Module Code	MEU33B01
Module Name	Thermodynamics
ECTS Weighting	5 ECTS
Semester taught	Semester 2
Module Coordinator/s	Professor Anthony Robinson
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. Recognise, classify and describe the basic operating functions and thermodynamic principles of energy conversion devices. LO2. Understand the concepts and solve problems related to perfect (Carnot), ideal (e.g. Rankine, Otto & Refrigeration) and actual cycles. LO3. Estimate the Thermal Efficiency (power generation systems) or Coefficient of Performance (refrigeration systems). LO4. Recognise the environmental and socio-economic implications associated with desired system output (power/ cooling) versus required 'cost' input (fuel/energy source). LO5. Analyse and solve problems relating to the rational use of energy. LO6. Perform laboratory and engine workshop tasks as a group and acquire, tabulate and analyse useful data in the laboratory. LO7. Communicate information and provide physical interpretation of measurements in a technical laboratory report. LO8. Utilise internet resources for independent investigation and communicate information to an audience via formal presentation. **Graduate Attributes: levels of attainment** To act responsibly - Introduced To think independently - Enhanced To develop continuously - Enhanced To communicate effectively - Enhanced
Module Content	This module is developed to strengthen the student's skills in the thermal fluid sciences and is organised into three main subsections: energy, energy conversion devices and power cycles. The energy part reinforces their understanding of the first and second laws of thermodynamics and the behaviour of ideal gases and pure substances; the property entropy is also introduced. The focus is on developing the mathematical modelling skills and analysis techniques for practical energy transfer problems. The energy conversion devices focuses on traditional and novel approaches for energy transfer and conversion with focus on devices found in power generation and refrigeration systems. Finally, power cycles will be considered ranging from internal combustion engines to steam power plants. The module content is as follows:

	· Introduction to energy transfer: revision of basic concepts, 1st & 2nd laws of thermodynamics, entropy. · The thermodynamics of practical energy conversion components and devices. · Steam and gas power cycles: e.g. Carnot cycle, ideal and actual Rankine, Otto, Diesel and Brayton cycles (including regeneration). · The Reverse Heat Engine: The Carnot reverse heat engine, ideal and actual refrigeration cycles, practical refrigerators and heat pumps.
Teaching and Learning Methods	This module uses Blackboard, podium lectures, a group assignment, a laboratory session and tutorials to help students achieve the required learning outcomes. There are 3 lectures and one tutorial per week.

Assessment Details
Please include the following:

- **Assessment Component**
- **Assessment description**
- **Learning Outcome(s) addressed**
- **% of total**
- **Assessment due date**

Assessment Component	Assessment Description	LO Addressed	% of total	Week due
Laboratory	Diesel engine lab report	6-7	10	2 weeks following lab session
Written examination	End of semester examination	1-5	80	Exam period
Group assignment	Renewable energy slides and presentation	8	10	Weeks 11 and 12

Reassessment Requirements	100% written examination

Contact Hours and Indicative Student Workload	**Contact hours: 46**
	Independent Study (preparation for course and review of materials): 40
	Independent Study (preparation for assessment, incl. completion of assessment): 25

Recommended Reading List	Thermodynamics: an Engineering Approach, YA Çengel and MA Boles, McGraw Hill Moran and Shapiro, Fundamentals of Engineering Thermodynamics (Wiley and Sons) Rogers and Mayhew, Engineering Thermodynamics Work and Heat Transfer, 4th. edition, S.I. units (Longman) Sonntag, Borgnakke and Van Wylen, Fundamentals of Thermodynamics, S.I. units, 6th. edition (Wiley)
Module Pre-requisite	2E5 Thermo-fluids
Module Co-requisite	NA
Module Website	https://www.tcd.ie/Engineering/undergraduate/baiyear4/modules/3B1.pdf
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	

COVID-19 contingency statement for Module Descriptors

While the intention is to deliver all lectures and tutorials face-to-face in a classroom, there is uncertainty due to the Covid-19 situation and part or all of the module delivery may need to change to an online delivery if required by government restrictions. In the case of a possible new lockdown scenario during teaching term:

- All lectures and tutorials will be delivered online using Blackboard. These sessions will be recorded and available for viewing via Blackboard at a later time.
- The group assignment and the end of semester exam will be online.