School of Civil and Environmental Engineering

Term 1, 2020

GMAT2700 FOUNDATIONS OF GEODESY AND GEOSPATIAL REFERENCE FRAMES

COURSE DETAILS

Units of Credit	6			
Contact hours	6 hours per week			
Class	Monday	4:00pm - 6:00pm	Electrical Engineering G03 (K-G17-G03)	
	Tuesday:	2:00pm - 4:00pm	Mathews Theatre C (K-D23-303)	
Workshop	Tuesday:	4:00pm - 6:00pm	CE 611	

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INFORMATION ABOUT THE COURSE

This 6 UoC course is one of the core subjects in the Bachelor of Engineering in Surveying (Honours) program, the Bachelor of Engineering in Geospatial Engineering (Honours) program as well as the combined Civil/Surveying program. It is based on the courses GMAT1110. Material from GMAT1110 has been structured to run sequentially with material in this course and this will aid in student understanding. This course introduces several fundamental concepts in surveying, geodesy, geospatial engineering, which will be used in forthcoming courses during your studies, such as GMAT3100; GMAT3150, GMAT3500, GMAT3700.

Prerequisites: GMAT1110

HANDBOOK DESCRIPTION

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.

See link to virtual handbook as
http://www.handbook.unsw.edu.au/undergraduate/courses/2020/GMAT2700.html

OBJECTIVES

The objectives of this course are

(a) to enhance your knowledge and skills in surveying and geospatial technology gained in previous studies and professional practices;
(b) to introduce you to the basic concepts of geodesy;
(c) to extend your knowledge base to the areas of geospatial reference systems, geospatial reference

frames/datums, such as GDA/ITRF, and map projections,

(d) to provide you with the concept of satellite-based precise positioning and the skills of defining datums/frames and determining coordinates of points;

(e) to provide an environment that fosters in our students the following attributes:

Attributes	Related to this course
the skills involved in scholarly enquiry	Significant
an in-depth engagement with relevant disciplinary knowledge in its interdisciplinary context	Significant
the capacity for analytical and critical thinking and for creative problem solving	Significant
the ability to engage in independent and reflective learning	Some
the skills to locate, evaluate and use relevant information (Information Literacy)	Some
the capacity for enterprise, initiative and creativity	Minimal
a capacity to contribute to, and work within, the international community	Minimal
the skills required for collaborative and multidisciplinary work	Minimal
a respect for ethical practice and social responsibility	Some
the skills of effective communication.	Significant

More details on how the teaching and learning activities in this course are linked to each of these attributes will be discussed in classes.

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"*.

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

EXPECTED LEARNING OUTCOMES

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

By the end of this Semester you should be able to

Learning Outcomes (LO)		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 geospatial reference systems and frames, gravity field and geoid*	*PE1.2, PE1.3, PE1.4*
3.	*Implement the practical procedures of the transformation between the reference systems/frames and Sun tracking*	*PE1.5, PE2.1, PE2.3*
4.	*Describe the purposes and methods of map projections*	*PE2.2, PE2.3, PE3.3*
5.	*Understand the concept of satellite-based precise positioning technology*	*PE1.2, PE1.3, PE1.4*
6.	*Use GPS/GNSS to define reference frames and determine the coordinates of points in a frame*	*PE2.4, PE3.3, PE3.4*

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.

COURSE PROGRAM

(The time slots for **visiting Sydney Observatory, Sun Tracking, GPS/GNSS Practical** as well as any other changes will be discussed/notified in the class and at the course website).

Week start	Monday – Lectures 4:00pm – 6:00pm	Tuesday - Lectures 2:00pm – 4:00pm	Tuesday – Workshops 4:00pm – 6:00pm
1 17/2	Course Outline. Fundamentals of Positioning; Introduction to Geodesy	Geodesy and Earth Motion	Introduction to Sun Tracking; Use of Matlab for geodetic computations
2 24/2	**Quiz 1** Concepts of Reference Systems and Reference Frames	Coordinate Transformation	Case study: Transforming coordinates
3 2/3	Time systems; Positioning, Navigation and Timing (PNT)	Reference Systems/Frames in Geodesy and Astronomy	Review of Sun Tracking; Case study: Positioning, Navigation and Timing (PNT)
4 9/3	Terrestrial Positioning and Horizontal Geodetic Datums; Practical review of datums	Earth's Gravity Field; Geoid and Gravity Models; Heights and vertical datums	Case study: GDA Technical manual and Height datums Preparation of Class Discussions on Sun Tracking
5 16/3	**Quiz 2** GPS SPP revision, error sources and RTK GPS/GNSS Surveying	Practical use of RTK GPS/GNSS	Case study: GPS/GNSS measurements and geometric strength analysis; Preparation for GNSS RTK Practical
6 23/3	Field Trip Week (This time slot rescheduled for Sun Tracking activities)- No class	Field Trip Week (This time slot rescheduled for visiting Sydney Observatory) – No class	Field Trip Week (This time slot rescheduled for visiting Sydney Observatory) – No class
7 30/3	Spherical and Ellipsoidal Computations; Reduction of observations;	**Class Discussion A:** Presentations on Sun Tracking results	Case Study: Spherical and Ellipsoidal Computations
8 6/4	**Quiz 3** Map Projections: Concepts, classifications, Basic map projection theory; Geodetic computations on ellipsoid	Transverse Mercator Projection; Lambert Conformal Conic Projection; Grid computations: Zone to zone	Case Study: GDA/MGA coordinate transformations
9 13/4	**Easter Monday** (This time slot rescheduled for Sun Tracking activities)-	No class. (This time slot rescheduled for GNSS RTK practical)	No class. (This time slot rescheduled for GNSS RTK practical) **GNSS practical report due**
10 20/4	Image coordinates and transformation; 3D Point Cloud	**Class Discussion B:** Presentations on geodesy and geospatial reference frames; Future trends in positioning and mapping, Surveying	Review of GNSS practical results; Revisions.

ASSESSMENT

Assessment for this course includes:

Assessment Items	Length	Weight	Learning outcomes (LO) assessed	Due date*	Deadline for absolute fail*	Marks returned
Quiz 1	*20 mins*	*5%*	LO: 1, 2	*Week 2*	Week 2	Week 2
Quiz 2	*20 mins*	*10%*	LO: 2, 3	*Week 5*	Week 5	Week 5
Quiz 3	*20 mins*	*10%*	LO: 4	*Week 8*	Week 8	Week 8
GNSS practical report	30 pages	15%	LO: 5, 5	Week 9	Week 10	Week 11
Class presentation A	10 mins	10%	LO: 2, 3	Week 7	Week 7	Week 7
Class presentation B	10 mins	10%	LO: 2, 4, 5, 6	Week 10	Week 10	Week 10
Final Exam	2 hours	40%	LO:1, 2, 3, 4, 5, 6			

***Due date/Deadline for absolute fail for the assessment item is the first class in the week specified in the above table.**

Quizzes and Assessment Criteria:
To reinforce the learning experience, quizzes will be given in "closed book" format during the lectures, see the details for the course program. 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.**

Class Discussion Presentations and Assessment Criteria*:*
Students should regularly attend the lectures and participate actively in class discussions during the lectures. The students are invited to give two short presentations to the **class workshops in Week 7 and Week 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 3 and Week 6.**

GPS/GNSS Practical Report and Assessment Criteria
Each student will be a member of a group of 4-6 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 7.**

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 provide to the class as part of revision. 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

Note:

1) 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.
2) The course coordinator reserves the right to adjust the final marks by scaling if agreed to by the Head of School.
3) Supplementary Examinations for Term 1 2020 will be held on Monday 25th – Friday 29th May (inclusive) should you be required to sit one. You are required to be available during these dates. Please do not to make any personal or travel arrangements during this period.

RELEVANT 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**

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.

DATES TO NOTE

Refer to MyUNSW for Important Dates available at:

https://student.unsw.edu.au/dates

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

All assignments and assessment items should be submitted with a signed Assessment Cover Sheet:

I declare that this assessment item is my own work, except where acknowledged, and has not been submitted for academic credit elsewhere, and acknowledge that the assessor of this item may, for the purpose of assessing this item:

Reproduce this assessment item and provide a copy to another member of the University; and/or,

Communicate a copy of this assessment item to a plagiarism checking service (which may then retain a copy of the assessment item on its database for the purpose of future plagiarism checking).

I certify that I have read and understood the University Rules in respect of Student Academic Misconduct.

Signed: .....date: ☐☐ ☐☐ ☐☐

ACADEMIC ADVICE

(Formerly known as Common School Information)

For information about:

- Notes on assessments and plagiarism,
- School policy on Supplementary exams,
- Special Considerations: student.unsw.edu.au/special-consideration
- Solutions to Problems,
- Year Managers and Grievance Officer of Teaching and Learning Committee, and
- CEVSOC.

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

Appendix A: Engineers Australia (EA) Competencies

Stage 1 Competencies for Professional Engineers

	Program Intended Learning Outcomes
PE1: Knowledge and Skill Base	PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals
	PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing
	PE1.3 In-depth understanding of specialist bodies of knowledge
	PE1.4 Discernment of knowledge development and research directions
	PE1.5 Knowledge of engineering design practice
	PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice
PE2: Engineering Application Ability	PE2.1 Application of established engineering methods to complex 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
PE3: Professional and Personal Attributes	PE3.1 Ethical conduct and professional accountability
	PE3.2 Effective oral and written communication (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