Australia's Global University

UNSW SYDNEY

Mechanical and Manufacturing Engineering

Course Outline

Semester 2 2017

AERO9610

The Space Segment

Contents

1. Staff contact details

Contact details and consultation times for course convenor

The course convener is Dr Jason Held, an adjunct lecturer normally working off campus. Best time for questions is face-to-face during the lecture. Also feel free to send a note directly connect via the moodle site.

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

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

Name: Taofiq Huq
Email: n.huq@unsw.edu.au

Name: Ben Southwell
Email: b.southwell@unsw.edu.au

Please see the course Moodle.

2. Important links

- Moodle
- UNSW Mechanical and Manufacturing Engineering
- Course Outlines
- Student intranet
- UNSW Mechanical and Manufacturing Engineering Facebook
- UNSW Handbook

3. Course details

Credit Points

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

The UNSW website states "The normal workload expectations of a student are approximately 25 hours per semester for each UoC, including class contact hours, other learning activities, preparation and time spent on all assessable work. Thus, for a full-time enrolled student, the normal workload, averaged across the 16 weeks of teaching, study and examination periods, is about 37.5 hours per week."

This means that you should aim to spend about 9 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	1500hrs – 1800hrs	Ainsworth 202 (K-J17-202)

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.

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.

At the end of the day, it is the customer who is waiting patiently for your satellite to solve their real world need, so your final solution is judged based on how well the total system supports that customer. Therefore it is one thing to design a spacecraft, but another proving that your design solves the customer’s need. It is the difference between having an interesting idea and a fully funded and operational mission that can fly.

By the end of this course, students will learn how to design their own spacecraft up to the Feasibility level, which is a core competency expected of any professional space engineer. Students will also learn how to close the loop between design and customer mission requirements. This requires:

1. Application of formal methods of spacecraft conceptual design, similar quality requirements for a NASA Phase-A study (a.k.a., Preliminary Design Review).
2. Development of a conventional satellite bus to include all subsystems, payload, and proving the design can feasibly solve a customer problem.
3. Investigation of mission plans using modern planning tools.
4. Analysis of a satellite mission plan in terms of how to form links between satellite design, mission design, and mission performance. This objective allows students to estimate though simulation how changes in their plans affect the number of customers their satellite mission can support.

The Space Segment course is a Core Specialisation Course within the Masters of Engineering Science Extended-Satellite Systems Engineering program (ELECSS8539). It is a recommended elective, which can be taken in either the first or second year of the program, although it is intended (though not required) to be taken early in the Satellite Systems Engineering Master's program.

The course is also available as a 4th year disciplinary elective within the Bachelor of Engineering. There are no prerequisite courses leading into this course; however it is expected that enrolling students will have completed 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.	Apply space engineering design methods to an entry level but professional standard	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	1.1, 1.3, 1.5, 2.3, 2.4

4. Teaching strategies

This is a project based course where you will learn by doing. Each class starts with a 1-3 hour lecture to review material, guide the design process, and answer questions. ***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 day***. The rest of the lecture is set aside for developing your own models based on equations provided in the material.

Each lecture will cover a single subsystem or related aspect of the spacecraft design. The students will then develop that subsystem on their own as an assignment due the next week.

Please note that classes start exactly on the hour. During a three hour session, there will normally be a ten-minute break.

5. Course schedule

Week	Topic	Location	Suggested Readings
1	Introduction, design process, space customers, payloads	Ainsworth 202 (K-J17-202)	Class readings
2	Mission Design	Ainsworth 202 (K-J17-202)	C. Brown Ch2 *Space Vehicle Design*, ch. 3
3	Mass budgets, Structures and Mechanisms	Ainsworth 202 (K-J17-202)	C. Brown, ch 2.2
4	Thermal Subsystems	Ainsworth 202 (K-J17-202)	C. Brown, ch 7
5	Power Subsystems and EPS budgets	Ainsworth 202 (K-J17-202)	C. Brown, ch 6
6	Attitude Determination and Control	Ainsworth 202 (K-J17-202)	C. Brown, ch 5
7	Propulsion	Ainsworth 202 (K-J17-202)	C. Brown, ch 4
8	C&DH	Ainsworth 202 (K-J17-202)	C. Brown, ch 8
9	Communications	Ainsworth 202 (K-J17-202)	C. Brown, ch 8 and Class Readings
10	<National Holiday>		
11	<National Holiday>		
12	Mission Planning Workshop	Ainsworth 202 (K-J17-202)	Class Readings
13	Final Report Due	(to tutors)	

6. Assessment

Assessment overview

Assessment	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Subsystem designs	2-5 pages	70%	1 and 4	Design feasibility as discussed in lectures and textbook, fit to mission	Day before the lecture via Moodle	Midnight Sunday 1st October	Two weeks after submission
Mission Plan	2-5 pages, with PIGI scene	10%	1	Lecture material from week X.	Before the break	N/A	The class after each assessment (i.e. weeks 5, 8 and 11)
Final Report	40 pages max	20%	1, 2 3, and 4	All course content from weeks 2-12 inclusive.	Exam period, date TBC	N/A	Upon release of final results

Assignments

There are three assessments in this course: Subsystem designs, a mission plan, and a final report.

Each lecture covers a single subsystem or related aspect of the spacecraft design. The students will then develop that subsystem on their own as an assignment due the next week. Each subsystem accounts for equal fraction of the total assignment assessment. Each submission will consist of a short description of the solution along with calculations (in excel or similar spreadsheet) demonstrating the design's feasibility. Students are expected to work with their own code or spreadsheets as part of their submission.

The mission design consists of a short report consisting of a description of the selected orbits, outputs from satellite simulations output (overpass information), and related calculations for customer volume, converted from the outputs. Software will be provided that can produce the orbit overpasses into a .csv format.

The final report due at the end of semester will consist of the completed solution to include a refined mission plan, updated spacecraft design (corrected from assignment feedback), and final analysis of how your spacecraft supports their customer experience.

Presentation

All non-electric submissions should have a standard School cover sheet which is available from this course's Moodle page.

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

Late submissions will be penalised 5 marks per calendar day (including weekends). An extension may only be granted in exceptional circumstances. Special consideration for assessment tasks must be processed through student.unsw.edu.au/special-consideration.

It is always worth submitting late assessment tasks when possible. Completion of the work, even late, may be taken into account in cases of special consideration.

Where there is no special consideration granted, the 'deadline for absolute fail' in the table above indicates the time after which a submitted assignment will not be marked, and will achieve a score of zero for the purpose of determining overall grade in the course.

Assessment Criteria

The following criteria will be used to grade assignments:

For reports:

• Identification of key facts and the integration of those facts in a logical development.
• Clarity of communication—this includes development of a clear and orderly structure and the highlighting of core arguments.
• Sentences in clear and plain English—this includes correct grammar, spelling and punctuation.
• Correct referencing in accordance with the prescribed citation and style guide.

For numerical calculations:

• Accuracy of numerical answers.
• All work shown.
• Use of diagrams, where appropriate, to support or illustrate the calculations.
• Use of graphs, where appropriate, to support or illustrate the calculations.
• Use of tables, where appropriate, to support or shorten the calculations.
• Neatness.

Examinations

This course has no examinations.

Special consideration and supplementary assessment

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

7. Attendance

You are required to attend a minimum of 80% of all classes, including lectures, labs and seminars. It is possible to fail the course if your total absences equal to more than 20% of the required attendance. Please see the School intranet and the UNSW attendance page for more information.

8. Expected resources for students

Textbooks

1. Elements of Spacecraft Design, C. D. Brown.
- This is *the* quintessential resource, a great reference for this class
https://books.google.com.au/books/about/Elements_of_Spacecraft_Design.html?id=mTSSMhcmVbkC&redir_esc=y

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/

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

Software

The Predictive Groundstation (PIGI), used to derive orbital overpasses and experiment with your constellations. Available online at https://saberastro.com/downloads/

A free license will be provided for the course after the first week.

9. 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.

This semesterm the course structure is changed from traditional presentations / examination delivery to a project based course which focuses on giving students direct hands-on experience.

10. 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: 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

Further information on School policy and procedures in the event of plagiarism is available on the intranet.

11. Administrative matters and links

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

- Attendance, Participation and Class Etiquette
- UNSW Email Address
- Computing Facilities
- Assessment Matters (including guidelines for assignments, exams and special consideration)
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Student Support 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