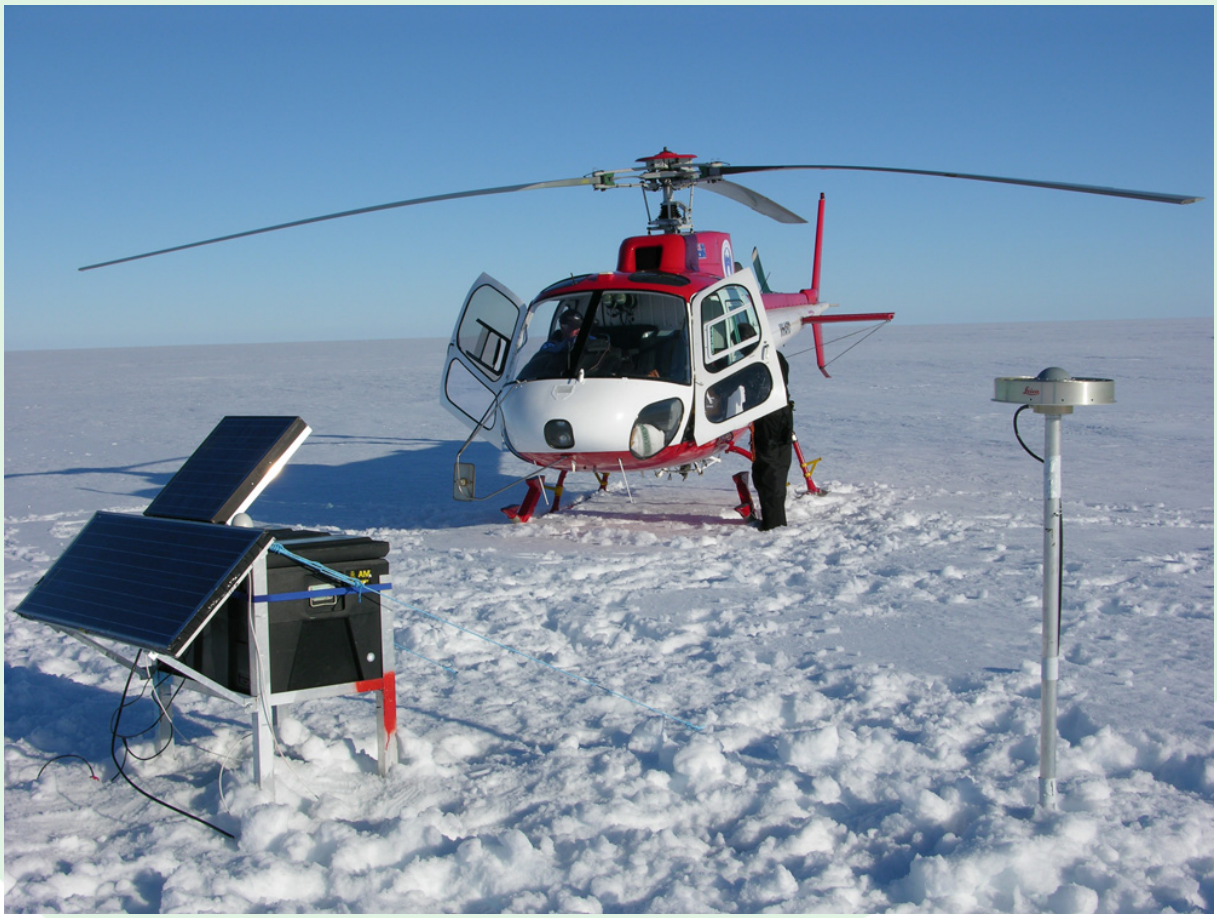
School of Civil and Environmental Engineering

UNSW Engineering

GMAT3700

Geodetic Positioning and Applications

Term 2, 2022



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

Concepts of geodetic positioning using GPS/GNSS. Introduction to GNSS other than GPS, including GLONASS, BeiDou and Galileo. Satellite orbit representation, analysis of GPS/GNSS carrier phase measurement errors, differential GNSS, integer ambiguity resolution, static baseline survey and control network design, adjustments of baseline measurements within control networks, height determination using GPS/GNSS, standards and specifications for GPS/GNSS geodetic control, Precise Point Positioning (PPP), online GPS data processing, continuous operating reference stations (CORS). Field exercises to complement the lectures, tutorials and class discussions for a greater understanding of precise GPS/GNSS positioning principles and performance using state-of-the-art user equipment. Discussion of modern geodesy: geometric techniques such as VLBI, SLR, DORIS & GNSS; gravity field mapping & mass transport; geodetic services and applications; the IAG and the Global Geodetic Observing System.

Course Aims

The course introduces the principles of precise GPS/GNSS positioning for precise surveying and geodetic applications

The course gives the student practical advice on establishing GPS control networks using static techniques, including the use of online processing services and Precise Point Positioning

The course will outline the fundamentals and modern concerns of geodesy, including recent developments in, and applications of, global and satellite geodesy

The course will describe today's geodetic technologies and global services, to support the surveying and geospatial disciplines, the geosciences and the community at large

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

Learning Outcome	EA Stage 1 Competencies
4. Understand role precise GPS positioning plays in support of geospatial data acquisition, point coordination,and modern geodesy	PE1.3, PE1.5, PE2.2, PE3.1

Teaching Strategies

This course (and similar) has been taught by the lecturer for many years at UNSW. The teaching strategies have been refined over the years based on student feedback and student performance in exams and assignments. Generally lectures are presented on each topic via PowerPoint presentations. These PowerPoint files are available in pdf format for download from the class Moodle web site.

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

1) Regular lectures

2) Workshops and computing tasks

3) GPS/GNSS fieldwork

4) Regular quizzes, and discussions on the questions from the quizzes

5) Essay writing

6) Class discussions

The material in this course emphasises precise GPS/GNSS positioning methods and the use if GPS/GNSS geodetic control applications. GPS/GNSS plays a special role in modern geodesy. This material satisfies the requirements for a geodesy course within a surveying/geospatial program. Teaching strategies are employed to ensure that the learning outcomes are satisfied.

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. Essay/ class presentation submission	20%	Not Applicable	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%	Not Applicable	1, 2, 3, 4

Assessment 1: Essay/ class presentation submission

Start date: 2 May 2022
Submission notes: see moodle

Essay and class presentation

Assessment criteria

Due Date: 04/08/2022 08:00 AM

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: 29/06/2022 09:00 AM
Submission notes: see moodle

Practical GNSS exercise

Assessment criteria

Due Date: 29/07/2022 04:00 PM

Attendance Requirements

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

Course Schedule

Week No. **(Strt Wk)**	**Lectures (2 hrs)** **Tuesday 11 – 13 pm** **CE G1**	**Lectures (2 hrs)** **Thursday 9 – 11 am** **CE G1**	**Workshop (2 hrs)** **Thursday 11 – 1 pm** **CE 201**
1 (30 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 4 Aug)	Wkshp 1: Mapping exercise* GDA assignment** (due 10 June)
2 (6 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 (13 Jun)	GPS Carrier Phase based positioning, DD (10)	GPS Errors (11) Introduction to GPS baseline processing (12)	
4 (20 Jun)	From baselines to networks (13)	Planning & executing surveys (14) RINEX (& other) formats (15)	Wkshp 3: Download RINEX data and investigate*
5 (27 Jun)	GNSS Heighting (16)	***Class exercise Prac planning****	Wkshp 4: Using Infinity for baseline computations CE 201
6 (4 Jul)		***Practical***	***Practical***
7	Multi-constellation GNSS (17) SBAS (18)	Datum modernisation, GDA2020 and ATRF (19)	*Process GNSS baselines*

(11 Jul)			
8 (18 Jul)	Principles of GNSS RTK (20) & N-RTK positioning (21)	CORS networks (22,23)	Process GNSS baselines *(Prac due 29/7)*
9 (25 Jul)	Precise Point Positioning (PPP) (24,25)	Datum transformations (26)	Wkshp 5: AUSPOS** Exercise *(Pres. due 4 Aug)*
10 (1 Aug)	Standards & practices for control Surveys (27) S/G Directions # 9 & 12 (28)	**Class presentations**	
11 (8 Aug)	Revision of material		

Resources

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=PLGvhNIiu1ubyEOJga50LJMzVXtbUq6CPo

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% Fail, 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 2022 will be held online between 12th - 25th August 2022 inclusive, and supplementary exams between 5th - 9th September 2022 inclusive. You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

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://app.acuityscheduling.com/schedule.php?owner=19024765

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

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CRICOS

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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	✓