16599 AERODYNAMIC PROPULSION SYSTEMS

Module Registrar: Dr I Taylor  ian.taylor@strath.ac.uk

Taught To (Course): Cohorts for whom class is compulsory / elective

Other Lecturers Involved: none

Credit Weighting: 10 (ECTS 5)

Assumed Prerequisites: ME203 Heat and Flow 2; ME301 Heat and Flow 3; ME405 Heat and Flow 4 (or equivalent Fluids/Thermodynamics classes)

Semester: 2

Compulsory / elective class

Academic Level: 5

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

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Tutorial</th>
<th>Laboratory</th>
<th>Groupwork</th>
<th>External</th>
<th>Online</th>
<th>Project</th>
<th>Assignments</th>
<th>Private Study</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>24</td>
<td>12</td>
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Educational Aim

This module aims to provide an understanding of the principles of propulsion systems for aircraft and rockets. 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.

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
  • propfan engines.

Design of axial flow compressors and turbines, free vortex designs

Off-design Performance

Rockets
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 Student should be able to calculate the required thrust for a propulsive device from the aircraft specification.
   C2 Student should be able to calculate the basic engine criteria necessary to deliver the required performance of an aircraft.
   C3 Demonstrate understanding of 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 Student should be able to calculate performance criteria for an engine (thrust; fuel usage; efficiency).
   C2 Demonstrate understanding by calculating appropriate performance criteria for a given engine.
   C3 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 Student 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 Student should be able to determine and calculate the overall engine performance.
   C3 Student 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 The student should understand how the engine components influence the overall engine performance.
   C2 Student should have an understanding of the design methodology for particular components and how their performance can be measured.
   C3 Demonstration of 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.

12 Principles of Assessment and Feedback
(on Learning & Teaching web pages: www.strath.ac.uk/learnteach/teaching/staff/assessfeedback/12principles/)

Deliver high quality feedback information that helps learners self-correct.
Regular feedback and discussion will be available in tutorial sessions. Feedback from courseworks will enable students to reflect on their understanding of the subject material prior to the final examination. Individual feedback will be available by appointment with the course lecturers.

Ensure that summative assessment has a positive impact on learning.
Coursework submissions will be returned with marks and detailed written feedback to allow students to reflect on their performance.

Encourage interaction and dialogue around learning (peer and teacher-student)
Discussion of the course material between teacher-student and also amongst peers will be encouraged in tutorial sessions. Students will also be encouraged to discuss courseworks with their peers to improve learning.

Informal feedback will be provided at regular tutorial sessions primarily through verbal discussion with individuals or groups on tutorial exercises attempted in advance by students (note:- to receive this feedback students should participate in these tutorials but attendance is not mandatory).

The marked courseworks will be returned to students with written feedback. Discussion of coursework results will be discussed during the lectures & tutorial sessions.
Formative feedback may also be given during personal appointments with the course lecturer.

Full solutions will be provided to the final exam, post assessment, along with 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:- exam scripts will not be returned to students and no collective discussion of exam performance will be facilitated). Individual feedback on the exam may be arranged if appropriate.

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 analysis reports 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

<table>
<thead>
<tr>
<th>Examinations</th>
<th>Courseworks</th>
<th>Projects</th>
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<tbody>
<tr>
<td>Number</td>
<td>Month(s)</td>
<td>Duration</td>
</tr>
<tr>
<td>1</td>
<td>May</td>
<td>2 hours</td>
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L/Outcomes

| All | LO1, LO3 and LO4 |

Indicate which learning outcomes (LO1, LO2 etc) are to be assessed by exam/coursework/project as required.

Coursework / Submissions deadlines: Coursework 1 – submission week 4; Coursework 2 – Submission week 7; Coursework 3 – Submission week 10.

Resit Assessment Procedures: 2hr resit examination in August.

PLEASE NOTE:

Students need to gain a summative mark of 50% to pass the module. If a coursework is not submitted, it will be awarded zero marks. Students who fail the module at the first attempt will be re-examined during the August diet. This re-examination will consist entirely of exam only.

Recommended Reading

****Purchase essential; ***Purchase recommended; **Highly recommended reading; *Simply for reference (do NOT purchase)

A reading list of recommended texts is issued at the start of the class. No single text is used. Comprehensive lecture notes are provided.

Additional Student Feedback

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

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<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Room No</th>
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<tr>
<td>Tutorial session – each Friday</td>
<td>10am-11am</td>
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Session: 2014/15

Approved:

Course Director Signature: Prof J Boyle

Date of Last Modifications: 28 August 2014
** MODULE TIMETABLE **

<table>
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<tbody>
<tr>
<td>Module Title:</td>
<td>Aerodynamic Propulsion Systems</td>
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** Brief Description of Assessment: **
1 exam of 2 hours duration in the May Exam diet.
3 courseworks in semester 2.

** Assessment Timing:- **
Indicate on the table below the start/submission dates for each assignment/project and the timing of each exam/assessment(s).

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<th>WK1</th>
<th>WK2</th>
<th>WK3</th>
<th>WK4</th>
<th>WK5</th>
<th>WK6</th>
<th>WK7</th>
<th>WK8</th>
<th>WK9</th>
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<th>WK11</th>
<th>WK12</th>
<th>Exam Period</th>
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<tbody>
<tr>
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<td>Course work 2 hand in</td>
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<td>Course work 3 hand in</td>
<td>Semester 2 exam</td>
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