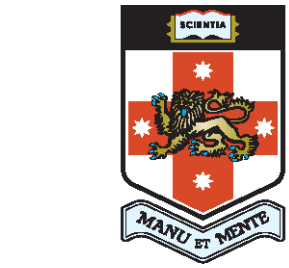

UNSW
SYDNEY

Faculty of Engineering

School of Minerals and Energy Resources Engineering

Undergraduate Course Outline

PTRL 4017
Well Technology

Professor Sheik Rahman

Dr. Zhixi Chen

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1. INFORMATION ABOUT THE COURSE

Course Code:	PTRL4017	Term:	T2, 2020	Level:	UG	Units/Credits	6 UOC
Course Name:	**Well Technology**						

Course Convenor:	***Professor Sheik Rahman***		
Contact Details	School of Minerals and Energy Resources Engineering TETB 212	EMAIL:	Sheik.rahman@unsw.edu.au
		Phone:	+61 2 9385 5659
Course Lecturer:	***Dr Zhixi Chen***		
Contact Details	School of Minerals and Energy Resources Engineering TETB 211	EMAIL:	zhixic@unsw.edu.au
		Phone:	+61 2 9385 5182
Contact times	**This course will be delivered online in T2. Please see Moodle for presentation times and requirements.** **Monday 13:00 – 16:00 (Weeks 1, 3-5, 7-11)** **Wednesday 11:00 – 14:00 (Weeks 1–5, 7- 10)** **Friday 14:00 – 17:00 (Weeks 5, 7)**		

1.1. Course Description

The course covers the following aspects:
Lecture Sequence A - Well Planning: Prediction of formation pore pressure and stress gradients. Determination of safe mud weight bounds for different in-situ stress conditions. Casing types and functions. API Casing manufacturing, dimensions, weights, grades, casing couplings and threads. Performance properties of the casing under load conditions (tension, burst and collapse). Casing design principals and procedures. Casing design in deviated and horizontal wells. Design and planning well trajectory. Surveying tools, procedures and calculation methods. Deflecting tools and directional control. Drill string and bottom hole assembly. Downhole mud motors. Drilling methods and equipment for directional, horizontal and multilateral wells.

Lecture Sequence B – Well completion: Interval selection and productivity considerations. Selection of completion design based on influence of reservoir heterogeneity, production methods and the required producing rate. Inflow performance analysis for oil and gas reservoirs (both Vogel and Fetkovich), summation of pressure drops (reservoir to well heads by nodal analysis) and matching completion with reservoir performance. Estimation forces (burst and collapse) on tubing due to various production operations including: different stages of production, well kill operation, squeeze cementing, hydraulic fracturing etc. Tubing packer movement due to the effect of various production operations and estimation of these forces as well as contraction and / or elongation of tubing due to these forces. Selection of tubing material and sizes based on forces on tubing. Selection of downhole equipment, tubing accessories and wellhead and wellhead equipment. Basics of perforation technique, selection of equipment and procedure for perforation of oil and gas well and estimation pressure losses in perforation tunnels and perforation interval. Causes of sand production, analysis of formation sand and prevention of sand production by managing production rate and pressure, evaluation different gravel packing techniques and design a typical gravel pack.

1.2. Course Completion

Course completion requires submission of all assessment items; failure to submit all assessment items can result in the award of an Unsatisfactory Failure (UF) grade for the Course.

1.3. Assumed Knowledge

Prerequisite: PTRL3015

1.4. Attendance

To pass this course it is expected that you will attend at least 80% of tutorials and lectures. *If your attendance is below 80% you will not be admitted to the final exam*. Attendance will be recorded when applicable. Normally, there is no make-up work for poor attendance. If you have misadventure or ill-health, please contact your course coordinator soon as possible. The attendance requirement is not meant to be punitive. It is included because participation is an important part of achieving the course outcomes.

2. AIMS, LEARNING OUTCOMES AND GRADUATE ATTRIBUTES

2.1. Course Aims

This course will enable students to acquire fundamental knowledge of well systems design and well completion and to apply the theory to the design, evaluation and optimization of casing program, well trajectory and well completion.

2.2. Learning Outcomes

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

1. Design and evaluate casing programs and casing strings;
2. Plan well trajectory, perform survey calculations;
3. Understand well completion technology and well completion equipment;
4. Analyze well performance and tubing performance; understand tubing movement and perform graphic tubing design;
5. Design perforation and prevention sand production.

3. REFERENCE RESOURCES

3.1. Reference Materials

Support material for this course including, whenever available, copies of lecture notes, lecture slides, recommended readings, etc. can be found on Moodle.

The lecture notes/slides may be viewed and downloaded from the UNSW-Moodle http://moodle.telt.unsw.edu.au/.

3.2. Recommended Materials

Followings are the recommended books for this course:

- Rahman S.S. and Chilingarian G.V.: **Casing Design Theory and Practice**, Elsevier Science B.V., Amsterdam, The Netherlands, 1995
- Inglis, T.A.: **Directional Drilling,** Petroleum Engineering and Development Studies, Vol. 2, Graham & Trotman, 1987.
- Bourgoyne A.T. Jr., Millheim K.K., Chenevert M.E. and Young F.S. Jr.: **Applied Drilling Engineering**, SPE Textbook Series, Vol. 2, Richardson, TX, USA, 1991.
- Buzarde L.E. Jr., R.L. Kastro, W.T. Bell and C.L. DePriester: **Production operations**, Course 1, Well Completions SPE Publications, 1972
- Allen T.O. and A.P. Roberts: **Production Operations,** Volumes I and II, Oil and Gas Consultants International Inc, 1989
- **Reservoir Engineering Hand Book**, Tarek Ahmed Gulf Publishing Company, 2000
- Michael J Economides, A Daniel Hill, Christine Ehlig Economides and Englewood Cliffs NJ.: **Petroleum Production Systems,** Prentice Hall 1994.

3.3. Other Resources

Links to websites etc.

The University and the Faculty provide a wide range of support services for students, including:

- UNSW Learning Centre (http://www.lc.unsw.edu.au)
- Counselling support - http://www.counselling.unsw.edu.au
- Library training and support services - http://www.library.unsw.edu.au/
- OnePetro – (http://www.onepetro.org)

3.4. Online Resources

There are numerous articles / information sources on casing design and cementing on the web. Many of them are sound, but many are either very lightweight or contain errors. Be very careful in your choice of web sources. Remember, UNSW librarians are usually happy to help you locate articles or make suggestions regarding possible material to help you in your academic work. You can also access basic online help at http://www.library.unsw.edu.au/

3.5. Report Writing Guide

The School has a Report Writing Guide (RWG). A copy of this is available on the course Moodle site.

4. COURSE CONTENT AND LEARNING ACTIVITIES

4.1. Course content

Lecture Sequence A:

1. Casing Types and Physical Properties
2. Performance Properties under Load Conditions
3. Principles of Casing Design
4. Well Planning
5. Survey Calculations
6. Surveying Methods & Tools
7. Directional Control, MWD & Rotary steerable system
8. Drilling Tools and Downhole Motors

Lecture Sequence B:

1. Well Completion Design
2. Well Performance Analysis
3. Tubing Performance Analysis
4. Tubing Design
5. Tubing Movement
6. Well completion Equipment
7. Perforation of Oil and Gas Wells
8. Sand Control

4.2. Learning Activities and Study Guide

UNSW	Activity	Content	
Wk		**Lecture Sequence A**	**Lecture Sequence B**
1	Lecture + In class activity	• Casing Types and Physical Properties • Tutorial: API casing classification	• Well Completion Design • Well Performance Analysis
2	Lecture + In class activity	• Performance Properties under Load Conditions • Tutorial: load on casing	Public Holiday on Monday 8 June
3	Lecture + In class activity	• Principles of Casing Design • Tutorial: Casing setting depth & program	• Well Performance Analysis • Tutorial: IPR curve for oil reservoir
4	Lecture + In class activity	• Principles of Casing Design • Tutorial: Casing without liner	• Well Performance Analysis • Tutorial: Calculation of productivity index (saturated, unsaturated); IPR curve for gas reservoir
5	Lecture + In class activity	• Principles of Casing Design • Tutorial: Casing with liner • Review on Casing Design	• Tubing Performance Analysis • Pressure gradient analysis Tutorial: Total pressure gradient calculation Tutorial: Pressure gradient calculation • **Lab (VirtuWell)**
6	Flexibility week	N/A	N/A
7	Lecture + In class activity	• **Midterm Exam** • Well Planning	• **Midterm Exam** • Tubing Performance Analysis Tutorial: Total pressure gradient calculation • **Lab (VirtuWell)**
8	Lecture + In class activity	• Well Planning • Surveying Calculations • Tutorial: Well trajectory	• Tubing Movement & Tubing Design • Tutorial: Tubing movement calculation
9	Lecture + In class activity	• Surveying Calculations • Surveying Methods & Tools • Tutorial: Surveying calculations	• Well completion Equipment
10	Lecture + In class activity	• Directional Control, MWD & Rotary steerable system • Drilling Tools and Downhole Motors • Review	• Perforation of Oil and Gas Wells • Tutorial: perforation design
11	Lecture + In class activity	N/A	• Sand Control • Tutorial: Determination of gravel and liner slot size • Review

Teaching Period 1st June – 10th August 2020
Study Period 11 – 13 August 2020
Exam Period 14 – 27 August 2020
Other UNSW Key dates: https://student.unsw.edu.au/new-calendar-dates

5. COURSE ASSESSMENT

5.1. Assessment Summary

Assessment task	Due date / week	Weight	Assessment	Learning outcomes assessed
1	Week 5	5%	**Assignment B1** Topic: Well completion methods, well performance analysis, pressure gradient calculation	3, 4
2	Week 7	5%	**Assignment A1** Topic: Casing program and casing string.	1
3	Week 7	30%	**Midterm Exam**	1, 3, 4
4	Week 9	5%	**Assignment B2** Topic: IPR/TPC analysis with Virtuwell, Tubing design, perforation design and sand control	3, 4, 5
5	Week 10	5%	**Assignment A2** Topic: Well trajectory design & Surveying calculations.	2
8	14 – 27 August	50%	**Final Exam**	1, 2, 3, 4, 5

Assignments related details/submission instructions will be available online through Moodle. Access to the Moodle site is via the Moodle icon on the MyUNSW homepage.

6. ASSESSMENT CRITERIA

The assessment criteria provide a framework for you to assess your own work before formally submitting major assignments to your course convenor. Your course convenor will be using this framework to assess your work and as a way to assess whether you have met the listed learning outcomes and the graduate attributes for your program. We ask that you don't use the assessment criteria guidelines as a checklist, but as a tool to assess the quality of your work. Your course convenor will also be looking at the quality, creativity and the presentation of your written assignment as they review the framework. Rubrics, wherever applicable, will be provided at the time of the assignment release.

6.1 Assignments

The specifications and marking rubrics will be provided at the time of the assignment release.

6.2 Midterm Exam

Guidelines for helping the preparation for the midterm exam will be released prior to the exam.

6.3 Final Exam

Guidelines for helping the preparation for the final exam will be released prior to the exam.

7. STUDYING A PG COURSE IN UNSW MINERALS AND ENERGY RESOURCES ENGINEERING

7.1. How We Contact You

At times, the School or your course convenors may need to contact you about your course or your enrolment. Your course convenors will use the email function within Moodle or we will contact you on your @student.unsw.edu.au email address.

We understand that you may have an existing email account and would prefer for your UNSW emails to be redirected to your preferred account. Please see these instructions on how to redirect your UNSW emails: https://www.it.unsw.edu.au/students/email/index.html

7.2. How You Can Contact Us

We are always ready to assist you with your inquiries. To ensure your question is directed to the correct person, please use the email address below for:

Enrolment or other admin questions regarding your program:
https://unswinsight.microsoftcrmportals.com/web-forms/

Course inquiries: these should be directed to the Course Convenor.

7.3. Computing Resources and Internet Access Requirements

UNSW Minerals and Energy Resources Engineering provides blended learning using the on-line Moodle LMS (Learning Management System).

It is essential that you have access to a PC or notebook computer. Mobile devices such as smart phones and tablets may compliment learning, but access to a PC or notebook computer is also required. Note that some specialist engineering software is not available for Mac computers.

Mining Engineering Students: OMB G48/49
Petroleum Engineering Students: TETB

It is recommended that you have regular internet access to participate in forum discussion and group work. To run Moodle most effectively, you should have:

- broadband connection (256 kbit/sec or faster)
- ability to view streaming video (high or low definition UNSW TV options)

More information about system requirements is available at www.student.unsw.edu.au/moodle-system-requirements

7.4. Accessing Course Materials Through Moodle

Course outlines, support materials are uploaded to Moodle, the university standard Learning Management System (**LMS**). In addition, on-line assignment submissions are made using the assignment dropbox facility provided in Moodle. All enrolled students are automatically included in Moodle for each course. To access these documents and other course resources, please visit:
www.moodle.telt.unsw.edu.au

7.5. Assignment Submissions

The School has developed a guideline to help you when submitting a course assignment.

We encourage you to retain a copy of every assignment submitted for assessment for your own record either in hardcopy or electronic form.

All assessments must have an assessment cover sheet attached.

7.6. Late Submission of an Assignment

Full marks for an assignment are only possible when an assignment is received by the due date.

We understand that at times you may not be able to submit an assignment on time, and the School will accommodate any fair and reasonable extension. We would recommend you review the UNSW Special Consideration guidelines – see following section.

Unapproved late submission will not be accepted and will be considered as no submission.

7.7. Special Consideration

You can apply for special consideration through UNSW Student Central when illness or other circumstances interfere with your assessment performance. Sickness, misadventure or other circumstances beyond your control may:

- Prevent you from completing a course requirement,
- Keep you from attending an assessable activity,
- Stop you submitting assessable work for a course,
- Significantly affect your performance in assessable work, be it a formal end-of-semester examination, a class test, a laboratory test, a seminar presentation or any other form of assessment.

We ask that you please contact the Course Convenor immediately once you have completed the special consideration application, no later than one week from submission.

More details on special consideration can be found at: www.student.unsw.edu.au/special-consideration

7.8. Course Results

For details on UNSW assessment policy, please visit: www.student.unsw.edu.au/assessment

In some instances, your final course result may be withheld and not released on the UNSW planned date. This is indicated by a course grade result of either:

- WD – which usually indicates you have not completed one or more items of assessment or there is an issue with one or more assignment; or
- WC – which indicates you have applied for Special Consideration due to illness or misadventure and the course results have not been finalised.

In either event it would be your responsibility to contact the Course Convener as soon as practicable but no later than five (5) days after release of the course result. If you don't contact the convener on time, you may be required to re-submit an assignment or re-sit the final exam and may result in you failing the course. You would also have a NC (course not completed) mark on your transcript and

would need to re-enroll in the course.

7.9. Students Needing Additional Support

The Student Equity and Disabilities Unit (SEADU) aims to provide all students with support and professional advice when circumstances may prevent students from achieving a successful university education. Take a look at their webpage: www.studentequity.unsw.edu.au/

7.10. Academic Honesty and Plagiarism

Your lecturer and the University will expect your submitted assignments are truly your own work. UNSW has very clear guidelines on what plagiarism is and how to avoid it. Plagiarism is using the words or ideas of others and presenting them as your own. Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. The University has adopted an educative approach to plagiarism and has developed a range of resources to support students. All the details on plagiarism, including some useful resources, can be found at www.student.unsw.edu.au/plagiarism.

All Mining Engineering students are required to complete a student declaration for academic integrity which is outlined in the assignment cover sheets. By signing this declaration, you agree that your work is your own original work.

If you need some additional support with your writing skills, please contact the Learning Centre or view some of the resources on their website: www.lc.unsw.edu.au/. The Learning Centre is designed to help you improve your academic writing and communication skills. Some students use the Centre services because they are finding their assignments a challenge, others because they want to improve an already successful academic performance.

7.11. Continual Course Improvement

At the end of each course, all students will have the opportunity to complete a course evaluation form. These anonymous surveys help us understand your views of the course, your lecturers and the course materials. We are continuously improving our courses based on student feedback, and your perspective is valuable.

Feedback is given via https://student.unsw.edu.au/myexperience and you will be notified when this is available for you to complete.

We also encourage all students to share any feedback they have any time during the course – if you have a concern, please contact us immediately.

8. SCHOOL ASSESSMENT COVER SHEET

School of Minerals and Energy Resources Engineering

Assessment Cover Sheet

Course Convenor: _____

Course Code: _____ Course Title: _____

Assignment: _____

Due Date: _____

Student Name: _____ Student ID: _____

ACADEMIC REQUIREMENTS

Before submitting this assignment, the student is advised to review:

- the assessment requirements contained in the briefing document for the assignment;
- the various matters related to assessment in the relevant Course Outline; and
- the *Plagiarism and Academic Integrity* website at < http:/www.lc.unsw.edu.au/plagiarism/pintro.html > to ensure they are familiar with the requirements to provide appropriate acknowledgement of source materials.

If after reviewing this material there is any doubt about assessment requirements, then in the first instance the student should consult with the Course Convenor and then if necessary with the Director – Undergraduate Studies.

While students are generally encouraged to work with other students to enhance learning, all assignments submitted for assessment must be their entire own work and duly acknowledge the use of other person's work or material. The student may be required to explain any or all parts of the assignment to the Course Convenor or other authorised persons. *Plagiarism* is using the work of others in whole or part without appropriate acknowledgement within the assignment in the required form. *Collusion* is where another person(s) assists in the preparation of a student's assignment without the consent or knowledge of the Course Convenor.

Plagiarism and *Collusion* are considered as Academic Misconduct and will be dealt with according to University Policy.

STUDENT DECLARATION OF ACADEMIC INTEGRITY

I declare that:

- This assessment item is entirely my own original work, except where I have acknowledged use of source material (such as books, journal articles, other published material, the Internet, and the work of other student/s or any other person/s).
- This assessment item has not been submitted for assessment for academic credit in this, or any other course, at UNSW or elsewhere.

I understand that:

- The assessor of this assessment item may, for the purpose of assessing this item, reproduce this assessment item and provide a copy to another member of the University.
- The assessor may communicate a copy of this assessment item to a plagiarism checking service (which may then retain a copy of the assessment item on its database for the purpose of future plagiarism checking).

Student Signature: Date:

Students are advised to retain a copy of this assessment for their records and submission should be made in accordance to the assessment details available on the course Moodle site.