ELEC9762
Space Mission Development

Course Outline – Semester 1, 2017

Never Stand Still | Faculty of Engineering | School of Electrical Engineering and Telecommunications

Course Staff

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Consultations: You are encouraged to ask questions on the course material during tutorial hours rather than via email. Lecturer consultation times will be advised. ALL email enquiries should be made from your student email address with ELEC9762 in the subject line, otherwise they will not be answered.

Keeping Informed: Announcements may be made during classes, via email (to your student email address) and/or via online learning and teaching platforms –!in this course, we will use Moodle https://moodle.telt.unsw.edu.au/login/index.php. Please note that you will be deemed to have received this information, so you should take careful note of all announcements.

Course Summary

Contact Hours

Students should expect to spend 3 hours weekly on recorded lectures and an additional 2 hours on reviewing course notes and recommended reading. Fortnightly face-to-face tutorials should occupy 2 hour per fortnight. An average of 3-4 hours per week is expected to be spent on the assignment.

Context and Aims

This course looks at the process involved in getting a mission from the proposal stage to the launch stage, including the test and evaluation processes. It will cover mission related aspects ranging from definition of the mission, through the mission specification and development to the launch and commissioning.

The course aims to give students an in-depth look at the process involved in defining and undertaking a space mission. Specific aims include:

1. Describe to students the process involved in defining a space mission.
2. Give students an understanding in deriving the mission specification
3. Explain to students how to go from the mission specifications to the system functions
4. Explain to students how to go from the functions to the elementary units: (specification, production)
5. Explain to students how to formulate a system development plan
6. Explain to students how to move from the elementary units to the system: assembly, integration and test on ground
7. Give students an understanding of the issues involved in the launch campaign and in-orbit testing (IOT

Indicative Lecture Schedule

Week	Content
Week 1	Introduction to the Module
Week 2	Space Mission Definition
Week 3	Mission Development Tools
Week 4	Specifying the Mission
Week 5	Specification to Functions
Week 6	Functions to Elementary Units 1/2
Week 7	Functions to Elementary Units 2/2
Week 8	Transitioning to Implementation 1/2
Week 9	Transitioning to Implementation 2/2
Week 10	Huygens Case Study 1/2
Week 11	Huygens Case Study 2/2
Week 12	Revision

Assessment

Mid-Semester Exam	10%
Assignment	50%
Final Exam (2 hours)	40%

Course Details

Credits

The University defines a UoC as requiring 25 hours of total learning effort per semester, spread over lectures, tutorials, labs, and the student's own study time (see https:// my.unsw.edu.au/student/atoz/UnitsOfCredit.html). Therefore, it is expected that 150 hours will be allocated to this course. For a Master's course, the only expected formal contact hours are the lectures, which accounts for about 32-40 hours out of this total. The students should then allocate around 110 hours of additional private hours to the subject over the semester.

Relationship to Other Courses

The ground segment and space operations course is a core specialisation course within the Master of Engineering Science (Satellite Systems Engineering) program (ELECOS8338). This course 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 Masters program. This course is also available as a Technical Elective in Electrical Engineering Undergraduate and Masters programs.

Pre-requisites and Assumed Knowledge

There are no prerequisite courses leading into this course, however it is expected that enrolling students will have completed a 4 year Bachelor's in Engineering and have prior undergraduate learning in Mechanics, Mathematics and Physics.

Learning outcomes

After successful completion of this course, you should be able to:

1. List the steps involved in undertaking a space mission
2. Explain the process involved in obtaining the mission specifications
3. Discuss the issues involved in fleshing out the system design
4. Describe the issues involved in the launch campaign
5. Describe the in-orbit testing (IOT) of the satellite.

This course is designed to provide the above learning outcomes which arise from targeted graduate capabilities listed in ***Appendix A***. The targeted graduate capabilities broadly support the UNSW and Faculty of Engineering graduate capabilities (listed in ***Appendix B***). This course also addresses the Engineers Australia (National Accreditation Body) Stage I competency standard as outlined in ***Appendix C***.

Syllabus

This course examines the steps and issues involved in the development of satellite missions. Topics covered include: mission definition and specification, moving from the mission to the functions, from the functions to the elementary units, system development plan, integration and testing (from the units to the system), launch and in-orbit testing (IOT). Specifically this will include:

Defining the mission (mission specification) will cover: Roles; Client (Need); Design/ Construction (Provider); Operator (Operational provider); Dissemination (Data network); End-User; and Mission types (Telecomms, GNSS, RO, Science).

From the mission to the functions, covering: Mission requirements (Functional, Performance, Design, Operational).

From the functions to the elementary units: Specification, production; Mission planning, Using browns approach to scoping a mission and to estimate the costs; and Development stages and time/budget per phase.

Program management: Mission phases (Prephase A – Phase E); Budgeting and cost modelling; and Time management

From the elementary units to the system, covering: assembly, integration and test on ground platform integration; coupling; thermal vacuum test; antenna integration and alignment; solar array integration; mechanical and Radio-frequency (RF) testing; readying for flight configuration; and Launch campaign & IOT

Teaching Strategies

Delivery Mode

The course will be delivered using a blended mode of recorded lectures and classroom interaction. The teaching in this course aims at establishing a good fundamental understanding of the areas covered using:

- Recorded lectures, which provide you with a focus on the core analytical material in the course, together with qualitative, alternative explanations to aid your understanding. These allow you to review the material at your own pace as many times as you need. The recorded lectures will be made available on Moodle. The video lectures will be uploaded on a week-by-week basis and accompanied by course notes, also be made available in Moodle.

- In-class Tutorials, which allow for exercises in problem solving and allow time for you to resolve problems in understanding of lecture material. Tutorials will begin in week 3.
- Consultation via email, which permit you to ask questions and clarify issues.

Learning in this course

You are expected to view all lectures, and attend all tutorials, and mid-semester exams in order to maximise learning. In addition to the lecture notes/video, you should read relevant sections of the recommended text. Reading additional texts will further enhance your learning experience. Group learning is also encouraged. UNSW *assumes* that self-directed study of this kind is undertaken in addition to attending face-to-face classes throughout the course.

Tutorial classes

You should attempt all of your problem sheet questions in advance of attending the tutorial classes. The importance of adequate preparation prior to each tutorial cannot be overemphasized, as the effectiveness and usefulness of the tutorial depends to a large extent on this preparation. Group learning is encouraged. Answers for these questions will be discussed during the tutorial class and the tutor will cover the more complex questions in the tutorial class. In addition, during the tutorial class, 1-2 new questions that are not in your notes may be provided by the tutor, for you to try in class. These questions and solutions may not be made available on the web, so it is worthwhile for you to attend your tutorial classes to gain maximum benefit from this course.

Assessment

The assessment scheme in this course reflects the intention to assess your learning progress through the course.

Mid-Semester Exam

The mid-session examination tests your general understanding of the course material, and is designed to give you feedback on your progress through the analytical components of the course. Questions may be drawn from any course material. Marks will be assigned according to the correctness of the responses.

Assignment

The assignment allows self-directed study leading to the solution of partly structured problems. Marks will be assigned according to how completely and correctly the problems have been addressed, the quality of the code written for the assignment (must be attached to the report), and the understanding of the course material demonstrated by the report.

The assignment report will be due on the Close of Business of Friday of Week 11. *Late reports will attract a penalty of 10% per day* (including weekends).

Final Exam

The exam in this course is a standard closed-book 2 hour written examination, scheduled during the end of semester exam period of semester 2, comprising five compulsory questions. University approved calculators are allowed. The examination tests analytical and critical thinking and general understanding of the course material in a controlled fashion. Questions may be drawn from any aspect of the course (including laboratory), unless specifically indicated otherwise by the lecturer. Marks will be assigned according to the correctness of the responses. *Please note that you must pass the final exam in order to pass the course.*

Relationship of Assessment Methods to Learning Outcomes

	Learning outcomes				
Assessment	**1**	**2**	**3**	**4**	**5**
Mid-semester exam	✓	✓	✓	✓	✓
Assignment	-	-	✓	✓	✓
Final exam	✓	✓	✓	✓	✓

Course Resources

Course Notes

Lecture notes have been prepared and will be available to students that cover the core content of the course. Additionally a detailed case study of the mission development of the Cassini/Huygens mission is also provided that will be referred to during the course. You will be told which sections of the text and/or handouts to read before each class so that you are prepared for the subject material and can ask questions about any topics that you are unsure about. You are recommended to take your own notes or annotate your own copy of the lecture notes or handouts.

On-line resources

Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials, host forums and occasionally quizzes. Assessment marks will also be made available via Moodle: https://moodle.telt.unsw.edu.au/login/index.php.

Mailing list

Announcements concerning course information will be given in the lectures and/or on Moodle and/or via email (which will be sent to your student email address).

Other Matters

Academic Honesty and Plagiarism

Plagiarism is the unacknowledged use of other people's work, including the copying of assignment works and laboratory results from other students. Plagiarism is considered a form of academic misconduct, and the University has very strict rules that include some severe penalties. For UNSW policies, penalties and information to help you avoid plagiarism, see http://www.lc.unsw.edu.au/plagiarism. To find out if you understand plagiarism correctly, try this short quiz: https://student.unsw.edu.au/plagiarism-quiz.

Student Responsibilities and Conduct

Students are expected to be familiar with and adhere to all UNSW policies (see https://my.unsw.edu.au/student/atoz/ABC.html), and particular attention is drawn to the following:

Workload

It is expected that you will spend at least **ten to twelve hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both face-to-face classes and *independent, self-directed study*. In periods where you need to need to complete assignments or prepare for examinations, the workload may be greater. Over-commitment has been a common source of failure for many students. You should take the required workload into account when planning how to balance study with employment and other activities.

Attendance

Regular and punctual attendance at all classes is expected. UNSW regulations state that if students attend less than 80% of scheduled classes they may be refused final assessment.

General Conduct and Behaviour

Consideration and respect for the needs of your fellow students and teaching staff is an expectation. Conduct which unduly disrupts or interferes with a class is not acceptable and students may be asked to leave the class.

Work Health and Safety

UNSW policy requires each person to work safely and responsibly, in order to avoid personal injury and to protect the safety of others.

Special Consideration and Supplementary Examinations

You must submit all assignments and attend all examinations scheduled for your course. You should seek assistance early if you suffer illness or misadventure which affects your course progress. All applications for special consideration must be **lodged online through myUNSW within 3 working days of the assessment**, not to course or school staff. For more detail, consult https://my.unsw.edu.au/student/atoz/SpecialConsideration.html.

Continual Course Improvement

This course is under constant revision in order to improve the learning outcomes for all students. Please forward any feedback (positive or negative) on the course to the course convener or via the Course and Teaching Evaluation and Improvement Process. You can also provide feedback to ELSOC who will raise your concerns at student focus group meetings. As a result of previous feedback obtained for this course and in our efforts to provide a rich and meaningful learning experience, we have continued to evaluate and modify our delivery and assessment methods.

Administrative Matters

On issues and procedures regarding such matters as special needs, equity and diversity, occupational health and safety, enrolment, rights, and general expectations of students, please refer to the School and UNSW policies:
http://www.engineering.unsw.edu.au/electrical-engineering/policies-and-procedures
https://my.unsw.edu.au/student/atoz/ABC.html

Appendix A: Targeted Graduate Capabilities

Electrical Engineering and Telecommunications programs are designed to address the following targeted capabilities which were developed by the school in conjunction with the requirements of professional and industry bodies:

- The ability to apply knowledge of basic science and fundamental technologies;
- The skills to communicate effectively, not only with engineers but also with the wider community;
- The capability to undertake challenging analysis and design problems and find optimal solutions;
- Expertise in decomposing a problem into its constituent parts, and in defining the scope of each part;
- A working knowledge of how to locate required information and use information resources to their maximum advantage;
- Proficiency in developing and implementing project plans, investigating alternative solutions, and critically evaluating differing strategies;
- An understanding of the social, cultural and global responsibilities of the professional engineer;
- The ability to work effectively as an individual or in a team;
- An understanding of professional and ethical responsibilities;
- The ability to engage in lifelong independent and reflective learning.

Appendix B: UNSW Graduate Capabilities

The course delivery methods and course content directly or indirectly addresses a number of core UNSW graduate capabilities, as follows:

- Developing scholars who have a deep understanding of their discipline, through lectures and solution of analytical problems in tutorials and assessed by assignments and written examinations.
- Developing rigorous analysis, critique, and reflection, and ability to apply knowledge and skills to solving problems. These will be achieved by the laboratory experiments and interactive checkpoint assessments and lab exams during the labs.
- Developing ethical practitioners who are collaborative and effective team workers, through group activities, seminars and tutorials.
- Developing independent, self-directed professionals who are enterprising, innovative, creative and responsive to change, through challenging design and project tasks.

Appendix C: Engineers Australia (EA) Professional Engineer Competency Standard

	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	✓