**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech in GEOTECHNICAL ENGINEERING**
**Effective from Academic Year 2017- 18 admitted batch**

**COURSE STRUCTURE AND SYLLABUS**

**I Semester**

| Category | Course Title | Int. marks | Ext. marks | L | T | P | C |
|---|---|---|---|---|---|---|---|
| PC-1 | Advanced Soil Mechanics | 25 | 75 | 4 | 0 | 0 | 4 |
| PC-2 | Advanced Foundation Engineering | 25 | 75 | 4 | 0 | 0 | 4 |
| PC-3 | Soil Dynamics and Machine Foundations | 25 | 75 | 4 | 0 | 0 | 4 |
| PE-1 | Earth & Rockfill Dams<br>Optimization Techniques<br>Applied Statistics | 25 | 75 | **3** | 0 | 0 | 3 |
| PE-2 | Soil - Structure Interaction<br>Rock Mechanics and Engineering<br>Physical Modeling in Geotechnical Engineering. | 25 | 75 | **3** | 0 | 0 | 3 |
| OE-1 | ***Open Elective – I** | 25 | 75 | 3 | 0 | 0 | 3 |
| Laboratory I | Advanced Geotechnical Engg. Lab-I | 25 | 75 | 0 | 0 | 3 | 2 |
| Seminar I | Seminar-I | 100 | 0 | 0 | 0 | 3 | 2 |
| **Total** | | **275** | **525** | **21** | **0** | **6** | **25** |

**II Semester**

| Category | Course Title | Int. marks | Ext. marks | L | T | P | C |
|---|---|---|---|---|---|---|---|
| PC-4 | Retaining Structures | 25 | 75 | 4 | 0 | 0 | 4 |
| PC-5 | Geo-Environmental Engineering | 25 | 75 | 4 | 0 | 0 | 4 |
| PC-6 | Ground Improvement Techniques | 25 | 75 | 4 | 0 | 0 | 4 |
| PE-3 | Geotechnical Earthquake Engineering<br>Design of Substructures<br>Geotechnics for Infrastructure | 25 | 75 | **3** | 0 | 0 | 3 |
| PE4 | Geosynthetics& Soil Reinforcement<br>Material Characterization and Pavement Engineering.<br>Offshore Geotechnical Engineering. | 25 | 75 | **3** | 0 | 0 | 3 |
| OE-2 | ***Open Elective – II** | 25 | 75 | 3 | 0 | 0 | 3 |
| Laboratory II | Advanced Geotechnical Engg. Lab-II | 25 | 75 | 0 | 0 | 3 | 2 |
| Seminar II | Seminar-II | 100 | 0 | 0 | 0 | 3 | 2 |
| **Total** | | **275** | **525** | **21** | **0** | **6** | **25** |

**III Semester**

| Course Title | Int. marks | Ext. marks | L | T | P | C |
|---|---|---|---|---|---|---|
| Technical Paper Writing | 100 | 0 | 0 | 3 | 0 | 2 |
| Comprehensive Viva-Voce | 0 | 100 | 0 | 0 | 0 | 4 |
| Project work Review II | 100 | 0 | 0 | 0 | 22 | 8 |
| **Total** | **200** | **100** | 0 | **3** | 22 | **14** |

**IV Semester**

| Course Title | Int. marks | Ext. marks | L | T | P | C |
|---|---|---|---|---|---|---|
| Project work Review III | 100 | 0 | 0 | 0 | 24 | 8 |
| Project Evaluation (Viva-Voce) | 0 | 100 | 0 | 0 | 0 | 16 |
| **Total** | **100** | **100** | **0** | **0** | **24** | **24** |

***Open Elective subjects must be chosen from the list of open electives offered by OTHER departments.**

**# For Project review I, please refer 7.10 in R17 Academic Regulations.**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech – I Year – I Sem. (Geotechnical Engineering)**

**ADVANCED SOIL MECHANICS**
**(PC-1)**

**Course Objectives:** To understand the physical and mechanical properties of soil and its behavior under external loads.

**Course Outcomes:** Students should be able to understand the soil behaviour under external loads, and procedures to measure relevant soil parameters.

**Unit-I**
**Introduction & Geostatic Stresses**: Classification of Soils, Consistency Limits, Stresses within a soil mass, Effective Stress principle, Geostatic stresses.

**Unit-II**
**Flow through Soils**: Permeability, seepage – Finite difference formulae for steady state and transient flows – flow nets – computation of seepage – uplift pressure, and critical hydraulic gradient.

**Unit-III**
**Compaction and Consolidation**: Compaction Curve, Compaction Control, Oedometer test, Over consolidation ratio, Primary and secondary consolidation settlement, One, two and three dimensional Consolidation, Consolidation of partially saturated soils.

**Unit-IV**
**Stress-Strain-Strength Behaviour of Soils**: Principle Stresses, Mohr Circle, Shear strength of soils; Failure criteria, drained and undrained shear strength of soils. Significance of pore pressure parameters; Determination of shear strength; Drained, Consolidated Undrained and Undrained tests; Interpretation of triaxial test results. Behaviour of sands; Critical void ratio; dilation in soils, Stress paths.

**Unit-V**
**Critical State Soil Mechanics**: Critical state parameters; Critical state for normally consolidated and over consolidated soil; Significance of Roscoe and Hvorslev state boundary surfaces; Yielding, Bounding Surfaces.

**TEXT BOOKS**

1. Das, B. M. & Sobhan K,- Principles of Geotechnical Engineering, Cengage Learning, Edition (2015)
2. Mitchell J.K. - Fundamentals of soil behaviour - John Wiley and Sons, Inc., New York. (Third edition) 2005

**REFERENCES:**

1. Atkinson J. H. - An Introduction to the Mechanics of Soils and Foundation - through critical state soil mechanics, McGraw- Hill Co. (1993)
2. J A Knappett and R F Craig – Craig's Soil Mechanics, Eighth Edition, Spon Press Taylor & Francis (2012)
3. Lambe, T. W. and Whitman, R. V.- Soil Mechanics SI version , John Wiley & Sons.(2011)

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech – I Year – I Sem. (Geotechnical Engineering)**

**ADVANCED FOUNDATION ENGINEERING**
**(PC-2)**

**Course Objectives:** To determine the bearing capacity of shallow and deep foundations and to estimate settlements of structures subjected to external loads, leading to design of foundations resting on soils.

**Course Outcomes:** Students should be in a position to design foundations for varieties of structures resting on soil deposits, and appreciate the importance of reliability based design in geotechnical engineering.

**Unit-I**
**Soil Exploration**: Exploration Methods; Planning the Exploration Program; Boring and Sampling; In Situ Tests: Standard & Cone Penetration Tests, Field Vane, Dilatometer, Pressure meter; Rock Sampling, Core Recovery, RQD; Geophysical Exploration; Preparation of Soil Report, Case Studies.

**Unit-II**
**Shallow Foundations**: **Bearing Capacity:**- Shear Failure; Effect of Water Table; Footings with Eccentric or Inclined Loads, Footings on Layered Soils, Slopes on finite layer with a Rigid Base at Shallow Depth, effect of compressibility of soil, on soils with strength increasing with depth, Plate Load tests, Presumptive bearing capacity.

**Unit-III**
**Settlement**: Components – Immediate, Primary and Secondary Settlements, Consolidation, Stresses and Displacements in Homogeneous, Layered and Anisotropic Soils; Bearing Pressure using SPT, CPT, Dilatometer and Pressure meter; Settlement of foundations on Sands-Schmertmann and Burland & Burbridge methods; Structure Tolerance to Settlement and Differential Settlements, Rotation, Codal Provisions.

**Unit-IV**
**Deep Foundations**: **Single Pile:** Vertically loaded piles, Static capacity- α, β and λ Methods, Dynamic formulae; Wave Equation Analyses; Point Bearing Resistance with SPT and CPT Results; Bearing Resistance of Piles on Rock; Settlement; Pile Load Test; Uplift Resistance; Laterally Loaded Piles -Ultimate Lateral Resistance; Negative Skin Friction; Batter Piles; Under Reamed Piles; Ultimate Capacity of Pile Groups in Compression, Pullout & Lateral Load; Efficiency; Settlements of Pile Groups; Interaction of Axially & Laterally Loaded Pile Groups, Codal Provisions.

**Unit-V**
**Special Topics of Foundation Engineering**
**Foundations on Collapsible Soils**: Origin and occurrence, Identification, Sampling and Testing, Preventive and Remedial measures.
**Foundations on Expansive Soils**: The nature, origin and occurrence, Identifying, testing and evaluating expansive soils, typical structural distress patterns and Preventive design & construction measures.
***Introduction to Reliability-Based Design**: Brief introduction of probability and statistics, LRFD for structural strength requirements, LRFD for geotechnical strength requirements, Serviceability requirements

**TEXT BOOKS:**
1. Das, B. M. - Principles of Foundation Engineering 5th Edition Nelson Engineering (2004)
2. Donald P Coduto – Foundation Design Principles and Practices, 2nd edition, Pearson, Indian edition, 2012. Phi Learning (2008)

**REFERENCE BOOKS:**
1. Bowles, J. E. - Foundation Analysis & Design 5th Edition McGraw-Hill Companies, Inc. (1996)

2. Poulos, H. G. & Davis, E. H. - Pile Foundation Analysis and Design john wiley & sons inc (1980-08)
3. Tomlinson, M. J. - Foundation Design and Construction - Prentice Hall (2003).
4. Baecher, G.B. & Christian, J.T. – Reliability and Statistics in Geotechnical Engineering, Wiley Publications (2003)

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech – I Year – I Sem. (Geotechnical Engineering)**

**SOIL DYNAMICS AND MACHINE FOUNDATIONS**
**(PC-3)**

**Course Objectives:** To understand the wave propagation in soils, determine dynamic properties of soil for analyzing and designing foundations subjected to vibratory loading.

**Course Outcomes:** Able to understand the fundamentals of wave propagation in soil media, evaluate the dynamic properties of soil, and design foundations for centrifugal and reciprocating machines.

**Unit-I**
**Fundamentals of Vibration**: Definitions, Simple harmonic motion, Response of SDOF systems of Free and Forced vibrations with and without viscous damping, Frequency dependent excitation, Systems under transient loads, Rayleigh's method of fundamental frequency, Logarithmic decrement, Determination of viscous damping, Transmissibility, Systems with Two and Multiple degrees of freedom, Vibration measuring instruments.

**Unit-II**
**Wave Propagation and Dynamic Soil Properties**: Propagation of seismic waves in soil deposits - Attenuation of stress waves, Stress-strain behaviour of soils under cyclic loads, Strength of cyclically loaded soils, Dynamic soil properties - Laboratory and field testing techniques, Elastic constants of soils, Correlations for shear modulus and damping ratio in sand, gravels, clays and lightly cemented sand. Liquefaction of soils and its evaluation using simple methods.

**Unit-III**
**Vibration Analyses**: Types, General Requirements, Permissible amplitude, Allowable soil pressure, Modes of vibration of a rigid foundation block, Methods of analysis, Lumped Mass models, elastic half space method, elasto-dynamics, effect of footing shape on vibratory response, dynamic response of embedded block foundation, Vibration isolation.

**Unit-IV**
**Design of Machine Foundations**: Analysis and design of block foundations for reciprocating engines, Dynamic analysis and design procedure for a hammer foundation, IS code of practice design procedure for foundations of reciprocating and impact type machines. Vibration isolation and absorption techniques.

**Unit-V**
**Machine Foundations on Piles**: Introduction, Analysis of piles under vertical vibrations, Analysis of piles under translation and rocking, Analysis of piles under torsion, Design procedure for a pile supported machine foundation.



**TEXT BOOKS:**

1. Swami Saran - Soil Dynamics and Machine Foundation, Galgotia Publications Pvt. Ltd. (2010)
2. Prakash, S. - Soil Dynamics, McGraw Hill Book Company (1981)

**REFERENCES:**

1. Prakash, S. and Puri, V. K. - Foundation for Machines: Analysis and Design, John Wiley & Sons, 1998.
2. Kameswara Rao, N. S. V. - Vibration Analysis and Foundation Dynamics, Wheeler Publication Ltd., 1998.
3. Das, B. M. & Ramana, G.V. - Principles of Soil Dynamics, 2nd Edition, CL Engineering Publishers, 2010.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech – I Year – I Sem. (Geotechnical Engineering)**

**EARTH & ROCKFILL DAMS**
**(PE-1)**

**Course Objectives:** Suitability of materials for earth and rock fill dams, causes of failures and to determine slope stability.

**Course Outcomes:** Able to design earth and rock fill dams, get familiarity with slope stability calculations, and prevention techniques for slope failures.

**Unit-I**
**Earth and Rock fill Dams**: General features, Selection of site; Merits and demerits of the earth and rock fill dams, Classification of earth dams, Materials of construction and requirements, Causes of failure, Safe design criteria. Instrumentation in earth dams: Pore pressure measurements, Settlement gauges, Inclinometers, Stress measurements, Seismic measurements.

**Unit-II**
**Failures, Damages and Protection of Earth Dams**: Nature and importance of failure, Piping through embankment and foundations, Methods of seepage control through embankments and foundations, Design Criteria for filters, Treatment of upstream and downstream of slopes, Drainage control, Filter design.

**Unit-III**
**Slope Stability Analysis**: Types of Failure: Failure surfaces - Planar surfaces, Circular surfaces, Non-circular surfaces, Limit equilibrium methods, Total stress analysis versus effective Stress analysis, Use of Bishop's pore pressure parameters, Short term and Long term stability in slopes.

**Unit-IV**
**Methods of Slope Stability**: Taylor Charts, Method of Slices, Effect of Tension Cracks, Vertical Cuts. Bishop's Analysis, Bishop and Morgenstern Analysis, Non-circular Failure Surfaces: Morgenstern and Price Analysis, Janbu Analysis, Spencer Analysis, Sliding Block Analysis, Seismic stability, Stabilization of slopes: Drainage measures, Soil reinforcement (geosynthetics/soil nailing/micro piles etc), soil treatment (cement/lime/thermal treatment), surface protection (vegetation/erosion control mats/shotcrete).

**Unit-V**
**Rock fill Dams**: Requirements of compacted rock fill, Shear strength of rock fill, Rock fill mixtures, Rock fill embankments, Earth-core Rock fill dams, Stability, Upstream & Downstream slopes.

**TEXT BOOKS:**

1. Christian, K. Earth & Rock fill Dams – Principles of Design and Construction, CRC Press, 1997.
2. Sowers, G.F. – Earth and Rock fill Dam Engineering, Asia Publishing House, 1962.

**REFERENCES:**

1. Bharat Singh and Sharma, H. D. – Earth and Rock fill Dams, 1999
2. Abramson, L. W., Lee, T. S. and Sharma, S. - Slope Stability and Stabilisation methods – John Wiley & sons. (2002)
3. Sherard, Woodward, Gizienski and Clevenger. Earth and Earth-Rock Dams. John Wiley &. Sons. 1963.
4. US Army Corp of Engineers, Earth and Rock-fill Dams, General Design and construction Considerations, University Press of the Pacific (2004).

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech – I Year – I Sem. (Geotechnical Engineering)**

**OPTIMIZATION TECHNIQUES**
**(PE-2)**

**Course Objectives:** To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems

**Course Outcomes:** The student will be able to understand the basic principles of optimization, and in a position to formulate optimization models for a wide range of civil engineering problems and able to solve them.

**Unit-I**
**Linear Programming:** Introduction and need for optimization in engineering design, formulating linear programs, graphical solution of linear programs, special cases of linear programming.

**Unit-II**
**The Simplex Method:** Converting a problem to standard form, the theory of the simplex method, the simplex algorithm, special situations in the simplex algorithm, obtaining initial feasible solution.

**Unit-III**
**Duality and Sensitivity Analysis:** Sensitivity analysis, shadow prices, dual of a normal linear program, duality theorems, dual simplex method. Integer Programming: Formulating integer programming problems, the branch-and-bound algorithm for pure integer programs, the branch-and-bound algorithm for mixed integer programs.

**Unit-IV**
**Non-linear Programming:** Introduction to non-linear programming (NLP), Convex and concave functions, NLP with one variable, Line search algorithms, Multivariable unconstrained problems, constrained problems, Lagrange Multiplier, The Karush-Kuhn-Tucker (KKT) conditions, the method of steepest ascent, convex combination method, penalty function, Quadratic programming,

**Unit-V**
**Dynamic programming:** Evolutionary algorithms: Genetic Algorithm, concepts of multiobjective optimization, Markov Process, Queuing Models.

**TEXT BOOK:**
1. S.S. Rao, Engineering Optimization: Theory and Practice, Wiley & Sons, New Jersey, 2009.

**REFERENCES:**
1. F.H. Hiller and G.J. Liberman, Introduction to Operations Research, Tata-McGraw-Hill, 2010.
2. W.L. Winston, Operations Research: Applications and Algorithm, 4th Edition, Cengage Learning, 1994.
3. K.Deb, Optimization for Engineering Design, Prentice Hall, 2013.
4. M.C. Joshi and K.M. Moudgalay, Optimization: Theory and Practice, Narosa, 2004.
5. K. Deb, Multi-Objective Optimization using evolutionary algorithms, John Wiley and Sons, 2009.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech – I Year – II Sem. (Geotechnical Engineering)**

**APPLIED STATISTICS**
**(PE-1)**

**Course Objectives:** A deep understanding of the most important statistical models and analytical tools for practical analysis of complex data, as well as the ability to analyze new types of problems.

**Course Outcomes:** Upon successful completion of the course, students should be able to apply statistics to a variety of problem from different areas.

**UNIT-I:**
**Introduction & Sampling Techniques:** Histogram, Frequency diagram, Role of Probability and Statistics in Civil Engineering, Skewness; Kurtosis; Definitions and Applications; Simple random sampling; Stratified sampling; Systematic sampling; Sample Size determination; Collection & Presentation of data, Design of Experiment.

**UNIT-II:**
**Statistical Distributions and Probability :** Random Variability, conditional probability, Uniform, Binomial, Poisson, Exponential and Normal distributions; Fitting of distributions; Skewness and Kurtosis, Mean and variance; Chi-square test of goodness-of-fit; lognormal, Beta distribution Probability - Laws of Probability; Conditional probability and Independent events; Kolmogorov – Smirnov (K-S test) Laws of expectation.

**UNIT-III:**
**Regression And Correlation:** Linear/non-Linear and multiple linear correlation analysis, Linear regression and correlation; Multiple correlation; Multiple correlation coefficient; Standard error of estimate; Analysis of Variance; Curvilinear regression;

**UNIT-IV:**
**Multi-Variate Data Analysis and Exact Sampling Distributions :**Types of data; Basic vectors and matrices; Simple estimate of centroid, Standard deviation, Dispersion, Variance and covariance; Correlation matrices; Principal component analysis; Time series analysis. Exact Sampling Distributions - Chi-square distribution; Students T-distribution;

**UNIT-V:**
**Tests Of Significance & Confidence Interval Estimation & Statistical Testing – I & II:** Large sample and small sample tests; Tests for single mean, Means of two samples, Proportions, two variances, two observed correlation coefficients, paired T-tests, Applications. Tests Of Significance & Confidence Interval – Intervals for mean, variance and regression coefficients; Tests of Hypothesis, goodness of fit test.



**TEXT BOOK**

1. Haldar, A.S. & Mahadevan,S., Probability, Reliability, Statistical Methods in Engineering Design, John Wiley and Sons Inc., New York, 2007.

**REFERENCES:**

1. Ang, A.H.S. & Tang, W.H. - Probability Concepts in Engineering – Emphasis on Applications to Civil Environmental Engineering, John Wiley and Sons Inc., New York, 2007.
2. Fenton, G.A. and Griffiths, D.V. - Risk Assessment in Geotechnical Engineering, John Wiley and Sons Inc., New York, 2008.
3. Montgomery, D.C. and Runger, G.C. – Applied Statistics

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech – I Year – II Sem. (Geotechnical Engineering)**

**SOIL STRUCTURE INTERACTION**
**(PE-2)**

**Course Objectives:** To understand the behavior of soil and its interaction analysis with the structure.

**Course Outcomes:** Can analyze soil-structure interaction considering different models for various soil conditions and for different structures.

**Unit-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 behaviour.

**Unit-II**
**Beam on Elastic Foundation**- Soil Models: Infinite beam, Two-parameters models, Isotropic elastic half space model, Analysis of beams of finite length, combined footings.

**Unit-III**
**Plates on Elastic Continuum**: Thin and thick rafts, Analysis of finite plates, Numerical analysis of finite plates.

**Unit-IV**
**Analysis of Axially and Laterally Loaded Piles and Pile Groups**: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap, Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system,

**Unit-V**
**Ground-Foundation-Structure Interaction**: Effect of structure on ground-foundation interaction, Static and dynamic loads.

**TEXT BOOKS:**

1. Selvadurai, A. P. S. - Elastic Analysis of Soil-Foundation Interaction, 1979
2. Rolando P. Orense, Nawawi Chouw & Michael J. Pender - Soil-Foundation-Structure Interaction, CRC Press, 2010 Taylor & Francis Group, London, UK.

**REFERENCES:**

1. Soil Structure Interaction – The real behaviour of structures, the institution of structural engineers, London, March 1989.
2. Poulos, H. G., and Davis, E. H. - Pile Foundation Analysis and Design, 1980
3. Scott, R. F. - Foundation Analysis, Prentice Hall, Englewood Cliffs, 1981
4. Bowles, J. E. - Foundation Analysis & Design 5th Edition McGraw-Hill Companies, Inc. (1996)
5. Das, B. M. - Principles of Foundation Engineering 5th Edition Nelson Engineering (2004)

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech – I Year – I Sem. (Geotechnical Engineering)**

**ROCK MECHANICS AND ENGINEERING**
**(PE-2)**

**Course Objectives:** To determine properties and behavior of various types of rock under different loading conditions for underground and open excavations.

**Course Outcomes:** Able to determine the required rock properties, determination of bearing capacity of rocks, checking the stability of slopes, and design underground and open excavation.

**Unit-I**
**Engineering Classification of Rocks**: Classification of intact rocks, Rock mass classifications, Rock Quality Designation (RQD), Rock Structure Rating (RSR), Rock Mass Rating (RMR), Norwegian Geotechnical Classification (Q-system), Strength and modulus from classifications, Classification based on strength & modulus and strength and fracture strain, Geoengineering classification.

**Unit-II**
**Laboratory and In-Situ Testing of Rocks:** Physical properties, Compressive strength, Tensile strength, Direct shear test, Triaxial shear test, Slake durability test, Schmidt rebound hardness test, Sound velocity test, In-Situ Tests: Seismic methods, Electrical resistivity method, In situ stresses, Plate loading test, Goodman jack test, Plate jacking test, In-situ shear test, Field permeability test.

**Unit-III**
**Strength, Modulus and Stresses-Strain Responses of Rocks**: Factors influencing rock response, Strength criteria for isotropic intact rocks, Modulus of intact rocks, effect of confining pressure, Uniaxial Compressive strength, Strength criteria for intact rocks, Strength due to induced anisotropy in rocks,. Stress Strain Models: Constitutive relationships, Elastic, Elasto-plastic, Visco-elastic, Elasto-viscoplastic stress-strain models.

**Unit-IV**
**Stability of Rock Slopes and Foundations on Rocks:** Rock slopes, Modes of failure, Rotational failure, Plane failure, Design charts, Wedge method of analysis, Buckling failure, Toppling failure, Improvement of slope stability and protection. Foundations on Rock: Introduction, Estimation of bearing capacity, Stress distribution, Sliding stability of dam foundations, strengthening measures, Settlements in rocks, Bearing capacity of pile/pier in rock, Remedial measures, Foundations located on edge of jointed slope.

**Unit-V**
**Underground and Open Excavations:** Blasting operational planning, Explosive products, Blast Design, Underground blast design, Controlled blasting techniques, blasting damage and control, Safe practice with explosives and shots.

**TEXT BOOKS:**

1. Goodman – Introduction to Rock mechanics, Willey International (1980).
2. Ramamurthy, T. - Engineering in Rocks for slopes, foundations, and tunnels, Prentice Hall India (2007).

**REFERENCES:**

1. Jaeger, J. C. and Cook, N. G. W. – Fundamentals of Rock Mechanics, Chapman and Hall, London.(1979)
2. Hoek, E. and Brown, E. T. - Underground Excavation in Rock, Institution of Mining and Metallurgy, 1982.
3. Brady, B. H. G. and Brown, E. T. - Rock Mechanics for Underground Mining, Chapman & Hall, 1993.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech – I Year – I Sem. (Geotechnical Engineering)**

**PHYSICAL MODELLING IN GEOTECHNICAL ENGINEERING**
**(PE-2)**

**Course Objectives:** To learn fundamental knowledge and techniques related to physical modeling in geotechnical boundary value problems, including similitude, principles of measurement and test program

**Course Outcomes:** Student will be able to understand scaling laws and modeling considerations for physical modeling in geotechnical problems both for static and dynamic conditions.

**Unit-I**
**Similitude and Modeling Principles:** Importance of physical Modeling, scaling laws, small-scale model studies in 1-g and N-g, historical Perspectives.

**Unit-II**
**Design of physical model and model ground preparation:** scale effects, flexible and rigid boundary conditions, preparation of sand/clay bed preparation, wet pluviation, dry pluviation, tamping techniques, slurry consolidation, uniformity of sand/clay beds.

**Unit-III**
**Model planning and measurement strategy:** Selection of Model dimension, model containers, preparation of models to test shallow and deep foundations, pull-out behavior, retaining walls, shaking table studies, vertical and inclined loading system, Perspex walls, markers, digital analysis.

**Unit-IV**
**Sensors and Data Acquisition: S**train gauges, Load cells, Earth Pressure Transducers, LVDTs, Linear Potentiometers, pore pressure transudes, accelerometers, Hydraulic jack, calibration methods, dead weight calibration, pneumatic calibration, frequency of calibration, calibration charts, calibration factor, In-soil & fluid calibration, data acquisition system.

**Unit-V**
Recent Developments in Physical Modelling: Static behaviour of shallow and deep foundations, Piles subjected to lateral loading, behaviour of foundation subjected to earthquake loading, foundations subjected to cyclic loading, use of shaking table, behaviour of foundations on expansive soils.

**TEXT BOOKS:**
1. David muir wood, Geotechnical Modelling, Spon Press, Taylor & Francis, 2004.
2. Madabhushi, G. - Centrifuge Modeling for Civil Engineers, CRC Press, Taylor and Francis Group, 2015.

**REFERENCE BOOKS:**
1. Taylor, R.N. Geotechnical Centrifuge Technology, Taylor and Francis Publication, 1995.
2. Charles Ng, Zhang, L.M., and Wang, Y.H. (2006) : Proceedings of 6th International Conference on Physical Modeling in Geotechnics, Hong Kong.
3. S. Springman, J. Laue & L. Seward, Proceedings of the 7th International Conference on Physical Modelling in Geotechnics, Zurich, Switzerland, 2010.
4. Gaudin, C. & White, D. The Proceedings of the 8th international conference on Physical modeling in Geotechnics, Perth, Australia, 2014.

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**M. Tech – I Year – I Sem. (Geotechnical Engineering)**

**ADVANCED GEOTECHNICAL ENGINEERING LAB – I**

**Course Objectives**: To obtain index and engineering properties of locally available soils, to understand the behavior of these soils under various loads and subsoil conditions.

**Course Outcomes:** Possible to classify and evaluate the behavior of the soil subjected to various loads and subsoil conditions.

1. Grain size analysis –Wet Sieve Analysis
2. Grain size analysis – Hydrometer Analysis
3. In-situ Unit Weight (core Cutter & Sand Replacement)
4. Liquid Limit, Plastic Limit and Shrinkage Limit
5. Proctor I.S. Compaction Test
6. Permeability of Clay Soils.
7. Free Swell, Swell Potential, Swell Pressure Test
8. Oedometer Test (for determination of $c_c$& $c_v$)
9. Direct Shear Test
10. Triaxial Tests- UU
11. Triaxial Tests- CU
12. CBR Test

**REFERENCE BOOKS:**

1. Head, K.H. – Manual of Soil laboratory testing, Volumes I – Soil Classification and Compaction Tests, 3rd Edition, CRC Press, Taylor and Francis group, 2006.

2. Head, K.H. – Manual of Soil laboratory testing, Volumes II – Permeability, shear strength and Compressibility Tests, 3rd Revised Edition, Ingram International Inc, 2011.

3. Head, K.H. and Epps, R.J. – Manual of Soil laboratory testing, Volumes III – Effective Stress Tests, 3rd Edition, Whittle Publishing, 2014.