# MODULE DESCRIPTION FORM

**DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING**

## ME928 ENERGY SYSTEMS ANALYSIS

| | | | |
|---|---|---|---|
| **Module Registrar: Dr Paul Tuohy** paul.tuohy@strath.ac.uk | **Taught To (Course):Cohorts for whom class is compulsory / optional / elective** | | |
| **Other Lecturers Involved: None** | **Credit Weighting:10** | **Semester:1** | |
| **Assumed Prerequisites: None** | **Compulsory/ optional / elective class** | **Academic Level:5/PG** | **Suitable for Exchange: Y** |

**Module Format and Delivery (HOURS i.e. 1 credit = 10hrs of study):**

| Lecture | Tutorial | Laboratory | Groupwork | External | Online | Project | Assignments | Private Study | **Total** |
|---|---|---|---|---|---|---|---|---|---|
| 20 | 16 | | | | | | 36 | 28 | 100 |

**Educational Aim**

This module aims to impart an understanding of the underpinning theoretical principles and practical calculation methods for analysis of renewable and non-renewable energy systems and an appreciation of how these systems are integrated in practical applications. Emphasis is on heat transfers and thermodynamic cycles.

**Learning Outcomes**

On completion of the module the student is expected to be able to

LO1 Recognise the basis of operation and carry out thermodynamic cycle performance analysis for modern renewable and non-energy systems.

LO2 Recognise the basis of operation and carry out heat transfer performance analysis for modern renewable and non-renewable energy systems.

**Syllabus**

The module will teach the following:

- An overview of common energy conversion systems and sub-systems, their application in renewable and non-renewable contexts.
- Laws of classical thermodynamics and principles of heat transfer.
- Thermodynamic analysis principles: properties and states, equilibrium, open and closed systems, reversibility, heat and work, properties of gases and vapours, state equations, property tables and diagrams, Carnot cycle, entropy, isentropic efficiency, nuclear reactions.
- Thermodynamic analysis methods: thermal power generation, steam cycles, gas turbine cycles, vapour compression cycles for heat pumps and refrigeration, absorption cycles. Applications in renewable and non-renewable systems.
- Heat transfer principles: conduction (Fourier's law), natural and forced convection, radiation, overall heat transfer, heat exchangers.
- Heat transfer analysis methods. Applications in buildings, districts, and renewable and non-renewable energy supply and conversion systems.
- Psychrometric principles and analysis methods: psychrometric properties and relationships, analysis methods including psychrometric chart. Application to indoor environment and related energy supply and control systems.

**Assessment of Learning Outcomes**

**Criteria**

For each of the Module Learning Outcomes the following criteria will be used to make judgements on student learning – these will be informally assessed in tutorials and formally assessed through assignments and exam:

LO1 Recognise the basis of operation and carry out thermodynamic cycle performance analysis for modern energy systems.
C1 Ability to carry out Thermodynamic Cycle Analysis for steam and gas power cycles and the refrigeration / heat pump cycle.
C2 Ability to identify and describe appropriate thermodynamic cycle applications in renewable and non-renewable energy systems for a wide range of contexts.

LO2 Recognise the basis of operation and carry out heat transfer performance analysis for modern energy systems.
C1 Ability to carry out appropriate heat transfer analysis considering conduction, radiation and convection individually and in combinations as appropriate to built environment, renewable and non-renewable energy systems.
C2 Ability to identify and describe appropriate heat transfer applications in renewable and non-renewable energy systems for a wide range of contexts including built environment.

The standards set for each criterion per Module Learning Outcome to achieve a pass grade are indicated on the assessment sheet for all assessment.

**Principles of Assessment and Feedback**
*(within Assessment and Feedback Policy at:https://www.strath.ac.uk/staff/policies/academic/)*

Expectations: The tutorials, assignments and exam questions are aligned and this is communicated to the students so that the students have clear expectations that by attempting the tutorials they will develop skills required for the assignments and by attempting the assignments they will develop the skills for the exam. Students are told that although the subject can appear daunting at the outset it is possible to achieve very good results once the analysis techniques are mastered.

Group learning and feedback: The course is delivered so that each lecture topic is followed a week later by a tutorial on that topic with tutorial questions identified a week in advance. The students are asked to work in 'buzz' groups to attempt the tutorial questions for the next week. The students get the opportunity in tutorial to discuss the approach and analysis steps and compare the tutor's solution to their own. Tutorial solutions are made available to students on Myplace to allow private reflection. General feedback on assignments (common mistakes or misunderstandings) is given to class in tutorials.

Student directed learning: The last 2 tutorials (weeks 9 and 10) after the main lecture topics have been covered, are open for the students to suggest the topics they would like to be covered again.

Individual feedback and encouragement: The assignments are marked with individual comments giving encouragement, feedback on errors and references to Myplace resources as appropriate.

Opportunities for closing gaps: The feedback from the tutorials allows students to address gap areas ahead of assignments and similarly assignment feedback allows gaps to be addressed before exam.

**Assessment Method(s) Including Percentage Breakdown and Duration of Exams**

| Examination | | | | Coursework | | Practical | | Project | |
|---|---|---|---|---|---|---|---|---|---|
| Number | Month(s) | Duration | ***Weighting*** | Number | ***Weighting*** | Number | ***Weighting*** | Number | ***Weighting*** |
| 1 | Dec | 2 hrs | 50% | 2 | 50% | | | | |
| *LO1,LO2 | | | | *LO1,LO2 | | * | | * | |

* ***L/Os:*** *Indicate which Learning Outcomes (L01, L02, etc) are to be assessed by exam/coursework/practical/project as required.*

**Coursework / Submissions deadlines (*academic weeks*):**
Assignment 1: split in 3 parts and made available weeks 3, 4, 5 requiring submissions in weeks 4, 5, 6. Assignment 2: split in 2 parts and made available in weeks 7, 8 requiring submission in weeks 8, 9.
Answers will be provided 1 week after submission of each part of assignment.

**Resit Assessment Procedures:**
2 hour examination in August exam diet.

**PLEASE NOTE:**
**Students must gain a summative mark of 50% to pass the module. Students who fail the module at the first attempt will be re-assessed during the August diet. This re-assessment will consist entirely of an exam. No marks from any previous attempts will be transferred to a new resit attempt.**

**Recommended Reading**

**A fundamentals course text book is supplied but students may find it useful to consult a supporting text book for an alternative perspective. Suitable text books include (but not limited to):**

Moran and Shapiro – Fundamentals of Engineering Thermodynamics, 6th edition (2008), Wiley
Çengel and Boles – Thermodynamics: an engineering approach, 6th edition (2008), McGraw-Hill
Çengel – Heat and mass transfer: a practical approach, 3rd edition (2007), McGraw-Hill
Rogers G and Mayhew Y, 'Engineering Thermodynamics', Longman.
Duffie and Beckman 'Solar Engineering'.

**Additional Student Feedback**
*(Please specify details of when additional feedback will be provided)*

| Date | Time | Room No |
|---|---|---|
| By email arrangement | By arrangement | By arrangement |

Session:2019/20

**Approved:**

| | |
|---|---|
| **Course Director Signature:** | ***E Henderson*** |
| **Date of Last Modifications:** | **27/08/2019** |

(Updated July 2019)

# MODULE TIMETABLE

| **Module Code:** | **ME928** | **Module Title:** | **Energy Systems Analysis** |
|---|---|---|---|

**Brief Description of Assessment:**

Assignment 1: split in 3 parts and made available weeks 3, 4, 5 requiring submissions in weeks 4, 5, 6. Assignment 2: split in 2 parts and made available in weeks 7, 8 requiring submission in weeks 8, 9.
Answers and individual feedbacks will be provided 1 week after submission of each part of assignment.

**Assessment Timing:-**

Indicate on the table below the start/submission dates for each assignment/project and the timing of each exam/assessment using the dropdowns provided. Dropdowns can be left blank. Add extra notes below the dropdowns.

**Please note: Timings can and will change, this should only be used as a guide.**

| **Semester One** | W&D Wk | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 | WK10 | WK11 | Exam Period |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Course work Set | Course work Set Course work Submit | Course work Set Course work Submit | Course work Submit | Course work Set | Course work Set Course work Submit | Course work Submit | Choose an item. Choose an item. | Choose an item. Choose an item. | Exam |

| **Semester Two** | C&D Wk | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 | WK10 | WK11 | Exam Period |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. Choose an item. | Choose an item. |