School of Civil and Environmental Engineering

Term 3, 2021

GMAT2120 Surveying and Geospatial Technology

COURSE DETAILS

Units of Credit	6 UoC		
Contact hours	6 hours per week		
Lecture	Monday,	3:00 – 5:00	Online
	Wednesday,	4:00 – 6:00	Online/ alternate with workshops
Pracs	Friday,	12:00 – 5:00	CE G7 Survey Store

Course Coordinator and Lecturer	Craig Roberts email: c.roberts@unsw.edu.au office: 9385 4464

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 also builds on GMAT2500 and GMAT2700. This course runs concurrently with GMAT2550 and some exercises have been structured to run concurrently. Elective GMAT3100 and GMAT3150 in third year will further extend this course.

Prerequisites: GMAT1110, GMAT2500, GMAT2700 Co requisite: MATH2019

HANDBOOK DESCRIPTION

See link to virtual handbook:

https://www.handbook.unsw.edu.au/undergraduate/courses/2021/GMAT2120/

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, 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 in the field. At the conclusion of this course students will 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 and the skills of effective communication

TEACHING STRATEGIES

The original material for this course was prepared by the previous lecturer, A/Prof Jean Rüeger and his expertise is acknowledged. The current material and the teaching methods have been modernised. Whilst using this material I will aim to engage you in an understanding of the topics and require you to read the text-based material in detail.

I have considered feedback from last year's students in this course and in response will continue to supply electronic teaching materials on Moodle. Due to COVID-19 restrictions and the smaller class size, I will present lectures live-online using Blackboard Collaborate (BBCU). I will endeavour to mark the reports promptly for effective student feedback. I 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. Previous students have found field practicals to be the most rewarding and enjoyable part of the course and for this reason they are compulsory for all students. **A doctor's certificate or other supporting documentation will be needed in the event that a student misses a field practical.**

Private Study	• Review lecture material and literature on Moodle • Do set problems and prac reports • Reflect on class problems and prac reports • Download materials from Moodle • Keep up with notices and find out marks via Moodle
Lectures	• Attend lectures!!! • Find out what you must learn • See methods that are not in the textbook • Follow worked examples • Hear announcements on course changes – there will be plenty!!!

Workshops	• Be guided by Demonstrators • Practice solving set problems • Ask questions
Assessments (multiple choice questions, quizzes, tests, examinations, practical exercise reports etc.)	• Demonstrate your knowledge and skills • Demonstrate higher understanding and problem solving
Laboratory Work	• Hands-on work, to achieve practical field work tasks • Prepare concise reports in the field • Practice working in groups • Attempt, fail, learn, repeat, improve

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.

After successfully completing this course, you should be able to:

Learning Outcome		**EA Stage 1 Competencies**
1.	*Know how to perform a precise digital levelling survey using a modern bar-code instrument, leap frog EDM height traverse using a modern total station to achieve first/second order quality, high precision horizontal and vertical directions using a modern total station and medium length EDM distance measurement.*	*PE1.1, PE1.5, PE2.2, PE2.3, PE2.4,*
2.	*Develop efficient field work practices such as skill with various surveying instruments, forward planning and logistics for complex survey tasks, production of clear field notes and redundant field checks to ensure accuracy.*	*PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE2.4, PE3.2, PE3.3, PE3.6*
3.	*Perform reductions of observations from various field exercises and all associated statistical analysis.*	*PE1.1, PE1.3, PE1.4, PE2.1, PE3.4*
4.	*Understand the relationships between the various instruments, techniques and errors that indicate the accuracy of the resulting measurements.*	*PE1.1, PE1.2, PE1.6, PE2.3*

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

COURSE PROGRAM

Week start	Monday 3 – 5 pm Online	Wednesday 4 - 6pm Online	Friday 12 – 5 pm CE G7 – Survey store
1 **13/9**	**L1:** Intro to Course (C)		
6 **18/10**	**L2:** Levelling revision, rotating & digital levels (C) **L3A:** Precise level prep for prac 1(C)	**L3B:** Precise levelling, errors in precise levelling & remedy (C)	
7 **25/10**	**L4A:** Data analysis & reductions (C) **T:** Prep for prac 2, booking, recording of precise levelling (C)	**L4B:** Adjusting levelling data (C) (Moodle quiz) **T:** Statistics of precise level reductions (C) **T:** Prac Briefing (C)	**P1:** Digi level coll test/ rotating laser level/ practice precise level run **P2:** Precise level run prac around campus (C/Y) *(Level Prac due 12/11)*
8 **1/11**	**L5:** Intro to Elec Theods, using a theod. for precision (C) **L10:** Theodolite use for precise direction measurement (C)	**L6:** Booking and reduction of directions, arcs, and stats (C) **T:** Booking / reduction of directions and zenith angles (C)	**P3:** Angle Resection and Trig. Heighting Obs(C/Y) *(Angle prac due 19/11)*
9 **8/11**	**L7:** Electronic Level Sensors, Electronic Data Recording (C) **L8:** Error of Horizontal Coll, Incl of Trunn axis, Circle Eccentricity (C)	**L9:** Correction of Dir and Zen Angles for non-vert of VA, Index Corr of Vertical Circle / Level Sensor, circle grad, errors (C) **L11:** Robotic Total Stations (C)	**P4:** Mini prac/ total station exercises (C/Y)
10 **15/11**	**T:** Principle of Digital Theods (C) **T:** Angles prac computations	**L12:** Trig heighting, effects of Earth curvature and refract (C)	**T:** Trig heighting questions – create excel sheet CE201
11 **22/11**	**L13:** Trig heighting observation procedures, precision of heights. EDM-height traversing (C)	**T:** Computations for heights in Prac 3 (Due 6/11) CE201	**P5:** Leap frog EDM Height traversing (C/Y) *(Prac due 10/12)*
12 **29/11**	**L14:** EDM history, physical laws **L15:** Principles/apps of EDM **L16:** EDM components (C)	**L17:** Propagation of radiowaves, coefficient of refraction **L18:** Refractive index 1st vel (C) Prac Briefing	**P6:** Demo met instrs, EDM long line measurement and reduction (C/Y) *(EDM Prac due 17/12)*
13 **6/12**	**L19:** Geometrical corrections **T:** EDM Prac comps (C) *CE201*	**L20:** Classification of EDM, EDM reflectors, Legal traceability (C) **T:** Prac 6 comps	***Practical Exam (C/Y)***
14 **12/12**	**T:** Practice exam and revision of theodolite errors (C)		

C – Craig Roberts, Y – Yincai Zhou

ASSESSMENT

Assessment for the course includes (note due dates will change if run in a compressed mode):

P1 Laser levelling prac	5%		Due on the day
P2 report (Levelling prac)	10%		Due 2 weeks after fieldwork
Moodle quiz Levelling	5%		As per allocation on Moodle
P3 report (Angle resec + Ht)	10%	(7 + 3)	Due 2 weeks after fieldwork (Ht - 1 week after wksh)
P4 report (Mini Prac)	5%		Due on the day
P5 report (Leap Frog)	10%		Due 2 weeks after fieldwork
P6 report (EDM)	10%		Due 2 weeks after fieldwork
Practical Exam	10%		Week 10
Final Exam	35%		TBA after exam period

Assessment Criteria for Field Practicals

Comments: Field practicals are a great opportunity to put theory into practice. Previous students have always rated field practicals very highly. Field practicals are group work (usually 3 per group) with either group or individual submissions (see details in separate prac exercises) usually 2 weeks after the exercise. Group members should exchange mobile phone number, e-mail address, etc. and field notes from the exercise as joint (or individual) submissions require considerable interaction. As there is much to do in a short period of time, marks are deducted strictly for lateness. Field practicals are compulsory. Students must wear closed shoes or will be asked to leave and receive zero marks. This is a strict WHS requirement. Students are expected to rotate the work amongst themselves and will be encouraged to do this by prac supervisors.

Marking scheme: Depending on the exercise, marks will be allotted for clear and concise field notes, computations as per instructions, correctness of working, accuracy of observations, completion of all tasks, field sketches (where required), relevant comments or answers to specific questions asked in instructions and submission by allotted deadline. Details of individual assessment are contained in prac instructions for each prac available on Moodle. Unless otherwise stated, reports must follow the instructions given in the handout "Submission of Reports". (A sample report is given on the course web site).

Submissions must include a declaration on the authorship of the work. Each submission is to have a title page (title of prac, date of submission, course code/name, student number/name) 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.

Penalties: 1 day late = 10% marks lost, 2 days late = 20% marks lost etc. The lecturer reserves the right to deduct marks for poor participation during the practical exercise at their discretion.

Feedback: The prac supervisor will attempt to mark the prac exercise within 2 weeks of submission and return the marked exercise with annotations to the prac group/ individual. An overall report will be sent to all students with generic feedback for all and a class discussion in the lecture period will also take place to reinforce any issues that arose.

Objectives and learning outcomes: The student will learn about group work, time management, meeting time constraints, producing results in the field, logistics, field preparation, concise report writing and field note taking, producing results to tolerance despite conditions, working safely and in accordance with WHS.

Assessment Criteria for Practical Exam

Comments: A practical exam will test students ability to perform some basic surveying tasks under time pressure. This exercise is designed to give students confidence in their field work abilities and prepare them for industrial training.

Marking scheme: The lecturer will mark this live in the field and students will know their mark immediately.

Penalties: Students will be allocated a 40-minute time window to undertake their practical exam in the field. If they arrive late, they will simply cut into their allocated time.

Feedback: The lecturer will assess the exam immediately after completion and allocate a mark. In the event that students have made mistakes, they will have the opportunity re-compute their computations in the field and learn from their mistake. The mark will not be changed but much will be learned.

Objectives and learning outcomes: The practical exam is a great test for the student to reinforce their practical abilities under time pressure – excellent preparation for industrial training.

Assessment Criteria for Final Exam

Comments: The final exam covers all material. The questions will be a mixture of theoretical and applied questions relying heavily on the practical and workshop exercises which are underpinned by the lecture slides. Coming to all lectures and workshops (pracs are compulsory) will give the student a significant advantage in the final exam.

Marking scheme: The marks (and part marks) will be listed at the start of each question. The exam is written with a mix of computational and theory style questions. Students should look at how many marks are allocated to each question and provide answers in accordance with the value of the marks allocated (ie don't spend 30 mins on a question worth only 2 marks out of 100!).

Penalties: Penalties are in accordance with standard UNSW exam practice.

Feedback: Students may contact the lecturer after the final exam for individual feedback.

Objectives and learning outcomes: The exam is designed to cover the broad range of topics covered in GMAT2120. Some questions will be applied and require the student to use their knowledge to answer a question that may require aspects from various topics within the curriculum. There are currently no past papers, but a practice exam is used for revision in week 11.

Supplementary Examinations for Term 3 2021 will be held on Monday 10 to Friday 14 January 2022 (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 Material (check the course website):

http://moodle.telt.unsw.edu.au

The Powerpoint lecture slides and other documents are available for download as PDF files at the course website.

Lectures can also be viewed as BBCU recordings.

Text and Reference Books

Text book:

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

Available in bookshop – compulsory to purchase for BE(Surveying) and Dual award BE (Civil)/B Surv students only.

Reference book:

- Rüeger, JM. “Electronic Distance Measurement”, 4th edition, 1996 (on Moodle site)

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

- Schofield, W. "Engineering Surveying", 4th edition, 1993

- Bannister, A., Raymond, S. Baker, R. (1992) Surveying, 6th Edition, Pitman, London.

- Kavanagh, B.F. (2003) Surveying: Principles and Applications, 6th Ed, Prentice Hall, ISBN 0-13-099582-7

Computational Aids

Pocket calculators are required during lecturing hours, for workshops, field practicals as well as exams in this course. They must 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.

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;
- Special Considerations: student.unsw.edu.au/special-consideration;
- General and Program-specific questions: The Nucleus: Student Hub
- Year Managers and Grievance Officer of Teaching and Learning Committee, and
- CEVSOC/SURVSOC/CEPCA

Refer to Academic Advice on the School website available at:

https://intranet.civeng.unsw.edu.au/key-staff-to-contact-during-your-studies-at-unsw

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