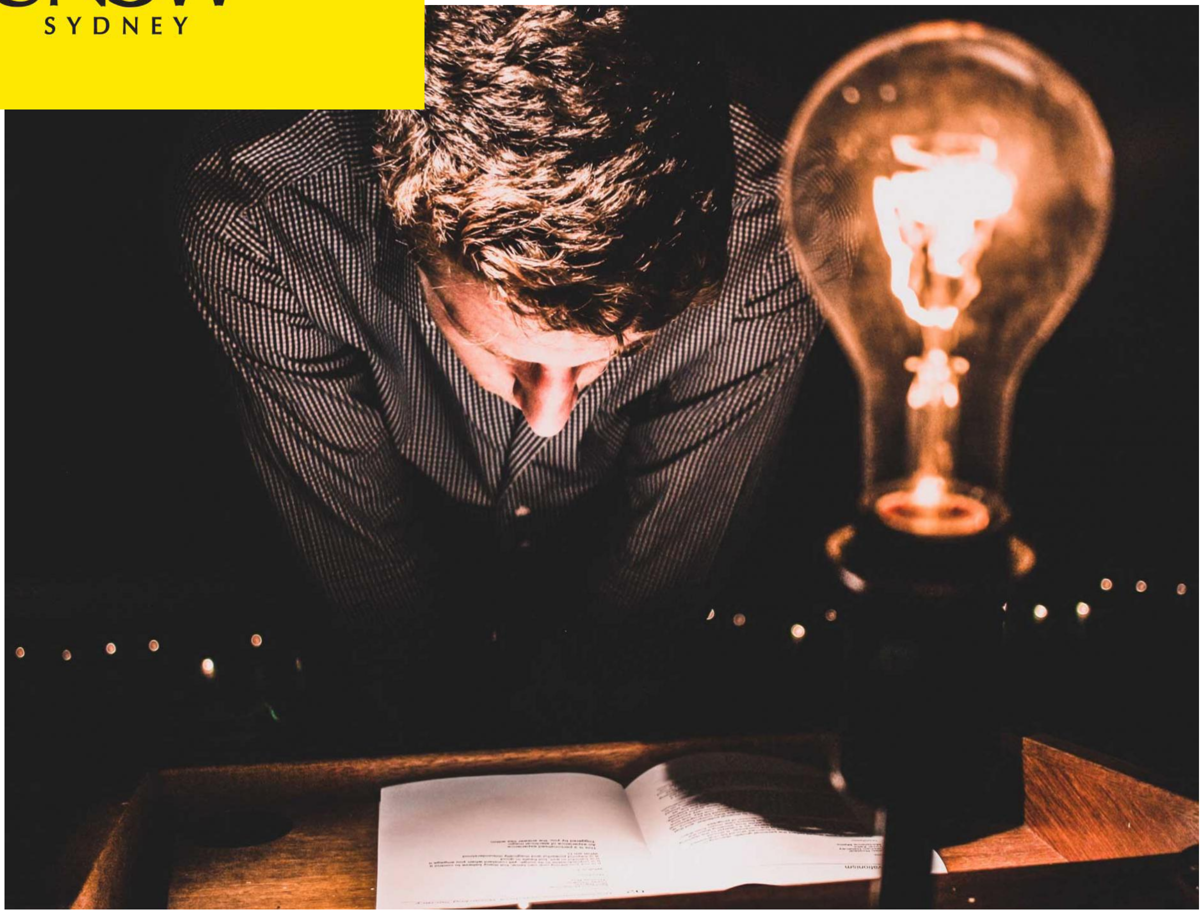

GMAT2700

Foundations of Geodesy & Geospatial Ref Frames

Term One // 2021

School of Civil and Environmental Engineering // UNSW Engineering

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Jinling Wang	jinling.wang@unsw.edu.au	You may contact me via Teams or email any time.	CE413	+61293854203

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

Credit Points 6

Summary of the Course

Cartesian coordinate systems, applications of Cartesian coordinate transformations in surveying. Mathematical transformations between geodetic, Cartesian and topocentric coordinate systems, ellipsoid geometry, orthometric and ellipsoid height systems. Map projections and ellipsoidal geometry, principles of map projections, surveying and mapping projections, transverse Mercator projection, ellipsoidal computations. Corrections to field observations. Geodetic and astronomical reference systems; the relationship between natural and geodetic reference systems, deflection of the vertical; geoid models and reference ellipsoids, height systems, celestial coordinate systems. Geodetic coordinate systems and datums; definition of AGD, GDA, AHD; the impact of tectonic motion on datum and coordinates; and international systems such as ITRF. The use of GPS/GNSS to define reference frames, as well as providing a means for a surveyor or geospatial engineer to determine coordinates of points in the frame.

Course Aims

a) The course introduces the concept of geodesy, coordinate reference systems and frames at the most general level. The student is expected to understand the basic operations on Cartesian coordinates of rotation, translation and reflection.

b) The course introduces the student to geodetic reference frames and the variety of coordinate systems used, and the conversion formulas for changing coordinates from one system to another.

c) The course presents ellipsoidal geometry concepts, and how computations of position from measured quantities such as distance and azimuth are performed. The transformation between geodetic coordinates and map projection coordinates for the case of the Universal Transverse Mercator projection is dealt with.

d) The course describes the concept of the Earth's gravity field and geoid, how it is computed, and the role that it plays in geodesy and in the definition of the height system used by surveyors and engineers.

e) The fundamental reference frames for Australian surveying and geodetic practice are described: AGD66/84, GDA94, AHD71, IRTFxx; and the transformations between them explained. The impact of tectonic motion, as well as local deformation, on coordinates in a reference frame is dealt with.

f) To gain experience in the use of RTK-GPS/GNSS for surveying and precise navigation applications.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Explain the definition of geodesy and its major tasks	PE1.1, PE1.2, PE1.6
2. Understand the basic concepts of the reference and coordinate systems	PE1.2, PE1.3, PE1.4
3. Implement the practical procedures of the transformation between the coordinate systems	PE1.5, PE2.1, PE2.3
4. Describe the purposes and methods of map projections	PE2.2, PE2.3, PE3.3
5. Identify the geodetic reference frames (datums) and map projection systems used in practice	PE2.2, PE2.3, PE1.4
6. Understand the concept of satellite-based precise positioning technology	PE1.2, PE1.3, PE1.4
7. Use GPS/GNSS to define reference frames and determine the coordinates of points in a frame	PE2.4, PE3.3, PE3.4

This course is designed to address the learning outcomes corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers.

Teaching Strategies

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. Workshop case studies and computing tasks;
3. GPS/GNSS practical;
4. Regular quizzes, and discussions on the questions from the quizzes;
5. Class discussions.

The most important factors in learning are students' commitment and learning methods. You are encouraged to attend all the lectures and other teaching activities. In addition, relevant resources on the web (visit the course website for details) are of great help in understanding the basic concepts discussed in the lectures and the trends in the discipline of surveying and geospatial engineering.

Based on some studies by a higher education research expert John Biggs, most active students in the class do not just listen, see, collect notes and take notes, but most importantly, they will *"express understanding; raise issues, speculate, solve problems, discuss, answer questions and reflect"*.

The material in this course is fundamental to surveying and geospatial engineering as it relates to the definition of reference systems and reference frames, and how to change/transform between coordindate systems/frames as well map projection concept and common projection methods. Emphasis is placed on fundamentals of geodesy; geodetic positioning concepts and geodetic reference frames/datums; Earth's gravity field and geoid, and vertical reference frames/height datums with particular reference to datums and systems relevant to Australia. Teaching strategies are employed to ensure that the learning outcomes are satisfied.

Students are strongly encouraged to do sufficient preparation for class discussions on selected topics. An example of the approaches to learning is:

Lectures	• Find out what you must learn • See methods that are not in the textbook • Follow worked examples
Visit Sydney Observatory	• Familiarise the history of the timing and navigation; • Ask questions on the invited talks • Reflect on the evolution of timing and reference frames
GPS/GNSS Practical/Sun Tracking Assignment	• Understand the concepts through hands-on work, • Set studies in context • Demonstrate data analysis and presentation skills
Workshop case studies/class discussions	• Practice solving set problems • Ask questions
Assessments (Quizzes, class discussions, etc.)	• Demonstrate your knowledge and skills • Demonstrate higher understanding and problem solving
Private Study	• Review lecture material and textbook • Do set problems and assignments • Reflect on class problems and assignments

Additional Course Information

Pre-requisites: GMAT1110

At UNSW, Normal workload expectations for each program are a minimum of 25 hours per semester per unit of credit, including class contact hours, preparation and time spent on all assessable work.

For each hour of contact it is expected that you will put in at least 1.5 hours of self-centred and self-directed study: for example, reading the course related materials provided through the course website and reflect on the conceptual framework discussed in the classes and workshops.

Assessment

Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
Quizzes	15%	Quiz 1: 1 March 2021; Quiz 2: 15 March 2021; Quiz 3: 12 April 2021	1, 2, 3, 4, 5, 6, 7
GPS/GNSS Practical Report	15%	16/04/2021 06:00 PM	2, 5, 6, 7
Class Discussion Presentations	20%	Presentation A: 29 March 2021; Presentation B: 19 April 2021	1, 2, 3, 4, 5, 6, 7
Final Exam	50%	Not Applicable	1, 2, 3, 4, 5, 6, 7

Assessment Details

Assessment 1: Quizzes

Start date: 01/03/2021 05:00 PM

Length: Each Quiz will take 15 minutes

Details:

To reinforce the learning experience, a total of three quizzes will be given in closed book format during the classes in Weeks 3, 5, and 9. Short answer questions will be asked on the materials presented in the previous lecturing period. Marks will be awarded for correct answers; partially correct answers will also be awarded with proportionally reduced marks. The detailed marking scheme will be provided to students after each quiz as part of feedback.

Additional details:

The quizzes will be scheduled into the workshop sessions in CE201, 5pm, Monday in Week 3, Week 5, Week 9.

Assessment 2: GPS/GNSS Practical Report

Length: GPS/GNSS practical report may have 30-35 pages

Details:

Each student will be a member of a group of 3-4 students to carry out the GPS/GNSS positioning filed work. The joint submission for the GPS/GNSS practical report requires considerable interaction between the students. Further information about the practical will be distributed during the lectures. All the practical reports are assessed in terms of: 1) Presentation (20%); 2) Field Notes and Computations (40%); 3) In-depth discussions on relevant issues (40%). The detailed marking scheme will be provided together with the practical instruction in Week 5.

Additional details:

If a student is unable to submit on time due to illness or other legitimate reason, then a brief written explanation must be given to the lecturer for consideration as soon as is feasible. In some cases the lecturer may grant an extension to the submission date provided he has been contacted before the due date. Otherwise, the marks for late submissions will be reduced: -10% (of the maximum mark) for each day late.

Submission notes: This is a group report.

Assessment 3: Class Discussion Presentations

Start date: Not Applicable

Length: 6-8 minutes for each presentation

Details:

Students should regularly attend the lectures/workshops and participate actively in class discussions during the lectures/workshops. The students are invited to give two short presentations to the classes in Weeks 7 and 10. These short presentations will offer the opportunities for students, a) to demonstrate and enhance their understanding of the concepts covered in the lectures; b) to establish links between the concepts and real world applications of these concepts, c) to develop technical presentation skills. The detailed marking scheme will be provided together with the class presentation instructions in Week 2 and 6.

Additional details:

Student presentations for the class discussions wil be scheduled during the Workshop sessions in Week 7 and Week 10.

Submission notes: Presentation PPT slides are submitted for feedback 2-3 days before the scheduled preasentation

Assessment 4: Final Exam

Start date: Not Applicable

Length: 2 hours

Details:

Final Exam will be of 2 hours duration. and will be held in the formal examination period, in closed book format, but the complicated formulae to be used in the exam will be provided in the examination paper. The final exam will cover all the contents covered in the course teaching activities. Past sample exam questions and answers will be provided to the class as part of revision in Week 10. The formal exam scripts will not be returned. The final mark for the course will be officially available to you via myUNSW. You may find the key dates for the UNSW exams at: https://student.unsw.edu.au/exam-dates

Additional details:

1. The course coordinator reserves the right to adjust the final marks by scaling if agreed to by the Head of School.
2. Supplementary Examinations for Term 1 2021 will be held by the School, should you be required to sit one. You are required to be available during the dates for the Supplementary Examinations. Please check with the School about the scheduled dates.

Attendance Requirements

The students are expected to attend the lectures, workshops and other teaching activities (such as GPS practicals) scheduled in this course.

Course Schedule

[View class timetable]

Timetable

Date	Type	Content
Week 1: 15 February - 19 February	Lecture	Course Outline. Fundamentals of Positioning; Introduction to Geodesy. Geodesy and Earth Motion
	Workshop	Introduction to Sun Tracking;; Use of Matlab for geodetic computations; Surveying vs Geodesy
Week 2: 22 February - 26 February	Lecture	Concepts of Reference Systems and Reference Frames; Coordinate Transformation
	Workshop	Case Study: Reference Frames
Week 3: 1 March - 5 March	Lecture	Time systems; Positioning, Navigation and Timing (PNT); Reference Systems/Frames in Geodesy and Astronomy
	Workshop	Review of Sun Tracking; Case studies: Coordinate Transformations; Positioning, Navigation and Timing (PNT)
Week 4: 8 March - 12 March	Lecture	Terrestrial Positioning and Horizontal Geodetic Datums; Practical review of datums; Earth's Gravity Field; Geoid and Gravity Models; Heights and vertical datums.
	Workshop	Case Studies; Gravity measurements from smartphones; GDA Technical manual and Height datums. Preparation of Class Discussions on Sun Tracking
Week 5: 15 March - 19 March	Lecture	GPS SPP revision, error sources and RTK GPS/GNSS Surveying; Practical use of RTK GPS/GNSS
	Workshop	Case study: GPS/GNSS measurements and geometric strength analysis; Preparation for GNSS RTK Practical
Week 6: 22 March - 26 March	Fieldwork	Field Trip Week (This time slot rescheduled for Sun Tracking activities)- No class
Week 7: 29 March - 2 April	Lecture	Spherical and Ellipsoidal Computations; Reduction of observations;
	Workshop	**Class Discussion A:** Presentations on Sun Tracking results
Week 8: 5 April - 9 April	Lecture	Map Projections: Concepts, classifications, Basic map projection theory; Geodetic computations on

		ellipsoid;
	Workshop	**Easter Monday** (This time slot rescheduled for Sun Tracking activities)-
Week 9: 12 April - 16 April	Lecture	Transverse Mercator Projection; Lambert Conformal Conic Projection; Grid computations: Zone to zone
	Workshop	Case Study: GDA/MGA coordinate transformations
Week 10: 19 April - 23 April	Lecture	Image coordinates and transformation; 3D Point Cloud; Review of GNSS practical results; Course Revisions.
	Workshop	**Class Discussion B:** Presentations on geodesy and geospatial reference frames; Future trends in positioning and mapping, Surveying

Resources

Prescribed Resources

Lecture Materials

The course materials will be available through "Moodle": http://moodle.telt.unsw.edu.au/

The Power Point lecture slides are available for download as PDF files at the course website.

Electronic resources on the lecture topics are available at the course website.

The class notes, latest journal articles and references related the course topics will be referred to and/or distributed during the lectures.

Text and Reference Books

Rizos C. (1997) *Principles and Practice of GPS Surveying*, Monograph No. 17, School of Surveying and Spatial Information Systems, UNSW. Online at:
http://www.sage.unsw.edu.au/about/school_pubs/pdfmono/mono17.pdf

Bossler, J., Jenson, J., Mcmaster, R., & Rizos, C. (eds.) (2002). *Manual of Geospatial Science and Technology*. Taylor & Francis Inc., ISBN 0-7484-0924-6, 623pp.

Mather, R.S. (1978) *The Theory and Geodetic Use of Some Common Projections*, Monograph 1, School of Surveying & Spatial Information Systems, UNSW.

Online at: **http://www.sage.unsw.edu.au/about/school_pubs/pdfmono/mono1.pdf**

Stolz, A. (2001) *An Introduction to Geodesy*, Monograph 16, School of Surveying & Spatial Information Systems, UNSW. Online at:
http://www.sage.unsw.edu.au/about/school_pubs/pdfmono/mono16.pdf

Recommended Resources

Computational Aids

Pocket calculators are required during lecturing hours, for exercises and practicals in this course. They have to be hand-held, internally powered and silent. They must be brought to all lectures and practicals.

Computer software relevant to this course and available in the School's computer lab CE611/201, includes: Matlab or MicroSoft Excel, which will be used for exercises and GPS practical reports, see the practical instructions for details.

Course Evaluation and Development

Students are encouraged to engage into all the teaching activities, and the feedback from students on any aspects of the course is always welcome. There will be regular chats with individual or groups of students, to deal with any potential difficulties in learning. As a small class, we have all the advantages to collect feedback and address any concerns in a timely manner.

This course has been a core subject for the UNSW surveying program over past few decades. The contents and teaching resources have been developed over the years. Some concerns on the complex mathematical aspects of the courses had mentioned by the past students, but this has been addressed with the activities focusing on the concepts behind the formulaes and additonal comoutational tools such as Matlab to gain more more insights into the complex equations.

Laboratory Workshop Information

6 GNSS RTK receivers from the Survey Store will be used for GPS/GNSS practical field work

Submission of Assessment Tasks

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

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

Key UNSW Dates - eg. Census Date, exam dates, last day to drop a course without academic/financial liability etc.

Final Examinations:

Final exams in Term 1 will be held online between 30th April - 13th May inclusive. You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

Supplementary Examinations:

Supplementary Examinations for Term 1 2021 will be held on 24th - 28th May inclusive should you be required to sit one. You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

ACADEMIC ADVICE

For information about:

- Notes on assessments and plagiarism;
- Special Considerations: student.unsw.edu.au/special-consideration;
- General and Program-specific questions: The Nucleus: Student Hub
- Year Managers and Grievance Officer of Teaching and Learning Committee, and
- CEVSOC/SURVSOC/CEPCA

Refer to Academic Advice on the School website available at:

https://www.engineering.unsw.edu.au/civil-engineering/student-resources/policies-procedures-and-forms/academic-advice

Image Credit

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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	