



Mechanical and Manufacturing Engineering

Course Outline

Term 1 2020

AERO9610

The Space Segment

Contents

1. Staff contact details	2
Contact details and consultation times for course convenor	2
Contact details and consultation times for additional lecturers/demonstrators/lab staff	2
2. Important links	2
3. Course details	2
Credit points	2
Contact hours	3
Summary and Aims of the course	3
Student learning outcomes	4
4. Teaching strategies	4
5. Course schedule	5
6. Assessment	6
Assessment overview	6
Assignments	7
Presentation	7
Submission	7
Marking	8
Examinations	8
Calculators	8
Special consideration and supplementary assessment	8
7. Expected resources for students	9
Textbooks	9
8. Course evaluation and development	9
9. Academic honesty and plagiarism	9
10. Administrative matters and links	10
Appendix A: Engineers Australia (EA) Competencies	11

1. Staff contact details

Contact details and consultation times for course convenor

Name: Naomi Tsafnat

Email: n.tsafnat@unsw.edu.au

Consultation will primarily take place during or after lectures. Please contact me by Moodle or email if you require further consultation.

Contact details and consultation times for additional lecturers/demonstrators/lab staff

Name: William Crowe

Email: w.crowe@unsw.edu.au

Name: Bohan Deng

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Please see the course [Moodle](#).

2. 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](#)

3. Course details

Credit points

This is a 6 unit-of-credit (UoC) course and involves 4 hours per week (h/w) of face-to-face contact.

The normal workload expectations of a student are approximately 25 hours per term for each

UOC, including class contact hours, other learning activities, preparation and time spent on all assessable work.

You should aim to spend about 8 h/w on this course. The additional time should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

Contact hours

	Day	Time	Location
Lectures	Monday	12noon – 2pm (wk 1-8,10-11)	Michael Hintze Theatre
	Tuesday	2pm – 4pm (wk 11)	Ainsworth 102
	Friday	2pm – 4pm (wk 1-7,9-10)	Ainsworth 102

Summary and Aims of the course

This course will give you a basis in the design issues involved in the engineering of the space segment to fulfil a space mission. This course is intended to deliver a broad overview of the engineering principles involved with the design, development, testing and implementation of the space segment of a space mission.

This course will cover the following areas of space segment design:

1. Design methodology for satellites;
2. Operational environment including the thermal, structural, and electromagnetic environment;
3. Hardware implementation of the space segment, incorporating payload types and satellite support subsystems; and
4. The design, integration and testing procedures used in developing the Space Segment.

Examples of current and past space missions are used to illustrate the design process and design implementation associated with the space segment of the mission. Where appropriate, theory associated with preliminary analysis of the operation and performance of the space segment is also presented.

Design is an open-ended problem for which there is normally no single correct answer, only “locally optimal” solutions. Spacecraft design is especially complex because of the challenging operational environment and highly interconnected responses of the components. Spacecraft design is also tightly coupled with mission design, so slight changes in orbit can have a great impact to the spacecraft. Changes to individual components can also have cascading effects on changes to the rest of the design. The start of the design process has limited information and many unknowns, so a process of iteration is key to success.

The Space Segment course is an Advanced Disciplinary Core Course within the Masters of

Engineering Science – Space Systems Engineering program (ELECTS8338).

The course is also available as a 4th year disciplinary elective within a Bachelor of Engineering.

There are no prerequisite courses leading into this course; however, it is expected that enrolling students will have the third stage of a Bachelor of Engineering from a related discipline (Electrical, Mechanical, Aerospace, Surveying, Computer Science) or equivalent and have prior undergraduate learning in Mechanics, Mathematics and Physics.

Student learning outcomes

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

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

Learning Outcome		EA Stage 1 Competencies
1.	Discuss and apply space systems engineering methodology and design methods to the space segment	1.1, 1.5, 1.6, 2.3, 2.4, 3.2
2.	Assess the impact of the space environment on spacecraft and space mission design	1.1, 2.3, 3.3
3.	Select and design space power systems, telecommunication links and systems, structures, propulsion systems, attitude determination and control systems and thermal control systems for a space mission	1.2, 1.5, 2.1, 3.3
4.	Have a thorough understanding of the different subsystems that make up a spacecraft, and how they function and interact with customer requirements in each stage of development	1.1, 1.3, 1.5, 2.3, 2.4

4. Teaching strategies

The material of this course will be presented through a combination of lectures and in-class demonstrations. The fundamental principles of and the specific system implementation cases will be illustrated with examples. Students are expected to prepare for the lecture in advance, as the sections of the textbook to be read will be available prior to each lecture. As a masters-level class, you are expected to read the assigned materials and attempt a few sample problems on your own prior to the start of each lecture. The lecture slides will take a different perspective from these written notes, and both the textbook and lecture overheads together constitute examinable material.

There will be no formal demonstration or laboratory sessions in this course.

5. Course schedule

Week	Topic	Location	Suggested Readings
1	Introduction, design process, systems engineering	Michael Hintze Theatre (Mon) Ainsworth 102 (Fri)	Fortescue 1, 20 Brown 2.1
2	Mission design, the space environment	Michael Hintze Theatre (Mon) Ainsworth 102 (Fri)	Brown 2 Griffin 3
3	Mass budgets, Structures and Mechanisms	Michael Hintze Theatre (Mon) Ainsworth 102 (Fri)	Brown 2.2, 10 Fortescue 8, 15 Griffin 8
4	Thermal subsystem	Michael Hintze Theatre (Mon) Ainsworth 102 (Fri)	Brown 7 Fortescue 11 Griffin 8
5	Power subsystem, EPS budgets	Michael Hintze Theatre (Mon) Ainsworth 102 (Fri)	Brown 6 Fortescue 10
6	Attitude Determination and Control	Michael Hintze Theatre (Mon) Ainsworth 102 (Fri)	Brown 5 Griffin 7 (pp325-376)
7	Propulsion	Michael Hintze Theatre (Mon) Ainsworth 102 (Fri)	Brown 4 (pp153-249) Griffin 5.1
8	Midterm quiz	Michael Hintze Theatre (Mon)	
9	Command and Data Handling (CDH), and Communications (TT&C)	Ainsworth 102 (Fri)	Brown 8 Fortescue 13
10	Launch Vehicles	Michael Hintze Theatre (Mon) Ainsworth 102 (Fri)	Fortescue 7.1-7.3
11	Subsystem interactions, mission operations and design methodology	Michael Hintze Theatre (Mon) Ainsworth 102 (Tue)	Fortescue 20 pp643-666

- Fortescue = Spacecraft Systems Engineering, Fortescue, Stark and Swinherd
 - Brown = Elements of Spacecraft Design, C. D. Brown
 - Griffin = Space Vehicle Design, Griffin, Michael D and French James R
- See “ 7. Expected resources for students” for more information on textbooks.

6. Assessment

Assessment overview

Task	Assessment	Group Project? (# Students per group)	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
T1: Assignment	Assignment proposal	No	2-4 pages	10%	1 and 4	Technical content, evidence of sufficient preliminary research done, and report writing skills	Week 2, Feb 28, via Moodle	March 2	Week 4
	Assignment draft	No	10-20 pages	20%	1 and 4	Technical content, evidence of sufficient research work done, and report writing skills	Week 7, April 3 via Moodle	April 6	Week 9
	Assignment final report	No	40 pages max	40%	1, 2, 3 and 4	Demonstration of engineering analysis of space mission in relation to topics learnt in class, technical content, and report writing skills	Week 11, May 1 via Moodle	May 4	Upon release of final results
T2: Quiz	Midterm quiz	No	1 hour	10%	1, 2 and 3	Course content weeks 1-6 inclusive	Week 8, April 6	N/A	Week 10
T3: Exam	Final exam	No	2 hours	20%	1, 2, 3 and 4	All course content	Exam period, date TBC	N/A	Upon release of final results

Assignments

The main assessment in this course is an assignment. You will be given a current space mission to analyse, based on the material taught in class about each subsystem. To support student learning, the assignment will have three deliverables: a proposal, a draft, and the final report.

In the **assignment proposal**, you will lay out your plan for the assignment analysis and present your preliminary research findings about your mission. You should also list the sources of information you will be using. This will go on to form the main part of your final report introduction.

The **assignment draft** will allow you to present your research findings for the subsystems covered so far in the course and receive feedback and suggestions from the demonstrators on your progress and on how to best complete your assignment.

The **final report** will include all of your research findings, including all subsystems, updated and completed based on your draft feedback, and a conclusion presenting the space segment analysis of your space mission, showing how it addresses the mission requirements and user needs.

Presentation

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.

Submission

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:

- a. Weekly online tests or laboratory work worth a small proportion of the subject mark, or
- b. Online quizzes where answers are released to students on completion, or

- c. Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date, or
- d. Pass/Fail assessment tasks.

Marking

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.

Examinations

You must be available for all quizzes, tests and examinations.

The **midterm quiz** will be a short, in-class exam that should take no more than an hour (although you will be given the full available two hours). It is intended to make sure you are keeping up with the lecture material, and to give you feedback on your progress before the final exam. It will cover all lecture material from weeks 1-6 inclusive.

The **final exam** will cover all material from the course lectures.

Final examinations for each course 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.

Calculators

You will need to provide your own calculator of a make and model approved by UNSW for the examinations. The list of approved calculators is available at student.unsw.edu.au/exam-approved-calculators-and-computers

It is your responsibility to ensure that your calculator is of an approved make and model, and to obtain an “Approved” sticker for it from the [Engineering Student Support Services Centre](#) prior to the examination. Calculators not bearing an “Approved” sticker will not be allowed into the examination room.

Special consideration and supplementary assessment

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.

Please note that UNSW now has a [Fit to Sit / Submit rule](#), which means that if you sit 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](#).

7. Expected resources for students

Textbooks

1. [Elements of Spacecraft Design](#), C. D. Brown.
2. Spacecraft Systems Engineering (4th ed) – Fortescue, Stark and Swinherd
3. Space Vehicle Design (2nd Edition), Griffin, Michael D and French James R, American Institute of Aeronautics and Astronautics

All three books are available at the UNSW library and UNSW book shop (in limited quantity) and are also available for download in PDF format from the UNSW Library's web site.

UNSW Library website: <https://www.library.unsw.edu.au/>

Another great resource is [Space Mission Analysis and Design](#), J.R. Wertz and W.J. Larson (affectionately known as SMAD), available in the library and online.

Handouts will be provided for any subjects covered in the classes which are not taken from the course texts. You are recommended to take your own notes or annotate your own copy of the course text and your handouts.

This course has a website on Moodle which includes lecture notes, lecture recordings and a discussion forum.

Moodle: <https://moodle.telt.unsw.edu.au/login/index.php>

8. 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.

In this course, recent improvements resulting from student feedback include changes to lecture topics and provision of more feedback to students throughout the course.

9. 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

10. Administrative matters and links

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

- [Attendance](#)
- [UNSW Email Address](#)
- [Special Consideration](#)
- [Exams](#)
- [Approved Calculators](#)
- [Academic Honesty and Plagiarism](#)
- [Equitable Learning Services](#)

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex 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
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (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