MODULE DESCRIPTION FORM

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

ME928 ENERGY SYSTEMS ANALYSIS

Module Registrar: Dr P 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**
Compulsory/ optional / elective class	**Academic Level:5**	**Suitable for Exchange: Y**

Required prerequisites

Note: It is the responsibility of ALL students to ensure that they satisfy the prerequisite knowledge for this module BEFORE adding as part of curriculum selection. If unsure, please contact the Module Registrar or discuss with your Programme/Year Adviser of Studies.

Mathematical skills are required:

Ability to manipulate and solve algebraic equations.

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 100% renewable energy systems plus an appreciation of how these systems are integrated in practical applications. Emphasis is on the heat transfers and thermodynamic cycles that underpin whole system clean energy storage, conversion, and delivery processes.

Learning Outcomes

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

LO1 Recognise the wider contexts, basis of operation, system integrations, and carry out thermodynamic cycle performance analysis for modern renewable energy systems and the energy systems they will replace.

LO2 Recognise the wider contexts, basis of operation, system integrations, and carry out heat transfer performance analysis for modern renewable energy systems and the energy systems they will replace.

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 energetic and thermodynamic cycle system performance analysis for modern energy systems.
C1 Ability to carry out energetic and thermodynamic cycle analysis for steam and gas power cycles and the refrigeration / heat pump cycle.
C2 Ability to identify, describe and assess 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, describe and assess 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/professionalservices/staff/policies/academic/)

Expectations: The tutorials, assignments and exam questions are aligned and this is communicated to the students to set 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 in more depth or revisited.

Individual feedback and encouragement: Formative assignment questions are set on each of the main topics (steam cycle and applications, gas cycle and applications, refrigeration and heat pump cycle and applications, heat transfer basics, heat transfer applications). Solutions are released 1 week after the formative assignment submissions and reviewed in class. The students have the opportunity to raise individual comments in class or using the class blog or direct to the class tutor. The tutor will give: encouragement, feedback on errors, and references to Myplace and wider resources as appropriate to close any identified gaps.

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 *(individual weightings)*

Examination				Coursework		Practical		Project	
Number	Month(s)	Duration	***Weighting***	Number	***Weighting***	Number	***Weighting***	Number	***Weighting***
1	Dec	2hrs	100%	5	0%				
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*):
Assignments: Questions are set after each of the 5 main topics is covered (normally weeks 3, 4, 5 requiring submissions in weeks 4, 5, 6; and weeks 7, 8 requiring submission in weeks 8, 9).
Answers will be provided 1 week after submission of each part of assignment and covered in class.

Resit Assessment Procedures:
2hr examination in July/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 July/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 textbook is supplied but students may find it useful to consult a supporting textbook for an alternative perspective. Suitable textbooks 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'.
'Engineering Toolbox' - online resource.

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: 2024/25

Approved:

Programme Lead/Director Signature: **Dr A McLaren**

Date of Last Modifications: **23/08/2024**

(MAE template updated July 2024)

MODULE TIMETABLE

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

Brief Description of Assessment:

Assessment will be solely based on the 2 hour class exam in December exam period.

Assessment Timing

Indicated on the table below are the start/submission dates for each assignment/project and the timing of each exam/assessment.

Please note: Timings could change during unforeseen periods of disruption; 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.