<table>
<thead>
<tr>
<th><strong>Module Code</strong></th>
<th>MEU22E05</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module Name</strong></td>
<td>Thermo-fluids</td>
</tr>
<tr>
<td><strong>ECTS Weighting</strong></td>
<td>5 ECTS</td>
</tr>
<tr>
<td><strong>Semester taught</strong></td>
<td>Semester 2</td>
</tr>
<tr>
<td><strong>Module Coordinator/s</strong></td>
<td>Assistant Prof. Seamus O’Shaughnessy (<a href="mailto:OSHAUGSE@tcd.ie">OSHAUGSE@tcd.ie</a>)</td>
</tr>
</tbody>
</table>

**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, solve problems, and communicate the solutions of simple fluid-based engineering problems including pressures and forces on submerged surfaces.

LO2. Understand the principal of basic fluid measurement devices.

LO3. Determine forces generated in systems such as jets and propellers.

LO4. Distinguish between ideal and real flows and evaluate practical problems associated with pipe flow systems.

LO5. Conceptualise and describe practical flow systems such as boundary layers and their importance in engineering analysis.

LO6. Evaluate thermo-fluid properties and solve basic problems using property tables, property diagrams and equations of state.

LO7. Analyse, solve problems, and communicate the solutions to practical closed systems and steady-flow devices by applying the conservation of energy principle.

LO8. Understand the limitations of engineering devices and systems based on the 2\textsuperscript{nd} law of thermodynamics.

LO9. Understand the concept of thermal efficiency and coefficient of performance and the environmental and socio-economic implications associated with desired system output (i.e. power/cooling) verses required ‘cost’ in.

LO10. Understand basic laboratory procedure and safety.

LO11. Acquire, tabulate and analyse useful data in the laboratory, and communicate information and provide physical interpretation of measurements in technical laboratory reports.

**Graduate Attributes: levels of attainment**

To act responsibly - Introduced

To think independently - Enhanced

To develop continuously - Enhanced

To communicate effectively - Enhanced
### Fluid Mechanics

- **Introduction:** Definition of a fluid, fluid properties, equation of state.
- **Principles and Equations of Fluid Motion and their applications:** Description of fluid flow, continuity equation, Euler and Bernoulli equations, Pitot total head and static tubes, venturi-meters, orifice plates.
- **Momentum Equation & its application:** Momentum equation for steady flow, applications to jet flows, impinging flows in pipe bends, momentum theory of propellers.
- **Flow Regimes and Pipe Flow:** Laminar and Turbulent Flows, Reynolds demonstration of flow regimes, criterion for laminar/ turbulent flow, Reynolds number, pipe flows, fully developed flow, laminar pipe flow, turbulent pipe flow, friction factor, friction losses, other losses.
- **Boundary Layers and Wakes:** Description of the boundary layer, laminar and turbulent boundary layers, physical, displacement & momentum thickness, effect of pressure gradient – separation and wake formation, drag forces.

### Thermodynamics

- **Introduction:** Properties of matter, the state postulate, forms of energy, processes, thermodynamic systems,
- **Properties of Pure Substances:** property tables, property diagrams, phase change, equations of state (ideal gas), specific heats.
- **Energy:** Energy transfer by heat, work and mass, flow work.
- **The First Law of Thermodynamics:** Closed system, open system, steady-flow engineering devices.
- **The Second Law of Thermodynamics:** Statements of the Second Law, heat engines, refrigeration devices, reversible versus irreversible processes, the Carnot cycle.

### Teaching and Learning Methods

The module encompasses a diverse variety of teaching and learning strategies. This is accomplished by coordinating formal lectures with teamwork-based problem-solving tutorial sessions supplemented by ‘hands-on’ laboratory experimentation and technical report writing. Students can avail of self-assessment online quizzes for every section of the module.

**Associated laboratory/project programme**

- Spark Ignition Engine Test,
### Assessment Details
**Please include the following:**
- Assessment Component
- Assessment description
- Learning Outcome(s) addressed
- % of total
- Assessment due date

<table>
<thead>
<tr>
<th>Assessment Component</th>
<th>Assessment Description</th>
<th>LO Addressed</th>
<th>% of total</th>
<th>Week due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam</td>
<td>End of Semester Written Exam</td>
<td>1 - 9</td>
<td>70</td>
<td>Exam Period</td>
</tr>
<tr>
<td>Continuous Assessment</td>
<td>Lab Report 1</td>
<td>10 - 11</td>
<td>7.5</td>
<td>2 weeks after lab</td>
</tr>
<tr>
<td>Continuous Assessment</td>
<td>Lab Report 2</td>
<td>10 - 11</td>
<td>7.5</td>
<td>2 weeks after lab</td>
</tr>
<tr>
<td>Continuous Assessment</td>
<td>Online Quiz</td>
<td>1 - 9</td>
<td>7.5</td>
<td>Week 9 (Fluids)</td>
</tr>
<tr>
<td>Continuous Assessment</td>
<td>Online Quiz</td>
<td>1 - 9</td>
<td>7.5</td>
<td>Week 15 (Thermo)</td>
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### Reassessment Requirements
The reassessment mode for this module is a written examination worth 100% of the reassessment grade.

### Contact Hours and Indicative Student Workload
**Contact hours:** 47 total (33 lectures, 10 tutorials, 2 x 2 hour laboratory sessions)

- **Independent Study (preparation for course and review of materials):** 35
- **Independent Study (preparation for assessment, incl. completion of assessment):** 43

### Recommended Reading List
See Blackboard for further information

### Module Pre-requisite
None

### Module Co-requisite
None

### Module Website

### Are other Schools/Departments involved in the delivery of this module? If yes, please provide details.

### Module Approval Date
Approved by

### Academic Start Year
September 9th 2019

### Academic Year of Date
2019/2020