Faculty of Engineering

**School of Minerals and Energy Resources Engineering**

Undergraduate Course Outline

# PTRL4020/PTRL 5010

# Natural Gas Engineering

Dr Habib Zughbi

**CONTENTS**



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## 1. INFORMATION ABOUT THE COURSE

| Course Code: | PTRL4020 | Term: | T1 2021 | Level: | UG | Units/Credits | 6 UOC |
|---|---|---|---|---|---|---|---|
| Course Name: | **Natural Gas Engineering** | | | | | | |

| Course Convenor: | ***Dr Habib Zughbi*** | | |
|---|---|---|---|
| Contact Details | School of Minerals and Energy Resources Engineering<br>TETB | EMAIL: | h.zughbi@unsw.edu.au |
| | | Phone: | 0431746278 |
| Contact times | **Lecture: Tue 5-7pm, Thu 5-6pm Online**<br>**Tutorial: Thu 6-8pm, Online and TETB G16** | | |

### 1.1. Course Description

This course focusses on three key areas in the development of natural gas projects. First, the course provides an introduction to hydrogen and various types of natural gas resources including conventional and unconventional gas resources. Secondly, the majority of the course examines the thermodynamics of hydrogen and natural gases and the estimation of their behaviour using cubic equations of state. Thirdly, the course explores the methods of processing produced gas and getting it to market.

### 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: MATH1231 or MATH1241

### 1.4. Attendance

To pass this course it is expected that you will attend at least 80% of tutorials and lectures. *Failure to meet the specified attendance requirements of the course may result in in the award of an Unsatisfactory Failure (UF) grade for the Course.*

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

Natural gas and hydrogen are becoming an increasingly important part of Australia's and the world's energy supply. Further, natural gas is put forward as a low emission alternative to other fossil fuels, while hydrogen is seen as the ultimate source of fuel to reduce GHG emissions. An extreme surge in research aiming at producing hydrogen at a competitive cost and the development of technologies to allow the development of unconventional gas resources has further added to the likelihood of having H2 commercially as a fuel and also to the expansion in the supply and demand for natural gas. It is important that Petroleum Engineering graduates understand the technical, economic and social issues at play in the development of hydrogen generation and natural gas resources.

The technical aspects of natural gas developments are covered throughout the Petroleum Engineering Program as part of other reservoir engineering, geology, drilling and production courses. This course complements these other courses by aiming to:

1. Combine students existing knowledge of fluid flow with a thorough grounding in the analysis and prediction of the PVT behaviour of hydrogen and natural gases through the application of the thermodynamic concepts and equations of state by applying these concepts to selected unit operations,

2. Introduce students to the types of natural gas resources and the economic and social context of their development and also to the latest in the race to produce and use hydrogen on a commercial level.

### 2.2. Learning Outcomes

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

1. Apply thermodynamic theory to predict & explain the properties and PVT behaviour of hydrogen and natural gases.
2. Perform preliminary design/analysis calculations for common unit operations in hydrogen and natural gas handling.
3. Critically engage in contemporary debates around the development of hydrogen generation and the various types of natural gas resources.

### 2.3. Graduate Attributes

UNSW aspires to develop graduates who are rigorous scholars, capable leaders, profession practitioners and global citizens.

The University has articulated a comprehensive list of Graduate Attributes (GAs) as a set of desired learning outcomes for all UNSW students. The full list, comprising sub-sets of the above four broad areas, may be found here:

https://my.unsw.edu.au/student/atoz/GraduateAttributes.html

The core graduate attributes which we develop in Natural Gas Engineering are:

- Scholars who have an understanding of their discipline in its interdisciplinary context (GA 1a)
- Scholars who are able to apply their knowledge and skills to solving problems (GA 1d)

- Scholars who are capable of effective communication (GA 1f)
- Leaders who are collaborative team workers (GA 2c)

## 3. REFERENCE RESOURCES

### 3.1. Reference Materials

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

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

### 3.2. Text (if applicable)

Following is the recommended books for this course.

*Smith, van Ness, Abbott, & Swihart (2018) Chemical Engineering Thermodynamics, 8th edition, McGraw-Hill. This is the 'text book' for the course. It is available from the UNSW Bookshop and the UNSW Library (660.28/70).*

### 3.3. Other Resources (if applicable)

Fundamentals of Engineering Thermodynamics by Moran & Shappiro provides a good introduction to thermodynamics and covers much but not all the content covered in this course. The library has 9 copies (621.4021/66).

Fundamentals of Natural Gas Processing by Kidnay & Parrish gives a good introduction to the natural gas industry and is available online through the UNSW Library website (http://www.crcnetbase.com/isbn/978-0-8493-3406-1).

Students will be suggested additional handbooks and texts related to particular topics covered in the course.

### 3.4. Online Resources

There are numerous articles / information sources on reservoir engineering 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/

# 4. COURSE CONTENT AND LEARNING ACTIVITIES

## 4.1. Course content

1. Course introduction; hydrogen generation and natural gas resources; energy, heat & work. Getting gas to market (gas specifications and processing)
2. The first law; state functions & reversible processes; heat effects; heating values; greenhouse gases
3. The second law; entropy; ideal & lost work; material, energy and entropy balances
4. PVT behaviour of ideal and real gases; reversible cycles for processes
5. Real equations of state; residual properties and real processes
6. Onshore transport of natural gas: compressors, turbines and pipelines
7. Vapour-liquid equilibrium and the phase behaviour of natural gases
8. Water vapour in natural gases; dehydration and hydrate inhibition
9. Hydrogen generation technologies and economics and possibly valves, nozzles and chokes in gas operations

## 4.2. Learning Activities Summary

| UNSW Week | Activity | Content |
|---|---|---|
| **1** **14th Feb** | 1x3h lecture, 2x1 h tutorial | Course introduction; hydrogen generation and natural gas resources; energy, heat & work. Getting gas to market (gas specifications and processing) |
| **2** **22th Feb** | 1x3h lecture, 2x1 h tutorial | The first law; state functions & reversible processes; heat effects; heating values; greenhouse gases |
| **3** **1st Mar** | 1x3h lecture, 2x1 h tutorial | The second law; entropy; ideal & lost work; material, energy and entropy balances |
| **4** **8th Mar** | 1x3h lecture, 2x1 h tutorial | PVT behaviour of ideal and real gases; reversible cycles for processes |
| **5** **14th Mar** | 1x3h lecture, 2x1 h tutorial | Real equations of state; residual properties and real processes |
| **6** **21rd Mar** | 1x3h lecture, 2x1 h tutorial | Flexibility week, 5x1 Consultation-Optional |
| **7** **28th Mar** | 1x3h lecture, 2x1 h tutorial | Onshore transport of natural gas: compressors, turbines and pipelines<br><br>Transport of hydrogen, examples. |
| **8** **4th Apr** | 1x3h lecture, 2x1 h tutorial | Vapour-liquid equilibrium and the phase behaviour of natural gases and hydrogen |
| **9** **11th Apr** | 1x3h lecture, 2x1 h tutorial | Water vapour in natural gases; dehydration and hydrate inhibition |
| **10** **18th Apr** | 1x3h lecture, 2x1 h tutorial | Hyhrogen generation technologies and possibly valves, nozzles and chokes in natural gas operations |

Study Period 23 Apr – 28 Apr 2022
Exam Period 29 Apr – 12 May 2022

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** | | 2 * 25% | **Class Quiz**<br>2 x 2hour, Online in class time quizzes | 1, 2, 3 |
| **2** | | 50% | **Final Exam**<br>A 2 hour, Online exam covering the entire course | 1, 2, 3 |

Assignments related details/submission-box 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 provides 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.

## 7. STUDYING A UG 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 a 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.

## 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.**