School of Civil and Environmental Engineering

Term 2, 2020

CVEN9630 Groundwater Hydrology and Resources Analysis

COURSE DETAILS

Units of Credit	6
Contact hours	4 hours online remote delivery per week
Classes: & Assignment Guidance	Monday online live lecture 18:00-20:00 (weeks 1-10) Wednesday online live lecture 18:00-20:00 (weeks 1-10) **For details see schedule on page 3**
Course Coordinator and Lecturer	A/Prof Martin S. Andersen m.andersen@unsw.edu.au and Moodle forum
Lecturers	Dr Christian Anibas c.anibas@unsw.edu.au Dr Helen Rutlidge h.rutlidge@unsw.edu.au

INFORMATION ABOUT THE COURSE

This course is a part of the Groundwater Resources M. Eng. Sci. program.

IMPORTANT NOTE: Since this is an online remotely delivered course, we rely on communicating with students through email and UNSW Moodle during the duration of the semester. It is the responsibility of the student to regularly check for announcements on Moodle and to make sure their provided email address is functional and regularly checked!

HANDBOOK DESCRIPTION

See handbook: **https://www.handbook.unsw.edu.au/postgraduate/courses/2019/CVEN9630**

OBJECTIVES

The aim of this course is to develop a student's understanding of the occurrence of groundwater and how it is interlinked with surface water. In addition, the student will understand the basic methods of groundwater investigations and development.

List of programme attributes:

- The skills involved in scholarly enquiry
- An in-depth engagement with the relevant disciplinary knowledge in its interdisciplinary context
- Capacity for analytical and critical thinking and for creative problem solving
- Ability to engage independent and reflective learning
- Information literacy and the skills to appropriately locate, evaluate and use relevant information
- A respect for ethical practice and social responsibility
- Skills for effective communication

TEACHING STRATEGIES

Private Study	• Review lecture material and textbook • Do set problems and assignments • 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
Lectures	• Find out what you must learn • See methods that are not in the textbook • Follow worked examples • Hear announcements on course changes
Assignment Guidance	• Be guided by the lecturers • Practice solving set problems • Ask questions
Assessments: Reading and major assignments	• Demonstrate your knowledge and skills • Demonstrate higher understanding and problem solving

EXPECTED LEARNING OUTCOMES

At the conclusion of this course, students should be able to:

1. Have an ability to understand what groundwater is and where it occurs
2. Understand the connectivity of surface water and groundwater resources, and
3. Understand how to investigate and develop groundwater resources

For each hour of contact it is expected that a student will put in at least 1.5 hours of private study.

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.	*Understand groundwater, its occurrence, distribution and value.*	*PE1.1, PE1.3, PE3.1*
2	*Knowledge of the physical and chemical characteristics of groundwater flow and storage.*	*PE1.2, PE2.1*
3.	*Knowledge of state-of-the-art investigation techniques used to quantify groundwater flow and storage.*	*PE1.2, PE1.3, PE3.1*
4.	*Application of physical relationships to quantitatively assess groundwater flow and storage.*	*PE1.2, PE2.1*
5.	*Knowledge of the design of groundwater extraction and monitoring infrastructure.*	*PE1.5, PE2.3, PE3.1*
6.	*Comprehend difficult groundwater investigation problems by solving questions based on real-world measurements.*	*PE1.2, PE2.1, PE3.2*

COURSE PROGRAM

Online live delivery time: 18:00 – 20:00			
Week	**Date**	**Topic**	**Lecturer**
1	**Monday 1st June**	**Lecture 1 (chapter 1):** Introduction to Hydrogeology and	**Martin Andersen**
	Wednesday 3rd June	**Lecture 2 (chapter 2):** Physical properties and Darcy's Law **Lecture 3 (chapter 3):** Transport equations and steady-state flow	**Martin Andersen**
2	**Monday 8th June**	**Lecture 4 (chapter 4):** Aquifer storage and abstraction impacts **This is a public holiday. Students are not expected to watch the live lecture.**	**Martin Andersen**
	Wednesday 10th June	**Lecture 5 (chapter 5):** Groundwater modelling fundamentals	**Martin Andersen**
3	**Monday 15th June**	**Assignment guidance**	**Martin Andersen**
	Wednesday 17th June	**Lecture 6 (chapter 6):** Recharge, discharge and SW-GW connectivity	**Martin Andersen**
4	**Monday 22nd June**	**Lecture 9 (chapter 11):** Drilling techniques **Lecture 13 (chapter 13):** Abstraction bore design and maintenance	**Christian Anibas**
	Wednesday 24th June	**Lecture 7 (chapter 7):** Well hydraulics	**Christian Anibas**
5	**Monday 29th June**	**Lecture 8 (chapter 8):** Pumping test interpretation	**Christian Anibas**
	Wednesday 1st July	**Assignment guidance**	**Christian Anibas** **Martin Andersen**
6	**Monday 6th July**	**Flexibility week – no lectures – individual assignment work**	
	Wednesday 8th July		
7	**Monday 13th July**	**Lecture 10 (chapter 9):** Geophysical techniques: Electrical **Lecture 11 (chapter 12):** Geophysical logging	**Christian Anibas**
	Wednesday 15th July	**Lecture 12 (chapter 10):** Geophysical techniques: Seismic	**Christian Anibas**
8	**Monday 20th July**	**Lecture 14 (chapter 14):** Groundwater chemistry	**Helen Rutlidge**
	Wednesday 22nd July	**Assignment guidance**	**Christian Anibas** **Martin Andersen**
9	**Monday 27th July**	**Lecture 15 (chapter 15):** Groundwater isotopes	**Helen Rutlidge**
	Wednesday 29th July	**Guest lecture:** Lumped parameter modelling and water isotope tracing Part 1	**Andy Baker**
10	**Monday 3rd August**	**Guest lecture:** Lumped parameter modelling and water isotope tracing Part 2	**Andy Baker**
	Wednesday 5th August	**Assignment guidance**	**Andy Baker** **Martin Andersen**

ASSESSMENT

The major assignments contain specific tasks and questions to be answered by each individual student in their own time **after** the scheduled online class times. Please note that the assignments do require significant time to complete, as they form the core part of assessing a student's understanding of the knowledge provided in this course. The purpose of these exercises is to enable students to develop the necessary depth of understanding of groundwater resources so that they can enter the workforce and contribute accordingly.

The final grade is calculated based on the weights of individual assessments. Passing this course requires a final grade of 50%. Please note that the Course Coordinator reserves the right to adjust the final scores by scaling if agreed to by the Head of School. 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.

NOTES:

1) Feedback will be given for Assignment 1A before 28th of June.
2) There is no exam at the end of session for this course.

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** *(this needs to explicitly describe what students are expected to demonstrate in the task)*	**Due date and submission requirements**	**Deadline for absolute fail**	**Marks returned**
Assignment 1A: Fundamental Hydrogeology	12 questions	10%	*PE 1.1* *PE 1.2* *PE 1.3* *PE 2.1* *PE 3.2*	*The correctness of answers to questions about the fundamentals of hydrogeology including: groundwater in a geological context using geological maps; calculating hydraulic heads and deriving equipotential maps and flowlines; applying Darcy's Law in various configurations; and analysing slugtests. This assignment is designed to capture the students understanding of the course material delivered in Lecture note Chapters 1-2. Marks are given for correct answers and summed to form an assignment grade.*	15 June 6 pm	17 June 6 pm	Before 28 June
Assignment 1B: Groundwater Storage and Groundwater Flow Modelling	2 main questions each with a number of sub-questions	25%	*PE 1.1* *PE 1.2* *PE 1.3* *PE 1.5* *PE 2.1* *PE 2.2* *PE 3.2* *PE 3.4*	*The correctness of answers to questions of increasing difficulty is quantified. The students will apply technical knowledge and engineering principles to: aspects of groundwater storage and steady state groundwater flow problems using a groundwater model. Questions are designed to develop and capture the student's in-depth knowledge of the material delivered in the Lecture note Chapters 3-5. Marks will be based on a student's logical thinking, as far as this can be reasonably inferred, and for correct answers and summed to form an assignment grade.*	29 June 6 pm	1 July 6 pm	19 July
Assignment 2: Transient Groundwater Flow to Wells; Pumping Test Analysis; Geo-Electrical and Seismic Survey Interpretation	# of questions TBC	25%	*PE 1.1* *PE 1.2* *PE 1.3* *PE 1.5* *PE 2.1* *PE 2.2* *PE 3.2* *PE 3.4*	*The correctness of answers to questions of increasing difficulty is quantified. The students will apply technical knowledge and engineering principles to: transient groundwater flow; groundwater flow to wells; aquifer test interpretation; Geo-electrical and seismic survey interpretation. Questions are designed to develop and capture the student's in-depth knowledge of the material delivered in the Lecture note Chapters 7-10. Marks will be based on a student's logical thinking, as far as this can be reasonably inferred, and for correct answers and summed to form an assignment grade.*	22 July 6 pm	24 July 6 pm	31 July
Assignment 3: Hydro-Geochemical Investigations	2 main questions each with a number	20%	*PE 1.1* *PE 1.2* *PE 1.3* *PE 1.5*	*The correctness of answers to questions of increasing difficulty is quantified. The students will apply technical knowledge and engineering principles to: hydrogeochemical knowledge and methods*	3 August 6 pm	5 August 6 pm	30 August

	of sub-questions		*PE 2.1* *PE 2.2* *PE 3.2* *PE 3.4.*	*for groundwater investigations. Questions are designed to develop and capture the student's in-depth knowledge of (Chapter 14). Marks will be based on a student's logical thinking, as far as this can be reasonably inferred, and for correct answers and summed up to form an assignment grade*.			
Assignment 4: Lumped Parameter Modelling and Water Isotope Tracing for Groundwater Investigations	# of questions TBD	20%	*PE 1.1* *PE 1.2* *PE 1.3* *PE 1.5* *PE 2.1* *PE 2.2* *PE 3.2* *PE 3.4*	*The correctness of answers to questions of increasing difficulty is quantified. The students will apply technical knowledge and engineering principles to: knowledge and methods applied to lumped parameter modelling and water isotope tracing for groundwater investigations. Questions are designed to develop and capture the student's in-depth knowledge of (Chapter 5, 6 and 15, as well as material provided at a later stage in connection to the guest lecture). Marks will be based on a student's logical thinking, as far as this can be reasonably inferred, and for correct answers and summed up to form an assignment grade*.	14 August 6 pm	16 August 6 pm	30 August

RELEVANT RESOURCES

Extensive notes are provided in the form of a book containing individual chapters for the course material.

General texts worth purchasing are:

- Applied Hydrogeology - Fourth Edition (2001) by C.W. Fetter; published by Prentice Hall - For a basic introduction.
- Groundwater hydrology (2005) by Todd, D. K., & Mays, L. W. Wiley, New Jersey.
- Hydrogeology: Principles and Practice (2014) Kevin M. Hiscock & Victor F. Bense. Published by Wiley-Blackwell.
- Groundwater Science (2012) by Charles Fitts. Published by Elsevier.
- Physical and Chemical Hydrogeology - Second Edition (1997) by Domenico and Schwartz; published by John Wiley and Sons - More detailed theoretical discussion of many aspects.
- Groundwater Hydrology - Conceptual and Computational Models (2003) by K.R. Rushton; published by Wiley - Excellent practical and theoretical approach to groundwater resource assessment.
- Water Wells and Boreholes - Misstear, Banks and Clark (2006); published by Wiley
- Geochemistry, Groundwater, and Pollution (2005); Appelo, C.A.J., Postma, D.; 2nd ed. A.A. Balkema, Rotterdam. 649 pp. ISBN: 04 1536 428 0 - Best textbook on the market for groundwater chemistry! It can be ordered via website **www.crcpress.com**

The UNSW Connected Waters web site provides a portal to the groundwater world. This can be accessed at **http://www.connectedwaters.unsw.edu.au**

The Hydrogeology Journal is the academic publication of the International Association of Hydrogeologists.

The web address for the IAH is **http://www.iah.org/**.

Journal articles are at **http://link.springer.de/link/service/journals/10040/index.htm**

Additional materials may be provided on Moodle during the course.

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**

ACADEMIC ADVICE

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