CVEN3203

Applied Geotechnics and Engineering Geology

Term One // 2021

School of Civil and Environmental Engineering // UNSW Engineering

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Dr Kurt Douglas	k.douglas@unsw.edu.au	TBC in class	CE 506	9385 5046

Lecturers

Name	Email	Availability	Location	Phone
Dr Babak Shahbodaghkhan	b.shahbodagh@unsw.edu.au	TBC in class	CE 507	

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

Credit Points 6

Summary of the Course

This course covers two important areas of geotechnical engineering: geology and applied geotechnics. The geology section covers the earth and it's formation, rock types; their behaviour and properties and subsurface mapping. The topics in the applied geotechnics include: theoretical and presumptive bearing capacity of shallow foundations, allowable settlement and foundations on sand and clay, lateral earth pressures, retaining wall design, single axially and laterally loaded piles and pile groups, excavation and dewatering.

Course Aims

It is an aim of this course to help develop the following graduate attributes:To give

students a solid grasp of the theory and practice of geotechnical engineering, and to be familiar with the bases of research to further develop its technology. In addition, graduates should be able to apply theory to
practice in familiar and unfamiliar situations;

To stimulate the intellectual curiosity of students so that they will be motivated to undertake independent reflective learning as a lifelong skill;

To teach students how to define, analyse and solve problems clearly and logically and in doing so be able to find, evaluate, interpret and collate information;

To develop independent critical thought within students so that when necessary they will be able to challenge current knowledge and thinking;

To encourage proactive behaviour in students and to give them the associated entrepreneurial skills necessary;

To promote a respect within students for individual human rights and dignity, particularly when it relates to members of the public or other people who will be affected by the projects that they design and execute;

To foster effective self-management skills;

To nurture the skills required for effective leadership including an ability to manage and deliver projects, an understanding of the social dynamics of group performance, a repertoire of processes for the effective management of groups, and the ability to value diverse backgrounds and opinions and function effectively in multidisciplinary teams; and

To impart sound IT working skills.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Have an introduction to geology and geotechnical engineering.	PE1.4
2. Describe geotechnical materials.	PE1.1, PE1.3, PE2.1, PE2.4, PE3.2
3. 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.	PE1.4, PE2.1, PE2.4, PE3.2, PE3.4
4. Have an appreciation and ability to converse with Engineering Geologists so as to develop geotechnical models for geologically complex sites.	PE3.2, PE3.6, PE1.4
5. Study the basic principles related to the theory and design of shallow foundations, deep foundations and retaining walls.	PE1.1, PE1.2, PE1.3, PE1.5, PE2.1, PE2.2, PE2.3

Teaching Strategies

The contents of this subject are presented in a number of formats as per below.

Lectures: These will be presented to discuss the basic geological principles. As geology is a visual subject, PowerPoint and video presentations will be used to enhance the course. In the second part of the course, lectures will provide and familiarise students with design and analysis methods used in engineering practice. Equally important, students will be exposed to the theories on which these methods are based so as to understand the assumptions and limitations of the methods. 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.

Workshops/labs: In the first half of the subject these are used to teach 'hands-on' rock and mineral description and classification; geological processes, geological mapping and the preparation of preliminary geotechnical models. Students are 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 an opportunity to discuss the lecture material with demonstrators and solve set problems.

Assignment: The group assignment involves looking at and measuring geology outside the class room and contains a considerable amount of self-learning that will be critical to the understanding of Sydney geology and mapping and descriptive techniques. The lecturer and demonstrators are available for guidance when doing the assignment. This includes getting feedback on drafts of student work. Much of the assignment information will be provided Online.

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.

Private study: Includes 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.

Additional Course Information

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; and how groundwater flows through soil and its effect on engineered structures. 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).

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.

Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
Geology Workshops	5%	Workshops Weeks 1-4	1, 2, 3, 4
Geology Quiz	20%	Quiz Starts 6pm 29/03/2021	2, 3, 4
Geology Assignment	25%	31/03/2021 04:00 PM	2, 3
Final Exam	50%	Formal UNSW Exam Period	5

Assessment Details

Assessment 1: Geology Workshops

Start date: Workshops Weeks 1-4

Details:

Completion of pre-work and full completion of weekly activity during the workshop

Additional details:

Satisfactory completion of pre-work and the complete weekly activity during the workshop will receive full

marks. Significant partial completion, half marks.

Marking will occur during each workshop.

Assessment 2: Geology Quiz

Start date: 29/03/2021 06:00 PM

Length: 1 hour 15 mins

Details:

Geology quiz will be closed book and will test understanding of the geology component of the course.

Additional details:

Release and submission of the quiz will be via Moodle. Marks are expected to be returned within 3 weeks of submission.

Assessment 3: Geology Assignment

Start date: Released Week 3

Details:

Field mapping and self-guided fieldtrip. Part A: You will be assessed on your ability to: create a preliminary geological model; develop a site description and plan; perform and present geological mapping. Part B: You will be assessed on the quality of your description of your geological observations as well as your poster presentation.

Additional details:

The content and requirements of the assignment will be released through Moodle and discussed in lectures.

Marks are expected to be returned within 3 weeks of submission.

The nature of the assignment may be modified by the course co-ordinator as a result of COVID restrictions.

Assessment 4: Final Exam

Start date: Not Applicable

Length: 1.5 hours (Total time including reading/upload TBC)

Details:

The final exam will only cover the Applied Geotechnics component of the course.

Attendance Requirements

Your controbution to the geology workshops (Weeks 1-4) will be assessed. You are required to attend your allocated workshops in these weeks to receive a Workshop mark.

Students are strongly encouraged to attend all other classes and review lecture recordings.

Course Schedule

View class timetable

Timetable

Date	Type	Content
Week 1: 15 February - 19 February		**Lecture Topics:** Plate tectonics & geological time. Minerals. **Workshop:** Engineering Geology (assessed)
Week 2: 22 February - 26 February		**Lecture Topics:** The rock cycle, rock formation & classification. **Workshop:** Engineering Geology (assessed)
Week 3: 1 March - 5 February		**Lecture Topics:** Structural geology**.** The geotechnical model & site investigations**.** Engineering rock descriptions. **Workshop:** Engineering Geology (assessed)
Week 4: 8 March - 12 March		**Lecture Topics:** Soils – including alluvial, aeolian, colluvial, residual. **Workshop:** Engineering Geology (assessed)
Week 5: 15 March - 19 March		**Lecture Topics:** Geology review. // Geotechnical design methods. **Workshop:** Applied Geotech.
Week 6: 22 March - 26 March		**Flexibility Week - No Lectures/Workshops**
Week 7: 29 March - 2 April		**Lecture Topics:** Bearing capacity of shallow foundations. **Workshop:** Applied Geotech. **Assessment:** Geology Quiz. Assignment Due
Week 8: 5 April - 9 April		**Lecture Topics:** Settlement of shallow foundations. **Workshop:** Applied Geotech.
Week 9: 12 April - 16 April		**Lecture Topics:** Design of pile foundations. Lateral earth pressure. **Workshop:** Applied Geotech.
Week 10: 19 April - 23 April		**Lecture Topics:** Design of retaining walls. **Workshop:** Applied Geotech.

Resources

Prescribed 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]

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.

Recommended Resources

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 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.
- Stereonet (as above)
- 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.

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

Other Useful Geotechnical Sources

Journals:

- 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)

Course Evaluation and Development

The course is reviewed annually through the myExperience survey. All responses are considered and we make changes to the course annually in response. We are also always happy to get feedback during the course for immediate consideration. You can email us directly or use the feedback discussion tool we have placed in Moodle.

We are aware from feedback that there is a lot of content in our course. You do not have to read and watch everything you are provided with, it is there if you need it or want to explore further. It is much like solving problems in industry, where you are required to identify the information you need to solve and delve deeply into the literature where required.

Submission of Assessment Tasks

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

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

Key UNSW Dates - eg. Census Date, exam dates, last day to drop a course without academic/financial liability etc.

Final Examinations:

Final exams in Term 1 will be held online between 30th April - 13th May inclusive. You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

Supplementary Examinations:

Supplementary Examinations for Term 1 2021 will be held on 24th - 28th May inclusive should you be required to sit one. You are required to be available on these dates. Please do not to make any personal or travel arrangements during this period.

ACADEMIC ADVICE

For information about:

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

Refer to Academic Advice on the School website available at:

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

Image Credit

Dr Kurt Douglas

CRICOS

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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	✓