AERO3660

Flight Performance and Propulsion

Term 1, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
John Olsen	j.olsen@unsw.edu.au	during tutorials	Ainsworth Building, 311C	9385 5217

Tutors

Name	Email	Availability	Location	Phone
Zoran Vulovic	z.vulovic@unsw.edu.au	on-line	Ainsworth 311D	9385 6261

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. The School will only be able to refer students on to the relevant team if contacted

Important Links

- Student Wellbeing
- Urgent Mental Health & Support
- Equitable Learning Services
- Faculty Transitional Arrangements for COVID-19
- Moodle
- Lab Access
- Computing Facilities
- Student Resources
- Course Outlines
- Makerspace
- UNSW Timetable
- UNSW Handbook

Course Details

Units of Credit 6

Summary of the Course

In this course, we start by looking at the atmospheric environment in which aircraft operate. The we examine the forces acting on aircraft during straight and level cruise flight. In doing so we clearly define different types of airspeeds and set about calculating the range and endurance of aircraft during cruise fro aircraft driven by propellers and for aircraft driven by jets. Then we examine aircraft performance during climb, descent (glide), and turning phases of flight. We finished the section on performance by looking at energy methods and at take-off and landing.

The performance part of the course if often concerned with finding with either the thrust or power required by an aircraft in some particular phase of flight, namely cruise, climb, turning or take-off.

In the second part of the course, we will look at how we match the thrust or power required by examining jet engines that produce thrust and reciprocating piston engines that produce power driving propellers. We also look at some relevent thermodynamics on gas mixtures and combustion.

We then finish the course by looking at helicopters and multi-rotor aircraft.

Course Aims

Flight Performance and Propulsion is an important stepping stone in aerospace engineering education. The Flight Performance component will teach you how the forces and moments acting on the aircraft can be used to analyse the performance of the aircraft. This section is closely related to a forthcoming aerodynamics course, where you will learn how these forces aerodynamic forces and moments are generated. The overall objective of the propulsion component is to introduce students to gas turbine engines and reciprocating engines (spark ignition). This course extends the basic thermodynamic and fluid mechanical principles which were learned in MMAN2600 and MMAN2700 to aerospace engineering and builds on the report-writing skills which were commenced in ENGG1000. The knowledge gained here is crucial for AERO4110 and AERO4120, as well as for the career of an aerospace engineer.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Understand the difference between true and equivalent airspeeds.	PE1.1, PE1.2
2. Understand compressible flow analysis.	PE1.1, PE1.2, PE1.3
3. Understand how to apply mathematical analysis to predict flight performance and to recognise the short comings of analysis.	PE1.1, PE1.2, PE1.3
4. Understand the workings of modern propulsion systems (gas	PE2.1, PE2.2

Learning Outcome	EA Stage 1 Competencies
turbines, reciprocating piston engines, propellers)	
5. To appreciate the strengths and weaknesses of Cumpsty's approach in analysing the behaviour of gas turbines.	PE1.1, PE1.2, PE1.3, PE2.1, PE2.2
6. Understand further thermodynamic analysis.	PE1.1, PE1.2, PE1.3, PE2.1
7. Understand the basics of helicopter and multi-rotor operation.	PE1.1, PE1.2, PE1.3, PE2.1

Teaching Strategies

This course involves four hours (three hours of lecture and one hour of tutorial) per week of face to face contact. It is expected that students will put in, at least, an additional six hours per week of their own time (including stuvac and exams). This time should be spent in revising lecture material, completing the set tutorial problems, and revising and learning for examinations.

The teaching strategies that will be used include:

- Presentation of the material in lectures.
- Tutorials to help students to understand concepts.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Final Exam	50%	Not Applicable	1, 2, 3, 4, 5, 6, 7
2. Assignment 1	10%	28/2/2022 at 3:00pm	1, 2, 3, 4
3. Assignment 2	30%	11/4/2022	1, 2, 3, 4, 5, 6, 7
4. Bankstown Flight Experiment	10%	22/4/2022	1, 2, 3, 4, 5, 6, 7

Assessment 1: Final Exam

Assessment length: 2hrs
Submission notes: Solutions and working submitted via Moodle Turnitin
Marks returned: With Final Results

Final Exam

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Assessment criteria

You will be assessed on all the sessions work.

Assessment 2: Assignment 1

Assessment length: Short
Submission notes: Solutions and working submitted via Moodle Turnitin
Due date: 28/2/2022 at 3:00pm
Deadline for absolute fail: One week after the due by date.
Marks returned: Two Weeks Later 14th March

Short Assignment

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Assessment 3: Assignment 2

Assessment length: Longish but not too long
Submission notes: Solutions and working submitted via Moodle Turnitin
Due date: 11/4/2022
Deadline for absolute fail: One week after the due by date.
Marks returned: 26th April, 2022

Long Assignment

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Assessment criteria

Work up to that point in session.

Assessment 4: Bankstown Flight Experiment

Assessment length: Short
Submission notes: Solutions and working submitted via Moodle Turnitin
Due date: 22/4/2022
Deadline for absolute fail: One week after the due date.
Marks returned: 6th May, 2022

Bankstown Flight Experiment (Substitute Assignment)

This assignment is submitted through Turnitin and students do not see Turnitin similarity reports.

Assessment criteria

The whole course.

Additional details

We are not sure what is happening with Bankstown as yet. If possible, we will run the flight exercises at Bankstown, but at this stage, it seems overwhelmingly likely that this won't happen. So I wil post a replacement assignment. Pending the COVID situation, flight simulation could be offerred as an optional ungraded exercise.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Schedule

Week 1, The Atmosphere, Lift & Drag, Straight and level Flight, Airspeeds.

Week 2, Compressible Flows, Normal Shocks and Obliques Shocks.

Week 3, The Breguet Range and Endurance Equations, Climbing Flight.

Week 4, Gliding and Turning Flight, Energy Methods, Take-Off, and Landing.

Week 5, Reciprocating Piston Engines, Propellers.

Week 6, Flexibility Week

Week 7, Propellers, Gas Turbines,

Week 8, Gas Mixtures, Helicopters.

Week 9, Helicopters and Quad Rotors.

Week 10, Chemical Reactions.

Note that this is a tentative schedule.

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.

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.

G. Hoyland, 2020, *Merlin, The Power Behind the Spitfire, Mosquito, and Lancaster*, Williams Collins.

Q. Quan. 2017, *Introduction to multicopter design and control*, Springer.

J. G. Leishman, 2016, *Principles of helicopter aerodynamics*, 2nd edition, Cambridge Aerospacce Series, Cambridge University Press.

Course Evaluation and Development

This course has been constantly upgraded for years. The course outline has had a major revision.

Laboratory Workshop Information

A hand out will be posted on Moodle if the Bankstown exercises and/or the flight simulations exercises are going to happen.

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, for a minimum of zero marks.

The late penalty is applied per calendar day (or part thereof), including weekends and public holidays, that the assessment is overdue.

Work submitted after the 'deadline for absolute fail' is not accepted and a mark of zero will be awarded for that assessment item. For example:

- Your course has an assessment task worth a total of **30 marks (Max Possible Mark)**
- You submit the assessment **2 days after the due date**
- The assessment is marked as usual and achieves a score of **20 marks (Awarded Mark)**
- The late policy is applied using **Late Mark = Awarded Mark - (Days*Penalty per Day)*Max Possible Mark**. Your adjusted final score is **8 marks** (20 - ((2*0.2)*30)).

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.

Special Consideration Outcomes

Assessments have default Special Consideration outcomes. The default outcome for the assessment will be advised when you apply for Special Consideration. Below is the list of possible outcomes:

Outcome	Explanation	Example
Time extension	Student provided more time to submit the assessment	e.g. 1 more week of time granted to submit a report
Supplementary assessment	Student provided an alternate assessment at a later date/time	e.g. a supplementary exam is scheduled during the supplementary exam period of the term
Substitute item	The mark for the missed assessment is substituted with the mark of another assessment	e.g. mark for Quiz 1 applied also applied as mark for Quiz 2, meaning if a student achieved a mark of 20/30 for Quiz 1 and was granted Special Consideration for Quiz 2, a mark of 20/30 would be applied for Quiz 2, etc
Exemption	All course marks are recalculated excluding this assessment and its weighting	e.g. The course has an assessment structure of: - Assignments 30%, - Lab report 30%, - Final Exam 40%. If the Lab report is missed and student is granted Special Consideration, then the assessment structure may be reweighted as follows: - Assignments 50% - Final Exam 50% as though the Lab report did not exist
Non-standard	Course Coordinator is contacted for the outcome when special consideration is granted as the outcome differs on a case-by-case basis	e.g. typical for group assessments where time extension supplementary assessment could be granted to the group member, time extension could be granted to the whole group, etc. Clarify with your Course Convenor for

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, for both regular and intensive terms. 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

****T1-2022 UPDATE****
- -

Public distancing conditions must be followed for all face-to-face classes. To ensure this, only students enrolled in those classes will be allowed in the room. No over-enrolment is allowed in face-to-face classes. Students enrolled in online classes can swap their enrolment from online to 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 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

Image Credit

Photo by Stephen Blake March 2017, Willis Annexe (J18) Thermofluids lab

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	