GMAT3700 Geodetic Positioning & Applications

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 (average)	
Class	Monday, 10:00 - 12:00	BUS105
	Tuesday, 15:00 - 17:00	BUS105
	Tuesday, 17:00 – 18:00	CE201
Course Coordinator & Lecturer	Chris Rizos email: c.rizos@unsw.edu.au Office: CE415 office: 93854205 phone	
Lecturer	Craig Roberts Email: c.roberts@unsw.edu.au Office: CE412	

INFORMATION ABOUT THE COURSE

This course is a 3rd year undergraduate 6UOC course in the B.E. programs.

HANDBOOK DESCRIPTION

http://www.handbook.unsw.edu.au/undergraduate/courses/2016/GMAT3700.html

OBJECTIVES

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 exercise to complement lectures and class discussions for a greater understanding of precise GPS/GNSS positioning principles and the use of 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, the IGS and the Global Geodetic Observing System.

This course aims to introduce you to:

(a) Fundamentals of Modern Geodesy, its applications & technologies, as well as how it is organised at a global, international level (IAG, IGS, GGOS)
(b) Basic concepts of precise GPS/GNSS positioning, including observation modelling & data processing
(c) Differential and Precise Point Positioning modes of positioning, including reference frame implications
(d) Practical procedures for GPS/GNSS, including fieldwork and computations
(e) different modes of precise GPS/GNSS positioning, principally post-processed
(f) different precise positioning applications, such as the establishment of control networks, densification of control and trajectory determination using carrier phase-based techniques
(g) Datum issues associated with precise GPS/GNSS positioning, especially in Australia

TEACHING STRATEGIES

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

1) Weekly lectures
2) Field exercise
3) Quizzes & discussions
4) Final examination

The lectures will provide the foundation to the course. The workshops, computational exercises, field exercise and quizzes/exam are intended to address the basic objectives of the course.

The most important factors in learning are the students' commitment and learning methods. You are encouraged to attend all the lectures and other teaching activities. In addition, relevant resources on the web are of great help in understanding the basic concepts of GPS/GNSS positioning discussed in the lectures. An important component of this course will be based on the actual conduct of a static GPS field exercise, and the processing of the data collected.

EXPECTED LEARNING OUTCOMES

By the end of this course the student should be able to:

(a) Explain the principles of GPS/GNSS precise positioning using carrier phase measurements, including the mathematical algorithms.
(b) Understand the GPS/GNSS errors and how Differential GPS/GNSS and Precise Point Positioning can be used to improve positioning accuracy.
(c) Understand the different ways in which GPS/GNSS field work can be conducted, for different applications, and the planning and testing procedures necessary.
(d) Understand the role precise GPS/GNSS positioning plays in support of geospatial data acquisition, point coordination, and Modern Geodesy.

ASSESSMENT

Assessment for the course consists of:

- Mini-quizzes**:** 10%
- Class presentation: 10%
- Essay submission: 15%
- Field exercise report: 30%
- Final examination: 35%

Mini-Quizzes

To reinforce the learning experience, short mini-quizzes will be given during the lecture period. Short questions will be asked on the material presented in the PREVIOUS lecture.

Essay Submission & Presentation

Several topics will require a written essay-type submission by the students. The essay report will be evaluated according to: a) presentation; b) clarity; and c) in-depth discussion on the relevant issues. A 15min presentation in class will also be required.

GPS Practical & Computations Report

One GPS practical will be conducted for the determination of *Static Geodetic Baselines.* 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 relevant issues. Further information about the practicals will be distributed during the lectures, and will be made available on the class web site.

Final Examination

The final examination will cover all topics related to precise positioning and modern geodesy. It will be a closed book examination.

COURSE PROGRAM

Week No. **(Start Date)**	**Lectures** **Monday: 10am-12noon** **BUS105**	**Lectures** **Tuesday: 3-5pm** **BUS105**	**Discussion & Computations** **Tuesday: 5-6pm** **CE201**
1 (25 July)	Introduction to the course Modern geodesy, geodetic technologies, the IAG & GGOS	Space geodetic applications	**No class**
2 (1 Aug)	Terrestrial reference frames ITRF, WGS84, GDA	Multi-constellation GNSS	Principles of satellite orbital motion
3 (8 Aug)	Introduction to GPS segments, signals & measurements	Basic GPS measurement modelling & positioning	GPS point positioning using pseudo-range measurements
4 (15 Aug)	Introduction to differential GPS positioning using carrier phase measurements	Introduction to differential GPS positioning using carrier phase measurements (cont)	RINEX (& other) formats
5 (22 Aug)	Baseline processing principles & ambiguity resolution	From baselines to networks	Planning & field procedures; standards & specifications for GNSS surveys
6 (29 Aug)	**Class presentations**	**Class presentations**	Using LGO for baseline & network computations
7 (5 Sept)	GDA94 & GDA2020; GNSS geodesy methodology vis-à-vis GNSS surveying	Principles of GNSS RTK & N-RTK positioning	Review of web resources related to CORS networks & GNSS services such as AusPos
8 (12 Sept)	CORS networks & services	**Practical**: GNSS baseline survey	**Practical**: GNSS baseline survey
9 (19 Sept)	Precise Point Positioning (PPP)	Precise Point Positioning (PPP) (cont)	Processing of GNSS baseline survey
	Mid-Session Break	**Mid-Session Break**	**Mid-Session Break**

10 (3 Oct)	**Public Holiday** **No class**	The IGS & its products; GNSS geodesy applications	Review of IGS products
11 (10 Oct)	Datum transformations	GNSS heighting & the use of AusGeoid09	Discussion on transformations
12 (17 Oct)	GNSS & future trends	Surveyors as positioning & coordinate experts	Revision of material
13 (24 Oct)	**No class**	**No class**	Revision of material

RELEVANT RESOURCES

The PPT slides are available for download as **PDF files** at the course Moodle site. The updated versions of the lectures will be uploaded each week before or after the lecture period in which the topic is presented. *Electronic resources on the lecture topics are also available at the course Moodle website.*

There is no text book for this course. The following general reference books will assist the student:

Guide to GPS Positioning, D. Wells, et al., Canadian GPS Associates, 1986.

Global Positioning System: Theory and Applications, J. Spilker & B. Parkinson (eds.), Vol. I & II, AIAA, 1996.

Understanding GPS: Principles & Applications, E. Kaplan & C.J. Hegarty (eds.), Artech House, 2nd ed., 2006.

GPS Positioning Guide, Geodetic Survey Division, EMR Canada, 1993.

GPS Manual, Principles & Applications, S. Dye & F. Baylin, Baylin Pubs., 1997.

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 and P. Enge, Ganga-Jamuna Press, 2001.

GPS Satellite Surveying, A. Leick, 3rd Edition, J. Wiley & Sons, 2004.

Computer software relevant to this course and available in the School's computer lab CE201, includes Matlab and Leica Geo-Office (LGO).

DATES TO NOTE

Refer to MyUNSW for Important Dates available at:

https://my.unsw.edu.au/student/resources/KeyDates.html

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 ADVICE

Refer to Academic Advice on the School website:

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

Expected Workload

At UNSW, the normal workload expectations of a student are 25-30 hours per session for each Unit Of Credit (UOC), including class contact hours, preparation and time spent on all assessable work. Hence 150-180 hours in total.

Academic Rules

Students should read the University Calendar (http://www.handbook.unsw.edu.au/general/2016/SSAPO/GeneralRules.html) for University Rules and special considerations.

Students are reminded that the University regards academic misconduct as a very serious matter. Unauthorised material must not be taken into a test or examination. Students are reminded that the University regards academic misconduct as a very serious matter (see https://my.unsw.edu.au/student/atoz/Plagiarism.html). Any work submitted for assessment must be entirely the student's own work. The penalty for any suspected academic misconduct ranges from zero mark for the assignment or exam involved, through failure of the course, to expulsion from the University. If absent from an examination, class test or practical, students must submit written documentation to the University.

Assignments are compulsory parts of the course and must be handed in by the due date. A mark of zero will be given for any submission which violates this rule. OR the marks for late submissions will be reduced as follows: -10% (of the maximum mark) for each 24 hour period late.

If a student is unable to submit on time due to illness or other legitimate reason, then a brief written explanation must be sent by email 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. Further assessment may be granted in this course at the lecturer's discretion.

If students attend less than 80% of classes without due cause they may be asked to “show cause”.

Grievances

In the first instance all grievances should be discussed with the lecturer involved. If the problem cannot be resolved then the Associate Head of the School of Civil & Environmental Engineering (A/Prof Mario Attard) will be involved.

Field Practical Class

If there is light rain field work is on, if rain is heavy then the practical might be postponed. Do not assume a class will be cancelled, attend on time and ask the supervisor. Do not forget umbrellas, water proof jackets, hats, sun cream, sturdy footwear (thongs or sandals are not acceptable), warm clothes, etc.

The practical exercise is an important part of the course as it both provides the student with hands-on experience, but also the data necessary for subsequent computations. The field exercise will be conducted in groups of 3 students, however the calculations and reports require individual work. It is important that each student within a group gets experience in each aspect of each practical. Students are required to read the supplied instructions before the exercise is commenced.

Some advice regarding the picking up, care and handing back of the GPS equipment:

1. *You should first inspect all equipment and make sure that it is in working order, otherwise you will be held responsible.* When returning equipment at the end of the field class, it should be handed back according to

instructions that will be given, piece by piece, so that it can be checked off. Not until all your equipment has been returned and signed off, does your responsibility end.

2. *Any equipment lost or damaged will have to be paid for by the group.* In the field, there is less danger of losing items if everything is laid close to an instrument box or in a group where pedestrians can safely bypass it.

The field GNSS receiver equipment used in this course is expensive. Please take due care of the equipment and give some thought to the way in which you handle it. You will be expected to know how to use the equipment in the field.

Students should not normally leave the field work location during the practical sessions. However students leaving the field for short periods must ask another student to look after their equipment and must inform the student (and the supervisor, if present) of their time of return. *No equipment is to be left unattended in the field at any time*.

Other Matters

Note that this course “Geodetic Positioning & Applications” is offered for the first time in 2016. Prior to 2016 there was a course GMAT3700 “Precise GPS Positioning”, and some of the content of that course has been transferred to this new course. The order in which material is presented has however been changed. Feedback on the course will be gathered by the lecturer in order to improve the course in future years. This feedback will be garnered both informally, as well as by means such as the Course and Teaching Evaluation and Improvement (CATEI) Process.