School of Civil and Environmental Engineering

Term 1, 2020

CVEN3203 APPLIED GEOTECHNICS AND ENGINEERING GEOLOGY

COURSE DETAILS

Units of Credit	6	
Contact hours	5 hours per week	
Class	Tues, 2:00 – 4:00	Clancy Aud
	Thurs, 12:00 – 2:00	Clancy Aud
Workshop	Thurs, 2:00 – 4:00 or 4:00 – 6:00	Various
Geology Quiz (Wk7)	Tues, 4:00 – 6:00 or 6:00 – 8:00	Various
Course Coordinator and Lecturer	Dr Kurt Douglas email: k.douglas@unsw.edu.au (preferred) office: CE 506	
Lecturer	Dr Babak Shahbodaghkhan email: b.shahbodagh@unsw.edu.au office: CE 507	

INFORMATION ABOUT THE COURSE

Geotechnical Engineering is the study of the behaviour of soil, rock and groundwater under engineered environments. Most engineering structures will inevitably have some sort of interaction with the ground surface. Geotechnical Engineers attempt to describe and/or model this interaction to achieve a safe and efficient design.

So far, you have studied CVEN3202 Soil Mechanics. Therefore, by now you should understand: the basic engineering classification of soil; how soil behaves under imposed stresses and strains; how groundwater flows through soil and its effect on engineered structures; and also basic slope stability. There are two main areas that you have not covered that will be addressed in this course:

(A) How to relate the 'real-world' geological environment to your knowledge of 'class-room' soil; and

(B) How to combine your current knowledge and Part (A) to perform a Geotechnical Engineering design.

Part (A) Engineering Geology

A Geotechnical Engineer must have an understanding not only of engineering principles but also of geology and the inherent variability and challenges it has for engineering. This course will teach you a basic understanding of geology including how geotechnical materials are formed, what their characteristics are and how to describe them using engineering and geological terms. It will attempt to give you some understanding of the challenges a geological environment may have for a particular engineering project. At the end of the course you should, for any site and engineering project, be able to either: (a) develop a preliminary geotechnical model for the site that can be used for design or (b) be able to discuss more complex geology with Engineering Geologists to again come up with a suitable geotechnical model.

Part (B) Applied Geotechnics

This part of the course represents the 'final stage' of a Geotechnical project. It will require you to study the conventional methods for the design and analysis of common geotechnical constructions including shallow and deep (pile) foundations and retaining walls. For many of you, this will be your final course in Geotechnical Engineering and we hope you gain an appreciation of some of the complexities of Geotechnical Engineering.

Those, no doubt attractive and highly intelligent students, looking for a demanding and challenging yet very satisfying career will obviously wish to pursue Geotechnical Engineering further. We have a number of Geotechnical electives in final year that will extend your knowledge even further into areas like advanced soil mechanics; applications of computer simulation techniques to geotechnical engineering problems; ground improvement and the design of pavements, tunnels and slopes. Come and talk to us if you want to know more.

As a graduate Geotechnical Engineer, you might expect to work on projects as diversified as: building and bridge foundation design; dam design and construction; road pavement design; slope stability analysis and stabilisation; and tunnel and mine design. Most typically you will do a part-time coursework masters with us after working for a year or two to supplement your knowledge (and provide an excuse for your high charge-out rate). Some of you may even wish to do a PhD (if interested come and talk with us any time, we have lots of projects/scholarships available).

HANDBOOK DESCRIPTION

See link to virtual handbook*:*

http://www.handbook.unsw.edu.au/undergraduate/courses/2020/CVEN3203

OBJECTIVES

- To introduce you to engineering geology and geotechnical engineering.
- To show you how to describe geotechnical materials.
- To show you how to assess the geology and geological history of a site so as to develop a preliminary geotechnical model that can be used as a basis for engineering design.
- To give you an appreciation and ability to converse with Engineering Geologists so as to develop geotechnical models for geologically complex sites.
- To study the basic principles related to the theory and design of shallow foundations, deep foundations and retaining walls.

Some of the program outcome attributes are listed in the table below together with how you may expect to achieve them.

An in-depth engagement with the relevant disciplinary knowledge in its inter-disciplinary context	This course takes your knowledge of soil mechanics, introduces engineering geology concepts and applies them to solve geotechnical problems
Capacity for analytical and critical thinking and for creative problem solving	Most of the assignments require you to consider a quantity of information and supplement it with your own research to solve open ended questions.
Ability to engage independent and reflective learning	You are expected to do pre and post lecture reading and study. Much of the notes and other resources provide references for further independent study to increase the depth of your knowledge.
The skills to locate, evaluate and use relevant information (Information literacy)	This course will use a number of types of references rather than just lecture notes to improve your information literacy. You will also be required to collate information from a number of sources for your assignment.

Skills for collaborative and multi-disciplinary work	The parts in Assignment 1 will be performed in groups. From previous experience, groups that receive high marks generally have good collaboration between members.
Skills for effective communication	Assignments are expected to be presented in a professional 'report style' manner (unless stated otherwise)

TEACHING STRATEGIES

The contents of this subject will be presented to you in a number of formats. Each of these are explained below together with our expectations of you.

Lectures: In the first part of the course, formal lectures will be presented to discuss the basic geological principles. As geology is a very visual subject, PowerPoint and video presentations will be used to enhance various aspects of the course. In the second part of the course, the lectures will provide and familiarise you with the design and analysis methods used in engineering practice. Equally important, you will be exposed to the theories on which these methods are based so that you can understand the assumptions and limitations of the methods, and possible modifications. Alternative methods other than those covered in the lectures exist in practice. It is important for a qualified engineer to understand and to critically examine those using fundamental theories.

You are expected to attend all the lectures as they will greatly assist in understanding what is presented in the textbook and lecture notes. The lectures will also be a primary point of communication between the class and us. Further communication will be via your student email and Moodle. It is very important that you frequently check your messages.

Demonstrations/workshops: The demonstrations/workshops in the first half of this subject are used to teach you 'hands-on' rock and mineral description and classification; geological processes, geological mapping and the preparation of preliminary geotechnical models. You will be expected to be present and participate at all workshops, as they will contain material not covered in the lectures. In the second half of the course, the workshops will provide you with the opportunity to discuss the lecture material with your demonstrators and to solve the set workshop problems. The problems may consist of past exam papers as well as problems given in the recommended texts or others. In order to understand the subject matter well, it is essential to attend the workshop classes and solve the workshop problems by yourself (preferably prior to the workshop timeslot so that you can maximise your outcomes from the workshops).

Assignment: It is important that you participate fully in your group assignments. The assignments contain a considerable amount of self-learning that will be critical to your understanding of Sydney geology and mapping and descriptive techniques. You may approach your demonstrators or myself for guidance when doing the assignment. This includes showing drafts of your work to me for comment prior to submission. A lot of the assignment information and useful resources like introductory site videos will be provided on Moodle.

Moodle: will be used to provide you with additional learning resources such as videos, geological animations, Moodle lesson reviews, copies of lecture notes and some presentations for review. Additional quizzes will be available and solutions to workshops will be given. Lots of useful links will also be provided. Note that sections have been split into: A – Geology and B – Applied Geotechnics. If something doesn't work or is missing, feel free to email.

Private study: Your private study should include a review and reflection of lecture material; doing workshop and assignment problems; and generally taking notice of the characteristics of the geological/geotechnical environments that you travel through each day.

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.	*To create a preliminary geological model using your understanding of geology, site history and observations that can be used as an input to the development of site investigations and geotechnical design.*	PE1.1, PE1.3, PE1.4, PE2.1, PE2.4, PE3.2, PE3.4, PE3.6
2.	*To perform basic geotechnical design of retaining walls, shallow foundations and piles.*	PE1.1, PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, 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

TERM 1, 2020 (Table indicative and subject to change)

Week	Topic	Assessments Due
1	Plate tectonics & geological time. Minerals.	Geology workshop
2	The rock cycle, rock formation & classification[F]	Geology workshop
3	Structural geology[F]. The geotechnical model & site investigations[B]. Engineering rock descriptions[B].	Geology workshop
4	Soils – including alluvial, aeolian, colluvial, residual.	Geology workshop
5	Geology review // Geotechnical design methods.	Applied Workshop
6	*No teaching week*	
7	Bearing capacity of shallow foundations.	**Geology Quiz** **Geology Assignment Due** Applied Workshop
8	Settlement of shallow foundations.	Applied Workshop
9	Design of pile foundations. Lateral earth pressure.	Applied Workshop
10	Design of retaining walls	Applied Workshop

Notes: B – Best to attend these classes before attempting Bronte Mapping component of assignment

F – Best to attend these classes before attempting the self-guided fieldtrip component of assignment

ASSESSMENT

The final grade for this course will normally be based on the sum of the scores from each of the assessment tasks. The Final Examination is worth 50% of the Final Mark if class work is included and 100% if class work is not included. The class work is worth 50% of the Final Mark if included. *A mark of at least 40% in the final examination is required before the other assessment tasks are included in the final mark. The formal exam scripts will not be returned but you are permitted to view the marked script.*

Students who perform poorly in the assessment tasks and workshops are recommended to discuss progress with the lecturer during the trimester. Note: The lecturer reserves the right to adjust the final scores by scaling if agreed by the Head of School.

The geology workshops will be used to teach you more about practical 'hands-on' geology. They are not directly related to lecture content. Marks will be awarded by demonstrators based on satisfactory completion and effort (both pre work and during the workshop) with the activities.

The geology assignment will comprise two parts. A field mapping component carried out in Bronte will give you experience in mapping rock defects (joints, bedding etc.). A self-guided field trip will require you to explore the geology of a part of Sydney, giving you a better understanding of what the rocks and geological structures of Sydney look like in the field.

The Geology Quiz will test your understanding of the Geology component of the course.

The Final Exam will test your understanding of the Applied Geotechnics component of the course.

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.

Supplementary Examinations for Term 1 2020 will be held on Monday 25th May – Friday 29th May (inclusive) should you be required to sit one. You are required to be available during these dates. Please do not make any personal or travel arrangements during this period.

PENALTIES

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

ASSESSMENT OVERVIEW

Item	Length	Weight	Learning outcomes assessed	Assessment Criteria	Due date and submission requirements	Deadline for absolute fail	Marks returned
Geology Workshops		5%	1	Satisfactory completion of pre-work and the complete weekly activity during the workshop will receive full marks. Significant partial completion, half marks	In class during Workshops Weeks 1 to 5.		In Workshop
Geology Assignment		25%	1	Part A: You will be assessed on your ability to: create a preliminary geological model; develop a site description and plan; and perform and present geological mapping. Part B: You will be assessed on the poster presentation and quality of your description of your geological observations.	4pm Wednesday 1st April, Week 7		Within 3 weeks of submission
Geology Quiz	1 hour 15 mins	20%	1	Quiz 1 will be closed book and will test your understanding of the geology component of the course.	4-6pm or 6-8pm Tuesday Week 7		Within 3 weeks of quiz
Final Exam	2 hours	50%	2	The final exam will **only** cover the Applied Geotechnics component of the course.	In formal exam period	See UNSW rules	As part of UNSW course results

RELEVANT RESOURCES

Textbooks - Geology

No compulsory text for geology however the following gives a good summary of various engineering geology topics:

Waltham, A. (2009) Foundations of Engineering Geology, 3rd Edition, Spon Press. [E-book Available Online through library]

Additional Readings - Geology

The following books may give you a better and deeper understanding of various aspects of the course. Duff (1997) and Skinner and Potter (2000) provide the geology basics whilst **Fell et al (2015)**, Hencher (2012), Goodman (1993) and Bell (2007, 2008) do a good job of relating geology (Goodman - rock only) to engineering using a number of geotechnical engineering case studies. The books can be sourced via UNSW library at the locations shown. This is only a sample, there are also a lot of other geology books in the library that you may find useful. You are encouraged to do your own research.

Bell, F.G. (2007) *Engineering Geology*. Burlington : Elsevier. [E-book Available Online through library]

Bell, F.G. (2008) *Basic Environmental and Engineering Geology*. Whittles Publishing. [551/227 C]

Branagan, D. (2000) *Field Geology of New South Wales*. NSW Department of Mineral Resources. [P 559.44/12]

Duff, D. (1997) *Holmes' Principles of Physical Geology*, 4th Edition, Chapman and Hall. [PQ551/18 AB]

Fell, R., MacGregor, P., Stapledon, D., Bell, G. and Foster, M. (2015) *Geotechnical Engineering of Dams*, Balkema, 2nd Edition [627.83/31 B and Online via library]

Goodman, R.E. (1993) *Engineering Geology: Rock in Engineering Construction*, Wiley. [P624.151/166]

Hencher, S. (2012) *Practical Engineering Geology*, Spon Press, London. [624.151/214 and Online via library]

Johnson, R.B. and DeGraff, J.V. (1988) *Principles of Engineering Geology*, Wiley, 1st Edition. [P 624.151/157 A]

Skinner, B. and Porter, S. (2000) *The Dynamic Earth*, 4th Edition, Wiley. [PQ551/194]

Standards Association of Australia, (1993) AS1726-1993: Geotechnical Site Investigations [All available online through UNSW – search for resource: Australian Standards (SAI Global)] - Note currently under review

Standards Association of Australia, (1993) AS4482.1-2005: Guide to the investigation and sampling of sites with potentially contaminated soil - Non-volatile and semi-volatile compounds

iPhone (and other almost as smart phones)

There are numerous apps being developed for various smart phones. At the moment, there are only a handful developed for geology that are free. Many of the ones for the iPhone are still pretty basic and look like they are still in development. Some that I have looked at include:

- GeoID (preferred) or similar - works as a geological compass. It allows you to measure the dip and dip direction of a defect by simply sitting the phone on the defect. Very useful for Bronte. There is a charge.
- Geotimescale – gives a summary of the geological time scale (turn 'Ages' off for this course)
- Microscope – shows examples of rock samples under a microscope – only a limited number of examples at the moment
- Jurassic – an application that explores the geological history of the Dorset and East Devon coast. The location is not really relevant but the example of how geology develops over deep time is. In the menu check out: 'Pangaea' – this includes an animation of the movement of continents from when Pangaea existed to the present; 'A walk through time' – this discusses the development of the local geology and includes an animation showing how geological sections develop over time (in this case a sedimentary sequence developing over the last 250 million years).

- Rocks – gives examples of various rock types with photos and (for a couple of rocks) thin sections – still a limited number and (probably) more will be added with time.
- Mohs – Gives Mohs hardness scale. You can tap on the numbers which will give you the mineral names. Tap on these and it will give you a mineral description and photo. Useful for class when we talk about minerals.
- Brightstones – Mineralogical database (with photos) from Delft.
- USGSSeismic – Gives a list of the latest earthquakes around the world.
- EarthObserver – Maps of the Earth. Includes *large scale* geology maps. Click on '>' to change base map.
- QuakeFeed – get the latest large earthquake notices to your phone.
- Theodolite – works as a hand-held theodolite. Not of huge use to the course but I like playing with it.

I have not looked at many you have to pay for. The best glossary would be the one by AGI however, at $36.99 best to use the UNSW library.

Textbooks – Applied Geotechnics

No texts are required. Although the texts below may be useful.

- Bowles, J.E. *Foundation Analysis and Design*, McGraw-Hill (any edition)
- Das, B. (2016) *Principles of Foundation Engineering*, 8th edition, Cengage Learning – concentrates on foundations (other editions still useful)
- Das, B. (2013) *Principles of Geotechnical Engineering*, 8th edition, Cengage Learning – concentrates on geotechnical properties
- Holtz, R.D., Kovacs, W.D. & Sheahan, T.C. (2010) *An Introduction to Geotechnical Engineering*, 2nd edition, Pearson International
- Poulos, H.G. and Davis, E.H. (1980) *Pile Foundation Analysis and Design*, Wiley
- Smith, I. (2006) *The Elements of Soil Mechanics*, 8th edition, Blackwell Scientific
- Standards Association of Australia, (2009) *AS2159-2009: Piling – Design & Installation*
- Standards Association of Australia, (1996) *AS2159 Supp 1-1996: Piling - Design and installation - Guidelines (Supplement to AS 2159-1995)*
- Standards Association of Australia, (2011) *AS2870-2011: Residential Slabs and Footings*
- Standards Association of Australia, (2002) *AS4678-2002: Earth-Retaining Structures*
- Tomlinson, M.J. (2001) *Foundation Design & Construction*, 7th edition, Harlow : Prentice Hall
- Tomlinson, M. and Woodward, J. (2014) *Pile Design and Construction Practice*, 6th edition, CRC Press

Moodle

Materials including videos, additional lessons, geological animations, lecture notes and presentations, workshop solutions, quizzes, past papers, Web links and student submissions will be provided through Moodle. Note that the pages have been split into: A – Geology and B – Applied Geotechnics.

Group work for assignments will also be facilitated via Moodle.

Other Useful Geotechnical Sources

Journals:

All journals can be found in The University of New South Wales Library (or online via the library resource database – i.e. catalogue).

Australian Geomechanics Journal	PJ624.1513205/3
Canadian Geotechnical Journal	PJ620.19105/1
Engineering Geology: an International Journal.	PJ624.1505/12
Ground Engineering	PJ624.05/91
Journal of Geotechnical and Geoenvironmental Engineering.	PJ624.05/66
Geotechnical and Geological Engineering.	PJ622.05/158
Environmental & Engineering Geoscience.	PJ550/E650
Geotechnique.	PJ624.15105/10
Proc. of the Institution of Civil Engineers. Geotechnical Engineering.	PJ624.05/46
Bulletin of Engineering Geology and the Environment.	PQ624.1505/11
Rock Mechanics and Rock Engineering.	PJ624.1505/7
International Journal of Rock Mechanics and Mining Sciences.	PJ622.05/4

Internet sites:

Many Internet sites exist. Useful links are available in Moodle for many of the lectures. The following are links to some of the main Geotechnical sites:

Australian Geomechanics Society: http://australiangeomechanics.org [Those looking for geotechnical work opportunities should see the 'corporate members' page for a list of geotechnical related companies working in Australia]

Australian Geomechanics Society, Sydney: http://australiangeomechanics.org/chapters/sydney/ (has monthly Geotechnical talks)

International Society for Soil Mechanics and Geotechnical Engineering: http://www.issmge.org

International Society for Rock Mechanics: http://www.isrm.net

International Association of Engineering Geology: http://www.iaeg.info

The Australasian Institute of Mining and Metallurgy: http://www.ausimm.com.au/

The U.S. Geological Survey: http://www.usgs.gov/

Google Scholar: https://scholar.google.com.au/ (good for looking at research papers on specific topics)

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

SCHOOL PRIZES

Results in this course may contribute to the Geotechnical Engineering Discipline Prize presented at the fourth year dinner. In 2019 the prize was worth $1000 and was sponsored by the geotechnical consultancy Pells Sullivan Meynink.

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