Module Leader
Dr C Abadie [1]

Lecturers
Dr C Abadie, Dr S Stanier & Dr D Liang [2]

Timing and Structure
Lent term. 14 Lectures + 2 examples classes. Assessment: 100% exam

Prerequisites
3D2 assumed; 3D1, 4D5 useful

Objectives
As specific objectives, by the end of the course students should be able to:

- Introduce the geology and geotechnical properties of the seabed in renewable energy and hydrocarbon producing regions;
- Learn about the key geotechnical design aspects and challenges of an offshore wind farm;
- Develop awareness of the geohazards prevalent in the offshore environment;
- Introduce offshore site investigation techniques and methods of sediment characterisation;
- Introduce the design of geotechnical offshore infrastructure including pipelines, shallow foundations, piles and anchors, for both renewable energy and hydrocarbon producing facilities;
- Develop an awareness of the potential impact of scour on subsea infrastructure.
- Understand the key technology and knowledge transfer from oil and gas operations to renewable energy applications

Content

Introduction (1 hour: cna24)

- A historical perspective on energy production in the offshore environment
- Design of offshore wind farm and layout
- Geotechnical challenges associated with offshore wind turbines
- Knowledge transfer potential from oil and gas operations to renewable energy applications

The offshore environment (1 hour: sas229)

- Continental drift and plate tectonics
- Extent and topography of the Continental margins
- Sediment characteristics, distribution and origins
- Offshore geohazards

Offshore site investigation (2 hours: sas229)
Purpose and techniques

Geophysical and geotechnical surveys

In-situ tests: cone penetrometer, full-flow penetrometers and vane shear

Sampling methods

Simple shear testing: strain and pore pressure accumulation

Model testing

Pipelines and cables (2 hours: sas229)

Pipeline and cable systems and terminology

Routing and hazard avoidance

Installation

Hydrodynamic stability and thermal expansion management

On-bottom stability: embedment, axial and lateral resistance

Buried stability: uplift resistance

Monopiles and piled foundations (3 hours: cna24)

Types and applications

North Sea examples: offshore renewables and hydrocarbon producing platforms

Axial response:
  - Capacity and stiffness
  - Behaviour in clay / sand / rock
  - Linear elastic pile stiffness solutions
  - Numerical analysis using the load transfer method

Lateral response:
  - Limiting lateral resistance and design charts
  - Typical P-y curves
  - PISA
  - Design for cyclic loading

Anchors and suction buckets (2 hours: cna24)

Type of buoyant facilities and mooring configurations

Types of anchor:
  - Surface / gravity anchors
  - Embedded anchors: piles, drop anchors, caissons and drag anchors

Design principles for:
  - Anchor chain response
  - Drag anchors
  - Drop anchors
  - Suction caissons

Next generation anchors

Shallow and Spudcan foundations (1 hours: cna24)

Offshore shallow foundations:
  - Types and applications
  - Ultimate limit state: bearing capacity and failure envelope approaches

Introduction to spudcan foundations and mobile jack-up platforms
  - Installation procedures
  - Design considerations
  - Bearing capacity and combined loading capacity

Ocean waves and scour (2 hours: dl359)

Ocean waves

Wave loads, wave boundary layer

Sediment transport
Scour and scour remediation techniques

Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [4] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes' (AHEP) document [5] which sets out the standard for degree accreditation.

The Output Standards Matrices [6] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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Links
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[2] mailto:cna24@cam.ac.uk, sas229@cam.ac.uk, dl359@cam.ac.uk