**DEPARTMENT OF CIVIL ENGINEERING**

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE

(An Autonomous Institution Affiliated to Anna University, Chennai)

GEOTECHNICAL ENGINEERING

M.E. DEGREE COURSE

(2016 REGULATIONS - CBCS)

CURRICULUM AND SYLLABI

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| GCT | MASTER OF ENGINEERING**GEOTECHNICAL ENGINEERING**CURRICULUM*(Full Time Candidates admitted during 2016-2017 and onwards)* |

MASTER OF ENGINEERING

**GEOTECHNICAL ENGINEERING**

**CURRICULUM**

*(Full Time Candidates admitted during 2016*– *2017 and onwards)*

FIRST SEMESTER

|  |  |  |  |  |  |  |  |  |  |  |
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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
|  | 16CEFC01 | APPLIED MATHEMATICS (Common with M.E. Structural Engg.) | FC | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
|  | 16GEPC01 | SHALLOW FOUNDATIONS | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPC02 | SITE EXPLORATION AND SOIL INVESTIGATION | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPC03 | STRENGTH AND DEFORMATION CHARACTERISTICS OF SOILS | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE I  | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE II  | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | TOTAL |  |  |  | 600 |  |  |  | 19 |

SECOND SEMESTER

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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
|  | 16GEPC04 | THEORETICAL SOIL MECHANICS | PC | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
|  | 16GEPC05 | DEEP FOUNDATIONS | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPC06 | SOIL DYNAMICS AND MACHINE FOUNDATIONS | PC | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
|  | 16GEPC07 | GROUND IMPROVEMENT TECHNIQUES | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE III – PROFESSIONAL ELECTIVE/INDUSTRY NEED BASED ELECTIVE | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE IV- PROFESSIONAL ELECTIVE/OPEN ELECTIVE | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | TOTAL |  |  |  | 600 |  |  |  | 20 |

MASTER OF ENGINEERING

**GEOTECHNICAL ENGINEERING**

**CURRICULUM**

*(Full Time Candidates admitted during 2016*–*2017 and onwards)*

THIRD SEMESTER

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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
|  | 16GEPC08 | PAVEMENT ENGINEERING | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE V  | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE VI  | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEEE01 | PROJECT PHASE -I | EEC | 100 | 100 | 200 | 0 | 0 | 12 | 6 |
|  |  | TOTAL |  |  |  | 500 |  |  |  | 15 |

* Industrial Training of 2 weeks duration with 1 credit.

FOURTH SEMESTER

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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
|  | 16GEEE02 | PROJECT PHASE -II | EEC | 200 | 200 | 400 | 0 | 0 | 24 | 12 |
|  |  | TOTAL |  |  |  | 400 |  |  |  | 12 |

MASTER OF ENGINEERING

**GEOTECHNICAL ENGINEERING**

**CURRICULUM**

*(Part Time Candidates admitted during 2016*– *2017 and onwards)*

FIRST SEMESTER

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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
|  | 16CEFC01 | APPLIED MATHEMATICS (Common with M.E. Structural Engg.) | FC | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
|  | 16GEPC01 | SHALLOW FOUNDATIONS | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPC02 | SITE EXPLORATION AND SOIL INVESTIGATION | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | TOTAL |  |  |  | 300 |  |  |  | 10 |

SECOND SEMESTER

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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
|  | 16GEPC04 | THEORETICAL SOIL MECHANICS | PC | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
|  | 16GEPC05 | DEEP FOUNDATIONS | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPC06 | SOIL DYNAMICS AND MACHINE FOUNDATIONS | PC | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
|  |  | TOTAL |  |  |  | 300 |  |  |  | 11 |

THIRD SEMESTER

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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
|  | 16GEPC03 | STRENGTH AND DEFORMATION CHARACTERISTICS OF SOILS | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE I  | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE II  | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | TOTAL |  |  |  | 300 |  |  |  | 9 |

MASTER OF ENGINEERING

**GEOTECHNICAL ENGINEERING**

**CURRICULUM**

*(Part Time Candidates admitted during 2016*–*2017 and onwards)*

FOURTH SEMESTER

|  |  |  |  |  |  |  |  |  |  |  |
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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
|  | 16GEPC07 | GROUND IMPROVEMENT TECHNIQUES | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE III – PROFESSIONAL ELECTIVE/INDUSTRY NEED BASED ELECTIVE | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE IV- PROFESSIONAL ELECTIVE/OPEN ELECTIVE | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | TOTAL |  |  |  | 300 |  |  |  | 9 |

FIFTH SEMESTER

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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
|  | 16GEPC08 | PAVEMENT ENGINEERING | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE V | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  |  | ELECTIVE VI  | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEEE01 | PROJECT PHASE - I | EEC | 100 | 100 | 200 | 0 | 0 | 12 | 6 |
|  |  | TOTAL |  |  |  | 500 |  |  |  | 15 |

* Industrial Training of 2 weeks duration with 1 credit.

SIXTH SEMESTER

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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
| 1. | 16GEEE02 | PROJECT PHASE - II | EEC | 200 | 200 | 400 | 0 | 0 | 24 | 12 |
|  |  | TOTAL |  |  |  | 400 |  |  |  | 12 |

MASTER OF ENGINEERING

**GEOTECHNICAL ENGINEERING**

**CURRICULUM**

*(Full Time Candidates admitted during 2016* – *2017 and onwards)*

FOUNDATION COURSE

|  |  |  |  |  |  |  |  |  |  |  |
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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
| 1. | 16CEFC01 | APPLIED MATHEMATICS(Common with M.E. Structural Engg.) | FC | 50 | 50 | 100 | 3 | 2 | 0 | 4 |

LIST OF PROFESSIONAL CORE COURSES

|  |  |  |  |  |  |  |  |  |  |  |
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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
| 1. | 16GEPC01 | SHALLOW FOUNDATIONS | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 2. | 16GEPC02 | SITE EXPLORATION AND SOIL INVESTIGATION  | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 3. | 16GEPC03 | STRENGTH AND DEFORMATION CHARACTERISTICS OF SOILS | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 4. | 16GEPC04 | THEORETICAL SOIL MECHANICS | PC | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| 5. | 16GEPC05 | DEEP FOUNDATIONS | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 6. | 16GEPC06 | SOIL DYNAMICS AND MACHINE FOUNDATIONS | PC | 50 | 50 | 100 | 3 | 2 | 0 | 4 |
| 7. | 16GEPC07 | GROUND IMPROVEMENT TECHNIQUES | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 8. | 16GEPC08 | PAVEMENT ENGINEERING | PC | 50 | 50 | 100 | 3 | 0 | 0 | 3 |

LIST OF EMPLOYABILITY ENHANCEMENT COURSES

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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
| 1. | 16GEEE01 | PROJECT PHASE -I | EEC | 100 | 100 | 200 | 0 | 0 | 12 | 6 |
| 2. | 16GEEE02 | PROJECT PHASE - II | EEC | 200 | 200 | 400 | 0 | 0 | 24 | 12 |

MASTER OF ENGINEERING

**GEOTECHNICAL ENGINEERING**

**CURRICULUM**

*(Full Time Candidates admitted during 2016*–*2017 and onwards)*

LIST OF PROFESSIONAL ELECTIVES

|  |  |  |  |  |  |  |  |  |  |  |
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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
|  | 16GEPE01 | EARTH RETAINING STRUCTURES | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPE02 | REMOTE SENSING AND ITS APPLICATIONS IN GEOTECHNICAL ENGINEERING | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPE03 | SOIL PROPERTIES AND BEHAVIOUR | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPE04 | FINITE ELEMENT ANALYSIS  | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPE05 | REINFORCED SOIL STRUCTURES | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPE06 | SLOPE STABILITY AND LANDSLIDES | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPE07 | ROCK MECHANICS IN ENGINEERING PRACTICE | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
|  | 16GEPE08 | FOUNDATION IN EXPANSIVE SOILS | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 1. 1
 | 16GEPE09 | GEOLOGY IN GEOTECHNICAL ENGINEERING | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |

LIST OF COMMON PG ELECTIVES IN THE DEPARTMENT OF CIVIL ENGINEERING

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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
| 1. | 16CEPE01 | SOIL STRUCTURE INTERACTION  | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 2. | 16CEPE02 | GEOTECHNICAL EARTHQUAKE ENGINEERING | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |
| 3. | 16CEPE03 | ENVIRONMENTAL ENGINEERING STRUCTURES | PE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |

MASTER OF ENGINEERING

**GEOTECHNICAL ENGINEERING**

**CURRICULUM**

*(Full Time Candidates admitted during 2016* –*2017 and onwards)*

LIST OF INDUSTRY NEED BASED ELECTIVE

|  |  |  |  |  |  |  |  |  |  |  |
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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
| 1. | 16GEIE01 | PROFESSIONAL PRACTICES IN DESIGN OF GEOTECHNICAL STRUCTURES | IE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |

LIST OF OPEN ELECTIVE

|  |  |  |  |  |  |  |  |  |  |  |
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| **S.No.** | **Subject****Code** | **Course Title** | **Category** | **Sessional****Marks** | **Final****Exam****Marks** | **Total****Marks** | **L** | **T** | **P** | **C** |
| 1. | 16GEOE01 | ENVIRONMENTAL GEOTECHNOLOGY | OE | 50 | 50 | 100 | 3 | 0 | 0 | 3 |

**16CEFC01 APPLIED MATHEMATICS**

**(Common with M.E.Structural Engg.)**

**L T P C**

**32 0 4**

**COURSE OBJECTIVES**

1. To acquire knowledge of solving problems linked to maxima and minima and integrals involving derivatives and also fitting of curves.

2. To familiarize problems on interpolation, dominant Eigen values and numerical quadrature and numerical cubature, various random processes.

3. To acquire knowledge of solving two dimensional partial differential equations numerically using finite differences

**COURSE OUTCOMES**

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

CO1: Gain the solutions of problems with extremum conditions including Lagrange’s undetermined multipliers and variational problems.

CO2: Understand the Eigen value problems and numerical solutions to interpolation, fitting a curve, numerical integration with one or two variables, Random processes.

CO3: Develop solutions of second order partial differential equations numerically using finite difference method.

**UNIT I Calculus of Variations (09)**

 Maxima and minima of functions of two variables– Lagrange’s method of multipliers– Functional– Euler’s equation– Variational problems involving one unknown function– Several unknown functions – Functional dependent of n higher order derivatives– Several independent variables– Isoperimetric problems– Ostrogradsky equation.

**UNIT II Numerical Methods (09)**

 Larange, Cubic Spline, Hermite interpolation – Least squares method to fit y=ax+b, y=ax2+bx+c,y=aebx,y=axb,y=abx – Numerical integration quadrature – Gauss, Legendre quadrature – Double integration using Trapezoidal and Simpson’s rule.

**UNIT III Eigen Value Problems (09)**

 Power method of finding the dominant Eigen values of a matrix– Jacobi method, Given’s method, Householder’s method, Rayleigh– Ritz method.

**UNIT IV Random Process (09)**

Classification of Random process– Stationary Process– Autocorrelation function and its properties – Cross correlation function and its properties – Mean Ergodic Process– Correlation Ergodic Process –Power Spectral Density function and its properties.

**UNIT V Partial Differential Equations (09)**

 Classification of second order PDE – Characteristic curves– Canonical reduction of PDE – Two dimensional wave equation of vibration membrane(Cartesian coordinates)– Finite difference approach to Parabolic, Hyperbolic, Ellipticand Poisson equations.

**TOTAL: 45 + 15 hrs**

***Reference Books:***

1. Venkatraman M.K, Higher Engineering Mathematics, National Publishing Co. Chennai, 2000.
2. S.R.K. Iyengar, R.K Jain, Numerical Methods, New Age International Publishers, New Delhi, 2009.
3. P. Kandasamy, K. Thilagavathy and K. Gunavathy, Numerical Methods, S. Chand & Co Ltd., New Delhi, 2010.
4. Veerarajan T, Probability and Random Processes (with Queueing Theory and Queueing Networks), McGraw Hill Education (India) Pvt. Ltd., New Delhi, Fourth Edition 2016.
5. Grewal.B.S., Numerical Methods in Engineering and Science, Khanna Publishers New Delhi, 2014.

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|  | *PO1* | *PO2* | *PO3* | *PO4* | *PO5* | *PO6* | *PO7* | *PO8* | *PO9* | *PO10* | *PO11* |
| *CO1* | *3* |  |  |  |  |  |  |  |  |  |  |
| *CO2* | *3* |  |  |  |  |  |  |  |  |  |  |
| *CO3* | *3* |  |  |  |  |  |  |  |  |  |  |

**16GEPC01 SHALLOW FOUNDATIONS**

**L T P C**

**3 0 03**

**COURSE OBJECTIVE**

To impart knowledge in selection and design of foundations based on bearing capacity and settlement.

**COURSE OUTCOMES**

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

CO1: Select a suitable foundation and evaluate bearing capacity and settlement.

CO2: Carry out structural design of shallow and special foundations.

CO3: Suggest suitable measures for expansive and difficult soils.

**UNIT I Introduction (09)** Developments – Need of foundation Engineering – Responsibility of foundation engineer – Shallow and deep foundations – Classification – Requirements of good foundations – Additional consideration– Selection of type of foundation – Hostile environment – Structural integrity – Economy.

**UNIT II Bearing Capacity (09)**

 Introduction – Criteria for computing Bearing Capacity – Theoretical methods – Terzaghi’s formula – Meyerhoff’s method – Vesic’s approach – Effect of compressibility of soil, water table, shape and width of foundation, inclination of load, eccentricity of load, layered soils – Hard rocks – Allowable bearing pressure – Evaluation of bearing capacity from in-situ tests – I.S. code provisions.

**UNIT III Settlement Evaluation (09)**

 Introduction – Immediate and time dependant settlement – Causes of settlement – Prediction of settlement – Minimizing settlement –Tolerable and allowable settlement – layered soils-stress path method – Evaluation from in-situ tests – Differential settlement – Causes and effects – Factors influencing – I.S. Code provisions – Special considerations for expansive and collapsible soils.

**UNIT IV Design of Foundations (09)**

 Analysis of foundation – Isolated – Strip – Combined footings and mat foundations. Conventional – Elastic approach – Soil Structure Interaction Principles – Application –Structural design of shallow foundations – Limit state method – Codal recommendations – Software applications.

**UNIT V Special Foundations (09)**

 Introduction to special foundations – Floating foundation – Foundation in expansive soils – Foundation on recent refuse fills – Design of foundation for seismic forces – Foundation design in relation to ground movement – Foundations on reclaimed soils – Codal recommendations.

**TOTAL: 45hrs**

***Reference Books:***

1. Peck, R.B. Hansen, V.E., and Thornburn, W.H., Foundation Engineering, John Wiley, 1974.
2. Winterkorn, H.F and Fang, Y.F., Foundation Engineering Handbook, Van Nostrand Reinhold, 1994.
3. Bowles, J.E. Foundation Analysis and Design, McGraw Hill, New York, 2001.
4. Tomlinson, M.J., Foundation Engineering, ELBS, Long man Group, UK Ltd, England, 1995.
5. Swami Saran, Soil Dynamics and Machine Foundation, Galgottia Publications Pvt. Ltd., New Delhi, 2010.
6. Day, R.W.,Geotechnical and Foundation Engineering, Design and Construction, McGraw Hill, 2010.
7. Donald P.Coduto, Geotechnical Engg, Principles and Practices, Pearson Education, 2010.
8. Robert Wade Brown, Practical Foundation Engineering Handbook, McGraw Hill, New York, 1996.
9. Vargheese, P.C., Limit State Design of Reinforced concrete, Prentice-Hall of India2009.
10. Muni Budhu, Soil Mechanics and Foundation, John Wiley and Sons, INC, 2000.

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|  | *PO1* | *PO2* | *PO3* | *PO4* | *PO5* | *PO6* | *PO7* | *PO8* | *PO9* | *PO10* | *PO11* |
| *CO1* |  |  |  |  | *2* |  |  |  |  |  |  |
| *CO2* |  |  | *3* |  |  |  |  |  |  |  |  |
| *CO3* |  |  |  | *1* |  |  |  |  |  |  |  |

**16GEPC02 SITE EXPLORATION AND SOIL INVESTIGATION**

 **L T P C**

**3 0 0 3**

**COURSE OBJECTIVE**

To impart knowledge on the preparation of soil exploration report based on laboratory, field exploration and testing techniques.

**COURSE OUTCOMES**

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

CO1: Plan for soil investigation and exploration in soil and rock

CO2 : Gain the practice of recovering samples using advanced sampling techniques.

CO3: Implement geotechnical instrumentation in the field and evolve solutions for different soil conditions.

**UNIT I Scope and Objectives of Site Investigation and Subsurface
 Exploration (09)**

 Scope and objectives – Preliminary desk studies – Planning an exploration programme – Location – Spacing – Depth of borings – Stabilization of bore holes– Soil Profile – Bore logs – Data Presentation – Soil investigation and exploration reports.

**UNIT II Exploration Techniques (09)**

 Methods of boring and drilling – Non-displacement and displacement methods – Drilling in difficult subsoil conditions – Geophysical exploration and interpretation – Seismic refraction and electrical resistivity methods.

**UNIT III Samples and Samplers (09)**

 Type of samples – Disturbed and undisturbed – Sample disturbance – Design features affecting sample disturbance – Area and recovery ratio – RQD – Types of samplers –Methods for preventing loss of samples – Shallow penetration samplers – Advanced sampling techniques – Offshore sampling – Preservation and handling of samples.

**UNIT IV Field Testing (09)**

 Field tests – Importance– Penetration testing – Standard Penetration Test – Static Cone Penetration Test – Dynamic cone penetration test – Plate load test – Field Vane shear test – Pressuremeter test – Data interpretation –Field Permeability test.

**UNIT V Instrumentation (09)**

Instrumentation in soil Engineering – Pore pressure – Ground water table – Strain gauges – Resistance and induction type – Load cells – Earth pressure cells – Settlement and heave gauges – Piezometers and slope indications – Inclinometer.

**TOTAL: 45hrs**

***Reference Books:***

1. Site Investigation by CRI clayton, N.E. Simon’s and M.C.Mathews – Cranada, 1976.
2. Surface exploration and sampling of soils for Civil Engineering – Purposes – M.JundHvorslev – Waterways Experiment Station, MISSISSIPPI, 1978.
3. Hunt R.E. Geotechnical Engineering Investigation Manual, McGraw Hill, 1984.
4. Winterkorn, H.F. and Fang, H.Y., Foundation Engineering Hand Book, a Nostrand Reinhold 1994.
5. Nair, R.J. and Wood, P.M., Pressuremeter Testing Methods and Interpretation, Butter worths, 1987.
6. Dunnicliff., J., and Green, G.E., Geotechnical Instrumentation for Monitoring Field Performance, John Wiley, 1993.
7. Hanna T.H., Field Instrumentation in Geotechnical Engineering, Trans Tech., 1985.
8. Bowles J.E., Foundation Analysis and Design, The McGraw Hill companies, inc., New York, 2001.

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|  | *PO1* | *PO2* | *PO3* | *PO4* | *PO5* | *PO6* | *PO7* | *PO8* | *PO9* | *PO10* | *PO11* |
| *CO1* |  |  | *1* |  |  |  |  |  |  |  |  |
| *CO2* |  |  | *1* |  |  |  |  |  |  |  |  |
| *CO3* |  |  |  | *2* |  |  |  |  |  |  |  |

**16GEPC03 STRENGTH AND DEFORMATION CHARACTERISTICS OF SOILS**

**L T P C**

**3 003**

**COURSE OBJECTIVE**

To impart knowledge on stress-strain characteristics of soils and its behaviour in the form of stress path and concepts of yield and failure criteria.

**COURSE OUTCOMES**

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

CO1:Evaluate the shear strength parameters of soil under different drainage conditions.

CO2:Use the concepts of stress path for different conditions.

CO3: Understand failure criteria of soils and apply models to study the time-deformation behaviour of soils.

**UNIT I Shear Strength of Cohesionless Soils (09)**

 Shear strength of granular soils – Direct shear – Triaxial Testing – Drained and undrained – Stress-strain behaviour – Dilatation – Contraction and critical states – Liquefaction and Liquefaction potential. Factors influencing – Stress-strain – Volume change behaviour of soils.

**UNIT II Shear Strength of Cohesive Soils (09)**

 Shear strength of clays – Stress-strain behaviour – Vane shear – UCC – Triaxial testing and stress path plotting – Pore pressure parameter of Skempton and Henkel – Total stress and effective stress approach – Shear strength of partially saturated clay in terms of stress state variables – Drained and undrained – Factors influencing stress-strain and shear strength.

**UNIT III Yield Criterion (09)**

 Concepts of yield and failure in soils – Yield criteria of Von Mises, Tresca,KvikPatriak, Drucker and Prager and their extended form – their applicability to soils – Detailed discussion of Mohr – Coulomb failure criterion.

**UNIT IV Stress Path and Stress – Strain Laws (09)**

 Lambe’s stress path for different cases – Stress path tests – Stress-strain laws for soils – Hyperbolic law – Linear visco-elastic and Elasto – Plastic laws – Yield functions, hardening law, flow rules and plastic strain computation – Elastic module – Cyclic loading – Limitation of linearity elastic model – Hyperbolic stress-strain model.

**UNIT V Critical State Soil Mechanics and Rheological Models (09)**

 Introduction to critical state soil mechanics – Boundary Surface – Roscoe and Hvorslev’s – Rheological models of Kelvin, Maxwell and Burger as applied to soils.

**TOTAL: 45hrs**

***Reference Books:***

1. Lambe, T.W. and Whitman R.V., Soil Mechanics in S.I. Units John Wiley, 1979.
2. Hotlz, R.D. and Kovais, W.D., Introduction of Geotechnical Engineering, Prentice – Hall1981.
3. Atkinson, J.H and Brandsby, P.L., Introduction to critical state soil mechanics, Cambridge University Press, New York, 1990
4. Braja, M. Das, Fundamentals of Geotechnical Engineering, Brooks/Cole, Thomson Learning Academic Resource, Center, ISBN-O0534-37114-0.
5. Keedwell, M.J., Rheology and Soil mechanics, Elsevier Applied Science Publishers Ltd. 1984, ISBN 0-85334-285-7.
6. Braja, M. Das, Advanced soil mechanics, McGraw Hill, 1997.
7. Wood. D.M., Soil behaviour and Critical State Soil Mechanics, Cambridge University Press New York, 1990.
8. Bazant, Z.P., Mechanics of Geo-materials, Rocks, Concrete and Soil, John Willey and Sons, Chilchester, 1985.

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**16GEPC04 THEORETICAL SOIL MECHANICS**

**L T P C**

**32 0 4**

**COURSE OBJECTIVE**

To learn elastic solutions by understanding stress-strain behaviour using theory of elasticity in anisotropic and non-homogeneous soil.

**COURSE OUTCOMES:**At the end of the course, students will be able to

CO1 : Apply theories of elasticity and plasticity to characterize the stress-strain behaviour of soil and evaluate stresses using different approaches.

CO2: Arrive at solutions for drained and undrained loading and to analyze the slopes, cuts and retaining structures for their stability using limit analysis.

CO3: Understand the concept of flow through soil media and to construct flow nets for different cases.

**UNIT I Theory of Elasticity (09)**

 Introduction – Material behaviour – Idealistic behaviour – Elastic, viscous and plastic – Elasticity and stability problems, concept of stress and strain – Plane stress, plane strain and axisymmetric problems – Equation of equilibrium and compatibility – Stress functions.

**UNIT II Stresses and Displacements (Elastic Solutions) (09)**

 Stresses in elastic half-space medium by external loads – Fundamental solutions – Boussinesq, Flamant, Kelvin and Mindlin solution – Applications of fundamental solutions – Anisotropic and non-homogeneous linear continuum – Influence charts – Elastic displacement.

**UNIT III Limit Equilibrium Analysis (09)**

 Limit equilibrium analysis – Perfectly plastic material – Stress-strain relationship – Stress and displacement field calculations – Slip line solutions for undrained and drained loading – Dimensional similitude.

**UNIT IV Limit Analysis (09)**

 Limit analysis – Principles of virtual work – Theorems of plastic collapse – Mechanism for plane plastic collapse – Simple solutions for drained and undrained loading – Stability of slopes, cuts and retaining structures. Centrifuge model – Principles and scale effects, practical considerations.

**UNIT V Flow Through Porous Media (09)**

 Flow through porous media – Darcy’s law – General equation of flow – Steady state condition – Solution by flow net – Fully saturated conditions – Flownetin anisotropic soils – construction of flownet for different cases.

**TOTAL: 45 + 15 hrs**

***Reference Books:***

1. Aysen, A., Soil Mechanics: Basic concepts and Engineering Application, A.A.Balkema Publishers, 2002.
2. Ulrich Smoltc, YK, Geotechnical Engineering Handbook (Vol. 1) Ernot&Sohn, 2002.
3. Aysen, A., Problem Solving inSoil Mechanics, A.A.Balkema Publisher, 2003.
4. Davis, R.O., and Selvadurai, A.P.S., Elasticity and Geomechanics, Cambridge University Press, 1996.
5. Taylor, R.N., Geotechnical Centrifuge Technology, Blackie Academic and Professional 1995.
6. Wai-Fah Chen, and Liu, X.L., Limit Analysis in Soil Mechanics, Elsevier Science Ltd., 1991.
7. Muni Budhu, Soil Mechanics and Foundations, John Wiley and Sons, Inc, Network, 2000.
8. Atkinson, J.H., Foundations and Slopes, McGraw Hill, 1981.
9. Harr, M.E., Foundations of Theoretical Soil Mechanics, McGraw Hill, 1966.
10. Cedergren, H.R., Seepage Drainage and Flownets, John Wiley, 1997.
11. Winterkorn, H.F., and Fang, H.Y., Foundation Engineering Handbook Galgottia, Booksource, 2000.
12. Karl Terzaghi,Theoritical Soil Mechanics, John Wiley & Sons Publications.

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**16GEPC05 DEEP FOUNDATIONS**

**L T P C**

**30 0 3**

**COURSE OBJECTIVE**

To gain knowledge on the design and construction of deep foundations, cofferdams

and underpinning.

**COURSE OUTCOMES**

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

CO1 : Select suitable deep foundation under given situations.

CO2 : Understand the behaviour of single and group of piles for its capacity and settlement.

CO3: Acquire knowledge on the stress distribution and settlement criteria of deep foundations and use design concepts of well foundations and cofferdams.

**UNIT I Pile Foundations (09)**

 General considerations – Function – Classification – Piling equipments and methods – Pile driving – Pile installation – Load tests on piles – Cyclic load tests – Indian Standard method – Uses and limitations of load tests – Model studies and their limitation. Pile spacing – Bearing capacity of groups of piles – Distribution of loading on piles – Culmann’s method – Stress distribution under pile foundation – Settlement of pile foundation – Elastic and consolidation settlements – Negative skin friction.

**UNIT II Design of Pile Foundations (09)**

 Length of piles – Type and structural design – Design of pile caps – Uplift and lateral forces – Batter piles – Damage to adjacent structural alignment of piles – Wave equation analysis – Problem on pile foundation in sands, clay, silt, loose and non uniform soils.

**UNIT III Piers and Caissons (09)**

 Piers – Drilled caissons – Large bored piles – Types – Design – Bearing capacity –Skin friction – Caisson – Classification – Design aspects – Design loads – Skin friction and sinking effort – Design of various components of caisson –Open, Pneumatic and floating caissons – Construction aspects of caissons.

**UNIT IV Well Foundations (09)**

 Well foundations – Advantages – Elements of a well foundation – Design aspects – Grip length – Forces acting – Design of various components of well foundation – Stability of well – Terzaghi’s analysis – IRC method – Construction of well foundation.

**UNIT V Coffer Dams and Under Pinning (09)**

 Coffer Dams – Problems of Foundations in bad ground and under water – Types of coffer dams – Braced coffer dam – Cellular cofferdams - design – Lateral pressures stability – Pipings – Average width of coffer dam – Coffer dam on rock – Coffer dam in deep soil deposit – Interlock stresses in cellular coffer dams – Construction of different types of coffer dams. Reasons for underpinning – Preliminary support columns and footings – Pier underpinning.

**TOTAL: 45hrs**

***Reference Books:***

1. Peck, R.B. Hansen, V.E., and Thornburn, W.H., Foundation Engineering, John Wiley, 1974.
2. Tomlinson, M.J., Foundation Engineering, ELBS, Long man Group, UK Ltd, England, 1995.
3. Bowles, J.E., Foundation Analysis and Design, McGraw Hill, New York, 2001.
4. Cemica, J.N., Geotechnical Engineering Foundation Design, John Wiley and Sons, Inc. 1995.
5. Das, B.M., Principles of Foundation Engineering, Design and Construction, PWS., Publishing, 1999 (Fourth Edition).
6. Donald, P.Coduto, Foundation Design Principles and Practices, Prentice Hall, Inc. Englewood Cliffs, New Jersey, 1996.
7. Grigorian, Pile Foundation for Buildings and structures in collapsible Soil, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, 1999.
8. Poulos, H.G., Davis E.H., Pile foundation analysis and designs, John Wiley and Sons, New York, 1980.
9. Winterkorn, H.F. and Fang, H.Y.,Foundation Engineering Handbook, Von Nostrand Reinhold, 1994.

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**16GEPC06 SOIL DYNAMICS AND MACHINE FOUNDATIONS**

**L T P C**

**3 20 4**

**COURSE OBJECTIVE**

To design different types of machine foundations based on the dynamic properties of soils and to get an exposure on vibration isolation techniques.

**COURSE OUTCOMES**

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

CO1 : Acquire knowledge to apply theories of vibration to solve dynamic soil problems.

CO2 : Evaluate the dynamic properties of soil using laboratory and field tests.

CO3 : Design various types of machine foundation and capable of selecting the types of vibration isolation materials and techniques.

**UNIT I Theory of Vibration (09)**

 Introduction – Nature of dynamic loads – Basic definitions – Simple harmonic motion – Fundamentals of vibration – Single degree and multi degree of freedom systems – Free vibrations of spring – Mass systems – Forced vibrations – Resonance – Viscous damping – Principles of vibrations measuring systems – Effect of transient and pulsating loads.

**UNIT II Dynamic Soil Properties (09)**

 Dynamic stress-strain characteristics – Principles of measuring dynamic properties – Laboratory techniques – Field tests – Block vibration test – Factors affecting dynamic properties – Typical values. Mechanism of liquefaction – Influencing factors – Evaluation of liquefaction potential – Analysis from SPT test – Dynamic bearing capacity – Dynamic earth pressure.

**UNIT III Machine Foundations (09)**

 Introduction – Types of machine foundations – General requirements for design of machine foundations – Design approach for machine foundation – Vibration analysis – Elastic Half-Space theory – Mass-spring-dashpot model – Permissible amplitudes – Permissible bearing pressures.

**UNIT IV Design of Machine Foundation (09)**

 Evaluation of design parameters – Types of Machines and foundations – General requirements – their importance – Analysis and design of block type and framed type machine foundations – Modes of vibration of a rigid foundation – Foundations for reciprocating machines, impact machines, Two – Cylinder vertical compressor, Double-acting steam hammer – Codal recommendations.Emprical approach – Barken’s method – Bulb of pressure concept – Pauw’s analogy – Vibration table studies.

**UNIT V Vibration Isolation (09)**

 Vibration isolation – Types of isolation – Transmissibility – Passive and active isolation – Methods of isolation – Use of springs and damping materials – Properties of isolating materials – Vibration control of existing machine foundation.

**TOTAL: 45 + 15 hrs**

***Reference Books:***

1. KameswaraRao, N.S.V., Dynamics soil tests and applications, Wheeler Publishing, New Delhi, 2000.
2. Prakash, S and Puri, V.K., Foundations for machines, McGraw Hill, 1987.
3. Moore, P.J.,Analysis and Design of Foundations for Vibrations, Oxford and IBH, 1985.
4. Vaidyanathan, C.V., and Srinivasalu, P., Handbook of Machine Foundations, McGraw Hill, 1995.
5. Arya, S., O’Nelt; S., Design of Structures and Foundations for Vibrating Machines, Prentice Hall, 1981.
6. Major, A., Vibration Analysis and Design of Foundations for Machines and Turbines, Vol. I. II and III Budapest, 1964.
7. Barkan, D.D., Dynamics of Basis of Foundation, McGraw Hill, 1974.
8. Swami Saran, Soil Dynamics and Machine Foundation, Galgotia publications Pvt. Ltd. New Delhi 2010.
9. Das B.M., Principles of Soil Dynamics, McGraw Hill, 1992.
10. Krammer S.L., Geotechnical Earthquake Engineering, Prentice Hall, International series, Pearson Education (Singapore) Pvt Ltd, 2004.
11. KameswaraRao, Vibration Analysis and Foundation Dynamics, Wheeler Publishing, New Delhi, 1998.

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**16GEPC07 GROUND IMPROVEMENT TECHNIQUES**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE**

To identify weak soils, suggest suitable improvements methods and to be familiar with the equipments used for improvement.

**COURSE OUTCOMES**

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

CO1 : Understand the parameters of weak soil and the techniques used for treating such soils.

CO2 : Know various types of stabilizers, stabilization techniques and its application in the field.

CO3 : Know the environmental sustainability of each method.

**UNIT I Dewatering (09)**

 Introduction – Scope and necessity of ground improvement – New Technologies – Basic concepts – Drainage methods – Ground water lowering by well points – Deep well, Vacuum and Electro – Osmosis methods.

**UNIT II Compaction and Sand Drains (09)**

 In-situ compaction of cohesionless and cohesive soils – Shallow and deep compaction – Vibration methods – Vibro-compaction, Blasting, Vibrating probe, Vibratory rollers, Vibro-displacement compaction, Vibroflotation – Concept, Factors influencing compaction – Heavy Tamping – Vertical drains – Preloading with sand drains, Fabric drains, Wick drains – Design of sand drains – Relative merits of different methods – Limitations.

**UNIT III Stone Column and Consolidation (09)**

 Precompression and consolidation – Dynamic consolidation – Electro-osmotic consolidation – Stone column – Functions – Methods of installation – Design estimation of load carrying capacity of stone column – Settlement of stone column – Lime piles – Earth reinforcement – Soil Nailing – Types of reinforcement material – Applications.

**UNIT IV Stabilization (09)**

 Introduction – Stabilization methods – Mechanical, Cement, Lime, Bitumen, Chemical stabilization – Electrical stabilization – Stabilization by Thermal and Freezing techniques – Ground improvement by excavating and replacing – Stabilization of expansive clays – Prewetting.

**UNIT V Grouting (09)**

 Introduction – Applications – Functions – Characteristics of grouts – Types of grout – Suspension and solution grouts – Basic requirements of grout – Displacement – Compaction grouting, displacement – Soil fracture grouting, Jet – Displacement grouting, Permeation grouting – Grouting equipment – Injection methods – Grout monitoring.

**TOTAL: 45hrs**

***Reference Books:***

1. Purushothama Raj, P., Ground Improvement Techniques, Laxmi Publications (P) Ltd., New Delhi, 2005.
2. Moseley M.D., Ground Treatment, Blackie Academic and Professional, 1998.
3. Shroff, A.V., Grouting Technology, in Tunneling and Dam, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 2009.
4. Koerner, R.M., Designing with Geosynthetics (fourth edition), Prentice Hall, New Jersey, 1999.

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**16GEPC08 PAVEMENT ENGINEERING**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE**

To gain knowledge on assessing stresses, design of flexible and rigid pavements and pavement rehabilitation techniques.

**COURSE OUTCOMES**

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

CO1 : Learn loading conditions and corresponding stresses and deformation developed.

CO2: Design flexible and rigid pavements as per IRC recommendations.

CO3: Acquire knowledge on the performance of pavement, types of stabilizers and their applicability in pavements.

**UNIT I Basic Concepts (09)**

 Pavement – types – Historical developments – Approaches to pavement design – Vehicle and traffic considerations – Behaviour of road materials under repeated loading – Stresses and deflections in layered systems.

**UNIT II Flexible Pavement (09)**

 Factors affecting flexible pavements–Material characterization for analytical pavement design – CBR and stabilometer tests – Resilient modulus – Fatigue subsystem – Failure criteria for bituminous pavements – IRC design guidelines.

**UNIT III Rigid Pavement (09)**

 Factors affecting rigid pavements – Design procedures for rigid pavement – IRC guidelines – Airfield pavements. Highway pavement – CRC pavements.

**UNIT IV Pavement Evaluation and Rehabilitation (09)**

 Pavement evaluation and rehabilitation, condition and evaluation surveys – Causes and types of distress in flexible and rigid pavements – PSI models – Serviceability index of rural roads – Overlay design, pavements maintenance management and construction.

**UNIT V Stabilization of Soils for Road Constructions (09)**

 The need for a stabilized soil – Design criteria and choice of stabilizers – Testing and field control – Stabilisation for rural roads – Use of geofabrics in road construction – Case studies.

**TOTAL: 45hrs**

***Reference Books:***

1. Wright, P.H., Highway Engineers, Johwiley& Sons, Inc. New York, 2009.
2. Yoder, R.J and Witchak, M.W., Principles of Pavment Design, John wiley, 2000.
3. Khanna, S.K and Justo C.E.G., Highway Engineering, New Chand and Brothers, Roorkee, 1998.
4. Design and specification of Rural Roads (Manual), Ministry of rural roads, Government of India, New Delhi, 2001.
5. Guidelines for the Design of Flexible Pavements, IRC : 37 – 2012, The Indian Roads Congress, New Delhi.
6. Guidelines for the Design of Rigid Pavements, IRC : 58 – 2012, The Indian Roads Congress, New Delhi.
7. O’ Flaherty, C.A., Highway Engineering (Vol. 2), Edward Arnold Cp. 1978.
8. Kadiyali, L.R., Transport planning & Traffic Engineering, Khanna Publishers, 2008.

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**16GEEE01 PROJECT PHASE- I**

**L T P C**

**0 0 12 6**

**COURSE OBJECTIVE**

To identify state of art problem, develop methodology for solutions using analytical and experimental work and prepare project report for reviews and viva-voce examination.

**COURSE OUTCOMES:** At the end of the course, students will be able to

CO1: Know the state of art in the particular area and will be in a position to carry the phase I project in a systematic way.

CO2: Enhance the ability to work independently on the topic using different experimental and analytical approaches.

CO3: Acquire a formulated methodology in solving any problem and to present the solutions in a proper way.

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**16GEEE02 PROJECT PHASE- II**

**L T P C**

 **0 0 24 12**

**COURSE OBJECTIVE**

To carry out intensive research on current topics preferably industry oriented, giving solutions to the identified problems and to publish technical papers in referred journals.

**COURSE OUTCOMES:** At the end of the course, students will be able to

CO1: Go deeper into specific areas using scientific research method.

CO2: Analyze and solve real life geotechnical problems with the knowledge gained through the project work.

CO3: Acquire the capability of preparing report highlighting their research findings and the same can be submitted to research journals.

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**16GEPE01EARTH RETAINING STRUCTURES**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE**

To impart knowledge on earth pressure theories, design of retaining walls, sheet pile walls with and without geosynthetic reinforcements.

**COURSE OUTCOMES**

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

CO1: Understand earth pressure theories, forces on retaining walls and design retaining walls.

CO2: Design earth retaining structures, soil nailing, pinning, and anchoring on stability considerations.

CO3: Apply concepts of reinforcement in earth retaining structures.

**UNIT I Earth Pressure Theories (09)**

 Introduction – State of stress in retained soil mass – Classical earth pressure theories – Active and Passive earth pressures – Earth pressure at rest – Earth pressure due to external loads – Empirical methods – Wall movements and complex geometry – Graphical method of computing earth pressure – Rehbann’s and Culmann’s approach.

**UNIT II Retaining Walls (09)**

 Retaining walls – Uses and types – Forces on retaining walls – Design of retaining walls by limit state method – General principles – Design and construction details – Design of solid gravity walls, Semi – gravity walls, cantilever walls, counterfort walls – Stability of retaining walls – Drainage arrangements and its influence.

**UNIT III Sheet Pile Walls (09)**

 Earth retaining structures – Selection of soil parameters – Analysis and design of cantilever and anchored sheet pile walls – Deadman and continuous anchor – Diaphragm and bored pile walls – Design requirements.

**UNIT IV Braced Excavation (09)**

 Braced cuts in sand and clay – Lateral pressure on sheeting in Braced excavation – Stability against piping and bottom heaving – Procedure for computation of lateral earth pressure for braced cuts and Flexible Bulk heads – Soil anchors – Soil nailing – Soil pinning – Methods of design.

**UNIT V Reinforced Earth Retaining Wall (09)**

 Reinforced earth retaining wall – General principles, Concepts and mechanism of reinforced earth – Design consideration of reinforced earth – Geotextile, geogrids, metal strips and facing elements – Construction – Selection of type of retaining structures – Construction practice – Field observations.

**TOTAL: 45hrs**

***Reference Books:***

1. Winterkorn H.F. and Fang H.Y., Foundation Engineering Hand book, Galgotia Book-source, 2000.
2. Rowe R.K., Geotechnical and Geo environmental Engineering Hand Book, Kluwer Academic Publishers, 2001.
3. Militisky .J and Woods R., Earth and earth retaining structures, Routledge, 1992.
4. Das B.M., Principles of Geotechnical Engineering (Fourth edition). The PWS series in Civil Engineering, 1998.
5. Clayton C.R.I. Militisky, J and Woods R., Earth pressure and earth retaining structures (second edition) Survey University Press, 1993.
6. McCarthy D.F., Essentials of soil Mechanics and foundations; Basic Geotechnics (sixth Edition) Prentice Hall, 2002.

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**16GEPE02 REMOTE SENSING AND ITS APPLICATIONS IN**

**GEOTECHNICAL ENGINEERING**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE**

To introduce the elements of GIS applied to Geotechnical Engineering and to be familiar with the use of GIS and GPS.

**COURSE OUTCOMES**

At the end of the course, students will be able

CO1: To study about the remote sensing system, analysis of data and the interpretation of data.

CO2: To study on the digital images.

CO3: To familiarize with GIS and GPS and to know the applications of these tools.

**UNIT I Introduction(09)**

 Remote sensing Fundamentals: Definition – Scope –Types and chronological development – Ideal and real remote sensing system. Comparison of conventionalsurvey, aerial remote sensing and satellite remote sensing –Advantages and limitationof satellite remote sensing.

EMR and Remote Sensing: Energy sources –Electro Magnetic Radiation – Spectralregions – Energy Interaction in the atmosphere – Atmospheric windows – EnergyInteraction with earth surface features – Spectral reflectance patterns for differentregion of EMR.

**UNIT II Sensors and platforms (09)**

 Electro-optical sensor systems – LANSAT, SPOT, IRS and IKONSsensors – scanning and orbiting mechanisms – Resolution: spatial, spectral, radiometric and temporal resolution of the satellites –Classification of platforms.

**UNIT III Images Interpretation and Digital Image Processing (09)**

Interpretation procedure –Elements of Photo Interpretation–Strategies of Image Interpretation –Keys of Image Interpretation –Basic equipments for Image Interpretation –Digital Signal Processing Digital analysis – Image Rectification and Restoration – Geometric correction – Image Enhancement and Image transformation.

**UNIT IV Geographical Information System (GIS) (09)**

 Definition data input and output : Topology, Digital elevation data – Data management – Relational data model –Spatial data models – Raster and Vector data Models –GIS analysis – Classification, overlay operation.

**UNIT V Application of RS and GIS in Geotechnical Engineering (09)**

Role of Remote Sensing and GIS in terrain investigation – Digital Terrain Modelling(DTM) –Triangulated Irregular Network(TIN) – Land use and Land cover mapping –Landslide studies and seismic hazard mapping.

**TOTAL:45hrs**

***Reference Books:***

1. AM Chandra, SK Ghosh,Remote Sensing and Geographic information system, Narosa Publishing house.

2. Lillesand T.M. and Kiefer R.W., Remote Sensing and image interpretation*,* John Wiley and Sons. New York.

3. J.B. Campbell, Taylor & Francis, Introduction to remote sensing*,* London.

4. J.R. Jensen*,* Introductory digital image processing, Prentice Hall International Ltd., London.

5. Kennie, T.J.M. and Matthews M.C., Remote Sensing in Civil Engineering, Surrey University Press, Glasgow.

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**16GEPE03SOIL PROPERTIES AND BEHAVIOUR**

**L T P C**

**3 00 3**

**COURSE OBJECTIVE**

To study about clay minerals, physical, physio-chemical, expansive and conduction

behaviourof soils.

**COURSE OUTCOMES**

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

CO1 : Get knowledge about the structure and identification of clay minerals.

CO2 : Use the concept of diffuse double layer theory and the cation exchange capacity to determine the chemical behaviour of soils.

CO3 : Understand the mechanism and effects of swelling, shrinkage in clay soils and the use of clay models in conduction phenomenon.

**UNIT I Formation of Soils and Clay Minerals (09)**

 Introduction – Soil Formation – Types of soils – Geological and pedogical background – Various soil deposits and their engineering suitability – Composition and structure of clay minerals – Structure of allophone, kaolinite, hallosite, montmorillonite, illite, chlorite and vermiculite minerals, mixed layer minerals.

 Classification and identification of clay minerals – X- ray diffraction data – electron microscopic analysis – Differential thermal analysis – Anion and cation exchange capacity of clays – Specific surface area – Bonding in clays.

**UNIT II Physical and Physio-Chemical Behaviour of Soils (09)**

 Physical and Physio-Chemical behaviour of Soils – Diffused double layer theory – Computation of double layer distance – Dielectric constant – Temperature on double layer – Ion Exchange – Cation exchange capacity – Causes of cation exchange effect – Fixation of cations – Determination of cation exchange capacity – Exchangeable cations.

**UNIT III Expansive and Shrinking Soil (09)**

 Introduction – Swelling and shrinking behaviour of soils – Problems associated – Characteristics affecting shrinkage – Crack formation during shrinkage – Measurements of shrinkage for samples – Factors influencing swell – Shrink characteristics – Swelling pressure of soils – Swell pressure determination – Mechanism of swelling – Volume changes and Engineering problems in the field – Osmotic swell pressure – Soil fabric and measurement – Sensitivity, activity,thixotrophy - Stress history – Identification of expansive clays.

**UNIT IV Compressibility and Collapsible Soil (09)**

 Introduction – Compressibility – Permeability behaviours of soils and clays – Mechanism involved – Factors governing compressibility – Soil water – Consumption of soil water – Capillary tube, capillary potential – Soil moisture – Methods of determination of soil moisture – Physical behaviour of soil water systems – Liquefaction – Liquefaction potential – Soil suction – Determination of suction potential – Collapsible soil – its identification – Effect on foundation.

**UNIT V Conduction Phenomenon and Prediction of Soil Behaviour (09)**

 Conduction in soils – Coupled flows – Electrical, Chemical, Hydraulic and Thermal flows in soils – Consolidation by Electro-osmosis – Clay mineralogy in relation to physical and engineering properties of clay minerals – Prediction of engineering behaviour of soils – Empirical correlations and their applicability – Granular soil structure – Clay structure models.

**TOTAL: 45hrs**

***Reference Books:***

1. Bowles J.E., Engineering properties of soils and their measurement, McGraw Hill 1970.
2. Mitchell J.K., Fundamentals of Soil Behaviour, John Wiley, New York, 1993.
3. Yong R.N. and Warkentin, B.P., Introduction of Soil Behaviour, Macmillan, Limited, London, 1979.
4. Das B.M. Principles of Foundation Engineering , PWS Publishing company, Boston, 1999.
5. McCarthy D.F., Essentials of Soil Mechanics and Foundations, Prentice Hall, 2002.

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**16GEPE04 FINITE ELEMENT ANALYSIS**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE**

To develop skills in the matrix operations to obtain solution for 1D and 2D problemsand axisymmetric and non-linear analysis.

**COURSE OUTCOMES**

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

CO1 : Understand the various stress-strain-displacement relations.

CO2 : Know the concept of stiffness matrix and understand choosing boundary conditions.

CO3 :Do the discretization of elements to solve the problems of plane stresses and plane strain, types of non linearity and their solutions.

**UNIT I Introduction to Elasticity (09)**

 Principles of Elasticity – Stress equations – Strain-Displacement relationships in matrix form – Plane stress – Plane strain and axisymmetric bodies of revolution with axisymmetric loading.

**UNIT II Element Properties and Isoparametric Formulations (09)**

Concept of an element – Various element shapes– Displacement models – Generalized coordinates – Shape functions – Formulation of 4-noded and 8-noded Isoparametric quadrilateral elements – Lagrangian elements – Serendipity elements.

**UNIT III Direct stiffness method (09)**

 Direct stiffness method – Element stiffness matrix – Global stiffness matrix – Boundary conditions – Application of DSM to simple Elements.

**UNIT IV Geotechnical Applications (09)** Application to problems such as stress distribution and deformation in isotropic and anisotropic soil and rock media – Stress and deformation around excavations and built-up embankments – Seepage through porous media – One dimensional consolidation – Stress distribution around openings in intact and fissured rock.

**UNIT V Software Applications (09)**

 Introduction to PLAXIS software – Applications of PLAXIS 2D on tunnel construction – Consolidation analysis of embankments – Soil displacement around excavation pit – Pore pressure distribution – Flow around a sheet pile wall – Pile driving –Flow through an embankment – Settlement of a footing on sand and clay – Construction of a road embankment.

**TOTAL: 45hrs**

***Reference Books:***

1. Krishnamurthy, Finite Element Analysis – Theory and programming, Second edition, Tata McGraw Hill Publishing Co., 1994.
2. Desai C.S., Elementary Finite Element Method, Prentice Hall, IINC, 1979.
3. Rajasekaran S., Finite Element Analysis in Engineering Design, Wheeler publishing 1993.
4. ChandrapatlaTirupathi, R and Belegundu Ashok, D., Introduction to Finite Elements in Engineering, Second edition, Prentice Hall of India, 1997
5. Dr.Sadhu Singh, Theory of Elasticity, Khanna Publishers, Fourth Edition.

6. David M. Potts and Lidija Zdravkovié Imperia, Finite Element Analysis in Geotechnical Engineering

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**16GEPE05 REINFORCED SOIL STRUCTURES**

**L T P C**

**3 00 3**

**COURSE OBJECTIVE**

To impart knowledge on geosynthetics, design principles and mechanism of reinforced soil, soil nailing and its applications in dams, embankments, pavements and foundation structures.

**COURSE OUTCOMES**

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

CO1 :Understand the soil reinforcement interaction mechanism.

CO2 : Enrich their knowledge on properties, testing methods of geosynthetics in earth reinforcement.

CO3 : Design various soil reinforcements, soil nailing in major projects.

**UNIT I Principles and Mechanisms (09)**

 Historical background – Initial and recent developments – Principles – Concepts and mechanisms of reinforced soil – Factors affecting behaviour and performance of soil – Reinforcement interactions.

**UNIT II Materials and Material Properties (09)**

 Materials used in reinforced soil structures – Fill materials, reinforcing materials, metal strips, Geotextile, Geogrids, Geomembranes, Geocomposites, Geojutes, Geofoam, natural fibres, coir Geotextiles – Bamboo – Timber – Facing elements – Properties – Methods of testing – Advantages and disadvantages – Preservation methods.

**UNIT III Design Principles and Applications (09)**

 Design aspects of reinforced soil – Soil reinforcement function – Separator, Filtration, Drainage, Barrier function – Design and applications of reinforced soil of various structures – Retaining walls – Foundations – Embankments and slopes.

**UNIT IV Geosynthetics and Applications (09)**

 Introduction – Historical background – Applications – Design criteria – Geosynthetics in roads – Design – Giroud and Noiray approach – Geosynthetics in landfills – Geosynthetic clay liner – Design of landfills – Barrier walls.

**UNIT V Soil Nailing and Case Histories (09)**

 Soil nailing – Introduction – Overview – Soil-Nail interaction – Behaviour – Design procedure – Behaviour in seismic conditions.

 Performance studies of reinforced dams, embankments, Pavements, Railroads, Foundations– Case studies.

**TOTAL:45hrs**

***Reference Books:***

1. Jewell, R.A., Soil Reinforcement with Geotextile, CIRIA, London, 1996.
2. John, N.W.M., Geotextiles, John Blackie and Sons Ltd., London, 1987.
3. Jones, C.J.F.P., Earth Reinforcement and Soil Structures, Earthworks, London, 1982.
4. Koerner, R.M., Designing with Geosynthetics, (Third Edition), Prentice Hall, 1997.
5. Proc. Conference on polymer and Reinforcement, Thomas Telford Co., London, 1984.
6. Gray, D.H., and Sotir, R.B., Biotechnical and Soil Engineering Slope Stabilization. A Practical Guide for Erosion Control, John Wiley & Son Inc., New York, 1996.
7. RamanathaAyyar, T.S., Ramachandran Nair, C.G. and Balakrishna Nair, N., Comprehensive reference book on Coir Geotextile, Centre for Development for Coir Technology, 2002.

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**16GEPE06 SLOPE STABILITY AND LANDSLIDES**

**L T P C**

**3 003**

**COURSE OBJECTIVE**

To impart knowledge on investigation, analysis, design and stabilization of slopes.

**COURSE OUTCOMES**

At the end of the course, students are able to

CO1 : Gain knowledge about the purpose of computing slope stability.

CO2: Familiar on the analysis of irregular slopes with different approaches and the use of instrumentation in the slope stability.

CO3 : Execute suitable ground improvement techniques in the field.

**UNIT I Stability of Slopes (09)**

 Introduction – Importance – General characteristics – Types of failures – Causes of failures – Purpose of stability computation – Investigation of failures – Procedure – Case studies.

**UNIT II Stability Analysis (09)**

 Stability analysis – Method of slices – Friction circle method – Soils with cohesion – Soils with cohesion and angle of internal friction. Critical states for design for embankments – Stability computations – Evaluation of pore water pressure.

**UNIT III Irregular Slopes (09)**

 Non-uniform soils – Janbu’s analysis – Taylor’s analysis – Bishop’s analysis – Total stress and effective stress approaches – Composite surfaces of sliding – Block sliding.

**UNIT IV Land Slides (09)**

 General Characteristics – Sources–Stability of Hill side slopes – Open cuts – Engineering problems involving the stability of slopes – Cuts in sand – Cuts in loess – Homogeneous and soft clay slopes – Sudden spreading of clay slopes – Clay flows – Clays containing pockets and sand masses – Slides in stiff clay slopes on shale – Slopes on weathered rock; talus slopes, slopes on over consolidated clays – Slides along coastal areas and tropically weathered residual soils – Long term stability of clay slopes.

**UNIT V Field Observations and Slope Stabilization (09)**

 Field instrumentation – Observation studies during construction – Post construction, piezometers – Settlement plates – Inclinometer – Case histories.Compaction of new embankments – Compaction of natural masses of soil and existing fills – Compaction of deep deposits of sand – Vibroflotation – Compaction of compressible soils – Drainage as a means of stabilization – Use of Geotextiles – Soil nailing.

**TOTAL: 45hrs**

***Reference Books:***

1. Chowdhury, D.F., Slope analysis, Prentice Hall, 1988.
2. Winterkorn, H.F. and Fang, H.Y., Foundation Engineering Handbook, Van Nostrand Reinhold, 1994.
3. Bramhead, E.N., The Stability of Slopes, Blacky Academic and Professionals Publications, Glasgow 1986.
4. Anderson, M.G., and Richards, K.S., Slope Stability, John Wiley, 1987.

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**16GEPE07 ROCK MECHANICS IN ENGINEERING PRACTICE**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE**

To make the students understand the properties of rock, pattern of failure, evaluation of stresses and stability considerations of rock masses.

**COURSE OUTCOMES**

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

CO1:Know the formation and classification of rocks in India.

CO2:Understand the in-situ stresses developed and methods of measurement.

CO3:Evaluate the strength parameters of rocks and adopt appropriate remedial measures for stability of critical slopes of rocks.

**UNIT I Classification of Rocks (09)**

 Rocks of peninsular India and the Himalayas – Index properties and classification of rock masses, competent and incompetent rock – Value of RMR and ratings in field estimations.

**UNIT II Strength Criteria of Rocks (09)**

 Behaviour of rock under hydrostatic compression and deviatoric loading – Modes of rock failure – Planes of weakness and joint characteristics – Joint testing, Mohr – Coulomb failure criterion and tension cut-off, Hoek and Brown Strength criteria for rocks with discontinuity sets.

**UNIT III Design Aspects in Rocks (09)**

 Insitu stresses and their measurements, flat jack – Over and under coring methods – stress around underground excavations – Design aspects of openings in rocks – Case studies.

**UNIT IV Slope Stability of Rocks (09)**

 Rock slopes – Role of discontinuities in slope failure, slope analysis and factor of safety – Remedial measures for critical slopes – Case studies.

**UNIT V Reinforcement of Rocks (09)**

 Reinforcement of fractured and jointed rocks – Shotcreting – Bolting – Anchoring – Installation methods – Case studies.

**TOTAL: 45hrs**

***Reference Books:***

1. Goodman, R.E., Introduction to Rock Mechanics, John Wiley and Sons, 1989.
2. Hool, E and Bray, J., Rock Slope Engineering, Institute of Mining and Metallurgy, U.K. 1981.
3. Hoek, E and Brown, E.T., Underground Excavations in Rock, Institute of Mining and Metallurgy, U.K. 1981.
4. Obvert, L. and Duvall, W., Rock Mechanics and the Design of Structures in Rock, John Wiley, 1967.
5. Bazant, Z.P., Mechanics of Geomaterials Rocks, Concrete and Soil, John Wiley and Sons, Chichester, 1985.
6. Wittke, W., Rock Mechanics:Theroy and Applications with Case Histories, Springerverlag, Berlin, 1990.

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**16GEPE08FOUNDATION IN EXPANSIVE SOILS**

 **L T P C**

**3 0 0 3**

**COURSE OBJECTIVE**

To get exposure on the properties of expansive soils and to study about the substructures placed on expansive soils.

**COURSE OUTCOMES**

CO 1. To assess the occurrence and distribution of expansive soils.

CO 2. To study the properties of expansive soils and the controlling techniques.

CO 3. To understand various methods of stabilization of expansive soils and foundations used in expansive soils.

**UNIT I General Principles (09)**

Origin of expansive soils – Physical properties of expansive soils –Mineralogicalcomposition – Identification of expansive soils – Fieldconditions that favour swelling – Consequences of swelling.

**UNIT II Swelling Characteristics (09)**

Swelling characteristics – Laboratory tests – Prediction of swellingcharacteristics – Evaluation of heave.

**UNIT III Techniques for Controlling Swelling (09)**

Horizontal moisture barriers – Vertical moisture barriers – Surface andsubsurface drainage – Prewetting – Soil replacement – Sand cushiontechniques – CNS layer technique.

**UNIT IV Foundationson Expansive Soils(09)**

Belled piers – Bearing capacity and skin friction –Advantages anddisadvantages – Design of belled piers – Underreamed piles – Design andconstruction.

**UNIT V Modificationof Swelling Characteristics(09)**

Lime stabilization – Mechainsms – Limitations – Lime injection – Limecolumns – Mixing – Chemical stabilization – Construction.

**TOTAL :45hrs**

***Reference Books:***

1. Fu Hua Chen, Foundations on Expansive Soils, Elsevier ScientificPublishing Company, New York.

2. GopalRanjan and A.S.RRao, Basic and Applied Soil Mechanics,New Age International Publishers –NewDelhi.

3. Hand Book on Underreamed and Bored Compaction Pile Foundation,CBRI, Roorkee.

4. IS : 2720 (Part XLI) – 1977 – Measurement of Swelling Pressure of Soils.

5. R.K.Katti, Search for Solutions in Expansive Soils.

6. Alam Singh, ModernGeotechnical Engineering, Geo-EnvironAcademia, Jodhapur.

7. Swami Saran, Analysis and Design of Substructures.

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**16GEPE09 GEOLOGY IN GEOTECHNICAL ENGINEERING**

**L T P C**

**3 00 3**

**COURSE OBJECTIVE**

To understand microscopic study of rocks, geophysical exploration for ground water and structural geology and also causes and preventing measures of landslides.

**COURSE OUTCOMES**

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

CO1 : Identify mineral content, texture and structural behaviour of rocks using microscopic study.

CO2: Carryout investigation for foundations of massive structures, handle situations of earthquake and landslide.

CO3: Do ground water survey and understand ground water investigation studies.

**UNIT I Introduction (09)**

 Soil formation – Survey – Soils of India – Texture and structure of igneous, sedimentary and metamorphic rocks. Microscopic study – Microscopic study of rocks with particular reference to texture – microscopic study of unconsolidated sediments with reference to their grain size and mineral content.

**UNIT II Geophysical Investigation (09)**

 Geotechnical Investigation – Geophysical methods of exploration – Electrical, Magnetic, gravitational, seismic, radioactive and geochemical methods – Influence of structure and texture of rocks, Engineering properties, foundation problems in igneous, sedimentary and metamorphic rocks including recent sediments – Case histories. Investigations for foundation of dams and reservoirs – Problem encountered and treatment, case studies – Investigation of canals and deep cuts – Case studies.

**UNIT III Land Slides (09)**

 Land Slides – Causes – Preventive and control measures – Engineering problems related to earthquakes, case studies.

**UNIT IV Ground Water (09)**

 Ground Water problems – Location of water tables, composition of ground water – Ground water surveys – Conservation of ground water – Scope of ground water investigation in Civil Engineering.

**UNIT V Structural Geology (09)**

 Altitude of beds – Dip and Strike, Characteristics, Types, Causes and mechanism of folding, Classification, Causes and mechanism of faults – Field evidences and Recognition of faults.Joint systems – Classification and its types, Difference between faults and joints.Definition, importance and field recognition of unconformity.

**TOTAL: 45hrs**

***Reference Books:***

1. ParbinSingh,Engineering and General Geology, Katson Publication House, 1987.
2. Blyth, Geology for Engineering, ELBS 1995.
3. Legget, Geology and Engineering, McGraw Hill Book Company, 1998.
4. Krynine and Judd, Principles of Engineering Geology and Geo techniques, 1998.

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**16CEPE01 SOIL STRUCTURE INTERACTION**

**L T P C**

**3 0 03**

**COURSE OBJECTIVE**

To get an idea on soil structure interaction, soil foundation models, finite difference and finite element analysis and elastic analysis of piles and piled raft.

**COURSE OUTCOMES**

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

CO1 : Understand various soil response models applicable to soil-foundation interaction analysis.

CO2 : Come up with elastic solutions for problems of pile, pile-raft system.

CO3 : Use software packages to analyze soil-foundation system including laterally loaded piles.

**UNIT I Soil - Foundation Interaction (09)**

 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 behaviour.

**UNIT II Beams on Elastic Foundation - Soil Models (09)**

 Infinite beam – Two parameters – Isotropic elastic half space – Analysis of beams of finite length – Classification of finite beams in relation to their stiffness – Analysis through application packages.

**UNIT III Plate on Elastic Medium (09)**

 Infinite plate – Winkler, Two parameters, Isotropic elastic medium, Thin and thick plates – Analysis of finite plates – Rectangular and circular plates – Numerical analysis of finite plates – Simple solutions – Analysis of braced cuts – Application packages.

**UNIT IV Elastic Analysis of Pile (09)**

 Elastic analysis of single pile – Theoretical solutions for settlement and load distribution – Analysis of pile group – Interaction analysis – Load distribution in groups with rigid cap – Pile raft – Application packages.

**UNIT V Laterally Loaded Pile (09)**

 Load deflection prediction for laterally loaded piles – Subgrade reaction and elastic analysis – Interaction analysis – Pile raft system – Solutions through influence charts –Application packages.

**TOTAL: 45hrs**

***Reference Books:***

1. Saran, S., Analysis and design of substructures, Taylor & Francis Publishers, 2006.
2. Hemsley, J.A., Elastic Analysis of Raft Foundations, Thomas Telford, 1998.
3. Poulos, H.G., and Davis, E.H., Pile Foundation Analysis and Design, John Wiley, 2008.
4. Murthy, V.N.S., Advanced Foundation Engineering, CBS Publishers, New Delhi, 2007.
5. McCarthy, R.N., Essentials of Soil Mechanics and Foundations: Basic Geotechnics, Sixth Edition, Prentice Hall, 2002.
6. Selvadurai, A.P.S., Elastic Analysis of Soil Foundation Interaction, Elsevier, 1979.
7. Scott, R.F., Foundation Analysis, Prentice Hall, 1981.
8. Structure Soil Interaction – State of Art Report, Institution of structural Engineers, 1978.
9. ACI 336, Suggested Analysis and Design Procedures for Combined Footings and Mats, American Concrete Institute, Delhi, 1988.

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**16CEPE02 GEOTECHNICAL EARTHQUAKE ENGINEERING**

**L T P C**

**3 00 3**

**COURSE OBJECTIVE**

To understand the mechanism of earthquake, wave propagation analysis, ground motion, earthquake hazards, their mitigation and design of earthquake resistant foundations.

**COURSE OUTCOMES**

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

CO1 :Acquire knowledge about the earthquake ground motion, making familiar with code and software packages to study the ground motion.

CO2 :Analyze the liquefaction susceptibility of the site using laboratory and field tests.

CO3 : Design earthquake resistant geotechnical structures and the methods to improve the ground for hazard resistance.

**UNIT I Earthquake Seismology (09)**

Causes of earthquake – Plate tectonics –Earthquake Fault sources – Elastic Rebound theory – Seismic waves– Elastic Rebound theory – Locating an earthquake – Quantification of earthquakes – Intensity and magnitudes – Locating an earthquake –Case studies.

**UNIT II Ground Motion and Ground Response analysis (09)** Characteristics of ground motion – Factors influencing ground motion – Evaluation of shear wave velocity – Lab tests – Need for Ground Response Analysis – Methods of Ground Response analysis.

**UNIT III Liquefaction and Lateral Spreading (09)** Liquefaction related phenomena – Liquefaction susceptibility – Evaluation of liquefaction by Cyclic Stress and Cyclic Strain approaches – Lateral deformation and spreading – Criteria for mapping liquefaction hazard zones – Liquefaction computation from Lab and Field tests.

**UNIT IV Seismic Design of Foundations, Retaining Walls and Slopes (09)** Seismic design requirements of foundation – Seismic design of pile foundations – Seismic design of retaining walls – Behaviour of reinforced slope under seismic condition – Recommendations of seismic codes related to geotechnical engineering.

**UNIT V Seismic Hazard Analysis (09)**

 Seismic hazard analysis – DSHA – PSHA – Seismic microzonation – Soil Improvement for remediation of seismic hazards.

**TOTAL: 45hrs**

***Reference Books:***

1. KameswaraRao, N.S.V., Dynamics soil tests and applications, Wheller Publishing – New Delhi, 2000.
2. Krammer S.L., Geotecnical Earthquake Engineering, Prentice hall, International series Pearson Education (Singapore) Pvt. Ltd., 2004.
3. KameswaraRao, Vibration Analysis and Foundation Dynamics, Wheeler Publishing, New Delhi, 1998.
4. McGuire, R.K., Seismic Hazard and Risk Analysis, Earthquake Engineering Research Institute. MNo – 10, ISBN 0-943198-01-1, 2004.
5. Mahanti, N.C., Samal, S.K., Datta, P., Nag N.K., Disaster Management, Narosa Publishing House, New Delhi, India ISBN : 81-7319-727X-2006.
6. Bharat Bhushan Prasad, Fundamentals of Soil Dynamics and Earthquake Engineering, PHI Learning Pvt.Ltd.,NewDelhi, 2009.
7. Bharat Bhushan Prasad, Advanced Soil Dynamics and Earthquake Engineering, PHI Learning Pvt.Ltd.,NewDelhi, 2011.

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**16CEPE03ENVIRONMENTAL ENGINEERING STRUCTURES**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

* To educate the students about design of pipes and concrete roofing.
* To impart knowledge about the design of water tank and special structures.
* To provide knowledge about repair and rehabilitation of structure.

**COURSE OUTCOMES**

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

CO1: To acquire knowledge about design of pipes and concrete roofing.

CO2: Able to do design of water tank and special structures.

CO3: To learn about repair and rehabilitation of structure.

**UNIT I Design of Pipes (09)**

 **Structural design of Concrete, Prestressed Concrete, Steel and Cast iron pipes - piping mains – joints – Leak detection - sewerage tank design – anchorage for pipes – massive outfalls – structural design - laying – Testing - hydrodynamic considerations - Advances in the manufacture of pipes.**

**UNIT II Design ofConcrete Roofing Systems (09)**

 **Design of concrete roofing systems – Cylindrical, Spherical and Conical shapes using membrane theory and design of various types of folded plates for roofing with concrete – Design of pumping stations – Drainage plan of a building.**

**UNIT III Analysis and Design of Water Tanks (09)**

 **IS Codes for the design of water retaining structures.Design of circular, rectangular, spherical and Intze type of tanks using concrete. Design of prestressed concrete cylindrical tanks – Economic analysis – introduction to computer aided design and packages.**

**UNIT IV Design of Special Purpose Structures (09)**

 **Underground reservoirs and swimming pools, Intake towers, Structural design including foundation of water retaining structures such as settling tanks, clariflocculators, aeration tanks, etc.,- effect of earth pressure and uplift considerations – selection of materials of construction.**

**UNIT V Repair and Rehabilitation of Structures (09)**

 **Diagonising the cause and damage, identification of different types of structural and non-structural cracks – repair and rehabilitation methods for Masonry, Concrete and Steel Structures. Exposure on Steel, Lattice Structures used in water and sewerage works.**

**TOTAL: 45hrs**

***Reference Books:***

**1. Krishna Raju, Prestressed Concrete, Tata McGraw Hill Publishing Co. 2nd edition, 1988.**

**2. N. C. Sinha& S .K. Roy , Reinforced Concrete, S. Chand and Co.,1985.**

**3. Hulse R. and Mosley W. H., Reinforced Concrete Design by Computer, Macmillan Education Ltd., 1986.**

**4. Ramaswamy G. S., Design and Construction of Concrete shell roofs, CBS Publishers, India, 1986**

**5. Green J. K. and Perkins P. H., Concrete liquid retaining structures, Applied Science Publishers, 1981**

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**16GEIE01PROFESSIONAL PRACTICES IN DESIGN OF GEOTECHNICAL STRUCTURES**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE**

To gain exposure on practical aspects of design relating to substructure elements using software, Geotechnical construction practices,and field execution of the works.

**COURSE OUTCOMES**

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

CO1: To know the field practises in investigations,safety, and quality on substructure components.

CO2: To design foundations for special structures using softwares.

CO3:To evaluate dynamic properties of soils and design Earthquake resistant foundations.

**UNIT I- Construction Techniques(09)**

Project planning – Geotechnical engineering practices – Soil profile – Bore log – Report review and preparation – Geotechnical Plant and Machinery – Safety aspects at site– Construction management – Quality control – Quality management – Geosynthetics–Geomembrane.

**UNIT II- Retaining Structures(09)**

Design of retaining wall – Design of culvert – Design of deep excavations – Sheet pile – diaphragm walls – Shoring system – Design of Caisson.

**UNIT III- Substurctures(09)**

Design of Tower Foundation – Design of Floating foundation– Design of Pile and Pile group – Design of underreamed pile – Design of abutment – Design of Pier – Design of mat foundation – Design of piled raft foundation.

**UNIT IV- Dynamic Response of Foundations(09)**

Soil behaviour – Dynamic properties of soil– Seismic performance analysis – Calculation of seismic loads in foundation – Design procedure for earthquake resistant foundation – Soil structure interaction – Retrofitting.

**UNIT V-Finite Element Analyses and Software Application (09)** Finite Element Analysis applied to Geotechnical Engineering – ANSYS – Modelling – Applications – Oasys – PLAXIS.

**TOTAL:45hrs**

***Reference books:***

1. Helmsley, Design Applications of Raft Foundations.
2. Michael John Tomlinson,R.Boorman,Foundation Design & Construction, Prentice Hall PTR,2001.
3. George paaswell, Retaining Walls:Design & Construction,Bibliobazaar,2009.
4. Design & Construction of bridge approaches,Transportation Research Board,1990.
5. M.J. Tomlinson,Taylor and Francis ltd., Pile design and construction practice, 1994.
6. Davies and Poulos, Analysis and design of pile foundation, John Wiley and Sons, 1980
7. J.E. Bowles, Foundation Analysis and Design, McGraw-Hill, 1997
8. V.N.S. Murthy, Advanced Foundation Engineering, CBS Publishers & Distributors, 2007
9. Swami Saran, Soil Dynamics and Machine Foundations, Galgotia Publications, New Delhi.
10. Potts and Zdravkovic, Finite Element Analyses Applied to Geotechnical Engineering, Vol.1 (Theory) and Vol. 2 Applications.

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**16GEOE01 ENVIRONMENTAL GEOTECHNOLOGY**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVE**

To acquire knowledge on the geotechnical engineering problems associated with soil contamination, safe disposal of waste, stabilization of waste, transportation of contaminant and site remediation techniques.

**COURSE OUTCOMES**

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

CO1: Assess the causes of soil pollution and suggest suitable methods of remediation for the contaminated sites.

CO2: Have thorough knowledge on the contaminant transport and the transformation processes.

CO3: Understand the mechanism of stabilization of waste and remediate contaminated soil with sustainability.

**UNIT I Soil – Pollutant Interaction (09)**

 Introduction to Geoenvironmental engineering – Environmental cycle – Sources, production and classification of waste – Causes of soil pollution – Factors governing soil – Pollutant interaction – Failures of foundations due to pollutants – Case studies.

**UNIT II Site Selection and Safe Disposal of Waste (09)**

 Safe disposal of waste – Site selection for landfills – Characterization of landfill sites– Risk assessment – Stability of landfills – Current practice of waste disposal – Monitoring facilities – Passive containment system – Application of geosynthetics in solid waste management – Rigid and flexible liners.

**UNIT III Transport of Contaminants (09)**

 Contaminant transport in sub surface – Advection – Diffusion – Dispersion – Governing equations – Contaminant transformation – Sorption – Biodegradation – Ion exchange – Precipitation – Hydrological consideration in landfill design – Ground water pollution – Bearing capacity of compacted fills – Foundation for waste fill ground – Pollution of aquifers by mixing of liquid waste – Protection of aquifers.

**UNIT IV Waste Stabilization and Disposal (09)**

 Hazardous waste control and storage system – Stabilization/Solidification of wastes – Micro and Macro encapsulation – Absorption, adsorption, precipitation – Detoxification – Mechanism of stabilization – Organic and inorganic stabilization – Utilization of solid waste for soil improvement – Case studies.

**UNIT V Remediation of Contaminated Soils (09)**

 Rational approach to evaluate and remediate contaminated sites – Monitored natural attenuation – Ex-situ and in-situ remediation – Solidification, Bio-remediation, incineration, soil washing, electro kinetics, soil heating, vitrification, bio-venting – Ground water remediation – Pump and treat, air sparging, reactive well –Case studies.

**TOTAL: 45hrs**

***Reference Books:***

1. Wentz, C.A., Hazardous Waste Management, McGraw Hill, Singapore, 1989.
2. Daniel, B.E., Geotechnical Practice for waste disposal, Chapman and Hall, London, 1993.
3. Proceedings of the International symposium of Environmental Geotechnology (Vol. I and II), Environmental Publishing Company, 1986 and 1989.
4. Ott, W.R., Environmental Indices, Theory and Practice, Ann. Arbor, 1978.
5. Fried, J.J., Ground Water Pollution, Elsevier, 1975.
6. ASTM Special Technical Publication 874, Hydraulic Barrier in Soil and Rock, 1985.
7. Westlake, K., Landfill Waste pollution and Control, Albion Publishing Ltd., England, 1995.
8. Lagrega, M.D., Buckingham, P.L., and Evans, J.C., Hazardous Waste Management, McGraw Hill, Inc. Singapore, 1994.

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**16CEPE03ENVIRONMENTAL ENGINEERING STRUCTURES**

**L T P C**

**3 0 0 3**

**COURSE OBJECTIVES**

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