<table>
<thead>
<tr>
<th><strong>Module Code</strong></th>
<th>MEU44B10</th>
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<tbody>
<tr>
<td><strong>Module Name</strong></td>
<td>Turbomachinery</td>
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<tr>
<td><strong>ECTS Weighting</strong></td>
<td>5 ECTS</td>
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<tr>
<td><strong>Semester taught</strong></td>
<td>Semester 2</td>
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<tr>
<td><strong>Module Coordinator/s</strong></td>
<td>Professor Stephen Spence</td>
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**Module Learning Outcomes** with reference to the **Graduate Attributes** and how they are developed in discipline

On successful completion of this module, students should be able to:

- **LO1.** Analyse compressible flows and calculate relevant parameters including stagnation, static and critical properties and Mach number.
- **LO2.** Describe and calculate properties for compressible flow passing through nozzles and through normal shocks.
- **LO3.** Draw a Mollier diagram to represent the thermodynamic processes through an axial or radial flow turbomachine or a cascade and calculate all quantities represented on the diagram.
- **LO4.** Use velocity vector triangles and 1D analysis to calculate the geometry, efficiency and power for radial and axial turbomachines.
- **LO5.** Use slip factor to calculate work input to a compressor impeller.
- **LO6.** Discuss the balance between aerodynamic and mechanical considerations in optimising the design of a compressor or turbine.
- **LO7.** Calculate flow and blade angles in a turbomachine or cascade blade.
- **LO8.** Understand and estimate the losses arising in the stator or rotor blade row of a turbomachine.
- **LO9.** Use established empirical loss correlations and design criteria to judge the feasibility of a design and predict the efficiency.
- **LO10.** Explain the physical reasons for compressor instability, stall and surge.

**Graduate Attributes: levels of attainment**

- To act responsibly - Enhanced
- To think independently - Enhanced
- To develop continuously - Enhanced
- To communicate effectively - Enhanced

**Module Content**

Turbomachinery is an essential technology for delivering the power and propulsion needed for society, particularly in rapidly developing economies. This module aims to integrate the fundamental principles of fluid mechanics and thermodynamics in order to analyse compressible flows and high speed turbomachinery. The module will instil students with an awareness of different power and propulsion applications and the importance of high efficiency energy conversion devices to minimise environmental impact, both in a national and global context. The module
provides an understanding of the unique issues associated with transonic flows and basic tools to analyse these. That understanding underpins a detailed treatment of design calculations for high speed turbomachinery, including aerodynamic performance, instability, losses and structural limitations on performance. The module covers the most important types of turbomachines; centrifugal compressors, radial turbines, axial compressors and axial gas turbines. Students also gain an appreciation of the manufacturer and user perspectives, such as costs, safety, durability, flexibility and noise.

The module content is structured into four sections:


**Radial Turbomachinery** – Centrifugal compressor; performance map, preliminary design of impeller and diffuser, Mollier diagram, slip factor, impeller back sweep. Radial turbine; performance map, preliminary design of rotor and nozzle, Mollier diagram, nominal design condition, velocity ratio, mechanical and material considerations.


**Teaching and Learning Methods**

This module uses Blackboard, podium lectures, a class test, and tutorials to help students achieve the required learning outcomes. There are 3 lectures and one tutorial per week. Subject to availability, the module will include one or two guest lectures from senior international industrial engineers or academics.
<table>
<thead>
<tr>
<th>Assessment Details</th>
<th>Assessment Component</th>
<th>Assessment Description</th>
<th>LO Addressed</th>
<th>% of total</th>
<th>Week due</th>
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<tbody>
<tr>
<td>Please include the following:</td>
<td>Class test</td>
<td>Compressible flow</td>
<td>1, 2</td>
<td>20</td>
<td>6</td>
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<tr>
<td></td>
<td>Written examination</td>
<td>End of semester examination</td>
<td>1-10</td>
<td>80</td>
<td>Exam period</td>
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- **Reassessment Requirements**: 100% written examination

- **Contact Hours and Indicative Student Workload**
  - **Contact hours**: 46
  - **Independent Study (preparation for course and review of materials)**: 55
  - **Independent Study (preparation for class test)**: 15

- **Recommended Reading List**
  - Thermodynamics: an Engineering Approach, YA Çengel and MA Boles, McGraw Hill

- **Module Pre-requisite**: 3B1 Thermodynamics, 3B2 Fluid Mechanics, 4B13 Fluid Mechanics

- **Module Co-requisite**: NA


- **Are other Schools/Departments involved in the delivery of this module?**
  - **If yes, please provide details.**: No

- **Module Approval Date**
- **Approved by**
- **Academic Start Year**
- **Academic Year of Date**