School of Civil and Environmental Engineering

UNSW Engineering

GMAT4150

Field Projects 2

Term 2, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Jinling Wang	jinling.wang@unsw.edu.au	You may contact me via Teams or email any time.	CE413	9385 4203

Lecturers

Name	Email	Availability	Location	Phone
Bruce Harvey	b.harvey@unsw.edu.au	You may contact me via Teams or email any time.	CE207	9385 4178

School Contact Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

Course Details

Units of Credit 6

Summary of the Course

Projects will involve small groups of students working as a team to complete the design and execution of selected tasks in Surveying and Geospatial Engineering. Topics may be cadastral surveys, remote sensing analysis of the environment from satellite images, digital photogrammetric mapping tasks, setting up a precise geodetic control network, the use of precise GNSS techniques, collection of data for and design of a GIS system, a precise engineering survey or the development and analysis of a geospatial database of a region. Students will usually be required to attend a one week off campus field work (survey camp) or regular day trips to an off campus field site and present the results of their group project in a well written technical report and individual presentations to the group.

Course Aims

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.

Course Learning Outcomes

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, PE1.2, 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”	PE1.1, PE1.5, PE2.4, PE3.2, PE3.5, PE3.6
3. Analyse and assess data and produce suitable 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

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.

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.

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, 2022, 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 9AM 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?

Assessment

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 task	Weight	Due Date	Course Learning Outcomes Assessed
1. Project Team (Group) Report	30%	21/06/2022 06:00 PM	1, 2, 3
2. Final (Individual) Report and presentation	60%	11/08/2022 06:00 PM	1, 2, 3
3. Individual Self-Assessment	10%	11/08/2022 06:00 PM	4

Assessment 1: Project Team (Group) Report

Assessment length: Project team (group) report:15-20 pages
Due date: 21/06/2022 06:00 PM
Marks returned: 24 June 2022

Project A

Project team (group) report (30%) (Due: 6pm, 21 June 2022) Will be assessed based on the following criteria:

- Review of relevant literature and existing data
- Pre-camp calculations and training sessions
- Report on tasks completed by this due date
- Planning of activities for remainder of this term, including field work logistics
- Quality of written presentation, on time, plagiarism statement

Project B

Project team (group) report (30%) (Due: 6pm, 21 June 2022) 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%

Assessment 2: Final (Individual) Report and presentation

Assessment length: a) Class presentation (Individual): 8-10 mins; b) Final (individual) report: 30-40 pages
Submission notes: Presentation due: 10am, 3 August 2022
Due date: 11/08/2022 06:00 PM
Marks returned: Week 13

Project A

Class presentation (10%) (Due: 10am, 3 August 2022) (a separate document will describe the details)

Final (individual) report (50%) (Due: 6pm, 11 August 2022) will be assessed based on the following criteria:

- Description of field work issues encountered
- DP and kml of the cadastral boundaries
- Report on the activities you participated in
- Conclusions and recommendations, including management issues
- Timesheet / log of hours spent on this project
- Quality of written presentation, on time, plagiarism statement

Project B

Class presentation (10%) (Due: 10am, 3 August 2022) (a separate document will describe the details)

Final (individual) report (50%) (Due: 6pm, 11 August 2022) 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%

Assessment 3: Individual Self-Assessment

Assessment length: Individual self-assessment: 2 -3 pages
Due date: 11/08/2022 06:00 PM

Individual self-assessment (10%) (Due: 6pm, 11 August 2022) will be assessed based on criteria supplied in a separate document.

Attendance Requirements

Students should attend all the scheduled project activities

Course Schedule

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 9am 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: Rural cadastral, plus GPR and hyperspectral drone (Supervisor: Bruce Harvey)

This project in 2022 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. 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 include a 3 day residential field trip in week 6 at Cataract Scout Park and will have a lab meeting each week during term working on the project. Additional time will be spent by students preparing reports producing plans and analysis. A total of almost 150 hours is expected but 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; possibly a UAV with hyperspectral camera; and Ground Penetrating Radar (GPR).

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

Proposed Project Tasks and Outcomes

- Prepare for and then conduct a rural cadastral survey of part of the boundary of the Scouting Australia site at Cataract. Find existing cadastral marks, measure their coordinates, compare with the DPs kml file, and compare dimensions with PO.
- Draw a DP of the cadastral boundaries and produce a kml file.
- Write a report about the Rural Cadastral Survey.
- Practice using GPR on campus then conduct a GPR survey to locate underground water pipes on one of the Cataract camp sites. Produce a detailed CAD plan of the results.
- Participate in an aerial survey of part of the site with a hyperspectral camera and analyse the images comparing them to optical images of the site.
- Manage the group so that all students participate actively, and efficient progress is made on the tasks.
- 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.
- The final report should include a log sheet showing the number of hours spent on this project including meetings, travel, on site and post processing, 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.

PROJECT B: Geospatial Mapping and Navigation for Metaverse (Supervisor: Jinling Wang)

Background

A map is a representation of the physical world, including the features of lands, streets, indoor environments and more. Maps have been becoming more and more digital in format, and accessible via mobile devices, laying a solid foundation for various applications, such as Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and Extended Reality (XR). Recently, an emerging area of technological development, called Metaverse, is focusing an even more immersive, open, shared 3D virtual world in which users can connect each other, and visit various spaces. In a new world of Metaverse, mapping and navigation are essential. Geospatial mapping and navigation, also called spatial computing, will be one of seven enabling components.

On the relationship between geospatial technologies and metaverse, one of the views is that metaverse is geospatial (https://www.geoconnexion.com/publication-articles/the-metaverse-is-geospatial). However, it is clear that, similar to the real world, real-time positioning, mapping and navigation are essential in a metaverse.

This project will test and evaluate some key sensors and technologies for potential use in geospatial mapping and navigation in metaverse. 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 mapping experiments, with some surveying and

geospatial technologies that can be used to collect and visualise geo-referenced digital environment.

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 as well as a navigation experiment platform.

To support geospatial 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 mapping and navigation results, precise total station surveys, GNSS RTK, 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 digital maps.

The aims of the project are to:

a) Understand the needs and requirements of digital mapping and navigation and applications in metaverse.

b) Analyse various error sources in the mapping and navigation generated from various sensors.

c) Evaluate the accuracy of the 3D features captured via various mapping methods.

d) Visualise the 3D maps

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

Objectives

Major objectives of this project are:

- To understand the concepts of metaverse, modern geospatial mapping and navigation technologies.
- 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 geospatial mapping

- To design, and carry out, a procedure to evaluate the accuracy of 3D reality features.
- To visualise the 3D reality features via a software tool.

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 metaverse: the concepts, historical developments, and applications, as well as the needs and requirements of geospatial technologies for positioning, mapping and navigation.

b) Project team workshops

Major activities during the workshops include: Guided discussions on metaverse concept and evolution and the principles behind modern multi-sensor mobile mapping and navigation systems. Discussions on various sensors for a mobile mapping and navigation 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 mapping and navigation experiment.

c) Real-time 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 which are required in a metaverse.

Then some field tests with the multi-sensor mapping and navigation system, Phoenix, 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 may include (more details will be discussed during the group meetings): Background of the project topic area: geosaptial mapping and navigation for metaverse; Motivation of this field project-based study; Literature review; Methods of evaluating the accuracy of digital maps and 3D features 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 geospatial mapping and navigation 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; Metaverse concept and evolution; Positioning, mapping and navigation needs in a metaverse; Analysis of error characteristics of real-time mapping process; Best practices for relevant data acquisition and processing; Workflow for data analysis, and 3D map creation and visualization; Evaluation for some specific 3D features; Conclusions and recommendations; References.

d) Individual self-assessment report

A separate document will describe the detail.

View class timetable

Timetable

Date	Type	Content
Week 4: 20 June - 24 June	Assessment	Project Team (Group) Report
Study Week: 8 August - 11 August	Assessment	Final (Individual) Report and presentation: Presentation due: 10am, 3 August 2022
	Assessment	Individual Self-Assessment

Resources

Prescribed Resources

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

Course Evaluation and Development

This is a capstone project course, The course projects have been designed to reflect the current trends and best practice in the profession. It has been always a favorate course for students over many years.

Laboratory Workshop Information

Computations and workshops may depend on progress of each project in the course. All the needs will be discussed via the project meetings. Special arrnagements will be made on a case-by-case basis.

Submission of Assessment Tasks

Please refer to the Moodle page of the course for further guidance on assessment submission.

UNSW has a standard late submission penalty of:

- 5% per day, for all assessments where a penalty applies, capped at five days (120 hours), after which a student cannot submit an assessment, and no permitted variation.

Academic Honesty and 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 Information

Final Examinations:

Final exams in T2 2022 will be held online between 12th - 25th August 2022 inclusive, and supplementary exams between 5th - 9th September 2022 inclusive. You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

ACADEMIC ADVICE

- Key Staff to Contact for Academic Advice (log in with your zID and password): https://intranet.civeng.unsw.edu.au/key-staff-to-contact-during-your-studies-at-unsw
- Key UNSW Dates - eg. Census Date, exam dates, last day to drop a course without academic/financial liability etc.
- CVEN Student Intranet (log in with your zID and password): https://intranet.civeng.unsw.edu.au/student-intranet
- Student Life at CVEN, including Student Societies: https://www.unsw.edu.au/engineering/civil-and-environmental-engineering/student-life
- Special Consideration: https://student.unsw.edu.au/special-consideration
- General and Program-Specific Questions: The Nucleus: Student Hub
- Book an Academic Advising session: https://app.acuityscheduling.com/schedule.php?owner=19024765

Disclaimer

This course outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle should be consulted for the up to date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.

Image Credit

Mike Gal.

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	✓
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	✓
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	✓
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering 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	✓
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	✓
PE3.2 Effective oral and written communication in 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	✓