ELEC9764

The Ground Segment and Space Operations

Term 1, 2023

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Alex von Brasch	a.vonbrasch@unsw.edu.au	Appointment via email	N/A	N/A

School Contact Information

Consultations: Lecturer consultation times will be advised during the first lecture. You are welcome to email the tutor or laboratory demonstrator, who can answer your questions on this course and can also provide you with consultation times. ALL email enquiries should be made from your student email address with ELEC/TELExxxx 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.

Student Support Enquiries

For enrolment and progression enquiries please contact Student Services

Web

Electrical Engineering Homepage

Engineering Student Support Services

Engineering Industrial Training

UNSW Study Abroad and Exchange (for inbound students)

UNSW Future Students

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

Email

Engineering Student Support Services – current student enquiries

- e.g. enrolment, progression, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries

- e.g. admissions, fees, programs, credit transfer

Course Details

Units of Credit 6

Summary of the Course

This course covers, in detail, the types and applications of ground segment used in space missions. It is intended to give the student a deeper understanding of the requirements and functions of the ground segment, building on the fundamentals taught in the first preceding course, The Space Segment (AERO9610). To achieve this, this course covers three aspects of the ground segment design: 1. Ground segment management, including mission planning, client/end-user requirements, flight operations segment requirements, payload data segment requirements and ground segment system designs; 2. Ground segment engineering, including Ground based communications design, data processing, data relaying, mission operating equipment, payload ground support, instrument operation and calibration and satellite simulation; and 3. Applications of the ground segment including, data downlinking, uplinking, relaying, tracking and ranging. Examples of current and past ground segments of space missions are used to illustrate the design process and design implementation. Where appropriate, theory associated with the preliminary analysis of the operation and performance of the ground segment is also presented. This course delivers to the student a broad overview of the engineering principles involved with the management, design, development, testing and implementation of the ground segment of a space mission.

Course Aims

This course aims to provide a detailed technical treatment of the design and operation of the ground segment of a satellite system. It aims to provide a broad context for the role of the ground segment in a satellite mission, a discussion of mission requirements pertaining to satellite ground stations, and overall ground segment design methodologies. Technical content covers satellite communication link design and analysis; network design and interfacing; earth station location selection and satellite tracking systems; and earth station architecture and hardware design. Each of these points will be discussed in relation to GEO versus non-GEO earth stations, broadcast versus bidirectional earth statons, and mobile versus fixed earth stations. Case studies of earth stations for specific satellite applications will be performed, including DVB Earth Stations and mobile and VSAT terminals, with the aim of illustrating specific architectural solutions and hardware alternatives.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Understand the role of the ground segment in the context of the overall space mission and the space system operation.	PE1.5
2. Cite specific design requirements for earth stations for different satellite applications.	PE1.5
3. Explain the principle factors that govern earth station site selection.	PE1.6
4. Understand and apply basic satellite tracking techniques	PE1.1

Learning Outcome	EA Stage 1 Competencies
employed in ground stations.	
5. Describe and contrast different earth station architectures as used in a variety of satellite applications.	PE1.5
6. Design simple satellite communication links, and perform detailed link budget analysis of a satellite links.	PE1.1
7. Analyse basic hardware options for earth station components and infrastructure, citing relevant factors such as performance, support, amd economic cost.	
8. Describe the basic principles of operations and maintenance of satellite earth stations.	PE1.3, PE2.2

Teaching Strategies

Lectures and tutorials. Learning will be supported by on-line tutorials and tutorial exercises (using STK software). Lectures present the technical ideas, analysis techniques, and real-world examples. Tutorial exercises allow students to apply the technical ideas to solve problems. The tutorial exercises and assignments allow students to develop deeper critical design and analysis methodologies.

Additional Course Information

Relationship to Other Courses

The ground segment and space operations course is a core specialisation course within the Masters of Engineering Science - Space Systems Engineering program (ELECTS8338). 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 Space 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.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Quiz	10%	Week 6	3, 4, 6
2. Final Exam	60%	As per final exam timetable	1, 2, 3, 4, 5, 6
3. Assignments	30%	Week 10	2, 3, 5, 6

Assessment 1: Quiz

Due date: Week 6

Mid-Term quiz, conducted on Moodle.

Assessment 2: Final Exam

Due date: As per final exam timetable

Final end of term exam

Assessment 3: Assignments

Due date: Week 10

Two assignments. One focussed on the design decisions of an earth station for a specific application. The second on the analysis of the function of an existing earth station.
Feedback on the student's idea through assessment and grading of submission.

Attendance Requirements

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

Course Schedule

This course consists of three hours of classes per week, on Thursdays 6 to 9pm. All components will be conducted on-line via Teams.

These classes will generally consists of lectures, with some sessions having tutorials and laboratories throughout the session. Laboratory sessions will be held in the Wireless Communication Lab in the School of Electrical Engineering, if permitted.

If possible, the course will also have a visit to the Optus Ground Station at Belrose. Arrangements for this will be made during the course, if possible.

View class timetable

Timetable

Date	Type	Content
Week 1: 13 February - 17 February	Lecture	Introduction
Week 2: 20 February - 24 February	Lecture	Ground Segment Elements and their role in a Space Mission
Week 3: 27 February - 3 March	Lecture	Earth Station Design and Locations
Week 4: 6 March - 10 March	Lecture	Satellite Communications 1
Week 5: 13 March - 17 March	Lecture	Satellite Communications 2
Week 6: 20 March - 24 March	Laboratory	Satellite TV Receiver system
	Assessment	Quiz
Week 7: 27 March - 31 March	Lecture	Earth Station internetworking and hardware
Week 8: 3 April - 7 April	Lecture	Space operations architectures and activities
Week 9: 10 April - 14 April	Lecture	Space mission operational phases and examples
Week 10: 17 April - 21 April	Lecture	Case Studies of Ground Stations
	Assessment	Assignments

Resources

Prescribed Resources

There is no prescribed textbook for this course. The notes, lectures, recordings, and tutorials will be made available via the course moodle website.

Recommended Resources

The following textbooks are recommended as good references:

- B. Ackroyd, World Satellite Communications and Earth Station Design; BSP Professional, 1990.
- P. Fortescue, J. Stark, & G. Swinard, Satellite Systems Engineering, 3rd Ed., John Wiley & Sons, 2003.
- B. Elbert, The Satellite Communication Ground Segment and Earth Station handbook; Artech House, 2001.
- J Wertz et al., ”Space Mission Engineering : The New SMAD” ; Microcosm Press, 2011.

Course Evaluation and Development

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 online student survey myExperience. 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.

Academic Honesty and Plagiarism

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 https://student.unsw.edu.au/plagiarism. To find out if you understand plagiarism correctly, try this short quiz: https://student.unsw.edu.au/plagiarism-quiz.

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.

Academic Information

COVID19 - Important Health Related Notice

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by NSW health or government authorities. **You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-isolate**. We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed.

If you are required to self-isolate and/or need emotional or financial support, please contact the Nucleus: Student Hub. If you are unable to complete an assessment, or attend a class with an attendance or participation requirement, please let your teacher know and apply for special consideration through the Special Consideration portal. To advise the University of a positive COVID-19 test result or if you suspect you have COVID-19 and are being tested, please fill in this form.

UNSW requires all staff and students to follow NSW Health advice. Any failure to act in accordance with that advice may amount to a breach of the Student Code of Conduct. Please refer to the Safe Return to Campus guide for students for more information on safe practices.

Dates to note

Important Dates available at: https://student.unsw.edu.au/dates

Student Responsibilities and Conduct

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

Workload

It is expected that you will spend at least **15 hours per week** studying a 6 UoC course, from Week 1 until the final assessment, including both formal classes and *independent, self-directed study*. In periods where you 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.

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 can apply for special consideration when illness or other circumstances beyond your control interfere with an assessment performance. If you need to submit an application for special consideration for an exam or assessment, you must submit the application **prior to the start** of the exam or before the assessment is submitted, except where illness or misadventure prevent you from doing so. Be aware of the "fit to sit/submit" rule which means that if you sit an exam or submit an assignment, you are declaring yourself well enough to do so and cannot later apply for Special Consideration. For more information and how to apply, see https://student.unsw.edu.au/special-consideration.

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:

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

https://www.unsw.edu.au/engineering/our-schools/electrical-engineering-telecommunications/student-life/resources

Disclaimer

This Course Outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.

Image Credit

Main Page - Canberra Deep Space Communication Complex (nasa.gov)

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	✓
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	✓
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering 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	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in 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	