# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal, Hyderabad -500 043

## STRUCTURALENGINEERING

## COURSE DESCRIPTOR

| | | | | | |
|---|---|---|---|---|---|
| **Course Title** | **ADVANCED DESIGN OF FOUNDATIONS** | | | | |
| **Course Code** | BSTB17 | | | | |
| **Programme** | M.Tech | | | | |
| **Semester** | II | CE | | | |
| **Course Type** | PROFESSIONAL COREELECTIVE | | | | |
| **Regulation** | IARE - R18 | | | | |
| **Course Structure** | **Theory** | | | **Practical** | |
| | **Lectures** | **Tutorials** | **Credits** | **Laboratory** | **Credits** |
| | 3 | - | 3 | - | - |
| **Chief Coordinator** | Mr. N. Venkat Rao, Associate Professor | | | | |
| **Course Faculty** | Mr. N. Venkat Rao, Associate Professor | | | | |

## I. COURSE OVERVIEW:

Civil Engineers are required to construct structures on the soil. The loads coming onto these structures, along with the self-weight, have to be safely transmitted to the soil beneath it. A geotechnical engineer must be able to design a footing in such a way that soil below it will not fail there will not be any excessive settlements in the soil. This course enables students to design a shallow and deep foundation, analyze the stability of slopes, and check the stability of retaining walls and embankments against failure. Through this course content engineers can design the foundation for safety and serviceability.

## II. COURSE PRE-REQUISITES:

| Level | Course Code | Semester | Prerequisites | Credits |
|---|---|---|---|---|
| UG | ACE003 | III | Engineering Geology | 4 |
| UG | ACE006 | IV | Geotechnical Engineering | 4 |

## III. MARKSDISTRIBUTION:

| Subject | SEE Examination | CIAExamination | Total Marks |
|---|---|---|---|
| Advanced design of foundations | 70 Marks | 30 Marks | 100 |

## IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ✔ | Chalk & Talk | ✔ | Quiz | ✔ | Assignments | ✘ | MOOCs |
| ✔ | LCD / PPT | ✔ | Seminars | ✔ | Mini Project | ✔ | Videos |
| ✘ | Open Ended Experiments | | | | | | |

## V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

**Semester End Examination (SEE):** The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into fiveunits and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

| | |
|---|---|
| 50 % | To test the objectiveness of the concept. |
| 50 % | To test the analytical skill of the concept OR to test the application skill of the concept. |

**Continuous Internal Assessment (CIA):**
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

| **Component** | **Theory** | | **Total Marks** |
|---|---|---|---|
| **Type of Assessment** | CIE Exam | Quiz / AAT | |
| **CIA Marks** | 25 | 05 | 30 |

**Continuous Internal Examination (CIE):**

Two CIE exams shall be conducted at the end of the 8$^{th}$ and 16$^{th}$ week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

**Quiz / Alternative Assessment Tool (AAT):**

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

## VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

| Program Outcomes (POs) | | Strength | Proficiency assessed by |
|---|---|---|---|
| PO 1 | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineeringfundamentals, and an engineering specialization to the solution of complex engineering problems. | 1 | Assignments/ Exams |
| PO 2 | **Problem analysis**: Identify, formulate, review research literature, and analyze complexengineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences | 2 | Assignments/ Exams |
| PO 3 | **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. | 2 | Assignments/ Exams |
| PO 6 | **The engineer and society:**Apply reasoning informed by the contextual knowledge to assesssocietal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. | 2 | Assignments/ Exams |

**3 = High; 2 = Medium; 1 = Low**

## VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

| Program Specific Outcomes (PSOs) | | Strength | Proficiency assessed by |
|---|---|---|---|
| PSO 1 | **Engineering Knowledge**: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication. | 2 | Assignments/ Exams |
| PSO 2 | **Broadness and Diversity:** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage. | - | - |
| PSO 3 | **Self-Learning and Service:** Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly. | - | - |

**3 = High; 2 = Medium; 1 = Low**

## VIII. COURSE OBJECTIVES (COs):

| The course should enable the students to: | |
|---|---|
| I | Decide the suitability of soil strata for different projects |
| II | Design shallow foundations deciding the bearing capacity of soil. |
| III | Analyze and design the pile foundation. |
| IV | Understand analysis methods for well foundation |

## IX. COURSE LEARNING OUTCOMES (CLOs):

| CLO Code | CLO's | At the end of the course, the student will have the ability to: | PO's Mapped | Strength of Mapping |
|---|---|---|---|---|
| BSTB17.01 | CLO 1 | Understand the need and methods of Soil Exploration | PO 3 | 2 |
| BSTB17.02 | CLO 2 | Understand various methods of sampling and boring | PO 3 | 1 |
| BSTB17.03 | CLO 3 | Learn how to perform field tests on SPT and DCPT | PO 3, PO 6 | 2 |

| | | | | |
|---|---|---|---|---|
| BSTB17.04 | CLO 4 | Learn how to perform Plate Load test for finding load bearing capacity, settlements of soils | PO 3 | 2 |
| BSTB17.05 | CLO 5 | Learn how to perform in-situ test using pressure meter | PO 3 | 3 |
| BSTB17.06 | CLO 6 | Understand the importance of geophysical methods | PO 3, PO 6 | 2 |
| BSTB17.07 | CLO 7 | Pile Group Capacity and Settlement. | PO 3 | 1 |
| BSTB17.08 | CLO 8 | Understand the need of Laterally Loaded Piles | PO 3, PO 6, PO 1 | 2 |
| BSTB17.09 | CLO 9 | Understand the need of Pile Load Tests | PO 3, PO 6, PO 1 | 2 |
| BSTB17.10 | CLO 10 | Analytical Estimation of Load- Settlement Behavior of Piles, | PO 3, PO 6, PO 1 | 2 |
| BSTB17.11 | CLO 11 | Proportioning of Pile Foundations | PO 3, PO 6, PO 1, PO 2 | 2 |
| BSTB17.12 | CLO 12 | Analyze Lateral and Uplift Capacity of Piles | PO 3, PO 6, PO 1, PO 2 | 2 |
| BSTB17.13 | CLO 13 | Understand IS and IRC Code Provisions | PO 3, PO 6, PO 1, PO 2 | 2 |
| BSTB17.14 | CLO 14 | Elastic Theory and Ultimate Resistance Methods. | PO 3, PO 2 | 2 |
| BSTB17.15 | CLO 15 | Tunnels and Arching in Soils | PO 2, PO 3 | 2 |
| BSTB17.16 | CLO 16 | Understand the need of Pressure Computations around Tunnels | PO 1, PO 2, PO 3 | 2 |
| BSTB17.17 | CLO 17 | Sheeting and Bracing Systems in Shallow and Deep Open Cuts | PO 1, PO 2, PO 3 | 2 |
| BSTB17.18 | CLO 18 | Analysis and Design of Coffer Dams | PO 2, PO 3, PO 6 | 2 |
| BSTB17.19 | CLO 19 | Understand Foundations under uplifting loads | PO 2, PO 3, PO 6 | 2 |
| BSTB17.20 | CLO 20 | Understand Soil-structure Interaction. | PO 1, PO 2, PO 3, PO 6 | 2 |

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## X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

| CLO | Program Outcomes (POs) | | | | | | | | | | | | Program Specific Outcomes (PSOs) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CLO 1 | | | 2 | | | | | | | | | | 2 | | |
| CLO 2 | | | 1 | | | | | | | | | | 2 | | |
| CLO 3 | | | 2 | | | 2 | | | | | | | 3 | | |
| CLO 4 | | | 2 | | | | | | | | | | 3 | | |
| CLO 5 | | | 3 | | | | | | | | | | 3 | | |
| CLO 6 | | | 2 | | | 2 | | | | | | | 2 | | |
| CLO 7 | | | 1 | | | | | | | | | | 2 | | |
| CLO 8 | 2 | | 2 | | | 3 | | | | | | | 3 | | |
| CLO 9 | 2 | | 2 | | | 2 | | | | | | | 3 | | |
| CLO 10 | 3 | | 2 | | | 3 | | | | | | | 2 | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO 11 | 1 | 2 | 2 | | | 3 | | | | | | | 3 | | |
| CLO 12 | 2 | 3 | 2 | | | 2 | | | | | | | 2 | | |
| CLO 13 | 3 | 3 | 2 | | | 3 | | | | | | | 3 | | |
| CLO 14 | | 2 | 3 | | | | | | | | | | 1 | | |
| CLO 15 | | 2 | 3 | | | | | | | | | | 2 | | |
| CLO 16 | 2 | 3 | 2 | | | | | | | | | | 3 | | |
| CLO 17 | 2 | 3 | 2 | | | | | | | | | | 3 | | |
| CLO 18 | | 2 | 3 | | | 2 | | | | | | | 1 | | |
| CLO 19 | | 2 | 3 | | | 3 | | | | | | | 2 | | |
| CLO 20 | 1 | 2 | 3 | | | 2 | | | | | | | 3 | | |

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## XI. ASSESSMENT METHODOLOGIES–DIRECT

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CIE Exams | PO 1, PO2, PO3, PO6 | SEE Exams | PO 1, PO2, PO3, PO6 | Assignments | PO 1, PO 2 | Seminars | PO 3 |
| Laboratory Practices | - | Student Viva | - | Mini Project | PO 1, PO 3, PO 6 | Certification | - |
| Term Paper | - | | | | | | |

## XII. ASSESSMENT METHODOLOGIES-INDIRECT

| | | | |
|---|---|---|---|
| ✔ | Early Semester Feedback | ✔ | End Semester OBE Feedback |
| ✘ | Assessment of Mini Projects by Experts | | |

## XIII. SYLLABUS

| | |
|---|---|
| **Unit-I** | **PLANNING OF SOIL EXPLORATION** |
| Planning of Soil Exploration for Different Projects, Methods of Subsurface Exploration, methods of Borings along with Various Penetration Tests. | |
| **Unit-II** | **SHALLOW FOUNDATIONS** |
| Requirements for Satisfactory Performance of Foundations, Methods of Estimating Bearing Capacity, Settlements of Footings and Rafts, Proportioning of Foundations using Field Test Data, Pressure - Settlement Characteristics from Constitutive Laws. | |
| **Unit-III** | **PILE FOUNDATIONS** |
| Methods of Estimating Load Transfer of Piles, Settlements of Pile Foundations, Pile Group Capacity and Settlement.<br><br>Laterally Loaded Piles, Pile Load Tests, Analytical Estimation of Load- Settlement Behavior of Piles, Proportioning of Pile Foundations, Lateral and Uplift Capacity of Piles. | |

| Unit-IV | WELL FOUNDATION |
|---|---|
| IS and IRC Code Provisions, Elastic Theory and Ultimate Resistance Methods. Tunnels and Arching in Soils, Pressure Computations around Tunnels | |
| **Unit-V** | **OPEN CUTS,COFFER DAMS** |
| Sheeting and Bracing Systems in Shallow and Deep Open Cuts in Different Soil Types. Coffer Dams, Various Types, Analysis and Design, Foundations under uplifting loads, Soil-structure Interaction. | |
| **Text Books:** | |
| 1. N.P. Kurian, "Design of foundation system", Narosa Publishing House.<br>2. J. E. Bowles, "Foundation Analysis and Design" , Tata McGraw Hill New York. | |
| **Reference Books:** | |
| 1. Analysis and Design of Substructures, Swami Saran, Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi. | |
| **Web References:** | |
| 1. http://nptel.ac.in/courses/105105039/ | |

## XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

| Lecture No | Topics to be covered | Course Learning Outcomes (CLOs) | Reference |
|---|---|---|---|
| 1-2 | Introductionto Soil Exploration | CLO 1 | T1:1.1 |
| 3 | Methods of soil Exploration | CLO 1 | T1:1.4 |
| 4 | Types of Boring | CLO 2 | T1:6.6 |
| 5-6 | Soil Sampling methods | CLO 2 | T1:3.1 |
| 7 | Standard Penetration test (SPT) | CLO 4 | T3:3.15 |
| 8-9 | Plate Load test | CLO 3 | T1:3.3, R1:2.10 |
| 10-11 | In-situ test using a pressure meter | CLO 3 | T1:3.8, R1:2.11 |
| 12-13 | Planning & Preparation of Soil investigation report | CLO 4 | T1:3.9 |
| 14 | Requirements for Satisfactory Performance of Foundations, | CLO 3 | T1:4.3 |
| 15-16 | Methods of Estimating Bearing Capacity, | CLO 5 | T1:5.9 |
| 17-18 | Settlements of Footings and Rafts, | CLO 5 | T1:5.4 |
| 19-20 | Proportioning of Foundations using Field Test Data, | CLO 6 | T1:5.4.1 |
| 21-22 | Pressure - Settlement Characteristics from Constitutive Laws. | CLO 7 | T1:5.6, R1:3.4 |
| 23-24 | Methods of Estimating Load Transfer of Piles,. | CLO 8 | T1:5.8, R1:3.4.1 |
| 25-26 | Settlements of Pile Foundations, | CLO 12 | T1:6.9to 6.10, R1:3.5 |
| 27 | Pile Group Capacity and Settlement. | CLO 11 | T1:6.5, R1:3.5.2 |
| 28-30 | Laterally Loaded Piles, | CLO 13 | T1:6.3, R1:3.6 |
| 31 | Pile Load Tests, | CLO 14 | T1:7.22 |
| 32-34 | Analytical Estimation of Load- Settlement Behavior of Piles, | CLO 15 | T1:7.22 |
| 35-37 | Proportioning of Pile Foundations | CLO 16 | T1:12.6.1, R1: 4.1 |
| 38 | Lateral and Uplift Capacity of Piles | CLO 16 | T1:12.6.2, R1: 4.1.2 |
| 39-40 | IS and IRC Code Provisions, | CLO 17 | T1:12.6.2, R1: 4.2 |
| 41 | Elastic Theory and Ultimate Resistance Methods. | CLO 17 | T1:12.6.2, |

| Lecture No | Topics to be covered | Course Learning Outcomes (CLOs) | Reference |
|---|---|---|---|
| | | | R1: 4.3 |
| 42 | Tunnels and Arching in Soils | CLO 17 | T1:12.6.3, R1: 4.4 |
| 43 | Pressure Computations around Tunnels | CLO 18 | T1:7.4, R1: 6.1 |
| 44 | Sheeting and Bracing Systems in Shallow and Deep Open Cuts | CLO 19 | T1:10.2.1, R1: 6.4 |
| 45 | Analysis and Design of Coffer Dams | CLO 19 | T1:10.2.4, R1: 6.6 |
| 46 | Foundations under uplifting loads | CLO 18 | T1:10.7, R1: 6.7 |
| 47 | Soil-structure Interaction. | CLO 20 | T1:8.4.2 |

## XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

| S No | Description | Proposed actions | Relevance with POs | Relevance with PSOs |
|---|---|---|---|---|
| 1 | Different Methods to increase the stability of slopes | Seminars/Guest Lectures/NPTEL | PO 3 | PSO 1 |
| 2 | Determination of Active and passive earth pressure by friction circle method | Seminars/Guest Lectures/NPTEL | PO 2 | PSO 1 |
| 3 | Design of foundation for expansive soils | Seminars/NPTEL | PO 3 | PSO 1 |

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