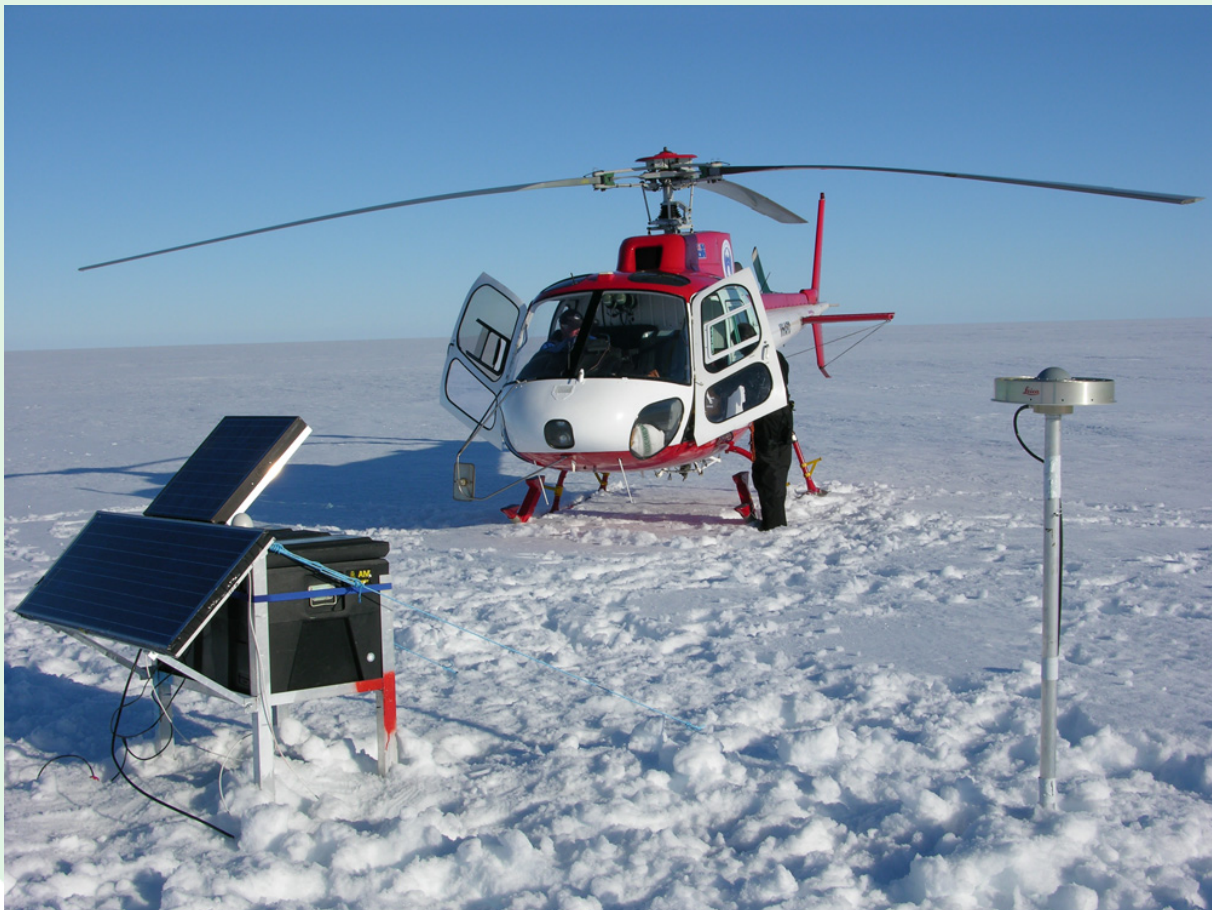


GMAT3700

Geodetic Positioning and Applications

Term 2, 2023



Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Craig Roberts	c.roberts@unsw.edu.au	Office hours	CE412	+61293854464

School Contact 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)

Course Details

Units of Credit 6

Summary of the Course

Learn concepts of geodetic positioning using GNSS. Revision of geodetic techniques (VLBI, SLR, DORIS & GNSS), Datums in Australia and international services (IGS, IAG, GGOS). Discussion of Modern Geodesy and its impact on the geosciences. Introduction to multi-GNSS including GPS, GLONASS, BeiDou, Galileo, QZSS and IRNSS. Satellite orbit representation, GNSS Signals, GNSS differential carrier phase-based positioning and errors measurement errors, static baseline survey to control network adjustment and design, Data formats and protocols, Heights from GNSS including AHD, Ausgeoid, gravity field mapping, and AVWS, SBAS, Datum modernisation, RTK, NRTK, CORS, Precise Point Positioning (PPP), Datum transformations, Standards and Specifications for GPS/GNSS geodetic control (SP1, S/G #9 & #12) and online GPS data processing. Field exercise to complement lectures and class discussions for a greater understanding of precise GPS/GNSS positioning principles and the use of state-of-the-art user equipment.

Course Aims

1. Fundamentals of Modern Geodesy, its applications & technologies, as well as how it is organised at a global, international level (IAG, IGS, GGOS)
2. Review of Australian datums and contemporary international datums
3. Precise GPS/GNSS positioning, including observation modelling & data processing
4. Practical procedures for GPS/GNSS, including fieldwork and computations using Leica Infinity
5. Precise GPS/GNSS positioning modes: Static, RTK, CORS, SBAS, PPP, NRTK, Multi-GNSS
6. Datum modernisation issues for precise GPS/GNSS positioning, especially in Australia
7. Standards and Practices for control surveying with GNSS and directions.
8. Enable the student to research an associated topic in this space and present it to the class.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Explain the principles of GPS precise positioning using carrier phase measurements, including the mathematical algorithms	PE1.1, PE1.2, PE1.4, PE2.1
2. Understand the GPS errors and how Differential GPS can be used to improve positioning accuracy	PE1.1, PE1.2, PE1.4, PE2.1
3. Understand the different ways in which a GPS "survey" can be conducted, for different applications, and the planning and testing procedures necessary	PE1.5, PE2.2, PE2.3, PE2.4, PE3.2, PE3.3, PE3.6
4. Understand role precise GPS positioning plays in support of	PE1.3, PE1.5, PE2.2, PE3.1

Learning Outcome	EA Stage 1 Competencies
geospatial data acquisition, point coordination, and modern geodesy	

Teaching Strategies

A variety of teaching activities will be included to achieve the optimal teaching and learning outcomes. Major teaching activities in this course are:

1. Weekly lectures
2. Field exercise on campus
3. Quizzes, hands-on workshops & discussions
4. Class presentation
5. Final examination

The lectures will provide the foundation to the course. Students are encouraged to come to lectures live and interact and ask questions. The workshops, computational exercises, field exercise/ processing and quizzes/exam are intended to deepen the concepts introduced in lectures. The critical review and class presentation encourage the student to indulge in one specialist area relating to course and share with the class.

The most important factors in learning are the students' commitment to learning. **Participation is everything.** In addition, relevant resources given are of great help in understanding the basic concepts of GPS/GNSS positioning discussed in the lectures. An important component of this course will be based on the actual design of a static GPS field exercise, the processing of the data collected and the subsequent report writing. The workshop exercises support this major submission.

Assessment

Assessment for the course consists of:

- Workshops and mini-quizzes: 22% (2 +2 +2 +2 +4 +2 +2 +2 +4)
 - (Wkp 1, 2, 3, prac planning, 5, Quiz 1, 2, 3 and GDA tech manual exercise)
- Class presentation submission: 20%
- Group Field exercise report: 25%
- Final examination: 33%

Workshops and Mini Quizzes

There will be 5 workshops during this course. Workshop 1, 2, 3 and the prac planning exercise in week 5 will require attendance and participation to score a maximum of 2 marks each. Workshop 4 will be to ensure all students have access to the Leica Infinity sw and can process. Workshop 5 will entail computation and submission of results and be worth 4 marks. To reinforce the learning experience, three short mini-quizzes based on material presented in previous lectures will be given during the lecture/ workshop period worth 2 marks each and a GDA assignment in week 1 will be worth 4 marks.

Critical Review & Class Presentation

Students choose a topic, critically review this topic and prepare a concise presentation to be delivered live (or pre-recorded). Instructions for assessment are given and in short comprise a) presentation; b) clarity; and c) in-depth discussion and full referencing. **Due Wednesday 3 August 4pm.** The 5 min presentation in class will also be delivered in Week 10. Attendance by all students will be compulsory for all presentations.

GNSS Practical & Computations Report

A GNSS static prac will be designed by the student cohort. One block of students comprising 4 groups each will design the field logistics. Each student will be a member of a group of 3 students. Groups will be finalised during the first weeks of the course. **Group** practical reports will be assessed with respect to: a) presentation; b) field notes & computations; and c) in-depth discussions on GPS baseline processing, network adjustment and any other relevant issues. Further information about the practicals will be distributed during the lectures and will be made available on the class web site. **Due Friday 29 July.**

Final Examination

The final examination will cover all topics related to precise positioning and modern geodesy.

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Critical review/ class presentation submission	20%	02/08/2023 04:00 PM	1, 2, 3, 4
2. Workshops and mini-quizzes:	22%	Not Applicable	1, 2, 3, 4
3. Final examination	33%	Not Applicable	1, 2, 3, 4

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
4. Group Field exercise report	25%	27/07/2023 04:00 PM	1, 2, 3, 4

Assessment 1: Critical review/ class presentation submission

Start date: 29 May 2023

Submission notes: see moodle

Due date: 02/08/2023 04:00 PM

Critical review and class presentation

Assessment 2: Workshops and mini-quizzes:

Submission notes: see moodle

In lab workshops backed up by some follow on quizzes

Assessment 3: Final examination

Final 2hr exam in exam period

Assessment 4: Group Field exercise report

Start date: 29/06/2023 09:00 AM

Submission notes: see moodle

Due date: 27/07/2023 04:00 PM

Practical GNSS exercise

Attendance Requirements

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

Course Schedule

Week No. (Strt Wk)	Lectures (2 hrs) Monday 4 – 6 pm CE G1	Lectures (2 hrs) Thursday 9 – 11 am CE 101	Workshop (2 hrs) Thursday 11 – 1 pm CE 201
1 (29 May)	Intro to the course/ admin (1) Revision of datums (2) GDA Tech manual revision + professional associations (3)	Modern geodetic technologies, the IAG & GGOS; Space geodetic applications (4,5) Presentation (due 2 Aug)	Wkshp 1: Mapping exercise* GDA assignment** (due 8 June)
2 (5 Jun)	Principles of satellite orbital motion (6) Revision of GPS (7)	Introduction to GPS signals & measurements (8) Analysis of Least squares GPS measurement modelling (9)	Wkshp 2: Planning software and online services, precise orbits*
3 (12 Jun)	Public Holiday	GPS Carrier Phase based positioning, DD (10)	GPS Errors (11) Introduction to GPS baseline processing (12)
4 (19 Jun)	From baselines to networks (13)	Planning & executing surveys (14) RINEX (& other) formats (15)	Wkshp 3: Download RINEX data and investigate*

5 (26 Jun)	GNSS Heighting (16)	<i>Class exercise Prac planning*</i>	Wkshp 4: Using Infinity for baseline computations CE 201
6 (3 Jul)		<i>Practical</i>	<i>Practical</i>
7 (10 Jul)	Multi-constellation GNSS (17) SBAS (18)	Datum modernisation, GDA2020 and ATRF (19)	<i>Process GNSS baselines</i>
8 (17 Jul)	Principles of GNSS RTK (20) & N-RTK positioning (21)	CORS networks (22,23)	Process GNSS baselines (Prac due 27/7)
9 (24 Jul)	Precise Point Positioning (PPP) (24,25)	Datum transformations (26)	Wkshp 5: AUSPOS** Exercise (Due 4 Aug)
10 (31 Jul)	Standards & practices for control Surveys (27) S/G Directions # 9 & 12 (28)	Class presentations	

[View class timetable](#)

Timetable

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Date	Type	Content
Week 9: 24 July - 28 July	Assessment	Group Field exercise report: see moodle
Week 10: 31 July - 4 August	Assessment	Critical review/ class presentation submission: see moodle

Resources

Prescribed Resources

The lectures and moodle site will contain numerous links and items of interest for the student. These will be discussed in lectures.

Recommended Resources

GPS for Land Surveyors, Van Sickle, J. (4th Edition) 2015 <https://www.e-education.psu.edu/geog862/node/1407>

Position, Navigation, and Timing Technologies in the 21st Century: Integrated Satellite Navigation, Sensor Systems, and Civil Applications, Volumes 1 and 2 (in UNSW Library e-book)

https://primoa.library.unsw.edu.au/permalink/f/11jha62/TN_cdi_proquest_ebookcentral_EBC6427526

https://primoa.library.unsw.edu.au/permalink/f/jhud33/UNSW_ALMA51307545750001731

Handbook of GNSS, Teunissen, P. & Montenbruck, O. 2017. (e-book Library)

Understanding GPS: Principles & Applications, E. Kaplan & C.J. Hegarty (eds.), Artech House, 2nd ed., 2006.

Introduction to GPS, A. El-Rabbany, Artech House, Mobile Comms series, 2002.

GNSS Global Navigation Satellite Systems: GPS, GLONASS, Galileo, and More, B. Hofmann-Wellenhof, H. Lichtenegger & E. Wasle, Springer Verlag, Wien New York, ISBN 978-3-211-73012-6, 516pp, 2008.

Global Positioning System: Signals, Measurements and Performance, P. Misra & P. Enge, Ganga-Jamuna Press, 2001.

GPS Satellite Surveying, A. Leick, 3rd Edition, J. Wiley & Sons, 2004.

Guide to GPS Positioning, D. Wells, et al., Canadian GPS Associates, 1986.

GPS

MOOC

https://www.youtube.com/watch?v=o1Fyn_h6LKU&list=PLGvhNliu1ubyEOJga50LJMzVXtbUq6CPo

Course Evaluation and Development

Students will receive feedback during and after lab exercises. Lectures will be interactive and seek student insight. The field practical exercise will give great opportunity for learning and feedback as students will work in groups and seek the same outcome from their observations. This course has been enhanced by student feedback from MyExperience.

Submission of Assessment Tasks

Please refer to the Moodle page of the course for further guidance on assessment submission.

UNSW has a standard late submission penalty of:

- 5% per day, for all assessments where a penalty applies, capped at five days (120 hours), after which a student cannot submit an assessment, and no permitted variation.

Academic Honesty and Plagiarism

Beware! An assignment that includes plagiarised material will receive a 0% mark, and students who plagiarise may fail the course. Students who plagiarise are also liable to disciplinary action, including exclusion from enrolment.

Plagiarism is the use of another person's work or ideas as if they were your own. When it is necessary or desirable to use other people's material you should adequately acknowledge whose words or ideas they are and where you found them (giving the complete reference details, including page number(s)). The Learning Centre provides further information on what constitutes Plagiarism at:

<https://student.unsw.edu.au/plagiarism>

Academic Information

Final Examinations:

Final Exams in T2 2023 will be held on campus between Friday 11th and Thursday 24th August (inclusive), and Supplementary Exams between Monday 4th and Friday 8th September (inclusive). You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

For students enrolled in the distance offering of a postgraduate course, and who reside further than 100km from UNSW Kensington campus, will be contacted regarding sitting an external exam. The school's External Exam Policy can be found on the Intranet.

ACADEMIC ADVICE

- Key Staff to Contact for Academic Advice (log in with your zID and password): <https://intranet.civeng.unsw.edu.au/key-staff-to-contact-during-your-studies-at-unsw>
- [Key UNSW Dates](#) - eg. Census Date, exam dates, last day to drop a course without academic/financial liability etc.
- CVEN Student Intranet (log in with your zID and password): <https://intranet.civeng.unsw.edu.au/student-intranet>
- Student Life at CVEN, including Student Societies: <https://www.unsw.edu.au/engineering/civil-and-environmental-engineering/student-life>
- Special Consideration: <https://student.unsw.edu.au/special-consideration>
- General and Program-Specific Questions: [The Nucleus: Student Hub](#)
- Book an Academic Advising session: <https://unswengacademicadvising.as.me/schedule.php>

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

Janssen collection

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	✓