safe waste disposal systems
- To gain comprehensive understanding about the planning and design of waste disposal systems
- To learn the analysis and design of applications of Geosynthetics in Geo-environmental applications.

Course Outcomes

CO-1 Competence in identifying the requirements of a safe waste disposal system.
CO-2 Ability to analyse and design the Geo-environmental application of geosynthetics
CO-3 Competence in construction practices and evaluation of post construction improvement.

UNIT – I

Wastes: source, production and classification of wastes, soil pollution processes, waste characterization.

UNIT – II

Waste disposal facilities such as landfills and impoundments, slurry walls, landfill planning and design.
Barrier systems – basic concepts, design and construction, stability, compatibility and performance contaminant transformation and transport in subsurface.

UNIT – III

Monitoring surface contamination, stabilization, and modification of wastes. **Reuse of waste materials**, contaminated site remediation. Case studies in waste handling.

UNIT – IV

Soil erosion and conservations – 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.

UNIT – V

Application of Geosynthetics : Introduction – Classification & Functions of Geosythetics –Over view of Geotextiles, Geogrids, Geonets, Geomembranes and Geocomposites.

Geosynthetics in Geo-environmental Engineering : Capping & Lining – Design requirements – Case studies.

Suggested Reading:

1. Daniel, D. E. Geotechnical practice for waste disposal, Chapman and Hall, London 1993
2. Rowe, R. K., Quigley, R. M. and Booker, Clay barrier systems for waste disposal facilities, J.R., E & FN Spon, London, 1995
3. Reddi, L. N., and Inyang, H. F. Geoenvironmental Engineering – principles and applications, Marcel Dekker, 2000
4. Bagchi, A. Design, construction and monitoring of landfills, John Wiley & Sons, New York 1994
5. Sharma, H. D. and Lewis, S. P., Waste containment systems, Waste stabilization and landfills: Design and evaluation John Wiley & Sons, New York 1994
6. Koener, R.M. (2012), "*Designing with Geosynthetics, Vol.1 & 2*, Xlibriss Corporation LLC.

Department of Civil Engineering
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CE 1317

GEOTECHNICS IN TUNNEL ENGINEERING

Pre-requisite : Soil Mechanics / Engg Geology of BE / B.Tech-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understand the factors governing selection of type and location of the tunnels.
- To gain comprehensive understanding about the planning and design of Tunnels
- To learn the construction practices and the associated challenges

Course Outcomes

CO-1 Competence in deciding the location of tunnels, type of tunnels and method of tunneling.
CO-2 Ability to analyse and design different components of the Tunnels and tunnel support systems.
CO-3 Competence in construction practices of Tunnels.

UNIT – I

Types of underground excavations: tunnel, shaft, cavern, etc. – Geotechnical and other parameters influencing location of a tunnel and its design; planning and Geotechnical Investigation for tunnelling.

UNIT – II

Geotechnical Analysis and Design of Tunnels – Analysis of state of stress in different stages of construction of a Tunnel – Design considerations of different components of a Tunnel. Application and use of Ground Improvement Techniques in construction of Tunnels.

UNIT – III

Methods of Tunnelling; selection of method of excavation.

Tunnelling in soft ground. Tunnelling in rock by drilling and blasting - method of excavation and design of blasting rounds. Tunnelling in rock by roadheading machines: cutting principles, method of excavation, selection, performance, limitations and problems.

UNIT – IV

Tunnelling in rock by tunnel boring machines: boring principles, method of excavation, Muck disposal. Selection, performance, limitations and problems; Excavation of large tunnels, special storage and underground space.

Shaft Sinking Methods –vertical, inclined, decline, shaft boring machines and their applications.

Muck disposal, Ground treatment,

UNIT – V

Supports in tunnels -operational criteria and principal types of supports.

Support design and stabilization techniques for underground tunnels and caverns. Steel supports, rock bolts, shotcrete, wire mesh, chainlink fabric and fibre reinforced shotcrete and other ground consolidation/grouting techniques. Tunnel services: ventilation, drainage and lighting.

Hazards in Tunnelling

Suggested Reading:

1. Tunnel Engineering Handbook by J O Bickel & T R Kuesel
2. Rock Mechanics Design in Mining & Tunneling by Z T Bieniawski

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Department of Civil Engineering

ME-CIVIL-Geotechnical Engineering

CE 1318

ADVANCED ENGENEERING GEOLOGY

Pre-requisite : Engineering Geology of BE / B.Tech-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understand the formation of Soils / Rock and its influence on their Engineering behavior.
- To learn Classification and characterization using advanced techniques such as Geophysical methods, RS, GIS etc.
- To gain comprehensive understanding about geological factors influencing the ground water hydraulics

Course Outcomes

CO-1 Ability to characterize the soil and rock based on their formation
CO-2 Competence in application of Geophysical methods for investigation of soils and rock
CO-3 Competence for accounting the geological aspects in the selection, investigation of ground for major civil engineering structures.

UNIT – I

Geology of soils: evolution, classification, characteristics, features, mechanical behavior and engineering uses of soils. Important clay minerals and their importance in soils.

Engineering geomorphology: evolution of different land forms ,(erosional and depositional) characteristic features and their suitability or response to various engineering works.

UNIT – II

Photogeology & remote sensing: Different types of aerial photographs, stereography, principles and uses of aerial photographs in the engineering practice. Infra red line scan(IRLS)and side looking airborne radar (SLAR) thermal properties of geological materials, sensors. Interpretation of landsat images and use of satellite images in civil engineering practice

UNIT – III

Engineering geophysics: principles, theory, instruments, filed methods, data collection and data interpretation of electrical and seismic refraction methods. application in engineering practice.

UNIT – IV

Ground water: artificial recharge of ground water, fluctuations in ground water levels due to various causes and management of ground water.

Environmental geology: effects of withdrawal of excessive ground water, disposal of solid and liquid wastes, environmental impact of water impoundment.

UNIT – V

Case histories: Engineering geology of most important dams and funnels of India.

References

1. Attewel and Farmer, *Principles of Geology*, Chapman and Publications, 1976.
2. Bell, F.G., *Fundamentals of Engineering Geology*, Butterworth Publications, 1983.
3. Bell, F.G., *Engineering Geology and Geotechnics*, Butterworth Publications, 1980.

w.e.f. 2017-18

Department of Civil Engineering

ME-CIVIL-Geotechnical Engineering

CE 1319

ROCK MECHANICS

Pre-requisite: SM & Adv. Engineering Geology of BE / ME-Civil Engg.
Instructions : (L/T/S/P) 3 theory periods per week (3/0/0/0)
Duration of University Examination : 3 Hours
University Examination : 70 Marks
Sessionals through continuous evaluation
(Two midterm assessments) : 30 Marks

Course Objectives

- To understand the formation of Rock, Classification, characterization, discontinuity analysis etc.
- To gain comprehensive understanding about state of stress in Rock mass and its measurement
- To learn the essentials of dynamic behavior of Rock Mass
- To learn analysis and design of Rock Slopes

Course Outcomes

CO-1 Competence in Rock Mass Characterization
CO-2 Ability to compute and measure state of stress in rock mass
CO-3 Competence for analysis and design of Rock Slopes and understanding about dynamic behavior of Rock Mass.

UNIT - I

Introduction : Rock as an Engineering material. review of rockmass classification systems.

Friction of Rocks: Phenomena with smooth surfaces, stiff stin slip oscillations.

Elasticity and strength of Rock: Stress, strain curve for different rocks under classical and modern strength criteria.

UNIT-II

Rock Discontnuity Analysis: Planes of weakness in rocks and their influnence on engineering works. Recording and plotting of discontinuity data.

Rock Testing: Laboratory and field testing of intact rocks masses as per standard practices.

UNIT-III

Initial stresses in rock and their Measurement: Infulence of the primary or virgin rock stresses on engineering works. Techniques for measurement of insitu stresses. Hydraulic fracturing the flat jack method and overcoring. Tunnels and Shafts: Secondary stress distribution around tunnels and shafts in elastic and plastic rocks. Methods of stabilization of tension zones.

UNIT-IV

Rock Slopes: Modes of failures, analysis of slopes, stabilization techniques.

UNIT- V

Rock Dynamics: Dynamic properties of rocks and their determination in the laboratory and field, rock blastering, rock bursts.

Suggested Reading:

1. Jaeger, J.C. and Cook, N.G.W., *Fundamentals of Rock Mechanics*", Chapman and Hall, 1976
2. Goodman, R.E. *Introduction to Rock Mechanics*, John Wiley and Sons, 1989
3. Vutukuri, V.S., Lama, R.D. and Saluja, S.S., *Handbook on mechanical properties of rocks,* Transtech Pub.1974

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Department of Civil Engineering

ME-CIVIL-Geotechnical Engineering

CE 1331

GEOTECHNICAL ENGINEERNIG LAB-I

Pre-requisites Advanced Soil Mechanics Theory

Instructions	**: 2 Lab periods per week**
Duration of University Examination	**: 2 Hours**
Sessionals	**: 50 Marks**

Objectives:

- Expose the students to different types of soils
- Experience the concepts of soil mass, soil solids, and soil structure.
- Understand the laboratory test procedures and appreciate the suitability of each test.
- Make the students to relate theoretical concepts in doing lab tests.

Outcomes:

- Competence in performing the laboratory experiments on soil specimen, analyse the results, interpret and validate the same
- Greater insight in to the soil behavior and hence enhanced understanding of soil mechanics
- Ability to model a field application in the laboratory to take up research

1. Identification tests(Minimum 10 samples)
   (a) Sieve analysis- Wet and dry hydrometer analysis-LL,PL, PI- Activity- Relative density- field application tests.
   (b) Chemical analysis- determination of organic content, $Caco_3$, p^H, soil section.
   (c) Mineralogical content tests – Clay mineral – kaolinite - Montmorillonite – illite – identification tests – D.T.A. – Sesquiexoxide x-ray diffraction methods- optical Methods
   (d) Blending of soils.

2. Modified compaction tests:
   (a) OMC- dry-clays and sand soil
   (b) Energy determination-w.r.t. field compaction and Vibro compaction methods
3. Permeability Tests:
   (a) Falling and constant head tests – Their implications – correlation w.r.t. grain size, viscosity- void ratio temperature- verification of $k=c.D_{10}^2$
   (b) Capillary permeability tests
   (c) Determination of 'k' for layered soils- Horizontal and Vertical
   (d) Drawing flow nets- analytical,graphica,electrical.
   (e) Design of graded filters

4. Consolidation Tests:
   (a) One,Two,Three Dimensional consolidation tests- evalution of k, c_v, T_v-Time lag studies- rate of consolidation.
   (b) Square root time, log log time methods.
   (c) Creep studies- secondary consolidation
   (d) Design of sand drains

3. Shear strength: On clay, sand and mixed soils.
   (a) Box shear, vane shear tests- tri axial tests to determine c and f
   (b)verification of shear tests- field studies
   (c) studies on use of large samples 75mm,100mm&150mm.
   (d)stress path studies
   (e) CBR tests- correlations

6.Swell and Swelling Tests (Expansive soils):
   (a) Determination of swell and swell potentials tests in Relation to mineralogical content.

Suggested Reading :

1. IS:2720 – Relevant Parts.
2. Lambe, T.W., "*Soil Testing for Engineers*", Wiley Eastern Ltd., New Delhi, 1969.

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Department of Civil Engineering

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CE 1332

GEOTECHNICAL ENGINEERNIG LAB-II

Pre-requisites : Advanced Soil Mechanics Theory
Instructions : 2 Lab periods per week
Duration of University Examination : 2 Hours
Sessionals : 50 Marks

Objectives:

- To learn advanced laboratory tests for evaluation of Ground Improvement, Vibration characteristics
- To understand the application and use of advanced instrumentation.
- To practice the geotechnical investigation methods

Outcomes:

- Competence in performing the laboratory / Field experiments pertaining to ground improvement, to analyze the results, interpret and validate the same
- Greater insight in to the soil behavior and hence enhanced understanding of advanced soil mechanics
- Ability to plan, organize and conduct of geotechnical investigations including report writing and issue of receommendations.

1. Stress distribution studies;
   (a) Model studies – verification of Boussesq & Westergaard theories-using loads cells-on cohessionless soil deposits.
   2. Instrumentation Engineering relevant to Geotechnical Engineering
   problems:
   (a) Settlement gauges
   (b) Inclinometers
   (c) Pressure cells and load cells
   (d) Nuclear meters

3. Ground Improvement techniques:
(a) Soil stabilization methods-cement,Ca,k,etc.
(b) Grouting tests-equipments.
(c) Geo textiles- Geo fabrics & synthetics-metallic-determination of Their basic properties-soil reinforcement tests (friction).

4. Rock Testing:
   (a) Compression tests
   (b) Tensile tests
   (c) Determination of E, classification of rocks, RQD.

5. Sub soil investigation:
   (a) Auger procedures
   (b) Collection of samples- procedures
   (c) Drilling methds- wash boring, percussion, rotary (field tests)
   (d) SPT tests
   (e) Cone tests (dynamic and static)
   (f) Vane shear tests
   (g) Plate load tests- cyclic, continuous

6. Vibration analysis tests:
(a) Use of pickups, oscillators, oscilloscopes- measurement of amplitudes, phase, frequency- resonance etc.
(b) Simple tests on footing tests- dynamic studies on cohesion less Soils- model or prototype studies
7. Geotechnical Reporting Methods, Summery, Preparation of project reports with recommendations.

Suggested Reading :

1. IS:2720 – Relevant Parts.
2. Lambe, T.W., "*Soil Testing for Engineers*", Wiley Eastern Ltd., New Delhi, 1969

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CE 1333

Seminar-I

Instruction : 3 periods per week
Sessional : 50 Marks

Course Objectives:

- To work on a specific technical topic in Construction Engineering and Management in order to acquire the skills of oral presentation.
- To acquire technical writing abilities for seminars and conferences.

Course Outcomes:

- Identify appropriate topic of relevance.
- Update literature on technical articles of selected topic and develop comprehension.
- Prepare a technical report.
- Deliver presentation on specified technical topic

At least two faculty members will be associated with the seminar presentation to evaluate and award marks.

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Seminar-II

CE 1334

Instruction : 3 periods per week
Sessional : 50 Marks

Course Objectives:

- To work on a specific technical topic in Construction Engineering and Management in order to acquire the skills of oral presentation.
- To acquire technical writing abilities for seminars and conferences.

Course Outcomes:

- Identify appropriate topic of relevance.
- Update literature on technical articles of selected topic and develop comprehension.
- Prepare a technical report.
- Deliver presentation on specified technical topic

The objective of the seminar is to prepare the student for a systematic and independent study of the state of art topics in his/her specialization. Seminar topics may be chosen by the students with the advice of the faculty members. Students are exposed to the following aspects:

Each student is required to submit a technical write-up, presentation of their study (about 20 minutes) followed by a discussion.

At least two faculty members will be associated with the seminar presentation to evaluate and award marks.

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PROJECT SEMINAR

CE 1335

Instruction : 3 periods per week
Sessional : 50 Marks

Each student will be attached to a faculty member, (Guide) for project seminar during third semester. The student will carry out the project which may be development of Software/Hardware/Simulation. Studies/ Design/ Analysis/Experimental related to his/her specialization: The work will be monitored regularly by the guide. At the end of semester, student will write the report on the work done and submit to the guide. Student has to present his/her work before two faculty members (one guide and other to be appointed by Chairman BOS) on a fixed day during last week of the semester in which the project seminar is offered. The sessional marks will be awarded jointly by these two examiners based on report, the presentation and viva voice.

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CE 1336

Dissertation

Instruction	**: 6 periods**
University Examination	**: viva voice**
Examination	**: 200 Marks**

Course Objectives:

- Expand on the defined research problem in dissertation.
- Conduct laboratory/analytical studies.
- Analyse data, develop models, offer solutions and give conclusions.

Course Outcomes:

- Develop on the defined research problem in dissertation.
- Carry out laboratory/analytical studies.
- Evaluate data, develop models, offer solutions and give conclusions.

Each student will be attached to a faculty member who will monitor the progress of the student. The student is required to submit a technical write-up, presentation of their study (about 20 minutes) followed by a discussion.

The dissertation shall be internally scrutinized by a Viva-Voce committee consisting of the Head of the Department, Chairman Board of Studies, Supervisor and Examiner.

The Dissertation will be scrutinized by an external examiner as per the institute guide lines applicable.

CE 1105 *w.e.f. 2017-18*

FINITE ELEMENT METHODS

No. of Credits	**: 3 Credits**
Instruction	**: 3 Periods per week**
Duration of University Examination	**: 3 Hours**
Semester End Evaluation	**: 70 Marks**
Continuous Internal Evaluation	**: 30 Marks**

Course Objectives:

- Learn the rudiments of finite element analysis.
- Study the fundamentals of domain discretization, interpolation, application of boundary conditions, assembly of global matrices, and solution of the resulting algebraic systems.
- Explain the core concepts of variational and weighted residual methods in FEM.
- Derive the element stiffness matrix for 1-D, 2-D and 3-D problems.
- Formulate the simple structural problems in to finite elements.

Course Outcomes:

- Build and analyse the FEA models for various engineering problems.
- Identify the information requirements and sources for analysis, design and evaluation.
- Use the standard finite element software to solve the structural engineering problems.
- Interpret the results obtained from FEA software, not only in terms of conclusions but also awareness of limitations.

UNIT – I

Introduction to FEM: Types of problems – Types of materials – Elastic, inelastic situations – Types of forces - Body forces, surface traction, point loads – Deformable bodies – Types of deformations – Homogeneous, non homogeneous problems – Equations of equilibrium for elastic 2-D, 3-D continua - Equilibrium equations for 2-D, 3-D boundary elements – Boundary conditions – Strain-displacement relation for 2-D, 3-D problems

– Stress-strain relation for 2-D, 3-D problems – Plane stress, plane strain problems.
Virtual work formulation: Application to problems of plane trusses with static indeterminacy not exceeding three.

Finite difference method with central differences: Solving ODE‘s and PDE‘s with central differences - Application to beam and plate bending problems of simple geometry.

UNIT – II

Variational formulation: Finite element formulation - Stationarity of functional - Given the functional or differential equation – Number of elements limited to two.

1-D Elements: Strain-displacement relation matrix - Stiffness matrix - Minimum potential energy approach - Rayleigh-Ritz Method - Introduction to natural coordinates - Stiffness matrix of second order bar element - Axial bar subjected to point loads, body forces and surface traction forces - Problems with kinematic indeterminacy not exceeding two.

2-D Triangular elements**:** Displacement models - Criterion for convergence - Geometric invariance - Conforming and non-conforming elements - 3-node triangular (CST) element - Strain-displacement matrix - Area coordinates, shape functions - Element stiffness and load matrices – Assembly of global stiffness and load matrices - Problems with kinematic indeterminacy not exceeding three.

2^{nd} Order triangular elements: Shape functions – Degradation technique - Strain-displacement matrix - Expression for stiffness matrix - Load matrices due to body forces and surface traction.

UNIT – III

Iso-parametric elements: Quadrilateral elements: **S**hape functions using natural coordinates - Strain- displacement matrices - Load matrices for body force and surface traction - Stiffness matrix - Load matrices for 4-node quadrilateral elements - Gauss quadrature of numerical integration - Problems with rectangular elements, kinematic indeterminacy not exceeding three.

2^{nd} Order Quadrilateral elements: - Shape functions for 2^{nd} order quadrilateral elements and for elements of with serendipity - Strain-displacement matrix - Load matrices for body force and surface traction.

UNIT – IV

Method of weighted residuals: Galerkin's method of weighted residuals: Application to problems of mathematics and structural engineering, number of trial functions not exceeding two.

Galerkin's finite element method: Weak form of trial function - Application to problems of mathematics and structural engineering, number of elements limited to two.

Axi-symmetric problems: Strain-displacement matrix - Stress-strain relationship - Stiffness matrix for 3-noded ring element - Load matrices for body force and surface traction - Problems with kinematic indeterminacy not exceeding three.

UNIT – V

Tetrahedron elements: Volume coordinates, Strain-displacement matrix - Stiffness matrix - Load matrices due to body force and surface traction - Introduction to hexahedron (brick) elements.

Non-linear Finite element analysis: Introduction – Problems with material non-linearity – Problems with geometric non-linearity – Problems with both material and geometric non- linearity.

Introduction to MSC Nastran: Illustration on different modules of Nastran - Structural engineering applications of the package - Creation of a simple 1-D model, 2-D model and a 3-D model - Analysis and post processing of the results.

Suggested Reading:

1. R.D. Cook, “Concepts and Application of Finite Element Analysis”, John Wiley and Sons, 1981.
2. O.C. Zienkiewicz and R.L. Taylor, “The Finite Element Method, Volume 1: The Basis”, McGraw-Hill, London, 1989.J.N. Reddy, “An Introduction to the Finite Element Method”, McGraw-Hill, New York, 1993.
3. David V. Hutton, “Fundamentals of Finite Element Analysis”, Tata McGraw-Hill, New Delhi, 2005.
4. K.J. Bathe, “Finite Element Procedures”, Prentice Hall of India, New Delhi, 2006.
5. T.R. Chandrupatla and A.D. Belegundu, “Introduction to Finite Elements in Engineering”, Prentice Hall of India, New Delhi, 2001.
6. P. Seshu, “Finite Element Analysis”, Prentice Hall of India, New Delhi, 2003.

CE 1116 *w.e.f. 2017-18*

ADVANCED CONCRETE TECHNOLOGY

No. of Credits	**: 3 Credits**
Instruction	**: 3 Periods per week**
Duration of University Examination	**: 3 Hours**
Semester End Evaluation	**: 70 Marks**
Continuous Internal Evaluation	**: 30 Marks**

Course Objectives:

- Learn the characterization of constituents of concrete.
- Design concrete mix by various methods as per different codes.
- Study the different types of admixtures, mix design, properties and applications of special concretes.

Course Outcomes:

- Learn hydration of cement and tests on properties of cement and aggregates.
- Comprehend the properties and testing of concrete in fresh and hardened state.
- Understand the shrinkage and creep mechanisms, curing and durability of concrete.
- Design concrete mixes by various methods.
- Familiarize with the types of admixtures, and applications of special concretes.

UNIT - I

Cement: Types of cement and their composition - Manufacture of Portland cement - Hydration of cement and hydration product - Structure of hydrated cement - Heat of hydration - Gel theories - Review of tests on properties of cement.

Aggregate: Classification of aggregates - Particle shape and texture - Bond and strength of aggregate and its influence on strength of concrete - Porosity - Absorption and moisture content and their influence - Soundness of aggregate - Alkali aggregate reaction - Sieve analysis and grading of aggregate - Review of tests on properties of aggregate.

UNIT - II

Properties of Concrete: Mixing and batching - Workability - Factors affecting workability - Measurements of workability - Various tests and procedures - Segregation and bleeding - Vibration of concrete - Types of vibrators and their influence on composition - Analysis of fresh concrete - Strength of concrete - Water-cement ratio - Gel space ratio - Effective water in the mix - Mechanical properties of concrete - Tests and procedure - Influence of various parameters on strength of concrete - Relationship between various mechanical strengths of concrete.

UNIT - III

Shrinkage and creep of concrete: Types of shrinkage - Mechanism of shrinkage - Fctors affecting shrinkage - Creep mechanism - Factors influencing creep - Rheological model - Effects of creep.

Curing of Concrete: Methods of curing - Maturity concept - Influence of temperature on strength of concrete.

Durability of Concrete: Permeability of concrete - Chemical attack of concrete - Tests on sulphate resistance - Effect of frost - Concreting in cold weather - Hot weather concreting and air entrained concrete.

UNIT - IV

Mix design of concrete: Basic considerations - Process of mix design - Factors in the choice of mix proportions and their influence - Quality control - Various methods of mix design - IS code method - British and ACI methods.

UNIT - V

Admixtures: Classification of admixtures - Chemical and mineral admixtures - Influence of various admixtures on properties of concrete and their applications.

Fly ash concrete: Mix design - Properties and its applications.

High strength concrete: Mix design -

Properties and its applications. Fiber

reinforced concrete: Mix design - Properties

and its applications.

Ferro cement - Lightweight concrete - High-density concrete - Recycled aggregate concrete and their applications.

Suggested Reading:

1. A.M. Neville, “Properties of Concrete”, English Language Book Society-Longman Publications, 1988.
2. P.K. Mehta and J.M.M. Paulo, “Concrete – Microstructure – Properties and Material”, McGraw-Hill, New York, 1997.
3. N. Krishna Raju, “Design of Concrete Mix”, CBS Publications, New Delhi, 1985.

GEOSPATIAL TECHNOLOGY

CE 1320 *w.e.f. 2017-2018*

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- Discuss the various spatial and non-spatial data types, and data base management techniques
- Develop the concepts and professional skills in utility of geospatial techniques
- Improve the working knowledge of geospatial techniques in field problems

Course Outcomes:

- Geospatial technology relating to the data acquiring and processing that is associated with geographic locations
- Application of Geospatial techniques in the decision support systems useful for decision makers and community services.
- Utility of Geospatial techniques in the fields of natural resource management, environment, urban planning and development, etc.

UNIT –I

Introduction - Basic concepts, socioeconomic challenges, fundamentals of geographical information systems (GIS), history of geographical information system, components of geographical information systems.

Projections and Coordinate Systems - Map definitions, representations of point, line, polygon, common coordinate system, geographic coordinate system, map projections, transformations, map analysis.

UNIT –II

Data Acquisition and Data Management - data types, spatial, non spatial (attribute) data, data structure and database management, data format, vector and raster data representation, object structural model filters and files data in computer, key board entry, manual digitizing, scanner, aerial photographic data, remotely sensed data, digital data, cartographic database, digital elevation data, data compression, data storage and maintenance, data quality and standards, precision, accuracy, error and data uncertainty.

Data Processing - Geometric errors and corrections, types of systematic and non systematic errors, radiometric errors and corrections, internal and external errors.

UNIT –III

Data Modeling - Spatial data analysis, data retrieval query, simple analysis, recode overlay, vector data model, raster data model, digital elevation model, cost and path analysis, knowledge based system.

GIS Analysis and Functions - Organizing data for analysis, analysis function, maintenance and analysis of spatial data, buffer analysis, overlay analysis, transformations, conflation, edge matching and editing, maintenance and analysis of spatial and non spatial data.

UNIT –IV

Applications of GIS - Environmental and natural resource management, soil and water resources, agriculture, land use planning, geology and municipal applications, urban planning and project management, GIS for decision making under uncertainty, software scenario functions, standard GIS packages, introduction to Global Positioning Systems (GPS) and its applications.

UNIT – V

Introduction to Remote Sensing - General background of remote sensing technology, objectives and limitations of remote sensing, electro-magnetic

radiation, characteristics, interaction with earth surface and atmosphere, remote sensing platforms and sensors, satellite characteristics, digital image processing, IRS series and high resolution satellites, software scenario functions, remote sensing applications to watershed modeling, environmental modeling, urban planning and management.

Suggested Reading:

1. Burrough, P. A., and McDonnell R. A. (1998). *Principles of Geographical Information Systems.* Oxford University Press, New York, Pp.333.
2. Choudhury S., Chakrabarti, D., and Choudhury S. (2009). *An Introduction to Geographic Information Technology.* I.K. International Publishing House (P) Ltd, New Delhi, Pp.276.
3. Kang-tsung Chang. (2006). *Introduction to Geographical information Systems.* Tata McGraw-Hill Publishing Company Ltd., Third Edition, New Delhi, Pp.432.
4. Lilysand T.M., and Kiefer R.W. (2002). *Remote Sensing and Image Interpretation*. John Wiley and Sons, Fourth Edition, New York, Pp.724.
5. Sabins F.F. Jr. (1978). *Remote Sensing Principles and Interpretations.* W.H. Freeman and Company, San Francisco, Pp. 426.
6. Tor Bernhardsen. (2002). *Geographical Information System.* Wiley India (P) Ltd., Third Edition, New Delhi, Pp. 428.
7. Hoffman-Wellenhof, B, et al. (1997). *GPS Theory and Practice.* Fourth Edition, Springer Wein, New York.

CE 1124 *w.e.f. 2017-18*

NEURAL, FUZZY AND EXPERT SYSTEMS

No. of Credits	3 Credits
Instruction	3 Periods per week
Duration of University Examination	3 Hours
Semester End Evaluation	70 Marks
Continuous Internal Evaluation	30 Marks

Course Objectives:

- Explain the concepts of neural networks, fuzzy logic, and genetic algorithms.
- Solve problems that are appropriately solved by neural networks, fuzzy logic, and genetic algorithms.
- Understand the structure of expert systems.
- Get exposure to software packages in practice.

Course Outcomes:

- Learn the mathematical theory behind the intelligent problem solving approaches and apply them to write the code to solve a particular design problem.
- Carry out three design projects in the course in neural networks, fuzzy logic, and genetic algorithms.
- Covers intelligent approaches to solving engineering problems that are appropriate for pattern matching, control, optimization, and other areas.
- Solve the problems pertaining to artificial neural networks, fuzzy logic and expert systems using standard software packages.

UNIT- I

Introduction: Brief introduction to the study of artificial intelligence - An insight to the concept of natural intelligence followed by the development of artificial neural networks, fuzzy logic systems and expert systems tool - Demonstration of the importance of artificial neural networks, fuzzy logic and expert systems with the help of at least two practical examples of civil engineering for each study - Importance of nuero-fuzzy systems.

UNIT - II

Neural networks: Components of artificial neural networks - Neurons - Inputs - Outputs - Error - Error propagation - Hidden layers - Threshold logic - Weights - Bias - Noise - Momentum - Rate of learning - Training and testing - Hebb's rule - Delta rule - Supervised learning - Generalized Delta rule - Unsupervised learning - Types of neural networks - Perceptions - Feed forward back propagation networks - Hop field networks.

UNIT - III

Fuzzy sets: Crispness - Vagueness - Uncertainty and fuzzy sets – Basic definitions and operations of Fuzzy sets - Approximate reasoning and membership function.

Fuzzy relations: Fuzzy relation and fuzzy composition - Fuzzy aggregation procedures - Dominance matrix - Weightages - Applications of fuzzy sets to civil engineering problems - Pattern recognition.

UNIT - IV

Expert systems: Structure of expert systems - Knowledge acquisition - Knowledge organization - Methods of representing knowledge - Types of inference engines - Reasoning under uncertainty - Various types of expert system tools - Heuristics - Search mechanism - Expert system development[1] and hybrid expert systems.

UNIT - V

Exposure to software packages: Neural networks (Mat lab tool kit) - Fuzzy logic — Expert systems (L5 object) - Applications of artificial neural networks, fuzzy logic and expert systems in civil engineering - Case studies with at least one problem on each aspect of ANN, FL and Expert systems.

Suggested Reading:

1. H.J. Zimmerman, “Fuzzy Sets, Decision Making and Expert Systems”, Kluwer Academic Publications, Boston, 1987.
2. Elaine Rich, Kevin Knight and S.B. Nair. “Artificial Intelligence”, Tata McGraw-Hill, New Delhi, 2009.
3. H. Adeli, "Expert Systems in Construction and Structural Engineering" Chapman & Hall, London, 1988.
4. J.A. Freeman and D.A. Skapura, “Neural Networks Algorithms, Applications and Programming", Addition-Wesley Publishing, Massachusetts, 1991.

CE 1404 *w.e.f. 2017-2018*

STATISTICAL TECHNIQUES

Instruction	3 periods per week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessionlas	30 Marks

Objectives:

- To introduce fundamental knowledge of sampling technique
- To describe basic statistical techniques such as statistical distributions and correlation methods
- To impart knowledge on exact sampling distributions and the tests of significance

Outcomes:

- Students who successfully complete this course will be able to:
- Use sampling techniques for conducting various surveys related to transportation engineering
- Decide best fit and develop the regression equations for the given variables
- Applications ofsampling distributions in Highway and Traffic Engineering problems.

UNIT-I

Introduction: Frequency distribution; Measures of central tendency; Measures of dispersion; Standard error, Moments(about mean, arbitrary numbers and orgin);Skewness; Kurtosis; Sampling-Definitions and Applications; Simple random sampling; Stratified sampling; Systematic sampling; Sample size determination; Applications in Highway and Traffic Engineering

UNIT-II

Statistical Distribution; Probability , Bayes' Theorem; Binomial, Poisson, Exponential and Normal distributions; Fitting of distributions; Mean and variance ; Chi-square test of goodness-of-fit; Applications in Highway and traffic Engineering. Mathematical expectation.

UNIT-III

Regression and Correlation : Linear regression and correlation; Multiple correlation; Multiple correlation coefficient; Standard error of estimate; Analysis of variance; Curvilinear regression; Applications in Transportation Engineering.

UNIT-IV

Multi Variate Data Distributions ; Types of data; Basic vectors and matrices; Simple estimate of centroid, Standard deviation Variance and covariance ; Correlation matrices ; Principal component analysis;. Time series analysis. Estimation-Point Estimation, In
terval Estimation, Box Plot, Maximum likelihood estimation, Biased & Non Biased Estimation.

UNIT - V

Exact Sampling Distributions and Tests of Significance; Chi-square distribution; students t-distribution; Snedectors F-distribution. Large sample and small sample tests ; Tests for single mean. Means of two samples, Proportions, two variances, two observed correlation coefficients, paired T-tests, Applications. Intervals for mean, variance and regression coefficients; Applications in Highway and Traffic Engineering Problems.

Suggested Reading

1. Basic Statistics - Simpson and Kafks; Oxford and IBH Calcutta,1969.
2. Fundamentals of Mathematical Statistics - Gupta, S.C. and Kapoor, K. V. Sultanchand
3. Multivariate Data Analysis – Cootey W.W & Cochens P.R; John Wiley & Sons

CE 0111 *w. e. f. 2017-2018*

ENGINEERING RESEARCH METHODOLOGY

No. of Credits	3 Credits
Instruction	3 Periods per week
Duration of University Examination	3 Hours
Semester End Evaluation	70 Marks
Continuous Internal Evaluation	30 Marks

Course Objectives:

- Learn the research types, methodology and formulation.
- Know the sources of literature, survey, review and quality journals.
- Understand the research design for collection of research data.
- Understand the research data analysis, writing of research report and grant proposal.

Course Outcomes:

- Differentiate the research types and methodology.
- Able to do literature survey using quality journals.
- Able to collect research data.
- Process research data to write research report for grant proposal.

UNIT - I

Research methodology: Objectives and motivation of research - Types of research - Research approaches - Significance of research - Research methods verses methodology - Research and scientific method - Importance of research methodology - Research process - Criteria of good research - Problems encountered by researchers in India - Benefits to the society in general. Defining the research problem: Definition of research problem - Problem formulation - Necessity of defining the problem - Technique involved in defining a problem.

UNIT – II

Literature survey: Importance of literature survey - Sources of information - Assessment of quality of journals and articles - Information through internet. Literature review: Need of review - Guidelines for review - Record of research review.

UNIT – III

Research design: Meaning of research design - Need of research design - Feature of a good design - Important concepts related to research design - Different research designs - Basic principles of experimental design - Developing a research plan - Design of experimental set-up - Use of standards and codes.

UNIT – IV

Data collection: Collection of primary data - Secondary data - Data organization - Methods of data grouping - Diagrammatic representation of data - Graphic representation of data - Sample design - Need for sampling - Some important sampling definitions - Estimation of population - Role of statistics for data analysis - Parametric vs. non parametric methods - Descriptive statistics - Measures of central tendency and dispersion - Hypothesis testing - Use of statistical softwares.

Data Analysis: Deterministic and random data - Uncertainty analysis - Tests for significance - Chi-square - Student's t-test - Regression modeling - Direct and interaction effects – ANOVA - F-test - Time series analysis - Autocorrelation and autoregressive modeling.

UNIT - V

Research report writing: Format of the research report – Synopsis – Dissertation - Thesis - Its differentiation – References – Bibliography – Webliography - Technical paper writing - Journal report writing - Making presentation - Use of visual aids.

Research proposal preparation: Writing a research proposal and research report - Writing research grant proposal.

Suggested Reading:

1. C.R Kothari, "Research Methodology, Methods & Technique", New Age International Publishers, New Delhi, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, Chennai, 2011.
3. Ratan Khananabis and Suvasis Saha, "Research Methodology", Universities Press, Hyderabad, 2015.
4. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publishing Pvt. Ltd., New Delhi, 2004.
5. Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.
6. G. Nageswara Rao, "Research Methodology and Quantitative methods", BS Publications, Hyderabad, 2012.

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