GMAT2120 Surveying and Geospatial Technology

Semester 1, 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	Monday, 4:00 – 6:00	UNSW Business School 220
Workshop	Wednesday, 2:00 – 3:00	QUAD 1049
Prac	Thursday, 1:00 – 5:00	Survey Store
Course Coordinator and Lecturer	Craig Roberts email: c.roberts@unsw.edu.au office: CE412 phone: 9385 4464	
Lecturer	Rod Eckels email: r.eckels@unsw.edu.au office: off campus phone	

INFORMATION ABOUT THE COURSE

This course is a part of a three year stream of 'pure' surveying measurement courses. It builds on GMAT1110. You should have already passed or been exempt from that course. If you have attempted but failed GMAT1110 then you should contact the course coordinator. This course will run concurrently with GMAT2500. Material from these two courses has been structured to run sequentially with material in this course and this will aid in student understanding. Session two will extend this knowledge in the course GMAT2700 and GMAT2550. Elective GMAT3100 and GMAT3150 in third year will further extend this course.

Prerequisites: GMAT1110 Co requisite: MATH2089, GMAT2500

HANDBOOK DESCRIPTION

www.handbook.unsw.edu.au/undergraduate/courses/2016/GMAT2120.html

OBJECTIVES

The aim of the course is to study surveying instrumentation in depth, particularly precise digital levels, electronic total stations and electronic distance meters EDM.

This course will cover a detailed investigation of some contemporary terrestrial surveying instruments and their use. The course will commence with precise digital levelling (bar code) instruments covering design, accuracy, error sources, precise levelling techniques, errors and calibration. The theory will be supported with a practical exercise. Secondly electronic total stations will be analysed including, circle reading, level sensors, centring systems, constrained centring, precise horizontal and zenith angle measurement, observation procedures and elimination of errors. This theory will be exercised with a larger field project and some minor exercises. Robotic total stations and newer ATR technology will be presented. Leap frog EDM ht traversing will be introduced and a prac exercise will be run. Finally, principles and applications of EDM, phase and pulse measurement techniques, wave propagation in atmosphere, measurement of atmospheric parameters, coefficient of refraction, velocity corrections, geometric

reductions, reductions of distances to the ellipsoid and analysis of errors will be exercised with a field prac exercise. At the conclusion of this course students gain an understanding of the impact specific field techniques and instrumentation have on the attainable precision when conducting terrestrial surveys.

During this course the following attributes will be exercised:

- the skills involved in scholarly enquiry
- an in-depth engagement with relevant disciplinary knowledge in its interdisciplinary context
- the capacity for analytical and critical thinking and for creative problem solving
- the ability to engage in independent and reflective learning
- the skills to locate, evaluate and use relevant information (Information Literacy)
- the capacity for enterprise, initiative and creativity
- an appreciation of, and a responsiveness to, change
- the skills of effective communication

TEACHING STRATEGIES

This course will be taught by two lecturers. We will make use of material prepared by the previous lecturer, A/Prof Jean Rüeger and acknowledge his expertise. This material and teaching methods based on our knowledge and experiences has been modernised. Whilst using this material we will aim to engage you in an understanding of the topics and require you to read the text based material in detail.

We have considered feedback from last year's students in this course and in response will continue to supply electronic teaching materials on moodle. We will endeavour to mark the reports promptly for effective student feedback. We have also made some improvements to the requirements of the pracs so that they can be more easily completed in one practical session.

Attendance and attention at lectures will be expected but will not be sufficient to learn the topics to the level required. There will be a lot of reading required. You will also need to do the calculations, practical assignments and workshop problems. There is a significant practical component to this course. It is important that you prepare thoroughly for the practicals by reading the instructions, visiting the site, and familiarising yourself with the equipment prior to the practical classes.

Private Study	• Review lecture material and textbook • Do set problems and assignments • Reflect on class problems and assignments • Download materials from Moodle • Keep up with notices and find out marks via Moodle
Lectures	• Follow worked examples • Read and re-read lecture and supporting materials on Moodle • Hear announcements on course changes
Workshops	• Be guided by demonstrators • Practice solving set problems • Ask questions
Assessments (practical exercises)	• Experience using high precision equipment • Develop your knowledge and skills • Achieve set tasks to required precision • Prepare professional reports of your work • Demonstrate higher understanding and problem solving

EXPECTED LEARNING OUTCOMES

By the end of this session you should know in detail about, and be able to use, modern electronic digital levels and electronic total stations (including EDM) to obtain the highest precision results with a full understanding of their error sources: magnitude, calibration and correction. Also you should be able to report professionally and thoroughly on results of measurements made with these instruments.

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

- Know how to perform a precise digital levelling survey using a modern bar-code instrument to achieve first/second order quality.
- Know how to observe high precision horizontal and vertical directions with a modern electronic total station.
- Perform reductions of observations from various field exercises and all associated statistics that indicate the precision of these observations.
- Know how to perform a leap frog EDM height traverse using a modern total station to achieve first/second order quality.
- Develop efficient field work practices such as skill with various surveying instruments, forward planning for survey tasks, production of clear field notes and redundant field checks to ensure accuracy.
- Understand the relationships between the various instruments, techniques and errors that indicate the accuracy of the resulting measurements.

For each hour of contact it is expected that you will put in at least 1.5 hours of private study.

ASSESSMENT

Assessment for the course includes:

P1 Laser levelling prac	5%	Due 1 week after fieldwork
P2 report (Levelling prac)	10%	Due 2 weeks after fieldwork
Levelling ass	5%	Due 1 week after allocation
P3 report (EDM)	10%	Due 2 weeks after fieldwork
P4 report (Leap frog)	10%	Due 2 weeks after fieldwork
P5 report (Angle resec)	10%	Due 2 weeks after fieldwork
P6 report (Mini Prac)	5%	Due on day of prac
Practical Exam	10%	Week 12 or 13
Final Exam	35%	In formal exam period

Practicals:

Each student will be a member of a group of 3 (or occasionally 2) students. Groups will be established during the first lecture. Students are free to select their partners; however students are advised to select their partners very carefully. Students that do not attend the first lecture, or cannot find a partner, will be put in a group by the lecturer. Get the address, mobile phone number, e-mail address, etc. of your group members immediately after the formation of the group. The joint (or individual) submissions for the practicals require considerable interaction between the students. Make sure that all field data are copied immediately after the fieldwork, so that all the students in the group have access to the data. Further information about the practicals will be distributed during the lectures, and are available on the class web site. Rules for practicals are given below.

All practicals (except mini-pracs) require individual reports by the students, even if the fieldwork was shared. Submissions are to be handed to the lecturer supervising the practical (or slip under their office door with appropriate title page) before the due date.

Reports must follow the instructions given in the handout "Submission of Reports". (A sample report is given on the course web site) Submissions have to include a declaration on the authorship of the work. Each submission is to have a title page (title of assignment, date of submission, course code, course name, student number, name of student) and a summary of results page. Word processed submissions are not required but encouraged. Spreadsheets may be used for computations as long as they are designed by the student. This should also be emailed with an appropriate file name ie John_Smith_GMAT2120_Prac 2.xls to aid organisation for the lecturer.

Each practical has instructions about computations and reporting. It is strongly recommended that student reports are written in the same sequence and with the same headings.

COURSE PROGRAM SEMESTER 1, 2016

Week start	Monday 4 - 6 pm UNSW Business School 220	Wednesday 2 - 3 pm QUAD 1049	Thursday 1 - 5pm Store EEG16
1 **29/2**	**L:** Introduction to Course (C). Revision of Levelling, Intro to precise levelling types (R) **L:** Principle of Digital Levels. (R)	**L:** Errors of precision digital levels (R)	**P1:** Collimation Test mini prac & rotating laser levelling of a grid (R)
2 **7/3**	**L:** Reduction of precise levelling data. Error analysis. Std & Specs. (R)	**T:** Prepare for prac. Booking, recording of precise levelling (R) *Levelling Assignment*	**P2:** Precise level run prac around campus (R) *(Level Prac due 24/3)*
3 **14/3**	**L:** Adjustment and error analysis of double run precision levelling (R)	**T:** Statistics of precise level reductions. (R)	**L#:** Historical Devel of EDM; Physical laws, principles/apps of EDM (C)
4 **21/3**	**L:** Propagation of Radiowaves through the atmosphere; Coefficient of refraction; Measurement of atmospheric parameters. (C)	**T:** Basic working principles of EDM. Class discussions. (C) *Levelling Assignment due*	**L#:** Geometrical corrections; Classification of EDM; EDM reflectors; Legal traceability. (C)
	MID	**SESSION**	**BREAK**
5 **4/4**	**APAS Conf**	**T:** Demonstration of meteorological instruments; Computation of humidity and e & Prac Briefing (C)	**P3:** EDM long line measurement and reduction (C/R) (Prac due 22/4)
6 **11/4**	**L:** Trig heighting, effects of earth curvature and refraction.	**T:** EDM Prac computations (C) *CE201*	
7 **18/4**	**L:** Trig heighting observation procedures, precision of heights. EDM-height traversing.	**T:** Trig heighting questions – create excel sheet *CE201*	**P4:** Leap frog EDM Height traversing (C/R) *(Prac due 6/5)*
8 **25/4**	**ANZAC Day**	**L:** Introduction to Electronic Theodolites and components. Using a theod. for precision (C)	**L#:** Precision direction measurement. Arcs of dirs booking /recording, error analysis. (C)
9# **2/5**	**No Lecture**		
10 **9/5**	**L:** Electronic Levels Sensors, Electronic Data Recording (C) **L:** Error of Horizontal Coll, Incl of Trun axis, Circle Eccentricity (C)	**T:** Prac Briefing (C) **T:** Booking / reduction of directions and zenith angles (C)	**P5:** Angle Resection and Trig. Heighting Obs (C) (Angle prac due 27/5)
11 **16/5**	**L:** Correction of Dir and Zen Angles for non-vert of VA, Index Corr of Vertical Circle / Level Sensor, circle graduation and other errors (C)	**T:** Angles prac computations in CE201 lab **T:** Principle of Digital Theods (C)	**P6:** Mini prac. Total station exercises (C) *(hand up in field)*
12 **23/5**	**L:** Robotic Total Stations and advances on standard digital theodolites (C)		Guest Lecture – Latest Total Stations – (C) *Practical exam (TBA)*
13 **30/5**		**T:** Practice exam and revision of theodolite errors (C)	

- FIG NZ, L# - Lectures in QUAD1001 from 2 – 4pm.

RELEVANT RESOURCES

Lecture Material can be found on the course website: **http://moodle.telt.unsw.edu.au/**

Messages and files for this course can be downloaded from the course website. Monitor the site during session because it will be updated regularly. The Powerpoint lecture slides are available for download as PDF files at the course website. The website material is only for use by students enrolled in this course.

The lecture material will be supplemented by numerous other materials which will be listed in lectures and various websites.

Reference Books

Some of these books are kept in "OPEN RESERVE" by the University Library.

Rüeger, J. M. 1996. Electronic Distance Measurement – An Introduction. 4th ed., Springer-Verlag, Berlin-Heidelberg-New York. Is out of print but one copy is kept in Open Reserve.

Uren, J & Price, WF. "Surveying for Engineers", 5th edition, 2010

Bannister, A., Raymond, S. & Baker, R. Surveying. 1992. 6th edition, Longman, England

Harvey, B. R. 2006. Practical Least Squares and Statistics for Surveyors, 3rd ed., Monograph No. 13, School of Surveying and Spatial Information Systems, University of New South Wales, 319 pages

Rüeger, J. M. 2003. Electronic Surveying Instruments – A Review of Principles, Problems and Procedures, Monograph No. 18, School of Surveying & SIS, University of New South Wales, 156 + x pages

Cooper, M. A. R., Modern Theodolites and Levels. 2nd ed., Granada, 1982

Deumlich, F. Surveying Instruments, Walter de Gruyter, Berlin, 1982

Kahmen, H., Faig, W. Surveying. Walter de Gruyter, Berlin, 1988

Muskett, J. Site Surveying, 2nd ed., Blackwell Science, Oxford, 1995

Uren, J & Price, WF, Surveying for Engineers, 4th edition, 2006

Computational Aids

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

Students may bring their own calculators to the exam but they must be approved calculators. The list of "approved" calculators is the same as that published by the Board of Studies NSW at

https://student.unsw.edu.au/exam-approved-calculators-and-computers

Students must attain a tamper proof sticker from the Engineering Student Centre to guarantee that their calculator is approved for the final exam.

Computer software relevant to this course is available in the School's computer labs on level 2 & 6 and includes: FIXIT4, MS Word, MS Excel.

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

ACADEMIC ADVICE

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

RULES FOR PRACTICAL FIELD CLASSES

ISSUING OF EQUIPMENT

During the issue of equipment, a large crowd around the store causes difficulties for everyone, so one group collects their equipment and the remaining groups should stand well back. A group is responsible for all equipment issued to it, with the student signing for the equipment as the representative.

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 to the Stores Officer, 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. *It is not sufficient to leave the equipment near the store and depart. Equipment must be returned at least 15 minutes prior to the timetabled time for completion of the class, even if the fieldwork is not complete.*

3. 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. No equipment is to be left unattended in the field at any time.

INSTRUMENTS

The equipment used in surveying is usually delicate and often valuable (> $10,000). Please make sure that you take due care of the equipment and give some thought to the way in which you handle it. The staff member in charge of your class will give detailed instructions about its use. *Theodolites and electronic total stations*, have fragile optical mechanical and electronic components and are delicately adjusted. *Shut instrument boxes immediately after removing/replacing the instrument.* Carrying total stations (on tripods) over the shoulder will not be tolerated in this School. Do not force any parts to move, check whether clamps are set, and do not over tighten clamps.

IN THE PUBLIC EYE

It is hoped that students taking part in surveying practicals on the campus will create a favourable impression on passers-by, **so behave like professionals**. The field classes give you an opportunity to handle interesting equipment and should be a welcome break from lectures. It is hoped you find them enjoyable as well as instructive.

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.

SUMISSION OF REPORTS ON PRACTICAL FIELD CLASSES

Time: Reports will generally be submitted as per the assessment time table. Note this could change depending on circumstances. Please come to lectures and read emails in case of changes. Late submissions will be penalised, unless accompanied by an appropriate reason and supported by relevant documentation (doctor's certificate).

Format: Bigger is not necessarily better. Be concise, but explain everything. All reports must be submitted on paper of A4 size and should be bound in a simple way, e.g. stapled. Reports may be submitted in hand written, typed or word processed form. They should be presentable and readable. Attached plans must be folded to A4 size. Computer outputs should be neatly cut/paste into the report. Reports should show how the results were obtained from the field data, that the relevant theory has been understood, and that the computation processes have been competently carried out. Comments and discussion will demonstrate your knowledge.

The basic structure of each report should be as follows:

1) Title Page
   Include course number and name, title of exercise, student's name, group number

2) Table of Contents
   Pages should be numbered consecutively, including those of the appendix.

3) Introduction and Locality sketch
   - Discuss briefly (one sentence each) what was done, where it was done, when it was done, who did what.
   - Confirm that the procedures prescribed by the practical instructions were followed (or list deviations and give reasons).
   - Include a locality sketch and a list of (essential) equipment (make, type, serial number, any instrument correction that might apply).
   - Confirm that all computations on the field forms and those in the report have been checked.)

4) Summary of Relevant Results (and Precisions) (Table form, one page)

5) Body of Report
   - Follow the numbering systems used in the prac instructions. Where applicable show abstracts of field data, calculation of corrections, necessary theory and/or statement of equation used, calculation of 'results', calculation of precisions. The practical instructions give some guidance on what processing and analysis is required.
   - Explain your calculation steps and comment on results.
   - All calculations must be fully documented and traceable.
   - When using spreadsheets, put the relevant result values into the Body of Report part and any long winded results can be placed in the appendix and referred to.

6) Conclusion and Comments
   This should include a critical appraisal of the methods used and of the results obtained. Discuss successes, failures, problems, defective equipment, how the practical could be made more effective, time spent in the field and the time spent for computation and the preparation of the report, etc.

7) References (author, year, title, edition, publisher, city of publication, no of pages)

8) Appendix (field sheets, field sketches, plans, check computations, etc.)

The following notes should be used for guidance in preparing reports:

Equations used in calculations must be listed in variable form and the source of the equation given (e.g. text book, lecture notes, etc.).

Where calculations are of a repetitive nature they should be set out in tabular form. Spreadsheets may be used. The marker may request emailing the spreadsheet to check equations for unorthodox results.

Significant intermediate results in the computation process should be shown.

Any rejection of field data must be justified and discussed with the supervisor and in the report.

A concise appraisal or criticism of the methods or techniques involved in the exercise should be included in the conclusion. (Comments based on guesses or intuition are to be avoided. Try to justify your conclusions.)

It is not necessary to describe, in detail, the methods used unless for some reason they varied from the instructions. (However, summarise methods and techniques in "Introduction".)

Compute to one decimal more than the input or measured data, but truncate this extra decimal when presenting final results. This avoids round-off error.

Instructions on field notes and plans

It is essential that the course number, group number and the student(s) name(s) appear prominently on all field books, field sheets, reports, plans, etc.

Each student should bring along to all practicals good quality pencils (H, 2H, 4H) or a neat pen for field notes, calculator, metric scale, printed field sheets as supplied in the prac instructions (Moodle)

Take neat field notes of all measurements taken in the field and not overcrowded. Best to use pencil if rainy weather. Use the given field from practical instructions. If no printed forms are distributed by the lecturer, these notes should be tabulated in a field book, and if necessary, referred to a diagram for clarification. Draw neat sketches or diagrams where appropriate. Use tables where appropriate.

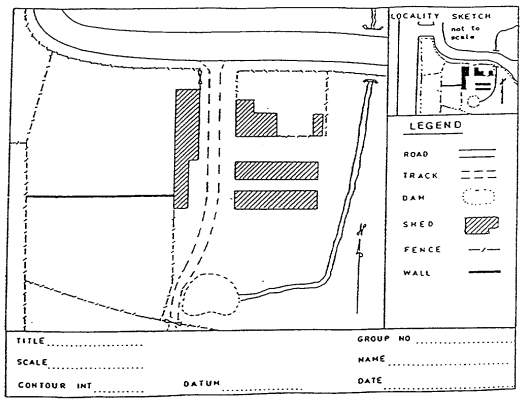
The field book (or form) must also contain the following information on every page: title, date, site, course number, group number, names of students in group, make, type and serial number of all important instruments, observer, booker, time of observations, general weather, etc. A locality sketch showing the area of the survey should be prepared at the beginning of each practical.

Erasures and overwriting are not permissible. Errors may be struck out and the correct value neatly written (above). NEVER EVER USE LIQUID PAPER OR SIMILAR ON FIELD NOTES. PLEASE DO NOT REWRITE FIELD NOTES TO LOOK PRETTY. There is a danger of transcription errors. It is better to see slightly messy ORIGINAL field notes than pretty BUT possibly erroneous field notes with no way of detecting an error.

At the end of each exercise, the field notes must be signed by your supervisor. These original, signed notes must always be submitted with the reports and/or plans.

Whenever possible, plans should be drawn with the North direction towards the upper edge of the paper. Plans should carry the following information in a block in the lower right hand corner:

- a heading, indicating the nature of the plan (e.g. Contour Plan, Detail Plan) and the general locality
- the scale of the plan, north point
- the datum for elevations and contours and for any grids shown on the plan
- the student's name, group number and course number, date of the survey



A conventional arrangement of detail on a plan is given above.

I hope you enjoy GMAT2120 – Surveying & Geospatial Technology

Craig Roberts
February 2016