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| **KERALA TECHNOLOGICAL UNIVERSITY**  http://ktu.edu.in/images/logo_final.png  **SCHEME AND SYLLABUS**  **FOR**  **M. Tech. DEGREE PROGRAMME**  **IN**  **CIVIL ENGINEERING**  **WITH SPECIALIZATION**  **GEOMECHANICS AND STRUCTURES**  **CLUSTER 05 (ERNAKULAM II)**  **KERALA TECHNOLOGICAL UNIVERSITY CET Campus, Thiruvananthapuram Kerala, India -695016**  **(2015 ADMISSION ONWARDS)** |

**KERALA TECHNOLOGICAL UNIVERSITY**

**SCHEME AND SYLLABUS FOR M. Tech. DEGREE PROGRAMME**

**Branch: CIVIL ENGINEERING**

**Specialization: GEOMECHANICS AND STRUCTURES**

**SEMESTER - I**

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| **ExamSlot.** | **Course No.** | **Subject** | **Hrs / Week** | | | **Internal Marks** | **End Semester Exam Evaluation Scheme (Marks)** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration (Hrs)** |
| A | 05CE6201 | Theoretical Geomechanics | 3 | 1 | 0 | 40 | 60 | 3 | 4 |
| B | 05CE6203 | Advanced Soil Mechanics | 3 | 1 | 0 | 40 | 60 | 3 | 4 |
| C | 05CE6205 | Advanced Design of Concrete Structures | 3 | 1 | 0 | 40 | 60 | 3 | 4 |
| D | 05CE6207 | Soil Exploration and Field Testing | 2 | 1 | 0 | 40 | 60 | 3 | 3 |
| E | 05CE621x | Elective - I | 2 | 1 | 0 | 40 | 60 | 3 | 3 |
|  | 05CE6277 | Research Methodology | 1 | 1 | 0 | 100 | 0 | 0 | 2 |
|  | 05CE6291 | Advanced Geotechnical Lab | 0 | 0 | 2 | 100 | 0 | 0 | 1 |
| **Total** | | | **14** | **6** | **2** |  |  |  | **21** |

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| **Elective-I** | |
| **Course No** | **Subjects** |
| 05CE6211 | Slope stability |
| 05CE6213 | Soil structure Interaction |
| 05CE6215 | Advanced Concrete Technology |

**SEMESTER –II**

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| **ExamSlot.** | **Course No.** | **Subject** | **Hrs / Week** | | | **Internal Marks** | **End Semester Exam.valuation Scheme (Marks)** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration (Hrs)** |
| A | 05CE6202 | Structural Design of Foundations | 3 | 1 | 0 | 40 | 60 | 3 | 4 |
| B | 05CE6204 | Foundation Analysis and Design | 2 | 1 | 0 | 40 | 60 | 3 | 3 |
| C | 05CE6206 | Ground Improvement Techniques | 2 | 1 | 0 | 40 | 60 | 3 | 3 |
| D | 05CE622x | Elective II | 2 | 1 | 0 | 40 | 60 | 3 | 3 |
| E | 05CE623x | Elective – III | 2 | 1 | 0 | 40 | 60 | 3 | 3 |
|  | 05CE6266 | Seminar-I | 0 | 0 | 2 | 100 | 0 | 0 | 2 |
|  | 05CE6288 | Mini Project | 0 | 0 | 4 | 100 | 0 | 0 | 2 |
|  | 05CE6292 | Civil Engineering Design Studio | 0 | 0 | 2 | 100 | 0 | 0 | 1 |
| **Total** | | | **11** | **5** | **8** |  |  |  | **21** |

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| **Elective-II** | | **Elective-III** | |
| **Course No** | **Subjects** | **Course No** | **Subjects** |
| 05CE6222 | Rock Mechanics | 05CE6232 | Ground Water Engineering |
| 05CE6224 | Prestressed Concrete Structures | 05CE6234 | Environmental Geotechinics |
| 05CE6226 | Earth and Earth Retaining Structures | 05CE6236 | Dynamics of Soil and Design of Machine Foundation |

**SEMESTER – III**

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| **Exam Slot.** | **Course No.** | **Subject** | **Hrs / Week** | | | **Internal Marks** | **End Semester Exam. valuation Scheme (Marks)** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration (Hrs)** |
| A | 05CE724x | Elective IV | 2 | 1 | 0 | 40 | 60 | 3 | 3 |
| B | 05CE725x | Elective V | 2 | 1 | 0 | 40 | 60 | 3 | 3 |
|  | 05CE7267 | Seminar-II | 0 | 0 | 2 | 100 | 0 | 0 | 2 |
|  | 05CE7287 | Project (Phase I) | 0 | 0 | 8 | 50 | 0 | 0 | 6 |
| **Total** | | | **4** | **2** | **10** |  |  |  | **14** |

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| **Elective-1V** | | **Elective-V** | |
| **Course No.** | **Subject** | **Course No.** | **Subject** |
| 05CE7241 | Marine Geotechnical Engineering | 05CE7251 | Analysis and Design of Pavements |
| 05CE7243 | Earthquake Analysis and Design of Structures | 05CE7253 | Geosynthetics in Civil Engineering |
| 05CE7245 | Advanced Steel Structures | 05CE7255 | Finite Element Analysis |

**SEMESTER – IV**

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| **ExamSlot.** | **Course No.** | **Subject** | **Hrs / Week** | | | **Internal Marks** | **End Semester Exam. valuation Scheme (Marks)** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration (Hrs)** |
|  | 05CE7288 | Project (Phase II) | 0 | 0 | 21 | 70 | 30 | 0 | 12 |
| **Total** | | | **0** | **0** | **21** |  |  |  | **12** |

**TOTAL : 68**

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| ****05CE6201**** | | **THEORETICAL GEOMECHANICS** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  To build the students knowledge on stress and strain distribution in soil, Rheological behavior of soil and failure theories. COURSE OUTCOMES:  * The students will be in a position to analyze stresses and strains occurring in soil. * The students will be able to apply various theories to analyse the strength and behaviour of soils under loads. * The students will be able to carry out model studies. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Analysis of stress and strain, Equilibrium equations - Compatibility equations - stress strain relationship. Generalized Hooke’s law. . Octahedral shear ,Stress function .Plane stress and plane strain - Simple two dimensional problems in Cartesian and polar co-ordinates. Deviator stress | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Stresses in Soil: Description of state of stress and strain at a point, stress distribution problems in elastic half pace Boussnesque’s analysis for concentrated force. Pressure bulb. Uniformly loaded circular and rectangular areas. Newmark influence diagram. Vertical and horizontal line loads. Uniform vertical load over a strip. Principal stress and maximum shear. Triangular and other loadings.  Westergaard’s analysis. Burmister’s two layer theory. Stress distribution around tunnels and vertical shafts. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | Rheological properties of material-equation of state, models, stress deformation behavoiur of soil subject to loading, solution of problems of linearly elastic solids. Deformation of Rheological constants. Pore pressure developed, settlement computations | 10 |
| **IV** | Failure theories, Yield criteria , Tresca, Von Mises , Mohr-Coulomb failure conditions. Failure loci in deviatoric plane and principal stress space, influence of intermediate principal stress on failure.  Constitutive Models in Soil Mechanics: Isotropic Elastic, Anisotropic Plasticity and Viscous Models. Representing Soil Behaviour using these Models. ; Advances in Constitutive models | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCES:**   1. Timoshenko, S. and Goodier J.N., “Theory of Elasticity”, McGraw Hill Book   Co., ewyork, 1988   1. Sadhu Singh, “Theory of Elasticity”, Khanna Publishers, New Delhi, 1988. 2. Slater R.A.C, “Engineering Plasticity”, John Wiley and Son, New York, 1977. 3. Chou P.C. and Pagano, N.J. “Elasticity Tensor, Dyadic and Engineering Approaches”, D. Van Nostrand Co., Inc., London, 1967. 4. Scott R. F. “ Principles of Soil Mechanics”, Addison & Wesley, 1963 5. Harr M.E, “Theoretical Soil Mechanics”, 1977 6. Selvadurai A.P.S., “Plasticity &Geomechanics”, Cambridge University Press, 2002 7. Chen W.F., “Limit Analysis & Soil Plasticity”, Elsevier Scientific, 1975 8. Desai C.S. and Christian, J.T. “Numerical Methods in Geotechnical Engineering”, McGrew Hill, New York, 1977. | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| ****05CE6203**** | | **ADVANCED SOIL MECHANICS** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  To make students understand soil structure, stress strain characteristics of soils, the mechanism of failure, settlement of soil, the factors that affect the shear strength and the various test procedures to determine the shear strength. COURSE OUTCOMES: The students will be able to identify and illustrate the structure of a soil and its stress strain behaviour.   * The students will get a thorough knowledge to analyse the strength characteristics and settlement behaviour of a soil strata. * The students will be in a position to determine the strength parameters of soil by conducting different tests. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Origin, nature and distribution of soil, classification of soil , description of individual particle, clay mineralogy, atomic bonds, clay-water electrolytes, soil fabric and structure. Clay mineral identification. X-ray and Differential Thermal Analysis. | | | | 9 |
| **INTERNAL TEST 1(Module 1)** | | | | | |
| **II** | Effective stress principle, steady state flow in soil, effect of flow on effective stress, determination of coefficient of permeability, surface tension and capillary phenomenon , measurement of capillary rise in soil consolidation ,one, two, three and radial direction, variation of effective stress during consolidation, consolidation tests and determination of consolidation parameters -measurement of swelling pressure- secondary consolidation and its effect on pre-consolidation pressure. | | | | 9 |
| **INTERNAL TEST 2(Module 2)** | | | | | |
| **III** | Shear strength- Stress path, Tri-axial ,direct shear, UCC and vane 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, -stress history, rate of loading, structure and temperature, anisotropy of strength, thixotropy, creep, determination of in situ undrained strength. | | | | 10 |
| **IV** | Soil settlement prediction in sand, simplified strain influence factor, SkemptonBjerrum modification- settlement of clays – pre compression –stress path for settlement calculation.  Compaction- tests, effect on soil structure, engineering behaviour on preloading compaction control in field | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Lambe T.W, Whitman R.V , “Soil Mechanics”, John Wiley & Sons,2008. 2. Mitchell, J. K, “Text book in Fundamentals of Soil Behaviour”, 2Ed, John Wiley &Sons, New York, 1993 3. Holtg,R.D and Kovacs W.D, “An Introduction to Geotechnical Engineering” , Prentice hall CO, N.J, 1981 4. Hough, B. K, “Basic Soil Engineering”, The Ronald Press Co, New York. 1957 5. Braja M Das, “Advanced soil Mechanics”, Taylor and Francis , 1997. 6. Scott R F, “Principles of Soil Mechanics”, Addison & Wesley. 1963. | | | | | |
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| COURSE CODE | | | COURSE NAME | L-T-P-C | YEAR | |
| ****05CE6205**** | | | **ADVANCED DESIGN OF CONCRETE STRUCTURES** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  The objective of this course is to make students to learn principles of Structural Design, To design different types of structures and to detail the structures. To evaluate performance of the structures.  **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Understand the principles of Structural Design * Design and develop analytical skills. * Summarize the principles of Structural Design and detailing * Understands the structural performance. | | | | | | |
| MODULE | | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | | Yield line method of analysis of slabs:– Characteristic features of yield lines– analysis by virtual work method – Yield line analysis by equilibrium method, Design of grid floor –Approximate method (IS code method). | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | | |
| **II** | | Design of continuous beams – Redistribution of moments, Design of portal frames. Design of building frames, Design of Pile foundation: Pile and Pile cap- single and group with friction and end bearing. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | | |
| **III** | Design of special RC elements:– Design of slender columns, Design of shear walls (with and without boundary elements), Design of Deep beams, Design of corbels. | | | | | 10 |
| **IV** | Design of flat slabs:– Introduction–components–IS Code recommendations– IS code method of design- with and without drop- interior and exterior panels. | | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**   1. Pippard A J S, “The Analysis of Engineering Structures”, Edward Arnold Publishers Ltd. 2. Krishna Raju N., “Advanced Reinforced Concrete Design”, CBS Publishers and distributors, New Delhi. 3. Krishna Raju., “Design of Reinforced Concrete Structures” 4. Punmia,Ashok K Jain,Arun K Jain,”Reinforced Concrete Vol:II”. 5. P C Varghese, “Limit State Design of concrete structures”. 6. P C Varghese, “Foundation engineering”. 7. S Ramamrutham, R Narayan., “Design of Reinforced Concrete Structures” 8. S SBhavikatti , "Advance R.C.C Design Vol II". 9. Rajagopalan, “Design of Storage structures” 10. Reynolds Handbook. 11. Relevant IS Codes. 12. Menon&Pillai – “Design of R.C.C. Structures” 13. Bikash Chandra chattophadhyay, Joyantamaity, “Foundation engineering”. 14. N P Kurian, “Design of Foundation Systems”. |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6207** | | **SOIL EXPLORATION AND FIELD TESTING** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To familiarize the students with principles of exploration, different methods of exploration and sampling techniques. To gain knowledge about Forensic analysis of geotechnical failures, offshore investigation and Geotechnical instrumentation.  **COURSE OUTCOMES:**   * The students will get expertise in planning and conducting soil investigation programme. * The students will be able to give soil investigation reports of various projects and will be able to suggest suitable foundations for the structures. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Principles of exploration; planning of investigation programmes , preliminary investigation-geophysical methods, electrical resistivity and seismic refraction methods, sounding, methods of exploration – open pits, trenches, shafts, tunnels, drifts, auger boring, rotary drilling, wash boring, percussion drilling, depth and spacing of exploration, codal provisions  Modern methods sampling, different samplers- open drive sampler, thin walled sampler, piston sampler; disturbed and undisturbed samples in cohesion less and cohesive soils, representative and non-representative samples, Sample retainers, Preservation and transportation of samples, sampling records. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Various types of field tests; plate load test, pressure meter tests, dilatometer tests, in-situ permeability tests, in situ vane shear test, bore hole shear tests.  Field testing for dynamic properties- Seismic Cross hole test, SPT, cyclic plate load test, Block Vibration Test, In situ measurement of K0 | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Standard Penetration Test, SPT Corrections, Uses of SPT value. Correlation of N value with shear strength and relative density. Static and Dynamic Cone Penetration Test, Uses of CPT value, Correlation with classification, shear strength and relative density, correlation with SPT and CPT value.  Investigation in rock, rock sampling , Rock quality designation Location of water table, soil profiles and bore log, interpretation of exploration data and report preparation Forensic analysis of geotechnical failures, methodology of back analysis | | | | 10 |
| **IV** | Pile load test – Pullout test, lateral load test., cyclic load test  Geotechnical Instrumentation – settlement, soil pressure, pore water pressure Investigation below sea/river bed; comparison between onshore and offshore investigation, bathymetry, drill ship and sea bed investigations, under water sampling | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Hunt R.E, “Geotechnical Engineering investigation Manual”, McGraw Hill, 1984 2. Bowles J.E., “Foundation Analysis and Design” (4Ed.), Mc.Graw Hill, NY, 1996 3. Tomlinson M.J, “Foundation Design and construction”, Pitman Publishing Limited, London, 1975. 4. Winterkorn H. F. and Fang H Y, “Foundation Engineering Hand Book”, GalgotiaBooksource, 1975. 5. Ranjan G. and Rao A S R, “Basic and Applied Soil Mechanics”, New Age international Publishers, 2000 6. Kurien, N.P., “Design of Foundation Systems : Principles & Practices”, Narosa, New Delhi, 1992 | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6211** | | **SLOPE STABILITY** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To provide students with an understanding of land slide phenomenon, analysis of slope stability, and to familiarize them with practical aspects of stabilizing slopes.  **COURSE OUTCOMES:**  The student will be able to analyze the stability of slope and will be able to suggest suitable slope stabilization method | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction, Natural slopes and Engineered slopes .Factors contributing slope failures, Types of failures Basic concept of slope stability. Factors considered for analysis: Site topography, Ground water, Shear strength, seismicity. Effect of ground water: Design, Wetting band approach, Developing of groundwater model, ground water effect on slope stability, ground water in rock. Monitoring of groundwater – Piezometer, observation wells. Site investigation: Planning of exploration program for slope stability. Concept of factor of safety. Pore water pressure. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Infinite slope analysis: In dry sand, c-φ soil with seepage. Planar surface analysis, Circular surface analysis- Friction circle method. Method of slices: Ordinary method of slices, Bishop method, Janbu’s method. Limit equilibrium method. Selection of Analysis method. Use of design charts. Effect of tension crack, vegetation, foundation load etc. on slope stability analysis. Earthquake loading considerations: Pseudostatic method, Newmark’s displacement method. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Methods of stabilizing slopes: Unloading – excavation, lightweight fill vegetation, Buttressing- Counter berms, shear keys, mechanically stabilized embankments. Drainage – Surface drainage, subsurface drainage, Reinforcement- Soil nailing, Stone columns, micropiles, Geosynthetically reinforced slopes, Retaining walls- driven piles,gravity and cantilever retaining walls, tie back walls. Soil hardening. Vegetation – general design, Species, biotechnical stabilization. Surface slope protection: Shotcrete, chunam plaster, masonry, Rip-Rap, Soil hardening- Compacted soil – cement fill, electro osmosis, grouting, lime injection, pre consolidation; Alternate methods – Complete removal of slide zone, Facility relocation, Bridging. Selection of stabilization methods. Rock slope stabilization methods. | | | | 10 |
| **IV** | Land slides: Identification, Types and mechanism, Features and dimensions, Land slide rates and type of movements, Seepage flow mechanism due to infiltration, Mechanism of rainfall induced landslides, field loading conditions, correlation between landslide and rainfall.mitigation.  Landfill slopes: Typical configurations, landfill waste engineering properties, Geosynthetics in landfill ,Geosynthetic Clay Liners, Anchor trenches. Construction of landfills. Stability: Excavation slope stability, waste fill stability, Cover system stability. Recent advances in slope stability analysis. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Abramson L. W, Lee T. S , Sharma S and Boyce G M , “ Slope Stability and Stabilization Methods”, Willey Interscience publications, 1996 2. Das B M,“Principles of Geotechnical Engineering”, Thomson Books, 2004 3. Lambe T W. and Whitman R V, “Soil Mechanics”, John Wiley & sons ,2008 4. Murthy V. N. S , “Principles of Soil Mechanics and Foundation Engineering”, UBS Publishers Private Ltd. **,** 2002 | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6213** | | **SOIL STRUCTURE INTERACTION** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To provide students with an understanding of soil-foundation interaction, beam and plate on elastic foundations and on analysis and design of pile.  **COURSE OUTCOMES:**   * The student gets knowledge to analyze on soil-foundation interaction problems. * The students will be able to analyze and design pile foundation. * The students will be capable to analyse and find solutions for settlement and load distribution problems. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Soil-Foundation Interaction:  Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behavior | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Beam on Elastic Foundation- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions ; Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, | | | | 10 |
| **IV** | Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts. | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**   1. Kurien N.P., “Design of FoundationSytems: Principles & Practices”, Narosa, New Delhi, 1992. 2. Melerski E.S., “Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation”, Taylor and Francis, 2006. 3. Reese L.C., “Single piles and pile groups under lateral loading”, Taylor & Francis, 2000 4. Jones G., “Analysis of Beams on Elastic foundation”, Thomas Telford, 1997. 5. Cakmak,A.S, “ Soil Structure Interaction”, Elsevier, 1987. |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6215** | | **ADVANCED CONCRETE TECHNOLOGY** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To provide students with an understanding of concrete mix design, modern trends in concrete manufacture and placement techniques. Familiarize on light weight concrete.  **COURSE OUTCOMES:**   * After studying this course, students will be able to determine the properties of concrete ingredients i.e. cement, sand, coarse aggregates, water by conducting different tests. * Design economic mix proportion for different exposure conditions and intended purposes. * Use different types of admixtures to improve the properties of concrete for different field applications. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Cement : Manufacture of Portland Cement - Chemical Composition of Portland Cement - Hydration of Cement- Types of Cement- Physical Properties of Cement- Chemical Requirements of Cement- Storage of Cement.  Water: Functions of Water- Suitability of Water- Sources of Water | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Aggregates: Properties & Testing of Aggregates- Deleterious Materials and Organic impurities - Aggregate Crushing Value - Aggregate Impact Value - Aggregate Abrasion Value - Soundness - Size and Grading of Aggregates - Fineness Modulus - Shape and Surface Texture of Aggregates - Specific Gravity, Density, and Water Absorption - Bulking of Sand  Chemical and Mineral Admixtures: Accelerators - Air Detrainer - Bonding Agents - Corrosion Inhibitors - Entraining Admixture - Foaming Admixture - Fungicide and Germicide Inhibition Admixture - Gas Former - Pigments - Pozzolanas - Pumping Aids - Retarder - Shrinkage Compensators - Superplasticizer - Waterproofing Compounds - Water Reducer | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | Concrete Mix design: Methods of Mix Proportioning- Factors Influencing Design of Concrete Mix- Mix Using IS:10262(2009)- Using ACI 211.1-91(2002)- British Mix Design Method (DOE Method)- Modification with Artificial Aggregate, Pozzolanas  Concrete Production: Batching- Mixing- Transporting- Tests of Fresh Concrete- Placing- Compacting- Curing- Finishing | 10 |
| **IV** | Engineering properties of concrete: Compressive Strength -Tensile Strength - Modulus of Elasticity - Poissons’s Ratio - Multiaxial Strength - Shear Strength -Bond Strength - Impact Strength - Fatigue Strength - Acceptance Criteria for Strength.  Durability: Creep- Relaxation- Shrinkage and Swelling- Permeability- Chemical Attack- Corrosion of Steel Rebars- Frost Action- Fire Damage- Design for Durability  Special concretes | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCES:**   1. A.M. Nevellie and J.J. Brook, - Concrete Technology, Pearson India 2. M.S. Shetty - Concrete Technology: Theory and Practice, S. Chand India 3. A.R Santhakumar – Concrete technology, Oxford University Press, New delhi 4. Krishnaraju, N., “Advanced Concrete Technology”, CBS Publishers. | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6277** | | **RESEARCH METHODOLOGY** | 1-1-0-2 | 2015 | |
| COURSE OBJECTIVES:  To generate awareness about the importance, types and stages of research along with different methods of data collection, analysis, interpretation and presentation of results.  **COURSE OUTCOMES:**  On successful completion of this course, students are able to understand   * The significance of different types of research and its various stages. * The different methods of data collection. * Different methods for analyzing data and interpreting the results. * The proper way of reporting and presenting the outcome | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction to research methodology. Types of research, research methods Vs methodology – stages of research process. Literature review – Problem definition- Research design for exploratory, descriptive and experimental research – Brief introduction to completely randomized design, randomized block design and Latin square designs (description only). | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Sampling fundamentals –Types of sampling: probability and non-probability sampling. Sampling theory, sampling distribution and sample size determination. Tools and techniques of data collection: Questionnaire and schedule for field surveys, interview, observation, simulation, experimental and case study methods. Collection, recording, editing, coding and scaling of data. Scale classification and types. Measurement of validity, reliability and practicality. Cronbach’s Alpha | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Descriptive and inferential statistics – Data analysis and interpretation –testing of hypothesis, testing of population mean, variance and proportion –Z test – t test – F test – chi square test. Test for correlation and regression –standard error of the estimate. Testing goodness of fit. Brief introduction to non parametric tests, factor analysis, discriminant analysis and path analysis (description only). Use of SPSS and other software. | | | | 10 |
| **IV** | Meaning of interpretation and inference: importance and care for interpreting results. Presentation of reports: popular reports and technical reports – structure and style. Oral and written presentations: Parts of a research report. Guidelines for writing research papers and reports – Writing different sections of a research paper – Introduction, Methodology, Results, Discussion, Conclusion, Abstract – Writing the title. Methods of giving references and appendices: referencing styles. Ethics in research. Use of computers and internet in research. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. C. R. Kothari, Research Methodology, Methods and techniques (New Age International Publishers, New Delhi, 2004). 2. R. Panneerseklvam, Research Methodology (Prentice Hall of India, New Delhi, 2011). 3. Ranjit Kumar, Research Methodology, A step by step approach (Pearson Publishers, New Delhi, 2005. 4. Management Research Methodology : K. N. Krishnaswami, AppaIyer and M Mathirajan, Pearson Education, Delhi, 2010 5. Hand Book of Research Methodology : M N Borse, SreeNivas Publications, Jaipur, 2004 6. Business Research Methods: William G Zikmund, South – Western Ltd, 2003 7. Research Methods in Social Science: P K Majumdar, Viva Books Pvt Ltd, New Delhi, 2005 8. Analyzing Quantitative Data: Norman Blaikie, SAGE Publications , London, 2003 9. SPSS for Windows: Pearson Education New Delhi, 2007 | | | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE6291** | **ADVANCED GEOTECHNICAL LAB** | 0-0-2-1 | 2015 |
| COURSE OBJECTIVES:  The objective of this course is to make students  To learn to carry out the tests for index properties, engineering properties and strength parameters of soil in the lab. To carry out and study field tests and study soil exploration methods.  **Outcomes:**  On completion of this course, students are able to   * Carry out tests for index properties and engineering properties of soil. * Carry out tests for strength parameters and settlement of soil. * Conduct soil explorations and carry out field tests of soil.   Standard and Modified Proctor Compaction Test  Permeability of fine grained soil  Atterberg Limits  Grain size analysis  Relative Density Test  Direct Shear Test  Vane shear test  Triaxial Shear Test (CU, CD, UU)  C.B.R (Unsoaked& soaked)  Consolidation Test  STUDY OF FIELD TESTS (evaluated only in internal assessment)  Standard Penetration test  Cone penetration test  Field vane shear test  Pile load test   * Geophysical Exploration | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6202** | | **STRUCTURAL DESIGN OF FOUNDATIONS** | 3-1-0-4 | 2015 | |
| COURSE OBJECTIVES:  To expertise students in structural design (limit state method) of shallow foundations, pile foundation,, well foundations, Specialfoundations for towers, water tank and chimneys.  **COURSE OUTCOMES:**   * The student will be capable in structural designing of shallow foundations, pile foundation, well foundations, foundation for towers, water tanks and chimneys and special shell foundations. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction to Limit State Design of reinforced concreteinfoundations; Soil pressure for structural design; structuraldesign of spread footings, isolated footings, combined footings, column pedestals, column footings, strap footings, strip footings under several column. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Structuraldesignofmatfoundations–beam andslabrafts–combinedpiledraft foundations (CPRF) – circularandannularrafts–Analysisofflexiblebeamsonelastic foundations–ACImethodfortheanalysisofbeamsandgridsonelasticfoundations– Analysis of flexible plates on elastic foundations. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Structural design of different types of piles – under reamed pile foundations – Design of pile cap – pile foundation – Design of large dia socketed piles – in filled vireneel frame foundations – steel column bases | | | | 10 |
| **IV** | Structural design of retaining walls- Cantilever retaining wall- Counter fort retaining wall Flexible retaining Structures –Cantilever Sheet Pile Wall- Anchored Bulk Heads. | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**   1. Bowles J.E., “Foundation Analysis and Design” (4Ed.), Mc.Graw Hill, NY, 1996   2. P.C.Varghese,“DesignofReinforcedConcreteFoundations”,PHI–LTD–New  Delhi, 1998   1. KurienN.P.,“Designoffoundationsystems–PrinciplesandPractices”,Narora   Publishing house – New Delhi (third edition),1992   1. UnnikrishnaPillai and DevdasMenon, “Reinforced concrete Design’, Tata McGraw Hill Publishers Company Ltd., New Delhi, 2006. |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6204** | | **FOUNDATION ANALYSIS AND DESIGN** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To familiarize students with different types of foundation, analysis and geotechnical design of shallow foundation, pile foundation cassions and well foundation, also to acquaint students with foundation provided in various soil condition, flexible analysis and soil structure interaction models  **COURSE OUTCOMES:**   * The student will be able to analyze soil structure interaction problems, bearing capacity and settlement problems. * The students will be able to carry out geotechnical design of shallow foundations, pile foundations and well foundations | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction to Soil -Structure interaction problems -Contact pressure distribution – factors influencing Contact pressuredistributionbeneathrigidandflexiblefootingscontactpressuredistribution beneath rafts –concentricallyandeccentricallyloaded cases–Modulusof Sub gradereaction–Determination of modulus of sub grade reaction – Factors influencing modulus of subgrade reaction | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Shallow FoundationBearingcapacity-Mayerhoff,HansenandVesic –bearingcapacityfactors,effectofwater table, shape of foundation, inclination. Settlement immediate and consolidation –pressure bulb distribution.Bearing capacity of foundation based on in-situ tests. Design of spread footing, column footing , combined footing.Mat foundations on cohesive and cohesion lesssoil- rigid beam analysis-Winklermodel | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | PileFoundationsIntroduction – Estimation of pile capacity by static and dynamic formulae – Wave equationmethodofanalysisofpileresistance –Load–Transfermethodofestimatingpile capacity – Settlement of single pile – Elastic methods.PileGroups–Considerationregarding spacing – Efficiency of pilegroups–Stresseson underlying soil strata – Approximate analysis of pile groups –Settlement of pile groups- Pile caps –Pile load tests– Negative skin friction, Underreamed piles. | | | | 10 |
| **IV** | Laterally loaded piles – Modulus of sub grade reaction method – ultimate lateral resistance of piles.  Well foundation- Design and construction. Bearingcapacity,settlementandlateral resistance. Tilts and shifts. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Lambe and Whitman, “Soil Mechanics”, Wiley Eastern,1976.   2. WinterkornH.F.andFangH.Y.Ed.,“FoundationEngineeringHandBook”, Van-Nostrand Reinhold, 1975.  3. BowlesJ.E.,“FoundationAnalysisandDesign”(4Ed.),Mc.GrawHill,NY,  1996  4. PouloseH.G.andDavisE.H.,“PilefoundationAnalysisandDesign”,John- Wiley & Sons, NY, 1980.  5. KurienN.P.Design of Foundation Sytems: Principles &Practices, Narosa,1992  6. Leonards G. Ed., “Foundation Engineering”, Mc.GrawHill,NY, 1962. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6206** | | **GROUND IMPROVEMENT TECHNIQUES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To enable students to identify problematic soil and their associated issues, propose suitable ground improvement techniques and to expertise in design and construction of reinforced soil structures and understand and test geosynthetics.  **COURSE OUTCOMES:**   * The student gets knowledge on different ground improvement techniques and their applications. * The student will be capable to suggest suitable soil stabilisation method to issues necessitated. * The student will be able to plan, analyse, design and test soil reinforcement structures. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction, Economic considerations Engineering properties of soil,, weak and compressible deposits. In situ densification – Vibrofloatation, Compaction pile ,Vibro Compaction Piles Dynamic Compaction, Blasting Preloading with and without vertical drains. Compressibility, vertical and radial consolidation, preloading methods. Types of Drains, Design of vertical Drains, construction techniques. Stone Column: Function Design principles, load carrying capacity, construction techniques, settlement of stone column . | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Ground Improvement by Grouting techniques, types of grout, desirable characteristics, grouting pressure, grouting methods. 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.  Soil Stabilization: Lime stabilization-Base exchange mechanism, Pozzolanic reaction, lime-soil interaction, lime columns. Cement stabilization: Mechanism, amount, age and curing. Fly-ash – Lime Stabilization, Soil Bitumen Stabilization. Deleterious effects of organic substances and sulphates on inorganic stabilization lime-sand columns, stone columns . | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | |
| **III** | Soil Reinforcement: Mechanism, Types of reinforcing elements, reinforcement-soil interaction, Reinforcement of soil beneath the roads, foundation. 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 | 10 |
| **IV** | Geosynthetics: Types and functions, Materials and manufacturing process, Testing and valuations Design and construction of geosynthetics , reinforced soil retaining structures, walls and slopes. 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. 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 . | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | |
| **REFERENCES:**  1. Moscly, M.P, “Ground Improvement”, Blackie Academic and Professional, Glasgow, 1994  2. Raj, P. Purushothama, “Ground Improvement Techniques”, Laxmi Publications, New Delhi, 2005  3. Van Impe, W.F, “Soil Improvement Techniques & their Evolution”, AA Balkema,1989.  4. Nayak N. V., Foundation Design Manual, DhanpatRai and Sons, Delhi, 1982  5. Ingold T.S , “Reinforced Earth”,Thomas Telford Ltd, London , 1982  6. Mandal J.N, “Reinforced Soil and Geotextiles”, Oxford and IBH Publishers Co. Pvt. Ltd, New Delhi, 1988  7. Robert M. Koerner, “Designing with Geosynthetics”, Prentice Hall, Englewood Cliffs, 1990  8. VenkatappaRao G, Surry GVS NarayanaRaju, “Engineering with Geosynthetics”, Tata McGraw Hill Publishing Company Ltd, New Delhi, 1990 | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6222** | | **ROCK MECHANICS** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To make the students understand engineering properties of rock, classification of rocks, laboratory testing of rocks, failure criteria, tunneling in rocks and various techniques to improve the in-situ strength of rocks  **COURSE OUTCOMES:**  On successfully completing this course unit, students will be able   * to apply popular failure criteria to determine the strength of both intact rock and discontinuities * assess the geometry of discontinuous rock masses using customary measures and techniques * apply closed-form solutions to the assessment of stress induced around underground openings | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction , objective, scope and problems of Rock Mechanics Formation of rocks, Physical properties, Classification of rocks and rock masses, Static Elastic constants of rock.Rock exploration – Rock coring, geophysical methods. Rock Testing: Laboratory and Field tests | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Discontinuities in Rock Masses: Discontinuity orientation, Effect of discontinuities on strength of rock , Strength Behaviour: Compression, Tension and Shear, Stress-Strain relationships,  Rheological behavior ; Strength/ Failure Criterion: Coulomb, Mohr, Griffith theory of brittle strength and other strength criteria. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Openings in rock mass and stresses around openings. Pressure tunnels, development of plastic zone. Rock support needed to avoid plastic deformation. Lined and unlined tunnels. Underground excavation and subsidence. Rock mechanics applications. | | | | 10 |
| **IV** | Bearing capacity of homogeneous as well as discontinuous rocks. Support pressure and slip of the joint. Delineation of types of rock failure. Unsupported span of underground openings, pillars. Rock slopes. Rock bolting. Plastic mechanics. Tunnels, shapes, usages, Methods of Construction, Problems associated with tunnels, tunneling. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  . Farmer W., “Engineering Behavior of Rocks”, Chapman and Hall Ltd, 1983  2. Goodman R. E., “Introduction to Rock Mechanics” , 1989  3. Sheorey P.R., “Empirical Rock Failure Criteria”, Balkema, Rotterdam, 1997  4. Vutukuri V.S. and Lama R D, “Hand Book on Mechanical Properties of Rocks”, Trans. Tech. Publications , 1986 | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6224** | | **PRESTRESSED CONCRETE STRUCTURES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To give in depth knowledge about concept of prestressing, prestressing methods, analysis and design of prestressed concrete flexural members, design of tension members and analysis of continuous beams.  **COURSE OUTCOMES:**  On successful completion of this course, students are able to   * Understand the basic concepts of Prestressed Concrete, methods and its application. * Analyse, comprehend the design and detailing of Prestressed concrete members used in practice. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Analysis and design of simply supported (post and pre tensioned) – PSC flexural members – Basic concepts – Stresses at transfer and service loads, ultimate strength in flexure – short term deflections and long term deflections as per IS Code – Design and analysis of post and pre tensioned PSC slabs. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Design for shear, bond and torsion – Design of end blocks (IS code method)– Design of prestressed concrete cylindrical water tanks – Design of prestressed concrete pipes. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Design of tension members – Design of compression members – compression members with and without flexure – Design of piles  Composite construction with precast RC beams- Analysis and design – Ultimate strength – Partial prestressing – Definitions – principles and design approaches. | | | | 10 |
| **IV** | Statically indeterminate structures – Analysis and design – Continuous beams – concept linear transformation – concordant cable profile and cap cables. | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**   1. Krishna Raju N, “Prestressed Concrete” , 4th Edition TMH New Delhi , 2000 2. Sinha N.C. & Roy, “Fundamentals of Prestressed Concrete”, S.Chand& Co, 1985 3. Rajagopalan N, “Prestressed Concrete”, Narora Publishing house, 2002   4. Lin T.Y, “Design of Prestressed Concrete Structures”, John Wiley & Sons , 1960  5. Pandit and Gupta, “Prestressed concrete”, CBS, 2002  6. F K Kong and R H Evans, “ reinforced and prestressed concrete”, TMH, 1999 |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6226** | | **EARTH AND EARTH RETAINING STRUCTURES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To build the students knowledge in the geotechnical design and construction methods of various earth retaining structures. Also to gain knowledge about earth pressure theories, stability of retaining structure, earth pressure around tunnel lining, shaft and silos  **COURSE OUTCOMES:**  After studying this course, students will   * Get knowledge about earth pressure theories, theories earth pressure around tunnel lining, shaft and silos and braced cuts. * Be able to analyze the stability of earth retaining structures, plan and design earth retaining structures, buried structures and cuts. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction – State of stress in retained soil mass – Earth pressure theories – Classical and graphical techniques – Active and passive cases – Earth pressure due to external loads, empirical methods. Wall movement and complex geometry. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Drainage and Stability Considerations.  Lateral pressure due to compaction, strain softening, wall flexibility, influence of drainage. Earth pressure due to earthquake forces – Stability of retaining structure. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Sheet Pile Walls  Retaining structure – Selection of soil parameters – Analysis and design of cantilever and anchored sheet pile walls. Dead man and continuous anchor. Diaphragm and bored pile walls – Design requirements. | | | | 10 |
| **IV** | Supported Excavations  Lateral pressure on sheeting in braced excavation, stability against piping and bottom heaving. Earth pressure around tunnel lining, shaft and silos. | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**   1. Winterkorn, H.F. and Fang, H.Y., “Foundation Engineering Handbook” ,Galgotia Booksource,2000. 2. Rowe, R.K., “Geotechnical and Geo environmental Engineering Handbook” , Kluwer Academic Publishers, 2001. 3. Militisky, J. and Woods, R., “Earth and Earth retaining structures”, Routledge, 1992. 4. Koerner, R.M., “ Design with Geosynthetics”, Prentice Hall, (Third Edition), 1997. 5. Day, R.W., “Geotechnical and Foundation Engineering: Design and Construction”, McGraw Hill, 1999. 6. Das, B.M., “Principles of Geotechnical Engineering”, The PWS series in Civil Engineering, (Fourth Edition), 1998 7. Clayton, C.R.I., Militisky, J. and Woods, R.I., “Earth pressure and Earth-Retaining Structures”, Survey University Press, (Second Edition),1993. 8. Mandal, J.N., “ Reinforced Soil and Geotextiles”, Oxford &IBH Publishing Co. Pvt. Ltd., New Delhi. 9. McCarthy, D.F., “Essentials of Soil Mechanics and Foundations: Basic Geotechnics”, Prentice Hall, (Sixth Edition),2002. |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6232** | | **GROUND WATER ENGINEERING** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To make the knowledge base of student in hydrology stronger and broader so that they can handle the design and analysis of environmental systems with confidence.  **COURSE OUTCOMES**:  After studying this course, students will get knowledge about ground water and well hydraulics and on quality of ground water. The students will also gain knowledge about planning, designing andmethodsofconstruction of different types of wells. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Occurrence of ground water: origin –rock properties affecting ground water vertical distribution–geologicformationsasaquifers –typesofaquifers–aquiferparameters-ground water basins –springs –ground water in permeable regions –ground water balance –ground waterflow–Darcy’slaw–laplaceequation–potentialflowlines–flownet–steadyradial flowintoawell–wellinuniformflow–steadyflowinleaky aquifer–aquiferwith percolation-seepage under a dam –unsteady flow –general equation –confined and unconfined aquifers | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Ground water and well hydraulics: steady unidirectional flow –steady radial flow in to a well–wellinuniformflow–steadyflowwithuniform discharge–unsteadyradialflowintoawell–confined,unconfinedandleakyaquifers –wellnearaquiferboundaries–multiple wellsystem–partially penetrating wells–characteristicswelllosses–pumpingtests–non equilibriumequation for pumping tests –Thies’ method –Jacob method –Chow’s method | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Tube wells: design –screened wells–gravelpackedwells –well loss-selectionofscreen size yieldofawell–testholes–welllogs–methods ofconstruction–dugwells–shallow tube wells–deep wells–gravitywells–drilling in rocks–screen installation–wellcompletion well development –testing wells for yield –collector –or radial wells –infiltration galleries well point system–failure of tube wells | | | | 10 |
| **IV** | Quality of ground water: ground water samples –measurementofwaterquality-chemical, physical and bacterial analysis – quality for domestic use – quality for agricultural use pumps–shallow wellpumps–groundwaterinvestigation–geographicalinvestigationelectricalresistivitymethod–seismicrefractionmethod – gravity and magnetic method – testdrilling–resistivitylogging–potentiallogging–artificialrecharge–rechargeby water spreading –sewage recharge –recharge through pits, shafts and wells | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Todd D.K., “ Ground Water Hydrology”, John Wiley , 1980 2. Garg S.P., “Ground Water & Tube wells”, Oxford & IBH , 1993 3. RaghunathH.M.,“GroundWater”,NewAge International Pvt. Ltd.,1987 4. Schwartz F. W. & Zhang H., “Fundamental of Ground Water”, John Willey & Sons, 2003 | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6234** | | **ENVIRONMENTAL GEOTECHINICS** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To make the students aware about Environmental Geotechniques, land fill engineering and contaminant transport.  **COURSE OUTCOMES:**  Students will get knowledge about different types of wastes and their disposal methods. The students will also gain knowledge about geotechnical reuse of waste materials and will be able to design engineered land fill. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction: Forms of waste, engineering properties (determination and typical values),.Selection of waste disposal sites: Site selection– selectioncriteria and rating; Solid waste disposal: Ash Disposal facilities- Dry disposal, waste disposal, Design of ash containment system, Stability of ash dykes; Reclaiming potentially combustiblesites,combustionprocess,combustiontests,useofcombustionpotential tests, Land fill gases , principal gases and their properties, Gas monitoring ,Data assessment and remedial solutions. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Subsurface contamination and Contaminant transport through porous media:mechanisms- advection and dispersion .ContaminantsofSolidWasteinLandfills: Types- Dry cell, wet cell, bioreactor, Design clay liners, geosyntheticclay liners for waste containment, cover and gas collection system.Stabilityoflandfills.LandfillInstruction&operation,sustainable wastemanagement.Remediation: Principle- planning, source control,soilwashing, bioremediation. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Geotechnical Reuse of Waste materials: Waste reduction, use in geotechnical construction, waste characteristics, transportation consideration, Engineering properties of Wastes, Waste material in Embankment and Fills. | | | | 10 |
| **IV** | Contaminants of Slurry wastes: Slurry transported wastes, slurry ponds, operation, Embankment construction and raising, Design aspects, Environmental Impact and control. VerticalBarriersforContaminant:Contaminatedsites,Typesofbarriers,Soil-Bentonite slurry trench walls, Cement-Bentonite slurry trench walls, construction, material and design aspects. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. ReddyK. R. andH D Sharma,“GeoenvironmentalEngineering:Site Remediation, waste containment, and emerging waste management technologies”, John Willey, 2004 2. YongRN.,“Geo Environmental Engineering: Contaminated Ground: Fate of pollutions and Remediation”, Thomson Telford, 2000. 3. ReddyLNandInyangH.I.,“GeoenvironmentalEngineering:Principlesand Applications”, Marcel Dek, 2000 4. HsaiyangFang“IntroductiontoEnvironmentalGeotechenology”,CRCpressNewyork , 1997 5. Cairmey.T.“Contaminatedlandproblemsandsolutions”,BlackieAcademic & Professional, 1993 6. Ayyar,R.S.R “Soil Engineering in relation to Environment”, LBS ,Thiruvananthapuram, 2000 7. Sivapullaiah ,P.V, ” Environmental Geotechnics”, IISC ,Bangalore | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE6236** | | **DYNAMICS OF SOIL AND DESIGN OF MACHINE FOUNDATION** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To enhance students knowledge in dynamic loading. Theory of vibrations, dynamic soil properties , Dynamic earth pressure, dynamic bearing capacity, vibration isolation , liquefaction of soils and to train the students in machine foundation design.  **COURSE OUTCOMES:**  Students will get knowledge about dynamic soil properties, bearing capacity ofdynamicallyloadedfoundations.The student will also be able to design foundations of reciprocating machines and foundations subjected to impact loads | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction to Soil Dynamics Vibration of elementary systems- free and forced vibration with and without damping, Analysis ofsystemswithSingledegreeandmulti-degreeoffreedom. Natural frequencies of continuous systems, resonance. Effect of vibrationon soil properties. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Bearing capacity ofdynamicallyloadedfoundations.Natureofdynamicloads-stress conditionsonsoilelements under earthquake loading -methods ofanalysisofmachine foundations-methodsbasedonlinearelasticweightlessspringsmethodsbasedonlinear theoryofelasticity(elastichalfspacetheory)-natureofdamping-geometric andinternal- Elastic Constants of soil andtheirexperimentaldetermination | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Design of Machine Foundations Type of machine foundations special considerations for design of machine. Vertical, sliding, rocking and yawing vibrations of a block foundation -simultaneous rocking, sliding and vertical vibrations of a block foundation -foundation of reciprocating machines-designcriteria-calculationofinducedforcesandmoments-multi-cylinder engines -numerical example (IS code method) | | | | 10 |
| **IV** | Foundations subjected to impact loads - design criteria - analysis ofverticalvibrationscomputationofdynamicforces- design of hammer foundations(IScodemethod)- vibration isolation – active and passive isolation -transmissibility -methods of isolation in machine foundations. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. BowlesJ.E.,“FoundationAnalysisandDesign”(4Ed.),Mc.GrawHill,NY,   1996  2. ShamsherPrakash, “Soil Dynamics”, McGraw Hill, 1981  3. Das B M, “Principles of Soil Dynamics”, Thomsons Engineering, 1992.  4. Saran S., “ Soil Dynamics and Machine Foundations”, Galgotia  Publications Private Ltd.,1999  5. Sreenivasalu&Varadarajan, “Handbook of Machine Foundations”, Tata  McGraw Hill ,2002  6. A Major,“VibrationAnalysisandDesignof Foundations for Machines andTurbines:DynamicalProblemsin Civil Engineering”, AkademiaiKiado Budapest Collets Holding Ltd, 1962  7. IS 2974 -Part I and II, “Design Considerations for Machine Foundations”  8. IS 5249: “Method of Test for Determination of Dynamic Properties Of Soils” | | | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE6266** | **SEMINAR - I** | 0-0-2-2 | 2015 |
| Each student shall present a seminar on any topic of interest related to the core / elective courses offered in the M. Tech. Programme. He / she shall select the topic based on the references from international journals of repute. They should get the topic approved by the Programme Co-ordinator / Faculty member in charge of the seminar and shall present it in the class. Every student shall participate in the seminar. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report submitted. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE6288** | **MINI PROJECT** | 0-0-4-2 | 2015 |
| Mini project is designed to develop practical ability and knowledge about practical tools/techniques in order to solve the actual problems related to the industry, academic institutions or similar area. Students can take up any application level/system level project pertaining to a relevant domain. Projects can be chosen either from the list provided by the faculty or in the field of interest of the student. For external projects, students should obtain prior permission after submitting the details to the guide and synopsis of the work. The project guide should have a minimum qualification of ME/M.Tech in relevant field of work. At the end of each phase, presentation and demonstration of the project should be conducted, which will be evaluated by a panel of examiners. A detailed project report duly approved by the guide in the prescribed format should be submitted by the student for final evaluation. Publishing the work in Conference Proceedings/ Journals with National/ International status with the consent of the guide will carry an additional weightage in the review process. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE6292** | **CIVIL ENGINEERING DESIGN STUDIO** | 0-0-2-1 | 2015 |
| COURSE OBJECTIVES:  The objective of this course is to make students  To learn the software for structural analysis and design of structures including soil structures and slopes.  To investigate the performance of structures under static and dynamic forces.  **COURSE OUTCOMES:**  On completion of this course, students are able to   * Understand the principles of structural analysis and design * Design and develop analytical skills. * Summarize the performance of structures for static and dynamic forces. * Use computer for managing projects   Applicationofsoftwarepackageslike PLAXIS,ANSYS,SAP,STRUDS,etc.in modelling, simulation, analysis, designanddraftingofstructuralcomponentsfor raft foundation, retaining wall, pile foundation, beams, columns , slopes and embankments using the concepts given intheorypapers. Thestudenthasto practicethepackagesby working out different types of problems. The student has to carry out a mini project work which will be evaluated for internal assessment. | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE7241** | | **MARINE GEOTECHNICAL ENGINEERING** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To enhance student’s knowledge in marine geotechnical engineering, engineering behaviour of marine soils, offshore soilinvestigation, foundations for jacket type structures  **COURSE OUTCOMES:**  On successfully completing this course unit, students will get knowledge about offshore soilinvestigation,properties of marine soils and different types foundations of offshore structuresAnd will be able to analyse and design offshore structures.  . | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction to Marine Geotechnical Engineering:  Scope of marine geotechnical engineering - Marine classification,propertiesofmarine sediments - Structure of marine soils - Cementation bonding - Morphology and genesis of marine and submarine sediments - Post-depositionalchanges - Effect of calcium carbonate in marine deposits.  Engineering behaviour of marine soils: Fine and coarse-grained deposits - Strength and deformation behaviour of fine - and coarse-grained marine deposits - Effect of cementation - Strength and deformation behaviour under static and cyclic loading | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Offshore SoilInvestigation: Planning and site exploration. Offshore-drilling. Sampling techniques.Laboratorytesting, Insitutestingmethodsandgeophysicalmethods. In-situ determination ofstrengthof submarinesoils-Penetrometer, piezocone, vaneand pressure meter techniques -  Foundations forGravityStructures:Typesofgravitystructures -Installationtechniques- Movement of gravity structures - Settlement of soil beneath gravity structures - Stress distribution beneath gravity structures - Stability of gravity structures under staticand cyclic loads | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Foundations for jacket type structures: Types - Installation techniques - Design considerations-Axialandlateralloadcapacityof piles-Lateralloaddeformation behaviour of piles - Calculation of bearing capacity of piles - Design of piles subjected to lateralloads-Reese-Matlockmethod & p-y curves method. | | | | 10 |
| **IV** | Foundations for jack up platforms: Types ofjack up platforms - Piles and mat supported - Spud cans - Different types - Techniques for installation and removal of jack up - Stabilityofjack upplatforms- Determinationof penetrationofsupports- Stability under lateral loads - Stability under static and cyclicloadeffects. Sea bed anchors, submarine pipe lines: General introduction to sea bed anchors, moorings, submarine pipe line etc. - General designconsiderations(brief outline only) -geotechnical aspects in the design and installation of sea bed anchors, moorings, submarine pipelines etc. | | | | 8 |

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| **REFERENCES:**  1. Chaney,F., “Marine geotechnologyand near shore/offshore structures”, ASTM, STP, 1986.  2. Chaney, R.C &Demars,K. R.,“Strength Testingof Marine Sediments - Laboratory and In-situ Measurements”, ASTM, STP -883, 1985.  3. George,P&Wood,D.,“OffshoreSoilMechanics”,Cambridge University  Press., 1985  4. Le Tirant,“Sea Bed Reconnaissance and Offshore Soil Mechanics forthe  Installation of Petroleum Structures”, Gulf Publ. Co., 1979.  5. Poulos,H.G &Davis,E.H.,“PileFoundation Analysis and Design”, John  Wiley, 1980.  6. “Numerical Methods in offshore Piling, Proc. Conf. Inst. of Civil  Engineers”, London 1980 |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE7243** | | **EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To enhance student’s knowledge in Seismology, Earthquake Monitoring, and Seismic Instrumentation.To expertise students in Earthquake Resistant Design of R.C.C. Buildings  **COURSE OUTCOMES:**  After studying this course, students will get knowledge about earthquake, effect of earthquakeon different types of structures and the student will also be able to design earthquake resistantR.C.C. buildings. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | EngineeringSeismology(Definitions,Introduction to Seismichazard,Earthquake Phenomenon), Seismotectonics and Seismic Zoning of India, Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of EarthquakeParameters,Microzonation. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Dynamics of Structures (SDOFS/ MDOFS), Response Spectra - Average Response Spectra - Design Response Spectra, Evaluation of Earthquake Forces as per codal provisions, Effect of Earthquakeon Different Types of Structures, Lessons Learnt From Past Earthquakes | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Structural Systems - Types of Buildings, Causes of damage, Planning Considerations, Philosophy and Principle of Earthquake Resistant Design, Guidelines for Earthquake Resistant Design, Earthquake Resistant Earthen Buildings, Earthquake Resistant Masonry Buildings-Designconsideration–Guidelines.  Earthquake Resistant Design of R.C.C. Buildings - Material properties - Lateral load analysis - Design and detailing – Rigid Frames – Shear wall – Coupled Shear wall. | | | | 10 |
| **IV** | MathematicalmodelingofmultistoriedRCBuildings–Capacity based design.Vibration Control - Tuned Mass Dampers – Principles and application, Basic Concept of Seismic Base Isolation – various Systems- CaseStudies, Important structures. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. PankajAgarwal and Manish Shrikhande, “Earthquake Resistant Design of   Structures”, Prentice Hall of India, 2006  2. SKDuggal,“EarthquakeResistantDesignofStructures”,OxfordUniversity  Press, 2007.  3. CourseNotes"DesignofReinforcedConcreteBuildings",IITKanpur,June  1999.  4. Paulay,TandPriestly,M.N.J.,“AseismicDesignofReinforcedConcreteand  Masonry buildings”, John Wiley and Sons, 1991.  5. Bruce A Bolt, “Earthquakes” WH Freeman and Company, New York, 2004  6. BungaleS.Taranath,"StructuralAnalysisandDesignofTallBuildings”,Mc  Graw Hill Book Company, New York, 1999.  7. StevenC.Kramer,“AtextBookonGeotechnicalEarthquakeEngineering”, Prentice hall International series, 2004  8. DasB.M.,“AtextBookonprinciplesofsoilDynamics”,Brooks,Code,  1993 | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE7245** | | **ADVANCED STEEL STRUCTURES** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  **COURSE OUTCOMES:** | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Review of loads on structures- Dead, Live,wind and Siesmic loads as per IS 800-2007-Design of purlins, louver rails Gable column and Gable wind girder-Analysis and Design of Gable frames-Design of moment resisting base plates.  Types of connections-Design requirement of bolted and weldedconnections-seated connections-unstiffened and stiffened seated connections-framed connections-moment resistant connections-split beam connections-semi rigid connections | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Design of self supporting chimney-design of base plates, foundations and anchor bolts-Guyed steel chimney-Guy ropes-Stresses due to wind. Along with load calculation-Gust factor method | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Theory of plastic bending-plastic hinge concept-mechanism method-Application to continuous beam and portal frames-Plastic moment distribution-Limit state Design-ultimate and serviceability limit states-Limit state design of axially loaded members-Design of beams | | | | 10 |
| **IV** | Behaviour of compression elements-Effective width for load and deflection determination-Behaviour of stiffened and unstiffened elements. Design of compression and tension members-Concept of lateral buckling-Design of beams-Deflection of beams-Design of beam webs. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**  1. Subramanian.N, “Design of Steel Structures”, Oxford University Press, 2008.  2.Lynn S. Beedle, “Plastic Design of Steel Frames”, John Wiley and Sons, New York, 1990.  3.Salmon C G,Johnson J E ,”Steel Structures –design and behavior”, Harper and row,1980.  4.Teaching resource for structural steel design ,INSDAG Kolkotta,2001  5.Duggal S K, “Limit state design of steel structure”, TMH publications, 2000  6.Rhodes J., ”Design of cold formed steel members” ,Elsevier Science Publishers, 1991. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE7251** | | **ANALYSIS AND DESIGN OF PAVEMENTS** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To build the students knowledge on the concept of pavement materials-testing, application and limitations. Also deals with various methods of pavement design.  **COURSE OUTCOMES:**  The students will get knowledge about types of pavements, its stress–strain variation and modern design methods | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Conventional aggregates and their evaluation, Bituminous binders- Properties, testing and applications; Bituminous mixes- Design, testing and evaluation; Materials for cement concrete and semi-rigid pavements, Design of mixes for stabilized roads ; Non- conventional and new pavement materials-their application and limitations. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Introduction: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements. Stresses and strains in flexible pavements: Stresses and strains in an infinite elastic half space , use of Boussinesq's equations - Burmister's two layer and three layer theories; Wheel load stresses, various factors in traffic wheel loads; Equivalent single wheel load of multiple wheels. Repeated load sand EWL factors | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Flexible pavement design methods for highways and airports: Empirical, semi-empirical and theoretical approaches; Development, principle, design steps of the different pavement design methods including AASHTO, Asphalt Institute, Shell Methods. | | | | 10 |
| **IV** | IRC method of pavement design; Stresses in rigid pavements: Types of stresses and causes; Introduction to Westergaard's equations for calculation of stresses in rigid pavement due to the influence of traffic and temperature; Considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses. Rigid pavement design: Design of cement concrete pavement for highways and runways; Design of joints, reinforcements, tie bars, dowel bars. IRC method of design; Design of continuously reinforced concrete pavements. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Atkins&Harold,“HighwayMaterials,Soils,andConcretes”,PrenticeHall– Pearson, 2003   2. RichardKimY.,“ModelingofAsphaltConcrete”,McGrawHillProfessional.,2008  3.Relevant IRC, ASTM, AASHTO and other Codes, Manuals and Specifications  4. LavinP.G.,“AsphaltPavements”1stEd,TaylorandFrancis,2007 | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE7253** | | **GEOSYNTHETICS IN CIVIL ENGINEERING** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To enhance student’s knowledge about various types ofgeosynthetics, its properties and its application.  **COURSE OUTCOMES:**   * The student gets knowledge about the types of geosynthetics, their manufacturing methods, properties and applications and testing. * The students can suggest the application of geosynthetics in a particular geotechnical issue. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Historical Development – Types of Geosynthetics – Geotextiles – Geogrids- Geonets – Geomembranes – Geocomposites – Functions – Reinforcement – Separation – Filtration –Drainage – Barrier Functions | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Raw Materials and Manufacturing Methods  Methods – Polyamide – Polyster – Polyethylene – Polypropylene – Poly Vinyl Chloride –Woven – Monofilament – Multifilament – Slit Filament – Non-Woven – Mechanically bonded Chemically bonded – Thermally bonded. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Properties of Geosynthetics:  Physical properties: Mass per unit area – Thickness – Specific gravity.  Hydraulic properties: Apparent open size – Permittivity – Transmissivity.  Mechanical Properties: Uniaxial Tensile Strength – Burst and Puncture Strength – Soil Geosynthetic friction tests  Durability: Abrasion resistance – Ultraviolet resistance. | | | | 10 |
| **IV** | Applications of Geosynthetics  Use of geosynthetics for filtration and drainage – Use of geosynthetics in roads – Use of reinforced soil in Retaining walls – Improvement of bearing capacity – Geosynthetics in landfills. | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**  1. G.VenkatappaRao and G.V.S SuryanarayanaRaju, “Engineering with Geosynthetics”, Tata McGraw Hill, New Delhi, 1990.  2. Robert M. Koerner, “Construction and Geotechnical Methods in Foundation Engineering” ,McGraw Hill, New York, 1985.  3. Robert M. Koerner, “Designing with Geosynthetics” , Prentice Hall, New Jersey, UAS,1989. |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05CE7255** | | **FINITE ELEMENT ANALYSIS** | 2-1-0-3 | 2015 | |
| COURSE OBJECTIVES:  To make students appreciate the basic concept, principles and other formulations in finite element method and its application in geotechnical engineering.  **COURSE OUTCOMES:**  The student gets knowledge about the basics of finite element method, different approaches of FEM, analysis of framed structures - 2D and 3D truss and beam elements, and applications, analysis of plate bending and shells. Also gain knowledge about use of FEM in soil and rock mechanics. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Basic Equations of Solid Mechanics - Review of equilibrium conditions, Strain-displacement relations, Stress - Strain relations, Principle of Virtual work & Stationery potential energy and variational formulation. Plane stress and plane Strain problems.  Basics of finite element method (FEM), different steps involved in FEM | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Different approaches of FEM, Direct method, Energy approach, Weighted residual Method; Displacement model - Shape functions - Lagrange and serendipity elements, Element properties. Finite Element modeling of one and two dimensional problems. Isoparametric elements, four node, eight node elements. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Analysis of framed Structures - 2D and 3D truss and beam elements and applications. Analysis of plane stress/strain and axisymmetric solids triangular, quadrilateral and isoparametric elements, | | | | 10 |
| **IV** | Numerical integration, order of integration  Analysis of plate bending Basic equations of thin plate theory. Reissner-Mindlin theory - Plate elements and applications. Analysis of shells - degenerated shell elements.  Use of FEM in soil and rock mechanics - Finite element programming and FEA Software | | | | 8 |

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| **END SEMESTER EXAM (ALL Modules)** |
| **REFERENCES:**   1. Desai, C.S and Abel J.F, “Introduction to Finite Element Method”, CBS Publishers and Distributors, Delhi. 1987 2. Cook R. D. “Concepts and Applications of Finite Element Analysis”, John Wiley, New York, 2004. 3. Zienkiewicz O. C. and Taylor R. L., “Finite Element Method, Butterworth Heinemann publication”, 2000. 4. Reddy J. N., “ An introduction to Linear Finite Element Method, Oxford University Press”, Oxford, 2004. 5. Smith I.M , “Programming the FEM with applications to Geomechanics”, John Wiley&Sons , 1982 6. Chandupatla T. R. &Belegundu A. D, “Introduction to Finite Elements in Engineering”, Prentice Hall of India Pvt. Ltd., New Delhi, 5th Reprint, 1999 7. Krishnamoorty C.S. “Finite element methods”, Tata-McGraw Hill, Second Edition, Delhi, 2002. 8. Gudehus.G, “Finite Elements in Geomechanics”, John Wiley & Sons , 1977 |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE7267** | **SEMINAR - II** | 0-0-2-2 | 2015 |
| Each student shall present a seminar on any topic of interest related to the core / elective courses offered in the M. Tech. Programme. He / she shall select the topic based on the references from international journals of repute. They should get the topic approved by the Programme Co-ordinator / Faculty member in charge of the seminar and shall present it in the class. Every student shall participate in the seminar. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report submitted. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE7287** | **PROJECT (PHASE-I)** | 0-0-8-6 | 2015 |
| The students are expected to select an emerging research area in the field of specialization. After conducting a detailed literature survey, they should compare and analyze research work done and review recent developments in the area and prepare an initial design of the work to be carried out as Project. It is mandatory that the students should refer National and International Journals and conference proceedings while selecting a topic for their thesis. He/ She should select a recent topic from a reputed International Journal, preferably IEEE/ACM. Emphasis should be given for introduction to the topic, literature survey, and scope of the proposed work along with some preliminary work carried out on the thesis topic.  Students should submit a copy of Phase-I Project report covering the content discussed above and highlighting the features of work to be carried out in Phase-II of the Project. The candidate should present the current status of the thesis work and the assessment will be made on the basis of the work and the presentation. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05CE7288** | **PROJECT (PHASE-II)** | 0-0-21-12 | 2015 |
| The students are expected to select an emerging research area in the field of specialization. After conducting a detailed literature survey, they should compare and analyze research work done and review recent developments in the area and prepare an initial design of the work to be carried out as Project. It is mandatory that the students should refer National and International Journals and conference proceedings while selecting a topic for their thesis. He/ She should select a recent topic from a reputed International Journal, preferably IEEE/ACM. Emphasis should be given for introduction to the topic, literature survey, and scope of the proposed work along with some preliminary work carried out on the thesis topic.  Students should submit a copy of Phase-I Project report covering the content discussed above and highlighting the features of work to be carried out in Phase-II of the Project. The candidate should present the current status of the thesis work and the assessment will be made on the basis of the work and the presentation. | | | |