School of Chemical Engineering

UNSW Engineering

CEIC3004

Process Equipment Design

Term 1, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Rita Henderson	r.henderson@unsw.edu.au	Wednesday 12-2pm and via MS Teams		
Helen Rutlidge	h.rutlidge@unsw.edu.au	Wednesday 12-2pm and via MS Teams		

Lecturers

Name	Email	Availability	Location	Phone
May Lim	m.lim@unsw.edu.au	Weeks 1-4: Monday 10am-12pm, Tuesday 1-3pm, and via MS Teams		
Sarah Grundy	s.grundy@unsw.edu.au	Weeks 5-9: Monday 10am-12pm, Tuesday 1-3pm, and via MS Teams		
Emma Lovell	e.lovell@unsw.edu.au	Weeks 5-9: Monday 10am-12pm, Tuesday 1-3pm, and via MS Teams		

School Contact Information

For assistance with enrolment, class registration, progression checks and other administrative matters, please see the Nucleus: Student Hub. They are located inside the Library – first right as you enter the main library entrance. You can also contact them via http://unsw.to/webforms or reserve a place in the face-to-face queue using the UniVerse app.

If circumstances outside your control impact on submitting assessments, Special Consideration may be granted, usually in the form of an extension or a supplementary assessment. Applications for Special Consideration must be submitted online.

For course administration matters, please contact the Course Coordinator.

Course Details

Units of Credit 6

Summary of the Course

This course teaches you how to select and design chemical process equipment. You will be introduced to a wide range of process equipment for different operations, including heat exchangers, pressure vessels and separation equipment ranging from distillation columns to centrifuges. The course is designed to assist you learn how to make equipment selection decisions and subsequently to conduct the detailed design of the selected equipment. Learning outcomes will be applied when designing chemical process plants in later studies (for example CEIC4001 Process Design Project) and in engineering practice.

You will undertake detailed studies in aspects of equipment design for several process units, such as a heat exchanger and a distillation column, to gain the skills involved with detailed equipment design. These designs will encompass aspects of design criteria specification, materials selection especially for processes with special requirements such as food processes, the importance of relevant design standards and legal requirements, and detailed mechanical design. This course is part of the chemical engineering design stream and thus the submission of a satisfactory design portfolio is part of the requirements for successful completion of the course.

Course Aims

The overall aim of this course is to enable you to develop an understanding of how to select and design equipment as relevant to a wide range of industrial applications. You should be able to define the different characteristics, configurations and operating conditions of the equipment and be familiar with the terms used in their design. You should have developed a good understanding of the advantages and limitations of the equipment for a given application and be able to advise a third party of the most appropriate option.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Select equipment used to carry out chemical reactions and to separate phases and the components within phases	PE2.1, PE2.2, PE3.6, PE3.5
2. Apply various methods for the detailed design of such equipment, with particular emphasis on distillation columns, heat exchangers and pressure vessels	PE2.1, PE2.2, PE2.3, PE3.5
3. Identify physical property data and other data needed for equipment design from a variety of sources.	PE3.4

Teaching Strategies

This course incorporates a blended learning environment in which background, contextual and basic

design information is delivered via online material Moodle, e.g. Moodle lesson. Lecture and tutorial activities will be devoted to teaching more complex information which extends that presented on-line and allows you to practice application of this knowledge in a supported environment. The on-line component will enable you to access the more readily digestible, background course material in your own time and incorporates self-assessment questions to provide instant feedback on your understanding. During the lectures and tutorials, time will be allocated to answer questions arising from the pre-class activities.

This course is divided into five sub-topics:

1. Equipment Selection (ES)
2. Separation Equipment Design (SED)
3. Heat Exchanger Design (HXD)
4. Pressure Vessel Design (PVD)
5. Distillation Column Design (DCD)

Learning and teaching activities associated with each of these topics will vary depending on the topic learning required. Broadly, the course will comprise pre-class on-line activities, interactive on-line lectures and a 1 hour face-to-face tutorial. Formal summative quizzes will be provided at specific timepoints to give both you and your lecturer an indication of how your learning is progressing. Where possible, the incorporation of process simulation and modelling software, for example Aspen, will be incorporated to enable you to learn how to use modern approaches to speed up the design process as would be undertaken in industry. Invited guest speakers will also provide seminars as appropriate in face-to-face sessions to give specialised information and contextualise learning.

The group design assignment will run throughout the session giving you the opportunity to experience an industry-relevant design problem that will allow you to put your learning into practice. This will also provide you the opportunity to practice collaborative learning skills. This project will involve both a group design report as well as an individual design portfolio. It will prepare you directly for the 4th year capstone project, CEIC4001, for which this course is a pre-requisite. Tutorial sessions will be used to troubleshoot issues that you are facing in your group assignment and to provide feedback on proposed solutions.

Additional Course Information

Time commitment

UNSW expects students to spend approximately 150 hours to successfully complete a 6 UOC course. For CEIC3004, we expect approximately 80 hours to be spent developing your knowledge, e.g. through attending lectures, completing pre-class lessons and post-class quizzes; approximately 30 hours to be spent on a group assignment, including participation at associated tutorials; and approximately 40 hours developing your individual design portfolio, again including participation at the relevant tutorials.

Competence

Students are expected to enter CEIC3004 having developed competencies in all the material covered in the pre-requisite courses, at least. Little time is available to remediate any deficiencies in your knowledge of those topics. Over the course of the term, you will be developing new competencies and to illustrate the standards we expect. Marking rubrics or guidelines will be provided for all assessments. The teaching staff will apply these marking guides fairly and provide you with feedback so you can

continue to improve over the term and beyond.

Participation

When you attend face-to-face classes, we expect you to actively participate in the activities organised. This may mean listening, taking notes, asking questions or engaging in peer discussions. It may also mean working by yourself or in groups on tutorial exercises. In line with NSW Health and Safe Return to Campus orders and guidelines, masks must be worn when attending the face-to-face component of this course as physical distancing may not always not possible. Please follow instructions on page 16.

To complete the Design Assignment, you are required to work in a team. We expect all team members to agree on how they will manage the team (e.g. making and documenting decisions), to assign the project work equitably and contribute to the delivery of project outputs to the best of their ability.

Students are expected to contribute to online discussions through MS Teams. You may wish to discuss challenges faced through this course, ask questions about course content, discuss solutions to tutorial and practice questions. It is expected that students will help each other, and the lecturers will contribute as required.

Attendance and punctuality

We expect students to be punctual and attend all lectures and tutorials. University commitments take precedence over regular work activities, holidays etc. Students who attend less than 80% of their possible classes may be refused final assessment. If you miss a class, we expect you to catch up in your time, lectures will be recorded and made available through MS Teams and Moodle.

Assessment

Assessment criteria and standards

Students will be provided with further details of the assessment activities and the associated rubrics on Moodle and during class.

Feedback on assessment

Where possible, self-assessment questions are incorporated into on-line learning material to assist students gain feedback to gauge their understanding as they work through the lessons. Students will receive rapid feedback through undertaking on-line quizzes which will be available at regular intervals throughout the course, providing students with information as to where they can improve their learning while simultaneously providing data to the lecturers on how well students are understanding on-line and class material. Tutorials have been developed to support the design assignment in which students will have the opportunity to gain feedback from peers, class lecturers and tutors on their designs.

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Group Design Assignment	25%	03/04/2021 09:00 PM	1, 2, 3
2. On-line Quizzes	25%	See Schedule/Moodle	1, 2, 3
3. Individual design portfolio	50%	01/05/2021 09:00 PM	1, 2, 3

Assessment 1: Group Design Assignment (Group)

Due date: 03/04/2021 09:00 PM

The equipment design assignment is a core part of this course. Engineering design is normally a team-based activity, and the project helps you to learn to do design in a team-based environment. The topic of the assignment and the assessment criteria will be given in a separate document. This component of the design assignment focuses on equipment selection. Design tutorials during weeks 1-5 will support the completion of the group component of the design assignment with marks assigned where appropriate.

This is not a Turnitin assignment

Additional details

This task will be supported by a number of tutorials designed to keep you on track and give you feedback as you progress in this assignment. Further information on the assessment task will be made available via Moodle.

Assessment 2: On-line Quizzes

Start date: See Schedule/Moodle
Due date: See Schedule/Moodle

The quizzes are on-line assessments designed to give rapid, two-way feedback on student learning across the various topics. Assessment will be on the basis of technical accuracy of calculations and proper application of engineering design principles with appropriate assumptions (graduate attributes S4 and S7)

This is not a Turnitin assignment

Additional details

Further information on these tasks will be made available via Moodle.

Assessment 3: Individual design portfolio

Due date: 01/05/2021 09:00 PM

Students will be required to complete an individual detailed design portfolio to demonstrate they have acquired the technical skills to undertake detailed equipment design. This component of the design assignment focuses on detailed equipment design of the equipment selected in the group design assignment. Design tutorials during weeks 7-10 will support the completion of the individual component of the design assignment with marks assigned where appropriate.

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Additional details

This task will be supported by a number of tutorials designed to keep you on track and give you feedback as you progress in this assignment. Further information on the assessment task will be made available via Moodle.

Attendance Requirements

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

Course Schedule

View class timetable

Timetable

Date	Type	Content
Week 1: 14 February - 18 February	Lecture	**Monday 10am-12pm** (via MS Teams): Course Introduction and *Pressure Vessel Design (PVD) 1:* Introduction
	Lecture	**Tuesday 1-3pm** (via MS Teams): *PVD 2:* Welding and Wall Thickness
	Lecture	**Wednesday 12-2pm** (via MS Teams): *Equipment Selection (ES) 1:* Introduction and Methods
	Tutorial	**Thursday 1-2pm** (SEB, B26 or SqH114) OR **2-3pm** (on-line): Tutorial - Design assignment orientation Tutorial attendance is compulsory
	Assessment	**Gantt Chart** due as a group submission on Sunday 20th, 9pm
Week 2: 21 February - 25 February	Lecture	**Tuesday 12pm-2pm (via MS Teams):** *PVD 3:* Vessel Ends
	Lecture	**Tuesday 1-3pm (via MS Teams):** *PVD 4:* Load and Vessel Support
	Lecture	**Wednedsay 12-2pm (via MS Teams):** *ES 2:* Water treatment
	Tutorial	**Thursday 1-2pm** (SEB, B26 or SqH114) OR **2-3pm** (on-line): Tutorial - Design assignment example assessment Tutorial attendance is compulsory
Week 3: 28 February - 4 March	Lecture	**Monday 10am-12pm (via MS Teams):** *Heat exchange (HXD) 1:* Intro to Heat Exchange
	Lecture	**Tuesday 1-3pm (via MS Teams):** *HXD 2:* Heat Transfer Coefficients
	Lecture	**Wednesday 12-2pm (via MS Teams):** *ES*

		3: Mining
	Tutorial	**Thursday 1-2pm** (SEB, B26 or SqH114) OR **2-3pm** (on-line): Tutorial - Fishbowl – Equipment selection methods Tutorial attendance is compulsory
	Assessment	**Pressure Vessel Design Quiz** due Monday 28th Feb, 9pm **Prepare fishbowl contribution** due Thursday 3rd March during tutorial **Team evaluation** due Sunday 6th March, 9pm
Week 4: 7 March - 11 March	Lecture	**Monday 10am-12pm (via MS Teams):** *HXD 3:* Pressure Drop
	Lecture	**Tuesday 1-3pm (via MS Teams):** *HXD 4:* Heat Exchangers Advanced
	Lecture	**Wednesday 12-2pm (via MS Teams):** *ES 4:* Air pollution abatement
	Tutorial	**Thursday 1-2pm** (SEB, B26 or SqH114) OR **2-3pm** (on-line): Tutorial - Group design presentation and reflection Tutorial attendance is compulsory
	Assessment	**Prepare group presentation** due Thursday 10th during tutorial **Group reflection** due Sunday 13th, 9pm
Week 5: 14 March - 18 March	Lecture	**Monday 10am-12pm (via MS Teams):** *Distillation Column Design (DCD) 1:* Multicomponent flash Calculations
	Lecture	**Tuesday 1-3pm (via MS Teams):** *DCD 2:* Shortcut methods
	Lecture	**Wednesday 12-2pm (via MS Teams):** *Separation Equipment Design (SED) 1:* Clarifiers
	Tutorial	**Thursday 1-2pm** (SEB, B26 or SqH114) OR **2-3pm** (on-line): Tutorial - Peer assessment of draft group report Tutorial attendance is compulsory
	Assessment	**Equipment Selection and Heat Exchange**

		Design Quizzes due Monday 14th, 9pm **Draft group report** due Wednesday 16th, 9pm **Peer assessment** due Sunday 20th, 9pm; **Team evaluation** due Sunday 20th, 9pm
Week 6: 21 March - 25 March		
Week 7: 28 March - 1 April	Lecture	**Monday 10am-12pm (via MS Teams):** *DCD 3:* Rigorous solution
	Lecture	**Tuesday 1-3pm (via MS Teams):** *DCD 4:* Process simulation on distillation column
	Lecture	**Wednesday 12-2pm (via MS Teams):** *SED 3:* Filters
	Tutorial	**Thursday 1-2pm** (SEB, B26 or SqH114) OR **2-3pm** (on-line): Tutorial - Individual design example assessment Tutorial attendance is compulsory
	Assessment	**Group Design Assignment** due Sunday 3rd April, 9pm
Week 8: 4 April - 8 April	Lecture	**Monday 10am-12pm (via MS Teams):** *DCD 5:* Plate efficiency; Approximate column sizing
	Lecture	**Tuesday 1-3pm (via MS Teams):** *DCD 6:* Plate contactors; plate hydraulic design
	Lecture	**Wednesday 12-2pm (via MS Teams):** *SED 3:* Dryers
	Tutorial	**Thursday 1-2pm** (SEB, B26 or SqH114) OR **2-3pm** (on-line): Tutorial - Individual design presentation and reflection Tutorial attendance is compulsory
	Assessment	**Team evaluation** due Tuesday 5th, 9pm **Prepare presentation** by Thursday 7th tutorial **Submit reflection** by Friday 8th, 9pm
Week 9: 11 April - 15 April	Lecture	**Monday 10-12pm (via MS Teams):** *DCD 7:* Enhanced distillation
	Lecture	**Tuesday 1-3pm (via MS Teams):** *DCD*

		8: Residue curve maps
	Lecture	**Wednesday 12-2pm (via MS Teams):** *SED 4:* Combined processes – Membrane bioreactors
	Tutorial	**Thursday 1-2pm** (SEB, B26 or SqH114) OR **2-3pm** (on-line): Tutorial - Equipment design 101 Tutorial attendance is compulsory
	Assessment	**Prepare "Equipment Wiki"** by Thursday 14th tutorial
Week 10: 18 April - 22 April	Tutorial	**Thursday 1-2pm** (SEB, B26 or SqH114) OR **2-3pm** (on-line): Tutorial - Peer assessment of draft individual reports Tutorial attendance is compulsory
	Assessment	**Separation Equipment Design and Distillation Column Design Quizzes** due Monday 18th, 9pm **Draft individual report** due Wednesday 20th, 9pm **Peer assessment** due Sunday 24th, 9pm
Study Week: 25 April - 28 April	Assessment	**Individual design portfolio** due Sunday 1st May, 9pm

Resources

Prescribed Resources

Online resources

Videos, lecture slides and suggested readings, tutorial exercises and solutions, plus links to other online resources will be provided on the course Moodle page. These will be progressively released as the semester progresses OR These are all currently available on the course website.

Recommended textbooks

Towler, Gavin & Sinnott, Ray K. (2013). Chemical Engineering Design - Principles, Practice and Economics of Plant and Process Design (2nd Edition). Elsevier. Online version available at:

http://app.knovel.com/hotlink/toc/id:kpCEDPPEP4/chemical-engineering/chemical-engineering

J.D. Seader & E.J. Henley, Separation Process Principles, John Wiley & Sons, 2nd or 3rd ed.

R.H. Perry & D.W. Green, Perry's Chemical Engineer's Handbook, latest edition, McGraw-Hill (available online in Library).

Additional material will be distributed on Moodle.

Other resources

You can access the full text of online resources available from the UNSW library using the UNSW VPN Service (https://www.it.unsw.edu.au/staff/vpn/#AccessingLibraryJournals).

Course Evaluation and Development

Student feedback will be gathered during the course using in-class polling and post-class questionnaires to gather rapid feedback that can be used to adapt the course to your needs as we move through the term. Towards the conclusion of the term, you will be sent a link to the more formal MyExperience survey which you can use to describe how you found the course and the lecturers. The results of the MyExperience survey are examined extensively to identify ways in which we can improve the course. Examples of ways in which this survey has been used to improve CEIC3004 include the addition of tutorials, the modification of peer review to better motivate students, and the inclusion of pre-class lessons.

Submission of Assessment Tasks

In the School of Chemical Engineering, all written work will be submitted for assessment via Moodle unless otherwise specified. Attaching cover sheets to uploaded work is generally not required; when you submit work through Moodle for assessment you are agreeing to uphold the Student Code.

Some assessments will require you to complete the work online and it may be difficult for the course coordinator to intervene in the system after the due date. You should ensure that you are familiar with assessment systems well before the due date. If you do this, you will have time to get assistance before the assessment closes.

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Late penalties

Unless otherwise specified, submissions received after the due date and time will be penalised at a rate of 5% per day or part thereof (including weekends). For some activities including Moodle quizzes and Team Evaluation surveys, extensions and late submissions are not possible.

Special consideration

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to submitting an assessment or sitting an exam.

UNSW has a Fit to Sit / Submit rule, which means that if you attempt an exam or submit a piece of assessment, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

Please note that students will need to provide some documentary evidence to support absences from any assessments missed because of COVID-19 public health measures such as isolation. UNSW will **not** be insisting on medical certificates for COVID-related absences of 7 days or less, with the positive PCR or RAT result being sufficient. Longer absences due to self-isolation or COVID-related illness will still need documentation such as a medical certificate.

Applications for special consideration **will still be required** for assessment and participation absences related to COVID-19. Special consideration requests should not be lodged for missing classes if there are no assessment activities in that class.

Academic Honesty and Plagiarism

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage (International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013). At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity and plagiarism can be located at:

- The Current Students site
- The ELISE training site

The Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct.

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism. Further information about referencing styles can be located at https://student.unsw.edu.au/referencing.

For assessments in the School of Chemical Engineering, we recommend the use of referencing software such as Mendeley or EndNote for managing references and citations. Unless required otherwise specified (i.e. in the assignment instructions) students in the School of Chemical Engineering should use either the APA 7th edition, or the American Chemical Society (ACS) referencing style as canonical author-date and numbered styles respectively.

Academic Information

To help you plan your degree, assistance is available from academic advisors in The Nucleus and also in the School of Chemical Engineering.

Additional support for students

- Current Student Gateway
- Engineering Current Student Resources
- Student Support and Success
- Academic Skills
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- IT Service Centre

Course workload

Course workload is calculated using the Units-Of-Credit (UOC). The normal workload expectation for one UOC is approximately 25 hours per term. This includes class contact hours, private study, other learning activities, preparation and time spent on all assessable work.

Most coursework courses at UNSW are 6 UOC and involve an estimated 150 hours to complete, for both regular and intensive terms. Each course includes a prescribed number of hours per week (h/w) of scheduled face-to-face and/or online contact. Any additional time beyond the prescribed contact hours should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

On-campus class attendance

Physical distancing recommendations must be followed for all face-to-face classes. To ensure this, only students enrolled in those classes will be allowed in the room. Class rosters will be attached to corresponding rooms and circulated among lab demonstrators and tutors. No over-enrolment is allowed in face-to-face class. Students enrolled in online classes can swap their enrolment from online to a **limited** number of on-campus classes by Sunday, Week 1.

In certain classroom and laboratory situations where physical distancing cannot be maintained or the staff running the session believe that it will not be maintained, face masks will be designated by the course coordinator as **mandatory PPE** for students and staff. Students are required to bring and use their own face mask. Mask can be purchased from IGA Supermarket (Map B8, Lower Campus), campus pharmacy (Map F14, Middle Campus), the post office (Map F22, Upper Campus) and a vending machine in the foyer of the Biological Sciences Building (Map E26, Upper Campus).

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by NSW health or government authorities. Current alerts and a list of hotspots can be found here. Do not come to campus if you have any of the following symptoms: fever (37.5 °C or higher), cough, sore throat, shortness of breath (difficulty breathing), runny nose, loss of taste, or loss of smell. If you need to have a COVID-19 test, you must not come to campus and remain in self-isolation until you receive the results of your test.

You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-

isolate. We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed. Further information is available on any course Moodle or Teams site.
For more information, please refer to the FAQs: https://www.covid-19.unsw.edu.au/safe-return-campus-faqs

Image Credit

Images from Shutterstock and iStock

top left: istock-530976219 Water filters

top right: istock-541282320 Sewage treatment plant aerial view

bottom left: shutterstock_610961285 Two stages ethanol distillation towers

bottom right: shutterstock_468255293 Metallic plate in heat exchange machine in the food industrial plant

CRICOS

CRICOS Provider Code: 00098G

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	✓