UNSW Course Outline

ZEIT8220 Space Propulsion - 2024

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General Course Information

Course Code : ZEIT8220
Year : 2024
Term : Semester 2
Teaching Period : Z2
Is a multi-term course? : No
Faculty : UNSW Canberra
Academic Unit : School of Engineering and Technology
Delivery Mode : Online
Delivery Format : Standard
Delivery Location : UNSW Canberra at ADFA
Campus : UNSW Canberra
Study Level : Postgraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Space Propulsion is dedicated to a fundamental aspect of space engineering: how to place spacecraft into orbit and how to maneuver them once there. With essentially no background medium to push against, many satellites require an onboard propulsion system which ultimately has a strong impact on mission success, and in many cases, may be a mission enabler. This

course will introduce the basics of space propulsion covering the rocket equation and space mission analysis, high-thrust and low-thrust orbital maneuvers, launch vehicles and orbit insertion, and current and emerging propulsion technologies, their general operation, and their practical usage in space. Technologies to be covered will include chemical propulsion, electric propulsion, propellantless propulsion, air-breathing hypersonic propulsion, and future thermal nuclear propulsion systems.

This course is aimed at providing students with a comprehensive overview of all aspects of space propulsion and giving them the knowledge and analytical tools to critically evaluate different technologies, and how to go about selecting such technologies for space missions. The course is designed to fill the common educational gap between propulsion technology (i.e. the “hardware”), and propulsion operations (i.e. the “orbital dynamics”). It serves as a good introduction to those students that: (1) may pursue design and development of actual propulsion systems in the future, (2) students entering the space industry that may need to use and select existing propulsion systems for their missions, or (3) students from other space engineering disciplines that would like to better understand space propulsion.

Course Aims

This course aims to:

1. Introduce space propulsion mission analysis enabling students to construct spacecraft mass and propellant budgets.
2. Highlight the difference between high-thrust and low-thrust propulsion systems and identify/design appropriate in-space maneuvers.
3. Equip students with a comprehensive knowledge of existing and emerging propulsion technologies and their fundamental operation, and how to select such systems for different space missions.
4. Equip students with an understanding of practical considerations related to the usage of propulsion systems in space and how this influences space mission design and satellite operations.

Relationship to Other Courses

This course assumes students have at least an undergraduate knowledge of mathematics and physics (including vectors). Access to a Windows, Mac, or Linux computer is required. Students are required to have completed the core course **ZEIT8007 – Space Operations**.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Synthesize complex, and sometimes conflicting, technical, geopolitical, environmental, and financial factors to establish an integrated set of space mission propulsion requirements.
CLO2 : Research different orbital maneuvers and apply established theoretical approximations or numerical simulations to design mission maneuver plans and construct propellant mass budgets.
CLO3 : Critically evaluate different propulsion technologies and assess their practical and functional utility in ensuring space mission success.
CLO4 : Recognize and evaluate important practical considerations related to the usage of propulsion systems in space and how these factors influence space mission design and satellite operations.

Course Learning Outcomes	Assessment Item
CLO1 : Synthesize complex, and sometimes conflicting, technical, geopolitical, environmental, and financial factors to establish an integrated set of space mission propulsion requirements.	• Assignments 1 and 2
CLO2 : Research different orbital maneuvers and apply established theoretical approximations or numerical simulations to design mission maneuver plans and construct propellant mass budgets.	• Peer assessment • Forum postings • Assignments 1 and 2
CLO3 : Critically evaluate different propulsion technologies and assess their practical and functional utility in ensuring space mission success.	• Peer assessment • Forum postings • Assignments 1 and 2
CLO4 : Recognize and evaluate important practical considerations related to the usage of propulsion systems in space and how these factors influence space mission design and satellite operations.	

Learning and Teaching Technologies

Moodle - Learning Management System | Zoom | Microsoft Teams

Learning and Teaching in this course

The Learning Management System

Moodle is the Learning Management System used at UNSW Canberra. All courses have a Moodle site which will become available to students at least one week before the start of semester.

Please find all help and documentation (including Blackboard Collaborate) at the Moodle Support page.

UNSW Moodle supports the following web browsers:

» Google Chrome 50+
» Safari 10+
** Internet Explorer is not recommended
** Addons and Toolbars can affect any browser's performance.

Operating systems recommended are:

Windows 7, 10, Mac OSX Sierra, iPad IOS10

For further details about system requirements click here.

Log in to Moodle here.

If you need further assistance with Moodle:

For enrolment and login issues please contact:
IT Service Centre
Email: itservicecentre@unsw.edu.au
Phone: (02) 9385-1333
International: +61 2 9385 1333

For all other Moodle issues please contact:
External TELT Support
Email: externalteltsupport@unsw.edu.au
Phone: (02) 9385-3331
International: +61 2 938 53331
Opening hours:
Monday – Friday 7:30am – 9:30 pm
Saturday & Sunday 8:30 am – 4:30pm

Other Professional Outcomes

Developing Graduate Capabilities

Successful completion of this course contributes to the acquisition of UNSW graduate

capabilities. UNSW aspires to develop globally focused graduates who are **rigorous scholars**, capable of **leadership** and **professional practice** in an **international** community.

Students will be encouraged to develop the following graduate capabilities by undertaking the course activities and mastering the knowledge content. These capabilities will be assessed within the assessment tasks:

1. The skills involved in scholarly enquiry.
2. An in-depth engagement with the relevant disciplinary knowledge in its interdisciplinary context.
3. The capacity for analytical and critical thinking and for creative problem solving.
4. The ability to engage in independent and reflective learning.

Additional Course Information

Academic Integrity and Plagiarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW staff and students have a responsibility to adhere to this principle of academic integrity. All students are expected to adhere to UNSW's Student Code of Conduct https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Plagiarism undermines academic integrity and is not tolerated at UNSW. It is defined as using the words or ideas of others and passing them off as your own, and can take many forms, from deliberate cheating to accidental copying from a source without acknowledgement.

For more information, please refer to the following:

https://student.unsw.edu.au/plagiarism

Referencing

In this course, students are required to reference following the APA 7 / Chicago NB referencing style. Information about referencing styles is available at: https://guides.lib.unsw.adfa.edu.au/c.php?g=472948&p=3246720

Study at UNSW Canberra

https://www.unsw.adfa.edu.au/study

Study at UNSW Canberra has lots of useful information regarding:

- Where to get help
- Administrative matters
- Getting your passwords set up
- How to log on to Moodle
- Accessing the Library and other areas.

Additional Information as required

CRICOS Provider no. 00098G

The University of New South Wales Canberra.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Peer assessment Assessment Format: Individual Short Extension: Yes (7 days)	10%	
Forum postings Assessment Format: Individual Short Extension: Yes (7 days)	20%	
Assignments 1 and 2 Assessment Format: Individual Short Extension: Yes (7 days)	70%	

Assessment Details

Peer assessment

Assessment Overview

For each of the two forum postings, students are required to critically evaluate a posting from their peers. These review postings should aim to provide a constructive assessment of the merits or shortcomings of the chosen posting. Students are encouraged to engage in a constructive free-flow discussion on the forum, but any postings as part of the peer assessment activity must be clearly labelled. This assessment task will be marked according to the quality of the review, its justification with appropriate references from the scientific literature, and its additional added value to the original forum question(s).

Course Learning Outcomes

- CLO2 : Research different orbital maneuvers and apply established theoretical approximations or numerical simulations to design mission maneuver plans and construct

propellant mass budgets.
- CLO3 : Critically evaluate different propulsion technologies and assess their practical and functional utility in ensuring space mission success.

Detailed Assessment Description

Two peer assessments of equal weight (5% each). Assessment instructions to be uploaded on the course Moodle site at least 4 weeks before the due date.

Peer Assessment 1 due 13 Aug

Peer Assessment 2 due 3 Sep

Forum postings

Assessment Overview

Students will be required to make two forum postings during the course. For each posting, a question(s) will be posed and released on the course Moodle site four weeks before the due date. Students will be required to perform a critical analysis or evaluation and post their response in the designated Moodle forum. The posed questions may include open-ended elements and be associated with important current or emerging factors related to space propulsion that could require a certain level of independent research outside of the course guided reading. No feedback will be provided on forum postings until after the corresponding peer assessment activity has been completed.

Course Learning Outcomes

- CLO2 : Research different orbital maneuvers and apply established theoretical approximations or numerical simulations to design mission maneuver plans and construct propellant mass budgets.
- CLO3 : Critically evaluate different propulsion technologies and assess their practical and functional utility in ensuring space mission success.

Detailed Assessment Description

Two forum postings of equal weight (10% each). Assessment instructions to be uploaded on the course Moodle site at least 4 weeks before the due date.

Forum Posting 1 due 6 Aug

Forum Posting 2 due 27 Aug

Assignments 1 and 2

Assessment Overview

As part of the course, students will be required to complete a major assignment (to be posted on the course Moodle site) related to a hypothetical space mission requiring propulsion. The assignment will be based on a realistic, open-ended, problem requiring students to not only demonstrate their understanding of the course material, but to also have critically reflected on this material, and to have understood the broader issues associated with space propulsion. They may also need to perform a certain level of independent research. The assignment will be split into two separate assignments connected by an overarching mission scenario:

Assignment 1 (20%): Requires students to design a space mission concept, including orbital maneuvers, that satisfy the scenario requirements.

Assignment 2 (50%): Requires students to design an appropriate propulsion system(s) that addresses the scenario requirements and is consistent with the mission concept/orbital maneuvers developed in Assignment 1.

The overall assignment scenario, together with specific questions, will be released on the course Moodle site. Students must complete the assignments and upload their answers in the form of a short document via the submission tool Turnitin.

Course Learning Outcomes

- CLO1 : Synthesize complex, and sometimes conflicting, technical, geopolitical, environmental, and financial factors to establish an integrated set of space mission propulsion requirements.
- CLO2 : Research different orbital maneuvers and apply established theoretical approximations or numerical simulations to design mission maneuver plans and construct propellant mass budgets.
- CLO3 : Critically evaluate different propulsion technologies and assess their practical and functional utility in ensuring space mission success.

Detailed Assessment Description

Assessment instructions to be uploaded on the course Moodle site at least 4 weeks before the due date.

Assignment 1 (20%) due 24 Sep

Assignment 2 (50%) due 25 Oct

General Assessment Information

The **Week 1 Practice Quiz** is a zero-weight assessment task **due in Week 4** that focuses on the content in Week 1 (rocket dynamics and orbital mechanics) and consists of a number of questions/scenarios that students must answer. This practice quiz is performed online on the course Moodle site and can be attempted as many times as needed. Feedback is provided to students immediately after completion of the quiz and before the census date (11 August). Similar practice quizzes are available for all weeks throughout the course. These quizzes provide students with an opportunity to confirm their understanding and implementation of the course content, and to identify any areas of difficulty.

All assessments must be completed **individually** by students (i.e. no group work). All marks obtained for assessment items during the session are provisional. Feedback on assessments will be provided within two weeks (10 working days) after the deadline, with the exception of Assignment 2 where feedback will be provided following the assessment review group meeting. The final mark as published by the university following the assessment review group meeting is **the only official mark.**

Late Submission of Assessments

Unless prior arrangement is made with the lecturer or a formal application for special consideration is submitted, a penalty of 5% of the total available mark for the assessment will apply for each day that an assessment item is late up to a maximum of 5 days (120 hours) after which an assessment can no longer be submitted and a grade of 0 will be applied.

Use of Generative AI in Assessments

Simple editing assistance: For all assessment tasks, you may use **standard** editing and referencing software (such as Microsoft Office and Grammarly), but not Generative AI. You are permitted to use the full capabilities of the **standard** software to answer the question. If the use of generative AI such as ChatGPT is detected, it will be regarded as serious academic misconduct and subject to the standard penalties, which may include 00FL, suspension, and exclusion.

Grading Basis

Standard

Requirements to pass course

Students are not required to pass any one particular assessment item. A total mark of at least 50 out of a total of 100 is needed to achieve a pass.

Course Schedule

Attendance Requirements

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

General Schedule Information

Week Date Topic

0 8-20 Jul 0. Course Welcome and Orientation (Lafleur)

1 15-21 Jul 1. Chapter 1: Rocket Dynamics (Lafleur)
Appendix A: Orbital Mechanics (Lafleur)

2 22-28 Jul 2. Chapter 2: Impulsive Maneuvers (Lafleur)

3 29 Jul-4 Aug 3. Chapter 3: Non-Impulsive Maneuvers (Lafleur)

4 5-11 Aug 4. Chapter 10: Launch Vehicles and In-Space Transportation (Lafleur)
Chapter 11: In-Space Propulsion Operations (Lafleur)
Forum Posting 1 due 6 Aug
Week 1 Practice Quiz due 10 Aug
Census Date - 11 Aug

5 12-18 Aug 5. Chapter 4: Performance Metrics and General Engineering Considerations (Lafleur)
Peer Assessment 1 due 13 Aug

6 19-25 Aug 6. Chapter 5: Cold/Warm Gas Propulsion (Lafleur)

7 26 Aug-1 Sep 7. Chapter 6: Chemical Propulsion (Secs. 6.1-6.3; Lafleur)
Forum Posting 2 due 27 Aug

8 2-8 Sep 8. Chapter 6: Chemical Propulsion (Secs. 6.4-6.5; Lafleur)

Peer Assessment 2 due 3 Sep

9 9-15 Sep 9. Chapter 7: Electric Propulsion (Secs. 7.1-7.5; Lafleur)

10 16-22 Sep 10. Chapter 7: Electric Propulsion (Sec. 7.6; Lafleur)
Chapter 8: Propellantless Propulsion (Lafleur)

11 23-29 Sep 11. Chapter 9: Emerging Propulsion Concepts (Lafleur)

Assignment 1 due 24 Sep

12 30 Sep-6 Oct 12. Assignment 2 Focused (Lafleur)

13 7-13 Oct 13. Assignment 2 Focused (Lafleur)

Assignment 2 due 25 Oct

Course Resources

Prescribed Resources

No hard copy textbook is required. All material will be provided digitally through the course Moodle page in the form of a dedicated book written for this course:

1. Lafleur T. (2024). *Space Propulsion*. Unpublished book.

Recommended Resources

- Humble R.W, Henry G.N., & Larson W.J. (1995). *Space Propulsion Analysis and Design*. New York: McGraw-Hill.
- Sutton G.P. & Biblarz O. (2017). *Rocket Propulsion Elements* (7th ed.). Hoboken: Wiley.
- Wertz J.R., Everett D.F. & Puschell J.J. (2011). *Space Mission Engineering: The New SMAD*. Hawthorne: Microcosm Press.
- Goebel D.M. & Katz I. (2008). *Fundamentals of Electric Propulsion: Ion and Hall Thrusters*. New York: Wiley.

Course Evaluation and Development

One of the key priorities in the 2025 Strategy for UNSW is a drive for academic excellence in education. One of the ways of determining how well UNSW is progressing towards this goal is by

listening to our own students. Students will be asked to complete the myExperience survey towards the end of this course.

Students can also provide feedback during the semester via: direct contact with the lecturer, the “On-going Student Feedback” link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff, and focus groups. Student opinions really do make a difference. Refer to the Moodle site for this course to see how the feedback from previous students has contributed to the course development.

Important note: Students are reminded that any feedback provided should be constructive and professional and that they are bound by the Student Code of Conduct Policy

https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Trevor Laflleur		Building 16, Room 203	N/A	You are welcome to seek consultation during normal working hours (09h00-18h00). Please email first to make an appointment for an in-person, phone, or virtual meeting (e.g. Microsoft Teams or Zoom).	No	Yes