UNSW Course Outline

GMAT2700 Foundations of Geodesy & Geospatial Ref Frames - 2024

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General Course Information

Course Code : GMAT2700
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : School of Civil and Environmental Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Undergraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Positioning and timing are critical aspects in surveying, mapping, navigation, and beyond. This

course will explore the fundamentals of positioning and timing, including the definitions of modern geospatial reference frames and widely used coordinate systems, such as, International Terrestrial Reference Frames (ITRF), Geocentric Datum of Australia (GDA), Australian Height Datum (AHD). The course offers an in-depth understanding of geodetic theories on the Earth's shape, gravity field, geoid, reference ellipsoid and map projections. You will use precise GPS/GNSS positioning instruments to define reference frames, as well as to determine coordinates of points in the frame.

Course Aims

1. 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.

2. 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.

3. 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.

4. 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.

5. 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.

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

Relationship to Other Courses

Pre-requisites: GMAT1110

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Explain the definition of geodesy and its major tasks
CLO2 : Explain the basic concepts of the reference and coordinate systems and coordinate transformations.
CLO3 : Describe the purposes and methods of map projections
CLO4 : Identify the geodetic reference frames (datums) and map projection systems used in practice
CLO5 : Explain the concept of satellite-based precise positioning technology
CLO6 : Use GPS/GNSS to define reference frames and determine the coordinates of points in a frame

Course Learning Outcomes	Assessment Item
CLO1 : Explain the definition of geodesy and its major tasks	• Quizzes • GPS/GNSS Practical Report • Class Discussion Presentations • Final Exam
CLO2 : Explain the basic concepts of the reference and coordinate systems and coordinate transformations.	• Quizzes • GPS/GNSS Practical Report • Class Discussion Presentations • Final Exam
CLO3 : Describe the purposes and methods of map projections	• Quizzes • GPS/GNSS Practical Report • Class Discussion Presentations • Final Exam
CLO4 : Identify the geodetic reference frames (datums) and map projection systems used in practice	• Quizzes • GPS/GNSS Practical Report • Class Discussion Presentations • Final Exam
CLO5 : Explain the concept of satellite-based precise positioning technology	• Quizzes • GPS/GNSS Practical Report • Class Discussion Presentations • Final Exam
CLO6 : Use GPS/GNSS to define reference frames and determine the coordinates of points in a frame	• Quizzes • GPS/GNSS Practical Report • Class Discussion Presentations • Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System

Other Professional Outcomes

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

Additional Course Information

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 coorindate 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.

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.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Quizzes Assessment Format: Individual	30%	Due Date: Thursdays in Weeks 2-5 and 8-9
GPS/GNSS Practical Report Assessment Format: Group	10%	Due Date: Friday, Week 9
Class Discussion Presentations Assessment Format: Individual	20%	Due Date: Tuesdays in Weeks 3, 5, 8, 10
Final Exam Assessment Format: Individual	40%	Due Date: Exam time to be scheduled

Assessment Details

Quizzes

Assessment Overview

To reinforce the learning experience, a total of six quizzes will be given in closed book format during class. 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..

Course Learning Outcomes

- CLO1 : Explain the definition of geodesy and its major tasks
- CLO2 : Explain the basic concepts of the reference and coordinate systems and coordinate transformations.
- CLO3 : Describe the purposes and methods of map projections
- CLO4 : Identify the geodetic reference frames (datums) and map projection systems used in practice
- CLO5 : Explain the concept of satellite-based precise positioning technology
- CLO6 : Use GPS/GNSS to define reference frames and determine the coordinates of points in a frame

Detailed Assessment Description

Quizzes will include various types of questions: short-answer questions, multiple choice qustions and problem-solving questions.

Assessment Length

Each Quiz will take about 15 minutes

Submission notes

Quizzes will be scheduled in the classes on Thursdays in Weeks 2-5 and 8-9

Assignment submission Turnitin type

This is not a Turnitin assignment

GPS/GNSS Practical Report

Assessment Overview

Each student will be a member of a group of 4-6 students to carry out the GPS/GNSS positioning filed work. Successful GPS/GNSS practical activities require considerable interaction between the students. Further information about the practical activities will be distributed during the

lectures. Building upon the collective efforts of collecting data, each student will carry out independent data analysis and submit an individual report. All the practical reports are assessed in terms of: 1) Presentation 2) Field Notes and Computations 3) In-depth discussions on relevant issues The detailed marking scheme will be provided together with the practical activity instruction.

Course Learning Outcomes

- CLO1 : Explain the definition of geodesy and its major tasks
- CLO2 : Explain the basic concepts of the reference and coordinate systems and coordinate transformations.
- CLO3 : Describe the purposes and methods of map projections
- CLO4 : Identify the geodetic reference frames (datums) and map projection systems used in practice
- CLO5 : Explain the concept of satellite-based precise positioning technology
- CLO6 : Use GPS/GNSS to define reference frames and determine the coordinates of points in a frame

Detailed Assessment Description

Based on the field work and data collected by the group, group reports and individual (reflection) reports are submitted for assessments.

Assessment Length

GPS/GNSS practical reports may have 10-20 pages

Assignment submission Turnitin type

This is not a Turnitin assignment

Class Discussion Presentations

Assessment Overview

Students should regularly attend the lectures and participate actively in workshop class discussions. The students are invited to give four short presentations to the class. 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 articulate relevant problems and issues in learning, d) to develop technical presentation skills. The detailed marking scheme will be provided together with the class presentation instructions in the week before each presentation.

Course Learning Outcomes

- CLO1 : Explain the definition of geodesy and its major tasks

- CLO2 : Explain the basic concepts of the reference and coordinate systems and coordinate transformations.
- CLO3 : Describe the purposes and methods of map projections
- CLO4 : Identify the geodetic reference frames (datums) and map projection systems used in practice
- CLO5 : Explain the concept of satellite-based precise positioning technology
- CLO6 : Use GPS/GNSS to define reference frames and determine the coordinates of points in a frame

Detailed Assessment Description

The topics of these class discussions will cover major aspects of this course: Geodesy, Reference Frames, GNSS and Map Projections. It is expected that the whole process of individual preparation and exchanges of insights among the participants during the discussions will facilitate the advanced investigative studies to achieve better learning experiences and outcomes.

Assessment Length

5 minutes for each presentation

Submission notes

Presentation PPT slides are submitted for feedback 2-3 days before the scheduled presentation

Assignment submission Turnitin type

This is not a Turnitin assignment

Final Exam

Assessment Overview

The final exam will be of 2 hours duration and will be held in the formal examination period. All content from the course may be assessed.

Course Learning Outcomes

- CLO1 : Explain the definition of geodesy and its major tasks
- CLO2 : Explain the basic concepts of the reference and coordinate systems and coordinate transformations.
- CLO3 : Describe the purposes and methods of map projections
- CLO4 : Identify the geodetic reference frames (datums) and map projection systems used in practice
- CLO5 : Explain the concept of satellite-based precise positioning technology
- CLO6 : Use GPS/GNSS to define reference frames and determine the coordinates of points in a frame

Detailed Assessment Description

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.

Assessment Length

2 hours

Assessment information

The course coordinator reserves the right to adjust the final marks by scaling if agreed to by the Head of School. Supplementary Examinations 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.

Assignment submission Turnitin type

This is not a Turnitin assignment

General Assessment Information

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 27 May - 2 June	Lecture	Course Outline. Fundamentals of Positioning; Introduction to Geodesy. Geodesy and Earth Motion.
	Workshop	Introduction to Sun Tracking; Use of Matlab for geodetic computations; Discussions on Surveying vs Geodesy; The Surveyor 4.0
Week 2 : 3 June - 9 June	Lecture	Concepts of Reference Systems and Reference Frames; Coordinate Transformation. Quiz 1 on Thursday.
	Workshop	Case Studies: Reference Frames; Review of Sun Tracking progress. Preparation on Class Discussion A
Week 3 : 10 June - 16 June	Lecture	Time systems; Positioning, Navigation and Timing (PNT); Reference Systems/ Frames in Geodesy and Astronomy; Terrestrial Positioning and Horizontal Geodetic Datums; Practical review of datums; Quiz 2 on Thursday
	Workshop	Case study on coordinate transformations. Class Discussion A on meaning of coordinates, positining concept, geodesy vs surveying.
Week 4 : 17 June - 23 June	Lecture	Earth's Gravity Field; Geoid and Gravity Models; Heights and vertical datums. Quiz 3 on Thursday
	Workshop	Case Studies; Gravity measurements from smartphones; GDA Technical manual and Height datums. Preparation of Class Discussions B on Sun Tracking
Week 5 : 24 June - 30 June	Lecture	GPS SPP revision, error sources and RTK GPS/GNSS Surveying; Practical use of RTK GPS/GNSS. Quiz 4 on Thursday
	Workshop	Case study: GPS/GNSS measurements and geometric strength analysis; Preparation for GNSS RTK Practical. Class Discussion B on Sun Tracking
Week 6 : 1 July - 7 July	Fieldwork	Field Trip Week (This time slot rescheduled for Sun Tracking activities) - No class
Week 7 : 8 July - 14 July	Lecture	Classes to be rescheduled for GPS/GNSS practicals and Sun tracking activities.
	Workshop	GPS/GNSS practical (to be rescheduled)
Week 8 : 15 July - 21 July	Lecture	Spherical and Ellipsoidal Computations; Reduction of observations; Map Projections: Concepts, classifications; Map projection theory; Geodetic computations on ellipsoid; Quiz 5 on Thursday
	Workshop	Class Discussion C on aspects of timing, gravity, geoid and GNSS RTK positioning. Review of GNSS practical results.
Week 9 : 22 July - 28 July	Lecture	Transverse Mercator Projection; Lambert Conformal Conic Projection; Grid computations: Zone to zone. Quiz 6 on Thursday
	Workshop	Case Study: GDA/MGA coordinate transformations. Preparation on Class Discussion D
	Assessment	GPS/GNSS Practical Report: Based on the field work and data collected by the group, group reports and individual (reflection) reports are submitted for assessments.
Week 10 : 29 July - 4 August	Lecture	Image coordinates and transformation; 3D Point Cloud; Geospatial Digital Twins; Course Revisions. Locus Charter: ethical and responsible practice when using location data
	Workshop	Class Discussion D: Presentations on geodesy and geospatial reference frames; Future trends in positioning, surveying, mapping and geospatail profession.

Attendance Requirements

Like other UG courses in the School, workshops for this course are compulsory (students are required to attend minimum 80%). If any student has difficulties to meet this attendance requirement, contact the course coordinator for alternative arrangements to cover the classes missed.

Course 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 course website

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 course website

Stolz, A. (2001) An Introduction to Geodesy, Monograph 16, School of Surveying & Spatial Information Systems, UNSW. Online at course website

Locus Charter: Principles to support ethical and responsible practice when using location data https://ethicalgeo.org/locus-charter/

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/ GNSS 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.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Jinling Wang		CE413	61293854203	You may contact me via Teams or email any time.	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

Final Examinations

Final Exams in T2 2024 will be held on campus between the 9th - 22nd August, and Supplementary Exams between the 2nd - 6th September 2024. You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

School Contact Information

For assistance with enrolment, class registration, progression checks and other administrative matters, please see the Nucleus: Student Hub. They are located inside the Library – first right as you enter the main library entrance. You can also contact them via http://unsw.to/webforms or reserve a place in the face-to-face queue using the UniVerse app.

For course administration matters, please contact the Course Coordinator.

Questions about the this course should normally be asked during the scheduled class so that everyone can benefit from the answer and discussion.