School of Civil and Environmental Engineering

Term 2, 2020

GMAT4150
FIELD PROJECTS II

COURSE DETAILS

Units of Credit	6	
Contact hours	Average 4 hours per week	
Class	Thursday, 3pm onwards	Online

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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/2020/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 supervisor 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 supervisor, who will monitor progress, and give advice on what assessment tasks will be submitted.

The supervisor will play the role of client and specify what tasks the supervisor wants students to complete. The supervisor 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 supervisor will be available to give advice to students before, during and after the fieldwork.

In Term 2, 2020, special measures should be taken to follow the social distancing 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.

In Term 2, the dedicated time slot for this course has been booked from 3pm each Thursday. This 4-hour timeslot will be used for any extended field work, data analysis (**relevant UNSW software packages are accessible remotely via an internet connection**), project team discussions via online teaching/meeting platforms (such as, BB Calibrate Ultra within the Moodle; MS Teams), without clashing with other classes.

Students should meet the supervisor during the scheduled online teaching activities each Thursday (unless advised otherwise) and describe their planned activities for the day.

It is possible to do field work or data analysis, on other days as well as the timetabled class, or perhaps instead of the Thursdays, 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 Thursday 3pm 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 online 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. In Term 2, 2020, each field work activity will require the written plan to follow the social distancing rules, and precautious safety measures are documented by the students.

Project Title: Geospatial Digital Twins: Measuring and Modelling the 3D Reality

Supervisor: Jinling Wang

Background

Digital Twin is a virtual model of a physical thing, process, service or system. In many digital twins, there is always a geospatial reference frame as one of their core pillars. One recent example is the NSW Digital Twin (https://nsw.digitaltwin.terria.io/), which should be instead called the NSW Geospatial Digital Twin.

Any geospatial digital twins, for example, for an intelligent transportation system or a smart city, will certainly be based on the geospatial data presented in an official national geodetic reference frame. Such geospatial data will not only contain the coordinates for some feature points, but also the detailed 3D presentation of individual reality features, such as a 3D digital model of trees and power poles, buildings, street furniture, or dense point cloud of road surface. Capturing a real-world environment place in a digital 3D model, combining various sensor measurements (including point clouds and imagery) can provide an accurate and digital representation of the space or the reality. Such captured reality data can be used for various applications, for example, planning, design, risk management, and various Location-Based Services (LBS).

Modern surveying and geospatial technologies are being developed to meet the challenges of measuring and modelling 3D reality features/buildings for geospatial digital twin development and operations. This project will select one of the carparks on UNSW Kensington Campus, and/or Rowland Park (close to UNSW, on the Bunnerong Rd, Daceyville NSW 2032) as field experiment sites to design and test some surveying and geospatial technologies that can be used to create the geo-refenced digital features/building information models for the existing NSW Digital Twin.

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/scout-series/). 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

A recent addition to the measurement tools is the Leica BLK3D hand-held system which can collect real-time in-picture 3D measurements (https://shop.leica-geosystems.com/blk3d-software). To support the 3D reality capture filed 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 3D reality capture 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, Autodesk Revit, and more, are available for GNSS, IMU, image and LiDAR data analysis to produce and visualise 3D models.

The aims of the project are to:

a) Understand the geospatial digital twin development and potential applications;
b) Analyse various error sources in the 3D models generated from surveying/mapping systems;
c) Evaluate the accuracy of the 3D reality features captured via various surveying and mapping methods;
d) Visualise the 3D reality features via a geospatial digital twin.

The project may be carried out by two teams at different experiment sites. Each team may have 3-5 students.

Objectives

Major objectives of this project are:

- To understand the concept of geospatial digital twins;
- 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 field work, modelling and visualisation;
- To design, and carry out, a procedure to evaluate the accuracy of 3D reality features;
- To visualise the 3D reality features via the NSW geospatial Digital Twin.

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 Digital Twins: the concepts, historical developments and applications, as well as the need and requirements of surveying and geospatial technologies for digital twins.

Some existing evaluation methods for a portable mobile mapping system will be discussed among the project team members and the supervisor.

b) Project team workshops

Major activities during the workshops include: Guided discussions on the basic concept of digital twins, 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 application case studies.

c) Surveying and mobile mapping procedure design and field tests

In Term 2 2020, each field work activity will require the written plan to follow the social distancing rules, and precautious safety measures are documented by the students.

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. Then some field tests are to be carried out at the Botany St Parking Station, or UNSW Barker St Carpark, (or 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

d) Measuring and Modelling the 3D reality

Several field survey and mapping activities will be carried for selected features around the UNSW carparks mentioned above; and/or walk path in the Roland Park. The captured 3D reality models are to be visualised via some Flythrough or Walkthrough software packages available online as the first step, then the final 3D models for the features/building information Models are to be uploaded into the NSW Digital Twin to verify the measuring and modelling accuracy for the features/building structures.

Deliverables

The major deliverables from this project are:

a) Project team (group) report (Due: 6pm, 24 June 2020):

Major contents in this group report include: Background of the project topic area: geospatial digital twins and their applications; Motivation of this study; Literature review; Methods of evaluating the accuracy of mobile mapping systems (both laser and vision based); Potential Applications of a mobile mapping system; Initial field testing and analysis; Project team working plan (including the measures to follow the social distancing rules) for various application case studies; Concluding remarks, List of references.

b) Individual class presentation (Due: 3pm, 6 August 2020):

A separate document will describe the details)

c) Final (individual) report (Due: 6pm, 6 August 2020)

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 a mobile mapping system; Best practices for relevant field work and data acquisition; Workflow for data analysis, 3D modelling and visualization via the NSW geospatial digital twins; Evaluation for some specific 3D reality features; Conclusions and recommendations; References.

d) Individual self-assessment report (Due: 6pm, 13 August 2020)

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*	*25%*	LO: 1, 2, 3	6pm 24 June	Week 4 (3pm, Friday)	Week 4
Class presentation (Individual)	10 mins	15%	LO: 2, 4	3pm 6 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 13 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.

Assessment Criteria are as follows:

Project team (group) report (25%) will be assessed based on the following criteria:

- Written presentation 2%
- Literature Review 5%
- Measures to follow the social distancing rules in field work 5%
- Initial field testing and analysis 5%
- Project team working plan for various application case studies 8%

Class presentation (15%) (a separate document will describe the details)

Final (individual) report (50%) will be assessed based on the following criteria:

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

Individual self-assessment (10%) will be assessed based on the following criteria:

- Written presentation 2%
- Quality of self-assessment 8%

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 Academic Advice on the School website available at:

https://www.engineering.unsw.edu.au/civil-engineering/student-resources/policies-procedures-and-forms/academic-advice

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