

## **Engineering Tripos Part IIB, 4D9: Offshore Geotechnical Engineering, 2023-24**

### **Module Leader**

[Dr S Stanier](#) [1]

### **Lecturers**

[Dr S Stanier & Prof 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: onshore 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

This syllabus contributes to the following areas of the [UK-SPEC](#) [4] standard:

[Toggle display of UK-SPEC areas.](#)

## General Learning Outcomes

Graduates with the exemplifying qualifications, irrespective of registration category or qualification level, must satisfy the following criteria:

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## Links

[1] <mailto:sas229@cam.ac.uk>

[2] <mailto:sas229@cam.ac.uk>; [dl359@cam.ac.uk](mailto:dl359@cam.ac.uk)

[3] <https://teaching25-26.eng.cam.ac.uk/content/form-conduct-examinations>

[4] <https://teaching25-26.eng.cam.ac.uk/content/uk-spec>