GMAT2700 Foundations of Geodesy and Geospatial Reference Frames

Semester 2, 2016

Never Stand Still | Faculty of Engineering | School of Civil and Environmental Engineering

COURSE DETAILS

Units of Credit	6	
Contact hours	5 hours per week	
Class	Wednesday: 13:00 - 15:00	CE G6
	Thursday: 10:00 - 12:00	CE G6
Exercises	Thursday: 12:00 - 13:00	CE 611
Course Coordinator and Lecturer	Jinling Wang email: jinling.wang@unsw.edu.au office: CE413 phone: 9385 4203	
Lecturer	Craig Roberts email: c.roberts@unsw.edu.au office: CE412 phone: 9385 4464	

INFORMATION ABOUT THE COURSE

This 6 UoC course is one of the core subjects in the Bachelor of Engineering in Surveying (Honours) program and the Bachelor of Engineering in Geospatial Engineering (Honours) program. It is based on the courses GMAT1110, GMAT2120 and GMAT 2500. This course will be concurrently run with GMAT2550. Material from these two courses 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 Co requisite: MATH2089, GMAT2500, GMAT2120

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
www.handbook.unsw.edu.au/undergraduate/courses/2016/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
an appreciation of and respect for, diversity	
a capacity to contribute to, and work within, the international community	Minimal
the skills required for collaborative and multidisciplinary work	Minimal
an appreciation of, and a responsiveness to, change	
a respect for ethical practice and social responsibility	
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) Exercises and computing tasks;
3) GPS/GNSS practical;
4) Regular quizzes, and discussions on the questions from the quizzes;
5) Essay writing;
6) 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
Exercises	• Practice solving set problems • Ask questions
Assessments (Quizzes, 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

By the end of this Semester you should be able to

(a) Explain the definition of geodesy and its major tasks;
(b) Understand the basic concepts of geospatial reference systems and frames;
(c) Implement the practical procedures of the transformation between the reference systems/frames;
(d) Describe the purposes and methods of map projections;
(f) Identify the geodetic reference frames (datums) and map projection systems used in practice;
(e) Understand the concept of satellite-based precise positioning technology;
(g) Use GPS/GNSS to define reference frames and determine the coordinates of points in a frame.

At UNSW, the normal workload expectations of a student are 24-28 hours per semester for each 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 2.5 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.

ASSESSMENT

Assessment for the course includes:

- Mini-quizzes 10%
- Exercises 10%
- GPS/GNSS practical report 10% (group submissions, due week 7)
- Essay task 10% (individual submissions, due week 11)
- Sun Tracking Assignment 10% (individual submissions, due week 12)
- Class discussion/participation 10%
- Final Exam 40% (during formal exam period)

***Mini-Quizzes**:*
To reinforce the learning experience, mini-quizzes will be given during the lectures. Simple questions will be asked on the material presented in the PREVIOUS lecturing period.

GPS/GNSS Practical Report
Each student will be a member of a group of 3-4 students to carry out the GPS/GNSS positioning exercises. The details of the requirements and assessment will be documented separately.

***Class Discussions/Participation**:*
Students should regularly attend the lectures and participate actively in class discussions during the lectures. In addition, students are invited to give a short presentation to the class workshop in Week 12. The attendance at the scheduled classes (including practicals) is necessary to achieve a satisfactory learning outcome from this course.

The Essay Task, Sun Tracking assignment and **Exercises** (including the GDA assignment) will be documented separately and distributed to you during the lectures and laboratory exercises sessions. *Any changes to the above assessment arrangement will be notified in the class and will also be updated at the course website*. *All the marking schedules will be explained to the class.*

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 formal exam scripts will not be returned.

Students who perform poorly in the mini-quizzes and exercises are recommended to discuss progress with the lecturer during the semester.

Note:

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.

COURSE PROGRAM

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

Week start	Wednesday – Lecture 13:00 – 15:00 CE G6	Thursday - Lecture 10:00 – 12:00 CE G6	Thursday – Exercises 12:00 – 13:00, CE611
1 25/7	Course Outline. Fundamentals of Positioning; Introduction to Geodesy; Discussions	Geodesy and Earth Motion	
2 1/8	Concepts of Reference Systems and Reference Frames	Coordinate Transformation	Use Matlab for Geodetic Computations; Introduction to Sun Tracking
3 8/8	**Quiz 1** Time systems	Reference Systems/Frames in Geodesy and Astronomy	Transforming Coordinates
4 15/8	Terrestrial Positioning and Horizontal Geodetic Datums (**CAR**)	Practical review of datums; GDA Technical manual (**CAR**)	GDA Tech manual assignment (**CAR**)
5 22/8	GPS revision, error sources and RTK GPS Surveying (**CAR**):	Practical use of RTK GPS and pitfalls (**CAR)**	The new SP1, SU, RU, PU and Class/ order (**CAR**)
6 29/8	*RTK GPS prac exercise (**CAR**)	**RTK GPS prac exercise (**CAR**)*	**RTK GPS prac exercise (**CAR**)*
7 5/9	**Quiz 2 (CAR)** Earth's Gravity Field; Geoid and Gravity Models;	Heights and vertical datums	Web-resources on heights/vertical datums (**GPS/GNSS report due**)
8 12/9	Spherical and Ellipsoidal Geometry	Reduction of observations onto reference ellipsoid	Spherical and Ellipsoidal Computations
9 19/9	Map Projections: Concepts and classifications	Geodetic Computations on Ellipsoid Basic Map Projection theory	Direct/ inverse solutions
Break 26/9	**Mid-Session Break**	**Mid-Session Break**	**Mid-Session Break**
10 3/10	No class (This time slot rescheduled for Sun Tracking activities)	No class. (This time slot rescheduled for visit to Sydney Observatory)	No class. (This time slot rescheduled for visit to Sydney Observatory
11 10/10	**Quiz 3** Transverse Mercator Projection	Lambert Conformal Conic Projection; Grid computations: Zone to zone	Projection computations **(Essay report due)**
12 17/10	Image coordinates and transformation	Review Sun tracking results/Preparation for class discussions	Class Discussions
13 24/10	Invited Lecture/Class Discussions	Revisions	

*****The time slot is to be rescheduled for practicals

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.gmat.unsw.edu.au/snap/gps/gps_survey/principles_gps.htm**

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. (1972) *The Theory and Geodetic Use of Some Common Projections*, Monograph 1, School of Surveying & Spatial Information Systems, UNSW.

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

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,
- 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:

http://www.engineering.unsw.edu.au/civil-engineering/resources/academic-advice