MODULE DESCRIPTION FORM

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

16599 AERODYNAMIC PROPULSION SYSTEMS

Module Registrar: Prof Matthew P. Cartmell matthew.cartmell@strath.ac.uk	**Taught To (Course): Cohorts for whom module is compulsory / optional (not available if taken ME425)**	
Other Lecturers Involved:	**Credit Weighting:10**	**Semester:2**
Compulsory / optional module	**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.

Basic Knowledge in Fluids/Thermodynamics

- Understand the fundamentals of the laws of thermodynamics and how they can be used to both design and assess the performance of engineering power systems.
- Thermodynamics laws: 1st law of thermodynamics applied to non-flow and steady flow systems; 2nd law of thermodynamics, its implications and thermal efficiency.
- Concepts: the properties of perfect gases, entropy and the concepts of the principle of increasing entropy, isentropic and polytropic efficiency.

Programming skills

- Basic knowledge and experience of coding in MATLAB or Python

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

Lecture	Tutorial	Laboratory	Groupwork	External	Online	Project	Assignments	Private Study	**Total**
22	11						45	22	100

Educational Aim

This module aims to provide an understanding of the principles and design of propulsion systems for aircraft. Throughout the course, the overall procedure and methodology for designing a propulsion device, starting from the aircraft concept and the associated engine requirements, through to the aero-thermal design of engine components is presented and discussed. Using a combination of lectures and project-based activities, students will develop an understanding of the overall design process and the performance of aerospace propulsion systems.

Learning Outcomes

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

LO1 Understand the propulsion requirements for an aircraft.

LO2 Understand and appreciate the measures of performance of propulsion devices and how they can be determined.

LO3 Appreciate the difference between various types of propulsion devices, the factors affecting the engine performance and the approach to design.

LO4 Understand the role of various engine components within the propulsion device, the design procedures for components and how their performance is calculated.

Syllabus

The module will teach the following:

Introduction –

- the various types of propulsion systems,
- historical development of gas turbine power units for jet propulsion.
- A brief review of thermodynamics laws

The general thrust equation
Propulsion performance characteristics
Aerothermodynamics of

- intakes,
- combustors and
- nozzles –
- compressible flow governing equations,
- nozzle flows,
- subsonic and supersonic intakes,
- combustion chamber and afterburner design.

Analysis of jet propulsion power units –

- the ram jet,
- pure turbojet,
- by-pass turbojets,
- turbofan engines and
- prop fan engines.

Design of axial flow compressors and turbines, free vortex designs
Off-design Performance

Assessment of Learning Outcomes

Criteria

For each of the Module Learning Outcomes the following criteria will be used to make judgements on student learning:

LO1 Understand the propulsion requirements for an aircraft.
C1 Students should be able to calculate the required thrust for a propulsive device from the aircraft specification.
C2 Students should be able to calculate the basic engine criteria necessary to deliver the required performance of an aircraft.
C3 To demonstrate an understanding of the principles by calculation of an appropriate engine configuration and performance for an aircraft specification.

LO2 Understand and appreciate the measures of performance of propulsion devices and how they can be determined.
C1 Students should be able to calculate performance criteria for an engine (thrust; fuel usage; efficiency).
C2 To demonstrate understanding by calculating appropriate performance criteria for a given engine
C3 To demonstrate understanding by selecting appropriate engine configuration and performance required to deliver the required aircraft performance.

LO3 Appreciate the difference between various types of propulsion devices, the factors affecting the engine performance and the approach to design.
C1 Students should be able to understand how various engine performance measures (thrust; fuel usage; efficiency) affect the suitability of a particular device for certain flight regimes.
C2 Students should be able to determine and calculate the overall engine performance.
C3 Students should understand and be able to discuss how configuration of various components (e.g. compressor pressure ratio; turbine entry conditions) influence overall engine performance.

LO4 Understand the role of various engine components within the propulsion device, the design procedures for components and how their performance is calculated.
C1 Students should understand how the engine components influence the overall engine performance.
C2 Students should have an understanding of the design methodology for particular components and how their performance can be measured.
C3 Students should demonstrate an understanding of component design through appropriate selection of design parameters to deliver necessary component performance.

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/)

Deliver high quality feedback information that helps learners self-correct.
Regular feedback and discussion will be available in tutorial sessions. (note: to receive this feedback students should participate in these tutorials, but attendance is not mandatory). Feedback from coursework will enable students to reflect on their understanding of the subject material prior to the final examination.

Ensure that summative assessment has a positive impact on learning.
Coursework will be assessed and detailed feedback on performance given by discussion during group (lecture/tutorial) sessions. Solutions to selected previous exam questions will be discussed, along with the reasons for techniques used, and to highlight common errors in the solutions. Formal, summative feedback will be provided by the return of examination marks to students after assessment (note that exam scripts will not be returned to students and no collective discussion of exam performance will be facilitated).

Encourage interaction and dialogue around learning (peer and teacher-student)
Discussion of the course material between lecturer-student and also amongst peers will be encouraged in tutorial sessions. Students will also be encouraged to discuss coursework with their peers to improve learning. Students are encouraged to collaborate in the calculations and models provided in the tutorial and coursework exercises and demonstration calculations provided during the course. However, it is emphasised that the coursework analysis they submit must be entirely their own work – i.e. background research plus results they have personally generated and interpreted.

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	Apr/May	2 hours	70%	1	30%				
* All				* All		*		*	

* ***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*):
Coursework – submission week 11

Resit Assessment Procedures:
2hr examination in July/August 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

*****Purchase recommended **Highly recommended reading*For reference (do NOT purchase)**

*** "Jet Propulsion" 3rd Edition, Cumpsty and Heyes, Cambridge University Press.

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

Date	Time	Room No
		Check timetable webpages for details

Session: 2024/25

Approved:

Programme Lead/Director Signature: Dr A McLaren

Date of Last Modifications: 05/07/2024

(MAE template updated July 2024)

MODULE TIMETABLE

Module Code:	**16599**	**Module Title:**	**Aerodynamic Propulsion Systems**

Brief Description of Assessment:

1 exam of 2 hours duration in the April/May Exam diet (70%).
1 coursework in semester 2 (30%) – anticipated timings provided below

Assessment Timing

Indicated on the table below are the start/submission dates for each assignment/coursework 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.	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.

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.	Course work Set	Choose an item. Choose an item.	Choose an item. Choose an item.	Choose an item. Choose an item.	Course work Submit	Exam