UNSW SYDNEY Australia's Global University

School of Civil and Environmental Engineering

Term 2, 2021

GMAT4150
FIELD PROJECTS II

COURSE DETAILS

Units of Credit	6	
Contact hours	Average 4 hours per week	
Class	Wednesday: 14:00 - 18:00	CE201

Course Coordinator and Project Supervisor

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INFORMATION ABOUT THE COURSE

This course builds on previous courses in years 1, 2 and 3. You should have already passed or been exempt from those courses. If you have not passed any of the year 1, 2 or 3 GMAT courses then you should contact the course convenor for advice and permission to enrol in this course.

This course changes considerably each year with new projects to challenge and educate students. In Term 2, 2020, one academic supervisor is involved. The project details are described in the course program section.

Prerequisite: GMAT3150

Monitor the class web site at moodle.telt.unsw.edu.au and your university email regularly.

HANDBOOK DESCRIPTION

https://www.handbook.unsw.edu.au/undergraduate/courses/2021/GMAT4150

OBJECTIVES

The objectives of the course are to broaden and deepen your knowledge and experience of surveying and geospatial data acquisition, surveying instrumentation and modern mobile mapping systems, field methods, and surveying and mapping software, by conducting your own survey and mapping activities at a site remote from the UNSW campus or on it. The aim is to involve you in management aspects of field survey and mapping tasks as well as gaining more experience in measurement, fieldwork design, and analysis, and to give you confidence in your ability to do survey and mapping of a type that you may not have done before at University or in employment.

This course is a capstone course in your degree.

Linking the objectives with the program outcome attributes and the assessment strategies for this course:

Objectives	Program outcome attributes	Assessment
Broaden and deepen surveying or geospatial knowledge and experience	Undertake field surveys without detailed instructions	Quality of surveying and mapping results. Quantity of surveying and mapping results. Report writing.
Management of surveys and geospatial mapping activities	Group work organised and lead by students. Ability to 'cost' the projects based on time spent on the tasks	Discussed and described in reports
Design	Design and plan the survey and mapping project, test the design by implementation	Discussed and described in reports
Self-Assessment	Each student to write a report that evaluates their performance in the course	A small component of the final mark is based on a student's self-assessment report.

This course provides an environment that fosters in our students the following attributes as listed:

the skills involved in scholarly enquiry	Significant
the skills for effective communication	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	Significant
the skills to locate, evaluate and use relevant information (Information Literacy)	Some
the capacity for enterprise, initiative and creativity	Significant
an appreciation of and respect for, diversity	Significant
a capacity to contribute to, and work within, the international community	Some
the skills required for collaborative and multidisciplinary work	Significant
an appreciation of, and a responsiveness to, change	Some
a respect for ethical practice and social responsibility	Some

TEACHING STRATEGIES

Different types of projects will be offered each year. Some projects may appeal more to students interested in Cadastral and Control Surveying, and others to Laser Scanning, Geospatial Mapping, Digital Twins; or GNSS or GIS projects. As far as possible, students will be given the chance to discuss with the course coordinator and project supervisors on any ideas/suggestions for new projects to be considered, with the view to following the technological development trends and training fundamental skills for modern surveyors/geospatial engineers.

Once the project has been selected, the team(s) of students will be expected to work closely with the project supervisors, who will monitor progress, and give advice on what assessment tasks will be submitted.

The project supervisors will play the role of client and specify what tasks the supervisor wants students to complete. The supervisors won't give lectures or extensive handouts describing in detail how to do the tasks. So the course is considerably different to GMAT3150. However, the project supervisors will be available to give advice to students before, during and after the fieldwork.

In Term 2, 2021, special measures should be taken to follow the COVID-Safe rules in all the activities in this course.

Learning methods will be discussed at our class meetings and in the field. A significant aspect of this course is the group work and management by students. Part of the learning will include self-assessment because it is important that professional surveyors and engineers are able to assess their abilities and performance reliably.

The CE201 computer lab has been booked from 2pm each Wednesday during Term 2 and a 4 hour timeslot has been set for the course so that extended field work can be carried out without clashing with other classes. Students should meet the supervisor at 2pm in the lab each Wednesday (unless advised otherwise) and describe their planned activities for the day. It is possible to do field or computer lab work on other days as well as the timetabled class, or perhaps instead of the Wednesdays, provided the supervisor agrees.

The teaching strategies that will be used and their rationale.

Private Study	• Join Moodle discussions of problems • Reflect on class problems and assignments • Download materials from Moodle • Keep up with notices and find out marks via Moodle
Assessments	• Demonstrate your knowledge and skills • Demonstrate higher understanding and problem solving
Laboratory/Field Work	• Hands-on group work, designing and carrying out surveys and mapping tasks • Collaborative report writing

Some quotes that relate well to this course:

I hear and I forget. I see and I remember. I do and I understand.

By three methods we may learn wisdom: First, by reflection, which is noblest; second, by imitation, which is easiest; and third by experience, which is the bitterest.

Confucius *Chinese philosopher & reformer (551 BC - 479 BC)*

For example: Imitation is the way lectures run (we try to teach you good ways to do things and get you to copy or implement them). Experience is what happened to you when you found that the RTK GPS, or Laser Scanner, can't be just picked up and used (the equipment needed to be setup and practiced). Or you had wrong scale factor entered in the EDM etc. Later in the course you can try the reflection part - when you write your report think about what you did before, at and after fieldwork; what would you do better if you were to do it again or do a similar survey elsewhere?

EXPECTED LEARNING OUTCOMES

By the end of this course you will have some experience at tackling new projects and working as part of a team. Further outcomes are listed or described in the project descriptions below.

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.

Example:

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

Learning Outcome		EA Stage 1 Competencies
1.	*Apply surveying/geospatial knowledge learnt so far in the program to design surveys using a range of equipment to solve challenging problems.*	*PE1.1, PE1.5, PE2.1, PE2.2, PE3.3*
2.	*Manage a team to solve problems, meet deadlines with appropriate outcomes and communicate these results in report form and/or via a presentation to "clients".*	*PE1.5, PE2.4, PE3.2, PE3.5, PE3.6*
3.	*Analyse and assess data and produce suitable surveying and geospatial products that are client ready.*	*PE1.2, PE1.3, PE2.3, PE3.4*
4.	*Provide a thorough and critical self-assessment of individual performance and provide this to supervisors.*	*PE1.6, PE3.1, PE3.3*

For each hour of all the scheduled activities for the course, it is expected that you will put in at least 1.5 hours of private study.

COURSE PROGRAM

During the week 1 class, students will be given the advice on the details for the project. The students will form groups for the project related activities to perform in Week 1, so make sure you attend. **The most critical activity in Week 1 will be the discussions on the social distancing measures for field work activities**.

The timetabled class is Wednesday 2pm onward each week. The 4-hour timeslot is intended so that you can do fieldwork and or data analysis for this project on some days (not necessarily every week) without interruptions from other classes. Of course you are encouraged to spend some other time on meetings, calculations, report writing, etc. Descriptions of the projects, site photos and maps, H&S forms, etc., will be discussed at the class meeting in Week 1.

The field surveys and mapping activities will be conducted as group work. Students within a group do not necessarily all do the same tasks. For example, one student might take on management duties and organise logistics while other students concentrate on design, pre-fieldwork calculations and preparations, etc. It is up to the groups to ensure all students contribute appropriately, as discussed in ENGG1000. The course coordinator may assign different marks to individual students, at their discretion, based on student performance in the field work and in the class discussions.

Survey Store Equipment
Students wishing to collect survey equipment from the survey store must give a detailed written list of requirements to their supervisor at least one day before its required use, or more as specified by project supervisor for field trips. There is no person permanently in the survey store so students will need to organise times of collection and return of equipment carefully. The supervisor will not be able to come and go from the store frequently during the day or at short notice.

PROJECT A: Forensic surveying (Project Supervisor: Bruce Harvey)

This project in 2021 has been designed to require students to think about how to tackle a problem that they might not have worked on before, or to work on it in a way different to what they might have experienced in part time employment.

This project has been designed to have a flexible implementation. Several options and tasks are described below. Some of those tasks will depend on how much field work we are allowed to do with COVID restrictions and how much equipment we can access. Our intention is to run this project in 'Face to Face' mode as much as possible. Students are expected to have regular meetings amongst themselves and with the client (the academic supervisor).

This project will not include a residential field week but will spend about one full day per week during term working on the project, in the office some days and in the field some days. Additional time will be spent by students preparing reports producing plans and analysis. A total of almost 150 hours is expected. Students should not 'waste' time doing idle activities merely to accumulate time for the project.

The equipment we hope to use might include: smart phones with GNSS apps; RTKGNSS; total stations; laser scanner; handheld laser scanner; possibly a UAV; and digital camera.

Proposed Project Outcomes

Write an expert witness report.

Collect evidence in a manner that could be used in a court case.

Write a thorough report of the project and archive all data.

Present an overview of the project to other students in this course.

Students will be required to submit a formal documented self-assessment and a log sheet showing the number of hours spent on this project including meetings, travel, on site and post processing.

The final report should include the total hours spent by students and a hypothetical costing of the "job". The main reason for including time sheets in the course is because some parts of industry report that some graduates are not experienced at recording total time spent on a project and the consequences for budgeting and quoting for future projects.

The project may be carried out by a team of 5-6 students.

Proposed Project Tasks

There are several possible tasks listed below. Not all students will do all of them. Some tasks we may spend more time on than others.

1. Do a literature search to find out how surveying can be used for Forensic or crime scene investigations, locally and worldwide. For example, look at tips and best practices when using a UAV to map a crash and crime scenes at http://www.forensics.trimble.com. Such things as GCP placement and targets, https://youtu.be/GixROAFH9dc

2. Do a literature search to find out how to collect evidence that can be used in court.

3. Learn how to write an expert witness report.

4. Create some fake crime or accident scenes and survey them and test the accuracy. For example a car accident survey by total station, RTK, laser scan, camera and drone. Consider the time taken to do the survey, safety of the personnel and the reliability of the survey results

5. Test the accuracy of a surveillance camera to measure the height of a person.

6. Given an outdoor photograph determine what time and date it was taken, by using the shadows in the photograph.

7. Investigate a very old photograph found on Trove. Where was it taken from (standpoint of camera)? Is there any other information we can determine from the photograph using surveying and photogrammetry skills?

8. Crime mapping and GIS. See Position Magazine, April/May 2021. P 17. And use GIS to track criminals: https://esriaustralia.com.au/locate21-presentations-and-resources

9. Consider how surveying or geospatial skills can be used in search and rescue for lost people who do not have phones or emergency beacons. How to know you have covered all the ground, like when police form a line and walk a site. Perhaps hit a golf or cricket ball into long grass and try to find it.

10. Mapping visualisation of Sydney midget submarine attack: https://www.abc.net.au/radio/programs/conversations/midget-subs-attack-sydney-ww2/12841278 and subsequent bombing https://www.woollahra.nsw.gov.au/library/local_history/world_war_2/stories_from_woollahra/shelling_of_the_eastern_suburbs.
    Try to map where they went, the damage caused and the trajectory of the projectiles.

PROJECT B: High Definition (HD) map for automated driving (Project Supervisor: Jinling Wang)

Background

Map is one of key outputs from the surveying ang geospatial profession. Nowadays, digital maps are widely available on our smart phones and cars for navigation and beyond. A new type of digital map, called High Definition (HD) map, will become an enabling technology for emerging autonomous vehicles.

HD Maps are not only the storage for geo-referenced road networks and lane level details but also provide unique landmarks or the whole appearance of the surrounding environment to support vehicle localization. More details on the HD maps can be found in the research paper: Li et al. (2020) "High Definition Map for Automated Driving: Overview and Analysis", Journal of Navigation, 73(2), pp.324-341, https://doi.org/10.1017/S0373463319000638.

It is a complex process to create a HD map, which will need to capture full geometric and topological details of a road network with measurements from various sensors, such as, GNSS, LiDAR, vision sensors. Modern surveying and geospatial technologies are being developed to meet the challenges of measuring and modelling complex road network 3D reality features for HD maps.

This project will select one of the carparks on UNSW Kensington Campus, and some sections of the roads around the Rowland Park (close to UNSW, on the Bunnerong Rd, Daceyville NSW 2032) as field test sites to conduct a HD mapping experiment, with some surveying and geospatial technologies that can be used to collect and visualise geo-referenced digital road features in a HD map, with OpenDRIVE format (https://www.asam.net/standards/detail/opendrive/).

Resources

The School has a handheld 3D laser mapping system, ZEB-REVO from GeoSLAM Ltd (UK). The ZEB-REVO laser mapping system, invented by CSIRO (Australia), is self-contained and does not rely on external positioning systems to produce 3D measurements which are suitable for 3D mapping applications in indoor, underground and outdoor environments, including locations previously inaccessible to larger scanning equipment. More information on ZEB REVO mapping system and potential applications can be found at the GeoSLAM website: https://geoslam.com/

The School has also purchased a mobile LiDAR system (Scout) from American company Phoenix, see the technical specifications of this system at (https://www.phoenixlidar.com/lidar-solutions/). With tight integration of Real Time Kinematic (RTK) GNSS, Inertial Measurement Unit (IMU), and high quality laser scanner, this Phoenix mobile LiDAR system can be mounted onto a mobile platform to collect high density, georeferenced, 3D point cloud of features at survey-grade accuracy

To support the HD mapping experiments, some high-resolution cameras or even cameras on a smartphone may be used to collect imagery for analysis. The School has several Canon Digital Cameras EOS450D, which can take high quality digital images (12.2 megapixels). By taking RGB photos around a feature, a 3D model can be generated using software such as Pix4Dmapper.

To validate or evaluate the HD mapping results, precise total station surveys and Terrestrial Laser Scanner Leica C5 are to be considered as options.

Software packages, such as, Novatel Inertial Explorer (IE), Pix4Dmapper, Leica Cyclone, Esri ArcScene, MathWorks Roadrunner, and more, are available for GNSS, IMU, image and LiDAR data analysis to produce and visualise HD maps.

The aims of the project are to:

a) Understand the High Definition mapping development and applications in automated driving;
b) Analyse various error sources in the HD maps generated from surveying/mapping systems;
c) Evaluate the accuracy of the 3D road features captured via various surveying and mapping methods;
d) Visualise the HD map features (such as, lanes, junctions, traffic signs etc.).

The project may be carried out by a team of 5-6 students.

Objectives

Major objectives of this project are:

- To understand the concept of HD map and the surveying/geospatial aspects in HD maps.
- To acquire new surveying and mapping skills with mobile mapping systems.
- To enhance and extend data processing skills for producing 3D point clouds/3D modelling.
- To develop best practice guide and workflow for HD map creation.
- To design, and carry out, a procedure to evaluate the accuracy of HD reality features.
- To visualise the HD reality features via a software tool, such as, MathWorks Roadrunner.

Methodology and Activities

This project is to be carried out as follows:

a) Literature review

A list of relevant background reading materials will be provided. Guided reading of these materials will be scheduled during project team activities.

Literature on HD maps: the concepts, historical developments, and applications, as well as the need and requirements of surveying and geospatial technologies for HD mapping.

b) Project team workshops

Major activities during the workshops include: Guided discussions on Navigation Map Standard (NDS) and OpenDRIVE road network data format; automated driving; the basic concept of HD maps, and principle behind modern multi-sensor mobile mapping system. Discussions on various sensors for a mobile mapping system such as GNSS, Inertial Navigation System (INS), camera and Laser scanner, etc. Demonstration of mobile mapping system operations; Hands on with data processing. Project team working plan for various tasks in the HD mapping experiment.

c) HD map creation and visualization procedure design and field tests

Based on the analysis of error characteristics of GNSS, RTK, INS, mobile mapping systems, efficient surveying and mapping procedures towards various operating environments and applications are to be designed. Such operational procedures as well as other best practice guidelines are to be analysed in terms of accuracy and reliability. Comparison of various HD map formats and HD map viewing tools; Then some field tests are to be carried out at the Botany St Parking Station, UNSW, and some sections of the roads around the Roland Park field experiment site, close to UNSW campus), and the results will be validated and compared with the results from precise total station survey methods.

Deliverables

The major deliverables from this project are:

a) Project team (group) report

Major contents in this group report include: Background of the project topic area: HD maps and their applications; Motivation of this study; Literature review; Methods of evaluating the accuracy of HD map created with multi sensor systems (both laser and vision based); Potential Applications of a mobile mapping system; Initial field testing and analysis; Project team working plan for various HD mapping experiment tasks; Concluding remarks, List of references.

b) Individual class presentation

A separate document will describe the details.

c) Final (individual) report

Each project team member should prepare a final project report to summarise the project work independently. The final report will include such sections as: Introduction; Analysis of error characteristics of HD mapping process; Best practices for relevant field work and data acquisition; Workflow for data analysis, HD map creation and visualization; Evaluation for some specific HD map features; Conclusions and recommendations; References.

d) Individual self-assessment report

A separate document will describe the detail.

ASSESSMENT

Details of each assessment component, the marks assigned to it, the criteria by which marks will be assigned, and the dates of submission are set out below.

Assessment Items	Length	Weight	Learning outcomes (LO) assessed	Due date*	Deadline for absolute fail*	Marks returned
Project team (group) report	*15-20 pages*	*30%*	LO: 1, 2, 3	6pm 23 June	Week 4 (6pm, Friday)	Week 4
Class presentation (Individual)	8-10 mins	10%	LO: 2, 4	2pm 4 August	Week 10 (6pm,Friday)	Week 11
Final (individual) report	*30-40 pages*	*50%*	LO: 1, 2, 3	6pm 11 August	Week 11 (6pm, Friday)	Week 12
Individual self-assessment	*2 -3 pages*	*10%*	LO: 1, 2, 3, 4	6pm 11 August	Week 11 (6pm, Friday)	Week 12

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

Each student should include a time sheet indicating the time spent on this course – in much the same way as a business would use to charge a client for work on a project. It should include travel and meeting time. Students should not spend more than 150 hours on the course. However, students should not spend 'waste' time doing idle activities merely to accumulate time for the project.

Students will be required to submit a formal documented self-assessment on their participation in this course. Students who spend too few hours on this course have probably not contributed significantly; that affects their own learning and the group's output. The main reason for including time sheets in the course is because some parts of industry report that some graduates are not experienced at recording total time spent on a project and the consequences for budgeting, and quoting for future projects.

As a management exercise, the final reports should include a hypothetical costing of the "job". Students are expected to have group meetings regularly and keep minutes and action items of those meetings.

Students are to prepare all necessary H&S documentation and to submit this to their supervisor.

Feedback for all reports will be given as soon as possible after submission. Details of the Self-assessment task will be given in a separate file on the class website.

Late work will be penalised at the rate of 10% per day after the due time and date have expired.

Project A Assessment Criteria are as follows:

Project team (group) report (30%) (Due: 6pm, 23 June 2021) will be assessed based on the following criteria:

Review of relevant literature 12%

Report on tasks completed by this due date 10%

Planning of activities for remainder of this term, including field work logistics 5%

Quality of written presentation, on time, plagiarism statement 3%

Class presentation (10%) (Due: 3pm, 4 August 2020) (a separate document will describe the details)

Final (individual) report (50%) (Due: 6pm, 11 August 2020) will be assessed based on the following criteria:

Expert witness report for one of the activities 15%

Description of field work issues encountered 10%

Drawings or 3D computer models of one of the investigated sites 15%

Conclusions and recommendations, including management issues 5%

Timesheet / log of hours spent on this project 2%

Quality of written presentation, on time, plagiarism statement 3%

Individual self-assessment (10%) (Due: 6pm, 11 August 2020) will be assessed based on criteria supplied in a separate document.

Project B Assessment Criteria are as follows:

Project team (group) report (30%) (Due: 6pm, 23 June 2021) will be assessed based on the following criteria:

- Written presentation 5%
- Literature Review 10%
- Initial field testing and analysis 10%
- Project team working plan for various application case studies 5%

Class presentation (15%) (Due: 3pm, 4 August 2020) (a separate document will describe the details)

Final (individual) report (50%) (Due: 6pm, 11 August 2020) will be assessed based on the following criteria:

- Written presentation 5%
- Review of other work 5%
- Quality of project work (design and justification) 10%
- Workflows, results and interpretation 15%
- Conclusions and recommendations 5%
- Documenting and archiving the full project field notes and data sets 10%

Individual self-assessment (10%) (Due: 6pm, 11 August 2020) will be assessed based on criteria supplied in a separate document.

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) No Final Exam/Supplementary Examinations for this course.

RELEVANT RESOURCES

- Materials from previous GMAT courses that you have studied.
- Additional materials provided on Moodle.
- Survey equipment from our store CE G7.

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

(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 Key Contacts on the Faculty website available at:

https://www.unsw.edu.au/engineering/student-life/student-resources/key-contacts

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