

ELEC9725

Satellite Navigation: Systems, Signals & Receivers

Term 1, 2023



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Andrew Dempster	a.dempster@unsw.edu.au	-	G17 409	56890

Demonstrators

Name	Email	Availability	Location	Phone
Phu Le	phule@unsw.edu.au	email	EEB 409	-

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 introduces the electronic and signal processing aspects of Global Positioning System (GPS) and other satellite navigation systems e.g. Galileo, GLONASS. The following topics are covered in the course: signal specifications for GPS L1, L2C and L5, GLONASS and Galileo signals, introduction to CDMA, frequency plan implications of the new GNSS signals, calculating a position, problems receiver designers must overcome (multipath, interference etc.), front-end RF design, correlator principles and approaches, signal acquisition/reacquisition, how measurements are made, receiver interfaces, augmentation systems (e.g. EGNOS, WAAS), Software Radio, weak signal and Assisted GPS and Interference. These principles will be illustrated using Matlab, allowing students to develop algorithm components of receivers.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Understand and explain how satellite navigation systems work and how they interact with each other	PE1.1, PE1.2, PE1.3, PE1.4, PE1.5, PE1.6, PE2.1, PE2.2, PE2.3, PE3.2, PE3.3
2. Understand and explain the workings of a satellite navigation receiver in terms of the signal design and why it has that design, and receiver subsystems and their functions in processing those signals	PE1.1, PE1.2, PE1.3, PE1.4, PE1.5, PE1.6, PE2.1, PE2.2, PE2.3, PE3.2, PE3.3
3. Select appropriate subsystems (e.g. antenna, RF front end) for a GPS receiver design	PE1.1, PE1.2, PE1.3, PE1.4, PE1.5, PE1.6, PE2.1, PE2.2, PE2.3, PE3.2, PE3.3
4. Make sound decisions about a GPS solution for integration within a larger system, based on your knowledge of how GPS components affect performance,	PE1.1, PE1.2, PE1.3, PE1.4, PE1.5, PE1.6, PE2.1, PE2.2, PE2.3, PE3.2, PE3.3
5. Make an educated selection of GNSS receiver from those receiving GPS, Glonass, WAAS, Galileo, QZSS signals on the L1, L2, L5, E5 and E6 frequencies.	PE1.1, PE1.2, PE1.3, PE1.4, PE1.5, PE1.6, PE2.1, PE2.2, PE2.3, PE3.2, PE3.3

Teaching Strategies

Please refer to the information in Moodle

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Final Quiz	30%	Not Applicable	1, 2, 3, 4, 5
2. In-class quizzes	10%	Not Applicable	1, 2, 3, 4, 5
3. Assignments	60%	Not Applicable	1, 2, 3, 4, 5

Assessment 1: Final Quiz

Assessment length: 2 hours

Multiple choice

Assessment 2: In-class quizzes

4 quizzes throughout the semester. Multiple choice

Assessment 3: Assignments

3 Assignments: 1. Create a signal 15%; 2. Process a signal 20%; 3. Presentation 25% Each requires a report. The first two require a Matlab program, the third an in-class presentation

Attendance Requirements

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

Course Schedule

[View class timetable](#)

Timetable

Date	Type	Content
Week 1: 13 February - 17 February	Lecture	Introduction to Radionavigation Introduction to GPS GPS Signal Specification
	Assessment	(Assignment 1 available)
Week 2: 20 February - 24 February	Lecture	Navigation Message Positioning Principles <i>GPS Rx Demo</i>
Week 3: 27 February - 3 March	Lecture	Positioning Errors Datums
	Assessment	Quiz 1
Week 4: 6 March - 10 March	Lecture	Differential GPS Augmentation Systems
	Tutorial	Assignment 1: Preparation
Week 5: 13 March - 17 March	Lecture	Receiver Architectures RF Front End and Antennas Correlators
	Assessment	Quiz 2 (Assignment 1 due) (Assignment 2 available)
Week 6: 20 March - 24	Lecture	Tracking Loops

March		Real GPS Data Namuru
Week 7: 27 March - 31 March	Lecture	Interference Weak Signal/ Assisted GPS
	Assessment	Quiz 3 (Assignment 3 available)
	Tutorial	Assignment 2: Feedback/Preparation
Week 8: 3 April - 7 April	Lecture	Multi-GNSS GPS L2C/L5 Signals Galileo Signals and Receivers
	Assessment	(Assignment 2 due)
Week 9: 10 April - 14 April	Lecture	Glonass/ Beidou/ QZSS GNSS in Society
	Assessment	Quiz 4
	Tutorial	Assignment 3: Feedback/Preparation
Week 10: 17 April - 21 April	Assessment	Assignment 3 Presentations (Assignment 3 due)

Resources

Prescribed Resources

COURSE RESOURCES

Textbooks

Prescribed textbook

- Elliott D Kaplan and Christopher Hegarty, "Understanding GPS: Principles and Applications (2nd ed)", Artech House, ISBN: 978-1-58053-895-4, 2005

Reference books

- James B-Y Tsui, "Fundamentals of Global Positioning Receivers: A Software Approach (2nd ed)", Wiley, ISBN: 978-0-471-70647-2, 2005
- Borre, K., Akos, D.M., Bertelsen, N., Rinder, P., Jensen, S.H. , "A Software-Defined GPS and Galileo Receiver: A Single-Frequency Approach", Birkhäuser, ISBN: 978-0-8176-4390-4, 2007
- Bradford W. Parkinson, James J. Spilker Jr., "Global Positioning System: Theory and Applications", vols I & II, American Institute of Aeronautics and Astronautics, ISBN: 978-1-56347-249-7, 1996

On-line resources

Moodle

As a part of the teaching component, Moodle will be used to disseminate teaching materials, host forums and provide news. 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).

Course Evaluation and Development

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 myExperience 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. Specifically with respect to 2020 feedback, assignment 1 has been made a group activity to increase student interaction.

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. Current alerts and a list of hotspots can be found [here](#). **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.engineering.unsw.edu.au/electrical-engineering/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

Synergies in Sound 2016

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	