UNSW SYDNEY | Australia's Global University

Mechanical and Manufacturing Engineering

Course Outline

Term 1 2019

AERO9610

The Space Segment

Contents

1. Staff contact details

Contact details and consultation times for course convenor

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

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

Details to be provided on Moodle before the start of the term.

2. Important links

- Moodle
- Lab Access
- Computing Facilities
- Student Resources
- Course Outlines
- Engineering Student Support Services Centre

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.

Contact hours

	Day	Time	Location
Lectures	Monday	4 pm – 6 pm	Ainsworth G02 (K-J17-G02)
	Thursday	1pm – 3pm	Old Main Building 229 (K-K15-229)

Please refer to your class timetable for the learning activities you are enrolled in and attend only those classes.

Summary and Aims of the course

This course gives the students a basis in the design issues involved in the engineering of the space segment in order to enable fulfillment of the mission. This course covers four areas of the space segment design:

1. Design methodology for satellites.

2. Operational environment, including orbits, orbital manoeuvres, interplanetary transfers as well as the thermal, structural, and electromagnetic environment.
3. The hardware implementation of the space segment, incorporating the payload types and satellite support subsystems.
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 the preliminary analysis of the operation and performance of the space segment is also presented. This course delivers to the student a broad overview of the engineering principles involved with the design, development, testing and implementation of the space segment of a space mission.

The Space Segment course is a Core Specialization Course within the Master of Engineering Science Satellite Systems Engineering program (ELECOS8338). It is an Advanced Disciplinary Elective course which can be taken in either the first or second year of the program, although It is intended (though not required) that this be taken early in the Satellite Systems Engineering Master's program.

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. Experience with MATLAB® or a similar software, although not required, would be helpful.

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 to the space segment	1.1, 1.5, 1.6, 2.3, 2.4, 3.2
2.	Understand the impact of mission objectives, mission constraints, and mission environment on spacecraft 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 in each stage of development	1.1, 1.3, 1.5, 2.3, 2.4

4. Teaching strategies

The course material will be taught through a combination of in-class lectures, text book content, and research articles. The lectures will focus on presentation of the core content of the course, while supplementary reading material will be used to highlight the current trends in spacecraft systems design. A team project, which involves designing of spacecraft system(s), will help students learn the basics of spacecraft design methodology.

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. The lecture slides will build upon the framework provided by the text, but they will also contain additional material. Both the textbook and lecture slides together constitute examinable material. Additionally, students will be encouraged to read research articles (and discuss them) in order to learn about the present state of spacecraft systems design. This material will ***not*** be included in the exams and is purely intended to help students learn about the present and the future of spacecraft systems design.

5. Course schedule

Week	Topic	Suggested Readings
1	Course introduction, a historical overview of space flight; Anatomy of spacecrafts and their missions.	Notes provided Space Vehicle Design, Ch. 1, 2 O*ptional Reading:* "Countdown: *A History of Space Flight*" by T.A. Heppenheimer
2	Spacecraft operating environment; Fundamentals of Orbital Mechanics	Space Vehicle Design, Ch. 3, 4 Spacecraft Systems Engineering, Ch. 4, 5
3	Launch vehicles and staging; Space propulsion methods	Space Vehicle Design, Ch. 5 Spacecraft Systems Engineering, Ch. 7 Elements of Spacecraft Design, Ch. 4, p153 – 249
4	Spacecraft attitude determination and control	Space Vehicle Design, Ch. 7 pp. 325 - 376 Elements of Spacecraft Design, Ch. 5
5	Spacecraft structural loads and design	Spacecraft Systems Engineering, ch. 8, 15 Space Vehicle Design, ch. 8 Elements of Spacecraft Design, ch. 2.2, 10
6	**Mid-Semester Exam**	

Week	Topic	Suggested Readings
7	Spacecraft thermal systems and atmospheric reentry; Telemetry, tracking and command systems	Space Vehicle Design, Ch. 6 & 9 Spacecraft Systems Engineering, ch. 13
8	Spacecraft power systems; Command and data handling	Spacecraft Systems Engineering, ch. 10 Elements of Spacecraft Design, ch. 6
9	Spacecraft systems integration; Current trends in spacecraft design and future of space travel/exploration	Spacecraft Systems Engineering, ch. 17 Notes provided
10	Revision and overflow	

6. Assessment

Assessment overview

Assessment	Group Project?	If Group, # Students per group	Length	Weight	Learning outcomes assessed	Assessment criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Mid-Semester Exam	No	N/A	2 Hours	30%	1, 2, and 3	Course content from Weeks 1 through 5	Week 6, in class	N/A	Week 8
Team Project	Yes	5	15 – 20 pages report + 5 minute presentation from each group	15% (Report: 10% Presentation: 5%)	1, 2, 3, and 4	All course content	Week 10, in class	N/A	Upon release of final results
Assignments	No	N/A	Less than 10 pages of content	15%	1, 2, and 3	Lecture material from weeks 1-2, 3 – 4, and 5 - 7.	During week 3, 5, and 8	N/A	The week after each assessment (i.e. weeks 4, 6 and 9)
Final exam	No	N/A	2 hours	40%	1, 2 and 3	All course content from weeks 1-10 inclusive.	Exam period, date TBC	N/A	Upon release of final results

Assignments

Presentation

All non-electronic 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

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

Final Exam: The final exam will be two hours in duration and held during the end-of-semester exam period. The exam will cover the entire course content and accounts for 40% of the available course grade.

Mid-Semester Exam: There will be an in-class exam in week 6, covering all material from weeks 1-5. The mid-semester exam is worth 30% of the course grade.

You must be available for all tests and examinations. 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 Supper 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 has interfered with your assessment performance, you are eligible to 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. Space Vehicle Design (2nd Edition), Griffin, Michael D and French James R, American Institute of Aeronautics and Astronautics
2. Spacecraft Systems Engineering (4th ed) – Fortescue, Stark and Swinherd
3. Elements of Spacecraft Design, C. D. Brown.
4. Research articles (available via UNSW's subscription to journals)
5. Optional reading: "Countdown: A History of Space Flight" by T.A. Heppenheimer (hard copy available from UNSW Library)

These books are available in pdf format from UNSW library's website and can also be purchased from UNSW book shop (in limited quantity). Hard copies of these books are also available in UNSW library. Prior to each lecture, the students will be informed of the sections of the book(s) relevant to that lecture so that they are prepared for the subject material. The students are encouraged to ask any questions they might have on the topics in the book.

The suggested research articles to read will be available via UNSW's subscription to the respective research journal.

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

UNSW Library website: https://www.library.unsw.edu.au/
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 inclusion of more guest lecturers to speak about their field of expertise.

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

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

10. 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
- UNSW Email Address
- Computing Facilities
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Student Equity and Disabilities Unit
- Health and Safety
- Lab Access
- Makerspace
- UNSW Timetable
- UNSW Handbook
- UNSW Mechanical and Manufacturing Engineering

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