Birla Institute of Technology & Science, Pilani
Hyderabad Campus

**FIRST SEMESTER 2022-2023**

**Course Handout (Part II)**

**Date: 29.08.2022**

In addition to part I (General Handout for the course appends to the time table) this portion gives further specific details regarding course.

Course No. : **CE F313**

Course Title : **Foundation Engineering**

Instructor-in-charge : **Prof. Anasua GuhaRay**

Instructor : Prof. Anasua GuhaRay, Ankur Abhishek

**Pre-requisite:** Soil Mechanics

**Scope and Objectives of the Course:**

This course aims to provide an in-depth understanding of different types of foundations for buildings and bridges. Comprehensive geotechnical analysis of foundation systems (spread footing, combined footing, raft foundation, pile foundations, retaining structures, slopes etc.) will be covered under this course. Special emphasis will be given on coverage of relevant code of practices for various types of foundations and retaining structures.

**Course Outcomes:** At the end of this course, the students will develop:

1. An ability to design retaining walls and slopes in different soil conditions.
2. An ability to determine bearing capacities of different types of soil based on different theories and design different types of shallow foundations for bearing and settlement.
3. An ability to design different types of deep foundations for bearing and settlement.
4. An ability to identify different ground improvement techniques for different types of soil and understand the basics of machine foundation and earthquake engineering.

Student Learning Outcomes (SLOs) assessed in this course – **(a), (e), (f), (j), (k).**

**Text Book**:

T1. Murthy, V. N. S. “Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering”, Marcel Dekker Inc., Special Indian Edition, First Indian Reprint, 2013.

**Reference Books:**

R1. Gopal Ranjan and A. S. R. Rao, “Basic and Applied Soil Mechanics”, New Age International Publishers, 2nd Edition, 2007.
R2. B.M. Das. Principles of Foundation Engineering. Cengage Learning, 7th Edn., 2010.
R3. Gulhati, SK, and Datta, M. “Geotechnical Engineering”, Tata McGraw-Hill Publishing Company Ltd, 2005.
R4. Saran, S. “Analysis and design of foundations and retaining structures subjected to seismic loads” I K Lee Publishers, 2012
R5. Knappett, J., Craig, R.F. Craig's Soil Mechanics, Eighth Edition, CRC Press, 2012.

| No. of Lectures | Topics to be Covered | Learning Objectives | Chapter in the Text Book / Reference Book | SLO |
|---|---|---|---|---|
| 1-5 | Lateral Earth Pressures | ● Analyze Lateral Earth Pressure (at Rest, Active and Passive) for cohesionless and cohesive soils<br>● Determine earth pressure for submerged backfill, sloping backfill, backfill with surcharge, layered soil, tension crack by Rankine’s Theory<br>● Determine deflection of Retaining Wall<br>● Calculate of earth pressures by Coulomb’s Wedge Theory | T1 Ch 11, IS: 1893 (Part 3) | (a), (e) |
| 6-9 | Concrete and Mechanically Stabilized Earth Retaining Walls | ● Study proportioning of retaining walls: Gravity, Cantilever, Counterfort.<br>● Design Unreinforced Retaining Walls: External Stability<br>● Design Mechanically | T1 Ch 19 | (a), (e), (f) |

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| | | Stabilized Retaining Walls: External and Internal Stability<br>● Study different Backfill and Reinforcing Materials (Geosynthetics, Geotextiles etc.) | | |
| 10-15 | Shallow Foundations I: Ultimate Bearing Capacity | ● Study the requirements, location, depth of foundation<br>● Study classification of shallow and deep foundations, isolated, strap and spread footings,<br>● Study the different terminology related to foundations<br>● Study the principal modes of soil failure: general, local and punching shear failures,<br>● Design shallow foundations by Terzaghi, Skempton and Meyerhof's Bearing Capacity Theory by introducing corrections for size, shape, depth, inclination, water table etc., eccentric loading<br>● Differentiate among bearing capacity theories by Hansen, Vesic and IS Code<br>● Analyze ultimate bearing capacity of soils based on SPT and CPT tests by empirical relationships<br>● Determine ultimate bearing capacity of footings resting on stratified deposits of soil | T1 Ch 12,<br>IS: 1904 (1986),<br>IS: 6403 (1981), | (a), (e), (f) |
| 16-17 | Shallow Foundations II: Settlement | ● Study effect of settlement on structure and permissible settlement<br>● Design shallow foundations for | T1 Ch 13,<br>IS: 8009 (Part 2) - 1980 | (a), (e) |

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| | | permissible settlement<br>● Study contact pressure distribution<br>● Analyze bearing capacity and settlement from model and field plate load test | | |
| 18-20 | Shallow Foundations III: Combined Footings, Mat and Raft Foundations | ● Design of Combined Footings by Conventional Method<br>● Design of Mat Foundation by Rigid Method<br>● Design of Floating Foundations | T1 Ch 14 | (a), (e) |
| 21-25 | Deep Foundations | ● Study types of piles according to composition, method of installation (driven and bored piles, pre-cast and cast in-situ piles, under-reamed piles)<br>● Analyze vertical load bearing capacity of single vertical pile for cohesionless and cohesive soil,<br>● Analyze ultimate skin resistance for single pile in cohesionless and cohesive soil<br>● Study Pile Load Tests<br>● Analyze efficiency of pile groups<br>● Analyze Vertical load bearing capacity of pile groups<br>● Study Negative Skin Friction, uplift capacity of pile group | T1 Ch 15 Part A and Part B,<br>IS 2911 (Part1) – 2010,<br>IS 2911 (Part2) – 2010,<br>IS 2911 (Part3) – 2010,<br>IS 2911 (Part4) – 2010 | (a), (e), (f) |

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| 26-28 | Laterally Loaded Vertical and Batter Piles | ● Study Winkler's Hypothesis<br>● Study p-y curves for solution of laterally loaded single piles<br>● Analyze behavior of laterally loaded batter piles in sand | T1 Ch 16 | (a), (e) |
| 29-30 | Pier and Well Foundations | ● Study types of drilled piers, methods of construction<br>● Study types and components of Well Foundations, Shapes of Well Foundation<br>● Study forces acting on Well Foundation | T1 Ch 17<br>+<br>R1 Ch 17 | (a), (e) |
| 31-34 | Slope Stability | ● Analyze stability of Infinite Slopes in Sand and Clay<br>● Study Taylor's Stability Number<br>● Analyze Finite Slopes by Method of Slices | T1 Ch 10 | (a), (e), (k) |
| 35-36 | Foundations on Collapsible and Expansive Soils | ● Study Swelling Potential, Swelling Pressure, Free Swell, Collapse Potential, Treatment methods for collapsible soils | T1 Ch 18 | (a), (e), (f) |
| 37-39 | Ground Improvement Techniques | ● Study introduction to different ground improvement techniques<br>● Study introduction to Deep Compaction, Sand Drains, Stone Columns, Sand Drains, Prefabricated Vertical Drains, Grouting | T1 Ch 21<br>+<br>R2 Ch 14 | (a), (e), (j) |
| 40-42 | Introduction to Machine | ● Study Dynamic Properties of | R1 Ch 18, | (a) |

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| | Foundations | Soil<br>● Study Single Degree of Freedom System<br>● Study Stiffness and Damping<br>● Study introduction to Block and Framed Foundations<br>● Study liquefaction of soil | IS 2974 (Part 1,2,3,4,5) – 1982, IS1893-part1,2,3,4,5 | |

***Student Learning Outcomes (SLOs):**

SLOs are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

**Evaluation Scheme:**

| Component | Duration | Weightage | Date & Time | Nature of Component |
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| **Midsemester Examination** | 90 mins | 30% | 31/10 1.30 - 3.00PM | Closed Book |
| **Home Assignments** (minimum 3 nos.) | - | 15% | Continuous | Open Book |
| **Surprise Quiz** (minimum 5 nos.) | - | 15% | Continuous | Open Book |
| **Comprehensive** | 3 hrs | 40% | 19/12 FN | Closed Book |

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| **Examination** | | | | |

**Chamber Consultation Hour:** W and Th 10-11 AM, or by prior appointment based on urgency through BITS email only.

**Notice**: All notices concerning the course will be conveyed through Google Classroom.

**Make-up Policy:**

1. Make-up will be granted only on genuine reasons (medical emergencies). For medical cases, a certificate from the concerned physician of the Medical Centre must be produced.
2. For the skill tests, surprise tests, lab demo sessions and tour case study (if any), make-ups are not possible.

**Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Instructor-in-charge**
**CE F313**