



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

DESIGN CONCEPTS OF SUBSTRUCTURES								
II Semester: CE								
Course Code	Category	Hours/Week			Credits	Maximum Marks		
BSTE20	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	40	60	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			
Prerequisite:								

I. COURSE OVERVIEW:

This course provides advanced knowledge on the design and analysis of substructures in geotechnical and structural engineering. Topics include soil-structure interaction, advanced bearing capacity theories, deep foundations, retaining systems, and ground improvement. Emphasis is on design methodologies, codal provisions, and case studies.

II. COURSE OBJECTIVES:

The students will try to learn:

- I. Advanced design concepts and analytical approaches for shallow and deep foundations.
- II. Principles of soil-structure interaction and their application in foundation behavior.
- III. Modern analysis and design techniques for retaining walls, braced excavations, and foundations in challenging soil conditions.
- IV. Ground improvement methods and case studies highlighting practical solutions in geotechnical engineering.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

- CO 1 Analyze soil-structure interaction using advanced theoretical models.
- CO 2 Design shallow foundations, rafts, and mats under various loading conditions.
- CO 3 Evaluate pile foundation behavior, capacity, and group action using analytical and codal approaches.
- CO 4 Design well foundations, retaining walls, and braced excavations considering stability and safety.
- CO 5 Recommend solutions for foundations in expansive, collapsible, and dynamic soil conditions.
- CO 6 Apply ground improvement techniques to enhance substructure performance.

IV. COURSE CONTENT:

MODULE –I: SOIL–STRUCTURE INTERACTION (9)

Fundamentals of soil–structure interaction and its importance in foundation design. Analytical models such as Winkler’s hypothesis and elastic continuum approach. Settlement analysis for rafts and piled raft foundations considering differential settlement.

MODULE -II: ADVANCED SHALLOW FOUNDATION DESIGN (9)

Classical and modern bearing capacity theories with correction factors. Analysis of shallow foundations subjected to eccentric, inclined, and dynamic loads. Design and performance evaluation of raft, mat, and compensated foundations with case studies.

MODULE -III: DEEP FOUNDATIONS (9)

Design of single piles and pile groups using static and dynamic approaches. Laterally loaded piles, uplift resistance, and negative skin friction concepts.

Codal provisions for pile design, load tests, and applications of well foundations.

MODULE -IV: RETAINING AND BRACED STRUCTURES (8)

Lateral earth pressure theories under static and seismic conditions. Design of rigid and flexible retaining walls with stability checks. Design principles of sheet piles, cofferdams, and braced excavations in urban construction.

MODULE -V: SPECIAL TOPICS AND GROUND IMPROVEMENT (10)

Design considerations for problematic soils such as expansive, collapsible, and marine clays. Introduction to machine foundations and dynamic soil–structure interaction. Ground improvement techniques – preloading, grouting, vibro-compaction, stone columns, and geosynthetics in foundation systems.

V. TEXT BOOKS:

1. Chen, W. F., and L. Duan, editors. “*Substructure Design*”. CRC Press, Taylor & Francis Group, 2014.
2. Jones, P. “*The Bones of the Book: Schematic Structure and Meaning Made from Books*”. Doctoral dissertation, University of the Arts London, 2017.
3. Restall, Greg. “*An Introduction to Substructural Logics*”. Routledge, 2002.

VI. REFERENCE BOOKS:

1. Arya, Chanakya. “*Design of structural elements: concrete, steelwork, masonry and timber designs to eurocodes*”. CRC Press, 2022.
2. Allen, Matthew S., Daniel Rixen, “*Substructuring in engineering dynamics*”. Cham, Switzerland: Springer International Publishing, 2020.
3. Reis, António J., and José J. Oliveira Pedro. “*Bridge design: concepts and analysis*”. John Wiley & Sons, 2019.

VII. ELECTRONICS RESOURCES:

1. <https://nptel.ac.in/courses/105105105>
2. <https://nptel.ac.in/courses/105105162>

VIII. MATERIALS ONLINE:

1. Course Outline Description
2. Tutorial Question Bank
3. Assignments
4. Model Question Paper – I
5. Model Question Paper - II
6. Lecture Notes
7. Early Lecture Readiness Videos
8. Power point presentation