AERO3660

Flight Performance and Propulsion

Term Three // 2020

School of Mechanical and Manufacturing Engineering // UNSW Engineering

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
John Olsen	j.olsen@unsw.edu.au	During Consultations	Ainsworth Building 311/C	9385 5217

School Contact Information

Location

UNSW Mechanical and Manufacturing Engineering

Ainsworth building J17, Level 1

Above Coffee on Campus

Hours

9:00–5:00pm, Monday–Friday*

*Closed on public holidays, School scheduled events and University Shutdown

Web

School of Mechanical and Manufacturing Engineering

Engineering Student Support Services

Engineering Industrial Training

UNSW Study Abroad and Exchange (for inbound students)

UNSW Future Students

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

(+61 2) 9385 4097 – School Office**

**Please note that the School Office will not know when/if your course convenor is on campus or available

Email

Engineering Student Support Services – current student enquiries

- e.g. enrolment, progression, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries

- e.g. admissions, fees, programs, credit transfer

School Office – School general office administration enquiries

- NB: the relevant teams listed above must be contacted for all student enquiries

Course Details

Credit Points 6

Summary of the Course

In this course, we will develop equations for simple phases of flight performance such as straight & level flight, climbing flight, descending flight, turning flight, take-off and landing. These equations will enable you to determine the various aerodynamic forces acting on the aircraft. In particular, we will be interested in finding the thrust required. In the case of propeller driven aircraft, we will then be able to determine the power that an engine/motor must be able to make available for climb as this is usually the case when maximum power is required.

During flight, most aircraft burn fuel which means that the weight of the aircraft varies non-linearly over the course of a flight mission. This can make it complicated to estimate the quantity of fuel required for a mission. You will be introduced to approaches to estimating the quantity of fuel required.

As the course deals with propulsion, you will learn the thermodynamic basics of engines, namely of reciprocating piston engines and gas turbine engines.

Course Aims

- to clearly differentiate between true and equivalent airspeeds;
- to introduce students to wings and the usual approach to the decomposition of drag and to make them aware of this approach's limitations;
- to introduce the different atmospheric layers and to the equations needed to predict the density, temperature and pressure at different altitudes;
- to introduce the analysis of steady-state climb and descent, turning flight and gliding flight and to link this Newtonian approach to energy methods;
- to introduce take-off and landing analysis;
- to introduce the analysis of compressible flow;
- to introduce students to the Breguet range and endurance equations and to enable them firstly to see how the assumptions used in the development of this equation limits its validity and secondly to suggest approaches to improve the accuracy of range prediction;
- to introduce a mathematical approximation to the behaviour of gas turbine engines so as to enable students to develop a deeper understanding of how these engines work;
- to review air-standard analysis of Otto cycle reciprocating piston engines and to introduce the air-standard analysis of the Dual cycle;
- to introduce students to actuator disk theory and blade element theory for propeller analysis to ensure that students understand why propellers are shaped the way they are;
- to introduce students to methods for calculating the properties of gas mixtures and to the basics of chemical reaction thermodynamics.

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. To clearly differentiate between true and equivalent airspeeds.	PE1.2

Learning Outcome	EA Stage 1 Competencies
2. To understand how the properties of the atmosphere change with altitude.	PE1.1, PE1.2, PE1.3
3. To understand when and how to use compressible flow analysis.	PE1.1, PE1.2, PE1.3
4. To develop a deeper understanding of how gas turbine engines work.	PE2.1, PE2.2
5. To appreciate the benefits of Dual cycle analysis over Otto cycle analysis.	PE1.1, PE1.2, PE1.3, PE2.1, PE2.2
6. • To understand actuator disk theory and blade element theory for propeller analysis and to be able to articulate why propellers are shaped the way they are.	PE2.1, PE2.2
7. To gain an initial understanding of how wings develop lift and to understand the limitations of the usual approach to the decomposition of drag.	PE1.1, PE1.3, PE1.2, PE2.1
8. To be able to calculate the properties of gas mixtures and the energy released during chemical reactions.	PE1.1, PE1.2, PE1.3, PE2.2, PE2.1
9. To estimate range and endurance but more importantly understand the limits to the validity of the current methods.	PE1.1, PE1.2, PE1.3, PE2.1, PE2.2
10. To be able to analyse steady-state climb and descent, turning flight and gliding flight.	PE1.1, PE1.2, PE1.3, PE2.1, PE2.2
11. To calculate take-off and landing distances and to see which parameters have to greatest influence.	PE1.1, PE1.2, PE1.3, PE2.1, PE2.2

Teaching Strategies

“Give a man a fish and you feed him for a day. Teach him how to fish and you feed him for a lifetime.” **Lao Tzu**

- Presentation of the material in lectures and discussions so that the students know how to approach complex engineering calculations required in industry.
- The problems I suggest you look at are intended to provide you with feedback and to allow you to investigate topics in greater depth. This is to ensure that you understand what you are being taught.

Assessment

Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
Assignment 1	10%	16/09/2020 09:00 AM	1, 2, 3, 7
Assignment 2	30%	18/11/2020 09:00 AM	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Bankstown Flight Experiments	10%	28/10/2020 09:00 AM	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11
Final Exam	50%	Not Applicable	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

Assessment Details

Assessment 1: Assignment 1

Details:

Short Assignment

Turnitin setting: This is not a Turnitin assignment

Assessment 2: Assignment 2

Details:

Long Assignment

Assessment 3: Bankstown Flight Experiments

Details:

Bankstown Flight Experiments

Turnitin setting: This is not a Turnitin assignment

Assessment 4: Final Exam

Start date: Not Applicable

Details:

Final Exam

Resources

Prescribed Resources

E. Torenbeek & Wittenberg, 2002, *Flight Physics, Essentials of Aeronautical Disciplines and Technology, with Historical Notes*, Springer.

AND POSSIBLY

N. Cumpsty & A. Heyes, 2015, *Jet Propulsion. A simple guide to the aerodynamic and thermodynamic design and performance of jet engines*, 3rd edition, Cambridge University Press.

Recommended Resources

D. G. Hull, 2007, *Fundamentals of airplane flight mechanics*, Springer.

A. Terari, 2016, *Basic Flight Mechanics: A Simple Approach Without Equations*, Springer.

J. Kurzke & I. Halliwell, 2018, Propulsion and Power, Springer International Publishing AG.

G. P. Sutton & O. Biblarz, 2017, Rocket propulsion elements, 9th edition, Wiley.

A. Miele, 2016, Flight Mechanics, Theory of flight paths, Dover Publications Inc, Mineola, New York.

C. B. Millikan, 1941, Aerodynamics of the airplane, Dover Publications, Inc, Mineola, New York.

A. Filippone, 2012, *Advanced aircraft flight performance*, Cambridge University Press.

D. P. Raymer, 1992, *Aircraft design: A conceptual approach*, 2nd edition, AIAA, Washington, DC.

J. D. Anderson Jr., 2012, *Introduction to flight*, McGraw Hill, New York, 10020NY.

R. D. Archer & M. Saarlas, 1996, *An introduction to aerospace propulsion*, Prentice-Hall, Inc., Upper Saddle River, New Jersey, 07458.

T. S. Taylor, 2009, *Introduction to rocket science and engineering*, CRC Press, Boca Raton, FL 33487-2742.

D. F. Anderson & S. Eberhardt, 2010, Understanding flight, 2nd edition, McGraw Hill.

B. Gunston, 2006, *The development of jet and turbine aero engines*, 4th edition, Patrick Stephens Limited (an imprint of Haynes publishing).

B. Gunston, 1999, *Development of piston aero engines*, 2nd edition, Patrick Stephens Limited (an imprint of Haynes publishing).

K. Hünecke, 1997, Jet engines. *Fundamentals of theory, design and operation*, Airlife Publishing Limited, Shrewsbury, England.

A. Bejan, 2006, *Advanced engineering thermodynamics*, 3rd edition, John Wiley & Sons, Hoboken, New

Jersey.

E. L. Houghton & P. W. Carpenter, 2003, *Aerodynamics for engineering students*, Butterworth-Heinemann (an imprint of Elsevier Science), Oxford.

J. A. Camberos & D. J. Moorhouse, 2011, *Exergy analysis and design optimization for aerospace vehicles and systems*, Editor-in-chief, F. K. Lu, Vol. 28, Progress in astronautics and aeronautics, AIAA, resto, Virginia.

M. H. Sadraey, 2013, *Aircraft design, A systems engineering approach*, Wiley.

Course Evaluation and Development

Notes have been heavily upgraded.

Laboratory Workshop Information

None

Submission of Assessment Tasks

Assessment submission and marking criteria

Should the course have any non-electronic assessment submission, these should have a standard School cover sheet.

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Late policy

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of 20 percent (20%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day.

Work submitted after the ‘deadline for absolute fail’ is not accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These are clearly indicated in the course outline, and such assessments receive a mark of zero if not completed by the specified date. Examples include:

1. Weekly online tests or laboratory work worth a small proportion of the subject mark, or
2. Online quizzes where answers are released to students on completion, or
3. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or
4. Pass/Fail assessment tasks.

Examinations

You must be available for all quizzes, tests and examinations. For courses that have final examinations, these are held during the University examination periods: February for Summer Term, May for T1, August for T2, and November/December for T3.

Please visit myUNSW for Provisional Examination timetable publish dates. For further information on exams, please see the Exams webpage.

Special Consideration

If you have experienced an illness or misadventure beyond your control that will interfere with your

assessment performance, you are eligible to apply for Special Consideration prior to submitting an assessment or sitting an exam.

UNSW now has a Fit to Sit / Submit rule, which means that if you attempt an exam or submit a piece of assessment, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

Please note that students will **not** be required to provide **any** documentary evidence to support absences from any classes missed **because of COVID-19 public health measures such as isolation**. UNSW will **not** be insisting on medical certificates from anyone deemed to be a positive case, or when they have recovered. Such certificates are difficult to obtain and put an unnecessary strain on students and medical staff.

Applications for special consideration **will** be required for assessment and participation absences – but no documentary evidence **for COVID 19 illness or isolation** will be required in T3.

Academic Honesty and Plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at UNSW is defined as using the words or ideas of others and passing them off as your own.*

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

If plagiarism is found in your work when you are in first year, your lecturer will offer you assistance to improve your academic skills. They may ask you to look at some online resources, attend the Learning Centre, or sometimes resubmit your work with the problem fixed. However more serious instances in first year, such as stealing another student's work or paying someone to do your work, may be investigated under the Student Misconduct Procedures.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Academic Information

Credit points

Course credit is calculated in Units-Of-Credit (UOC). The normal workload expectation for one UOC is approximately 25 hours per term. This includes class contact hours, private study, other learning activities, preparation and time spent on all assessable work.

Most coursework courses at UNSW are 6 UOC and involve an estimated 150 hours to complete. Each course includes a prescribed number of hours per week (h/w) of scheduled face-to-face and/or online contact. Any additional time beyond the prescribed contact hours should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

On-campus class attendance

Public distancing conditions must be followed for all T3 face-to-face classes. To ensure this, only students enrolled in those classes will be allowed in the room. Class rosters will be attached to corresponding rooms and circulated among lab demonstrators. No over-enrolment is allowed in face-to-face class. Students enrolled in online classes can swap their enrolment from online to other additional, **but limited**, number of on-campus classes by Sunday, Week 1. Please refer to your course's Microsoft Teams and Moodle sites for more information about class attendance for in-person and online class sections/activities.

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by NSW health or government authorities. Current alerts and a list of hotspots can be found here. **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate.** We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed. Further information is available on any course Moodle or Teams site.

In certain classroom and laboratory situations where 1.5 metres physical distancing cannot be maintained or there is a high risk that it cannot be maintained, face masks will be considered **mandatory PPE** for students and staff.

For more information, please refer to the
FAQs: https://www.covid-19.unsw.edu.au/safe-return-campus-faqs

Guidelines

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism

Important Links

- Moodle
- Lab Access
- Health and Safety
- Computing Facilities
- Student Resources
- Course Outlines
- Engineering Student Support Services Centre
- Makerspace
- UNSW Timetable
- UNSW Handbook
- UNSW Mechanical and Manufacturing Engineering
- Equitable Learning Services

Image Credit

Synergies in Sound 2016

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	✓
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering problem solving	✓
PE2.2 Fluent application of engineering techniques, tools and resources	✓
PE2.3 Application of systematic engineering synthesis and design processes	
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in professional and lay domains	
PE3.3 Creative, innovative and pro-active demeanour	
PE3.4 Professional use and management of information	
PE3.5 Orderly management of self, and professional conduct	
PE3.6 Effective team membership and team leadership	

School of Mechanical and Manufacturing Engineering

Assignment Cover Sheet

- Please print clearly and complete all sections.
    - If group assessment, all group members must sign the declaration below.
- Before submitting this assignment, students are strongly recommended to review the course outline, assessment requirements and UNSW's Plagiarism and Academic Integrity website.
- Please retain a copy of this assignment for your records.

Course and Assignment Information

Course code: _____ Course name: _____

Course Convenor name: _____

Assignment: _____

Assignment due date: _____ Date submitted: _____

Group OR Individual Assignment:

Student Declaration

Instructions: *Read the following declaration and confirm your acceptance by signature on the next page.*

In preparing this assessment task I/we have followed the Student Code Policy. I/We certify that I/we have read and understand the University requirements with respect to student academic misconduct outlined in the Student Code Policy and the Student Misconduct Procedure. I/We declare that this assessment item is my/our own work, except where acknowledged, and has not been submitted for academic credit previously in whole or in part.

I/We acknowledge that the assessor of this item may, for assessment purposes:

- Provide a copy to another staff member of the University
- Communicate a copy of this assessment item to a plagiarism checking service which may then retain a copy of the assessment item on its database for the purpose of future plagiarism checking.

Continue to page 2

I/We have retained a copy of this, my/our assignment, which I/we can provide if necessary. By signing this declaration, I/we agree to the statements and conditions above.

zID	**Surname/Last Name:**	**Given/First name:**	**Signature**

For School use only	Received on: _____	Mark: _____
Marked by: _____		