AERO9500

Space Systems Architectures and Orbits

Term Three // 2020

School of Mechanical and Manufacturing Engineering // UNSW Engineering

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Danielle Moreau	d.moreau@unsw.edu.au	Please contact Danielle by email to arrange an appointment outside of scheduled teaching times.	Ainsworth Building (J17), Level 4, Room 408E	(02) 9385 5428

Lecturers

Name	Email	Availability	Location	Phone
Naomi Tsafnat	n.tsafnat@unsw.edu.au	Please contact Naomi by email to arrange an appointment outside of scheduled teaching times.		

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

This course gives an overview of satellite systems, describing their main applications and providing a detailed introduction into the principles of orbital mechanics. The course focuses on orbital mechanics, covering orbit description and analysis, perturbations, orbital manoeuvres, interplanetary transfers and launch systems.

Course Aims

The course aims to furnish students with an understanding of the space segment of satellite and spacecraft systems, and their applications. Specific aims include:

1. Describe the history and current state of space flight.
2. Describe spacecraft orbits, for Keplerian orbits and their perturbations.
3. Describe and calculate common spacecraft manoeuvers and their associated fuel costs.
4. Describe and calculate the basics of rocket propulsion and spacecraft launch systems.
5. Describe and calculate the mechanics of interplanetary travel.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Explain the main applications of satellites and the way affect our everyday lives.	PE1.1, PE1.3
2. Describe the overall system design of a satellite and its supporting earth stations, and be able to cite the major functional subsystems of a satellite along with the principles of operation of each, and the associated overall design aspects.	PE2.3, PE2.2
3. Analyse spacecraft orbits and their perturbations, and recognise commonly employed satellite orbits.	PE1.1, PE1.2, PE1.3, PE2.1
4. Compute delta-V and fuel requirements for various orbital manoeuvres, interplanetary transfers, and launches.	PE1.3, PE2.1, PE2.2

Teaching Strategies

The course material will be taught through a combination of lectures, tutorials and textbook content. The lectures and tutorials will be delivered online using Microsoft Teams.

The lectures are designed to cover the terminology, core concepts and theories. They are intended to provide a foundation for further investigation. The fundamental principles of and the specific system

implementation cases will be illustrated with examples and simulations. The lecture slides will take a different perspective from the written notes, and both the lecture notes and lecture slides together constitute examinable material. The lecture material will be available to students electronically before each class via Moodle.

The course schedule provides a breakdown of the course along with some suggested reading during each week. Students are expected to prepare for lectures in advance by reading the appropriate sections of the textbook prior to the lesson. In addition to these, students are encouraged to explore further reading material suggested in the “Recommended resources for students” section.

Worked tutorial-type questions will be presented in the tutorials to expose students to the techniques involved in solving exam-style questions on this topic. A list of suggested problems and their answers (though not worked-out full solutions) will be posted for each topic. It is highly recommended that you make use of these problem sets and make sure you understand how to solve them.

Assessment

Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
Assignments	30%	20/11/2020 05:00 PM	1, 3, 4
Mid-term Exam	30%	30/10/2020 05:00 PM	1, 3
Final exam	40%	Not Applicable	1, 3, 4

Assessment Details

Assessment 1: Assignments

Start date: Not Applicable

Details:

2 Assignments:

1. Draft report: due Friday week 3.
2. Final report: due Friday week 10.

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

Assessment 2: Mid-term Exam

Start date: Not Applicable

Details:2 hour mid-term exam.

Assessment 3: Final exam

Start date: Not Applicable

Details:2 hour open book final exam.

Attendance Requirements

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

Course Schedule

View class timetable

Timetable

Date	Type	Content
Week 1: 14 September - 18 September	Lecture	Orbits introduction • Course overview • Historical overview of astrodynamics • Kepler's Laws • Orbit geometry and nomenclature Reading: Ch 1, 2.1, 3.0 – 3.1
	Tutorial	
Week 2: 21 September - 25 September	Lecture	Orbit equation • Conic sections • Constants of orbital motion • 2 body problem • Orbit equation • Coordinate systems • Lagrange points Reading: Ch 3.1 – 3.15 , 3.1.7, 3.1.8
	Tutorial	
Week 3: 28 September - 2 October	Lecture	Orbital elements • Classic Orbit Elements (COE) • Alternate orbit elements (AOE) • Orbit types • Sidereal time Reading: Ch 3.4, 3.4.1, 3.4.1.1, 3.4.2 , 3.4.3 , 3.1.6 – 3.1.6.4
	Tutorial	
Week 4: 5 October - 9 October	Lecture	Impulse Orbit Manoeuvres • Hohmann transfers • Simple plane changes • Combined plane changes

		• Rendezvous Reading: Ch 3.2 – 3.2.4, 3.4.1.3, 3.4.1.4
	Tutorial	
Week 5: 12 October - 16 October	Lecture	Ground tracks and orbit perturbations Reading: Ch 3.3.2, 3.3.3
	Tutorial	
Week 7: 26 October - 30 October	Lecture	Propulsion • Spacecraft propulsion • Launch vehicles • Rocket equation Reading: Ch 4.1, 4.2, 4.3.1, 4.3.2
	Tutorial	
Week 8: 2 November - 6 November	Lecture	Launch • Launch sites • Launch SEZ and deltaV Reading: Ch 3.3.1, 3.4.1.2 --3.4.1.5, 3.4.3.1, 3.4.3.2
	Tutorial	
Week 9: 9 November - 13 November	Lecture	Interplanetary transfers • Interplanetary travel • Patched-conics method • Gravity assist trajectories Reading: Ch 3.5 – 3.5.4.4, 3.5.9, 3.1.5.1
	Tutorial	
Week 10: 16 November - 20 November	Lecture	Revision and overflow • Review topics as requested by students
	Tutorial	

Resources

Prescribed Resources

There is a required textbook for this course which is available as an e-book via the UNSW library website:

- Elements of Spacecraft Design, C. Brown

The relevant chapters are shown in the course schedule and are also stated on the course Moodle page. A few printed copies are also available in the library. It is expected that students read the relevant chapters prior to the lecture and refer to them when studying.

Recommended Resources

There are also several recommended books that are closely related to course content. Many of these books are available through the library:

- Astronautics, second edition, U. Walter.
- Spacecraft Systems Engineering, fourth edition, P. Fortescue, G. Swinerd and J. Stark
- Introduction to Flight, seventh edition, J. D. Anderson Jr (chapters 8 and 9).
- Orbital Mechanics for Engineering Students, second edition, H. Curtis.
- Fundamentals of Astrodynamics, R. R. Bate, D. D. Mueller and J. E. White

Course Evaluation and Development

Feedback on the course is gathered periodically using various means, including the UNSW myExperience process, informal discussion in the final class for the course, and the School's Student/Staff meetings. Your feedback is taken seriously, and continual improvements are made to the course based, in part, on such feedback.

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

Other Matters

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

https://pixabay.com/photos/rocket-ses-9-launch-cape-canaveral-1245696/

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	