UNSW Course Outline

ELEC9764 The Ground Segment and Space Operations - 2024

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General Course Information

Course Code : ELEC9764
Year : 2024
Term : Term 1
Teaching Period : T1
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Electrical Engineering & Telecommunications
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

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 other courses in the

Satellite Engineering discipline.

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, up-linking, 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, the 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 stations, 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

Course Learning Outcomes
CLO1 : Explain the role of the ground segment in the context of the overall space mission and the space system operation.
CLO2 : Cite specific design requirements for earth stations for different satellite applications, including the factors that govern earth station cite selection.
CLO3 : Describe and apply basic satellite tracking techniques employed in ground stations, and being able to critically compare evaluate different options for a given space mission.
CLO4 : Demonstrate how to design simple satellite communication links and perform detailed link budget analysis of a satellite system.
CLO5 : Analyse basic hardware options for earth station components and infrastructure, citing relevant factors such as performance, support, amd economic cost.
CLO6 : Describe the basic principles of operations and maintenance of satellite earth stations.

Course Learning Outcomes	Assessment Item
CLO1 : Explain the role of the ground segment in the context of the overall space mission and the space system operation.	• Assignment
CLO2 : Cite specific design requirements for earth stations for different satellite applications, including the factors that govern earth station cite selection.	• Final Exam • Assignment
CLO3 : Describe and apply basic satellite tracking techniques employed in ground stations, and being able to critically compare evaluate different options for a given space mission.	• Quiz • Final Exam
CLO4 : Demonstrate how to design simple satellite communication links and perform detailed link budget analysis of a satellite system.	• Quiz • Final Exam • Assignment
CLO5 : Analyse basic hardware options for earth station components and infrastructure, citing relevant factors such as performance, support, amd economic cost.	• Quiz • Final Exam • Assignment
CLO6 : Describe the basic principles of operations and maintenance of satellite earth stations.	• Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System

Other Professional Outcomes

Engineers Australia, Professional Engineer Stage 1 Competencies

The course learning outcomes (CLOs) contribute to your development of EA competencies:

PE1: Knowledge and Skill Base

- PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals: CLOs 3, 4
- PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing: n/a
- PE1.3 In-depth understanding of specialist bodies of knowledge: CLO 6
- PE1.4 Discernment of knowledge development and research directions: n/a
- PE1.5 Knowledge of engineering design practice: CLOs 1, 2, 3
- PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice: CLO 2

PE2: Engineering Application Ability

- PE2.1 Application of established engineering methods to complex problem solving: n/a
- PE2.2 Fluent application of engineering techniques, tools and resources: CLOs 5, 6
- PE2.3 Application of systematic engineering synthesis and design processes: CLO 5
- PE2.4 Application of systematic approaches to the conduct and management of engineering projects: n/a

PE3: Professional and Personal Attributes

- PE3.1 Ethical conduct and professional accountability: n/a
- PE3.2 Effective oral and written communication (professional and lay domains): n/a
- PE3.3 Creative, innovative and pro-active demeanour: n/a
- PE3.4 Professional use and management of information: n/a
- PE3.5 Orderly management of self, and professional conduct: n/a
- PE3.6 Effective team membership and team leadership: n/a

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.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Quiz Assessment Format: Individual	10%	Due Date: week 6
Final Exam Assessment Format: Individual	60%	Due Date: During Final Exam period, TBA
Assignment Assessment Format: Individual	30%	Due Date: Week 10

Assessment Details

Quiz

Assessment Overview

This is a mid-term in-class quiz. It comprises multiple-choice questions, as well as short answer and calculation-based questions. The quiz assesses student's understanding of the material covered thus far in the course.

Course Learning Outcomes

- CLO3 : Describe and apply basic satellite tracking techniques employed in ground stations, and being able to critically compare evaluate different options for a given space mission.
- CLO4 : Demonstrate how to design simple satellite communication links and perform detailed link budget analysis of a satellite system.
- CLO5 : Analyse basic hardware options for earth station components and infrastructure, citing relevant factors such as performance, support, amd economic cost.

Final Exam

Assessment Overview

The final exam aims to assess students’ overall competency. It is a standard 2-hour written examination to be scheduled during the final exam period. Questions may be drawn from any aspect of the course. Marks will be assigned according to the correctness of the responses.

Course Learning Outcomes

- CLO2 : Cite specific design requirements for earth stations for different satellite applications, including the factors that govern earth station cite selection.
- CLO3 : Describe and apply basic satellite tracking techniques employed in ground stations, and being able to critically compare evaluate different options for a given space mission.
- CLO4 : Demonstrate how to design simple satellite communication links and perform detailed link budget analysis of a satellite system.

- CLO5 : Analyse basic hardware options for earth station components and infrastructure, citing relevant factors such as performance, support, amd economic cost.
- CLO6 : Describe the basic principles of operations and maintenance of satellite earth stations.

Assignment

Assessment Overview

This is an open-ended assignment focused on ground station design for a specific mission/ application in question. The work also needs to include a detailed link budget analysis and analysis of the ground station communication system. The report (up to 10 pages) will be marked against assessment criteria.

Course Learning Outcomes

- CLO1 : Explain the role of the ground segment in the context of the overall space mission and the space system operation.
- CLO2 : Cite specific design requirements for earth stations for different satellite applications, including the factors that govern earth station cite selection.
- CLO4 : Demonstrate how to design simple satellite communication links and perform detailed link budget analysis of a satellite system.
- CLO5 : Analyse basic hardware options for earth station components and infrastructure, citing relevant factors such as performance, support, amd economic cost.

General Assessment Information

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 2 : 19 February - 25 February	Lecture	Introduction Ground Segment Elements and their role in a Space Mission
Week 3 : 26 February - 3 March	Lecture	Earth Station Design and Locations
Week 4 : 4 March - 10 March	Lecture	Satellite Communications 1
Week 5 : 11 March - 17 March	Lecture	Satellite Communications 2
Week 6 : 18 March - 24 March	Laboratory	Satellite TV Receiver system
Week 7 : 25 March - 31 March	Lecture	Earth Station internetworking and hardware
Week 8 : 1 April - 7 April	Lecture	Space operations architectures and activities
Week 9 : 8 April - 14 April	Lecture	Space mission operational phases and examples
Week 10 : 15 April - 21 April	Lecture	Case Studies of Ground Stations

Attendance Requirements

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

General Schedule Information

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.

Course 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.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Eamonn Glennon		N/A	N/A	Appointment via email	Yes	Yes

Other Useful Information

Academic Information

I. 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, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, 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.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. 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

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable

Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the 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 or your primary learning management system (LMS) 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/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

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.

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 or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) 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. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be 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 will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, 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

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)

School-specific Information

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.

Use of AI for assessments

Your work must be your own. If you use AI in the writing of your assessment, you must acknowledge this and your submission must be substantially your own work. More information can be found on this website.

Workplace Health & Safety (WHS)

WHS for students and staff is of utmost priority. Most courses involve laboratory work. You must follow the rules about conduct in the laboratory. About COVID-19, advice can be found on this website.

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