School of Chemical Engineering

UNSW Engineering

CEIC2009

Material and Energy Balances in the Chemical Process Industry

Term 3, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Xunyu Lu	xunyu.lu@unsw.edu.au	Via email or by appointment	TETB building (H6) room 352	0293859793

Lecturers

Name	Email	Availability	Location	Phone
Edgar Wong	edgar.wong@unsw.edu.au	Via email or by appointment	Science and Engineering Building E8 Office 436	

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

In this course, the relationships between the integration of thermodynamics and mass and energy balance in chemical plants are elucidated. Students will learn to solve chemical process problems involving several unit operations, gases and liquids, recycle, bypass or purge streams and chemical reactions. More detailed mechanisms of mass transfer such as diffusion and convection will be provided for fixed and free interfaces and for simple geometries. Particular emphasis will be placed on using these concepts to show how the interactions between chemical process plant and the environment arise and how the same concepts are used to control or mitigate the interactions.

Course Aims

This course aims to develop your competency in analysing and solving problems involving (i) mass transfer (MT) and (ii) materials and energy balances (MEB). These basic chemical engineering skills are essential for the solution of many environmental problems, so the approach and textbooks used are classic chemical engineering ones, with an emphasis on environmental applications.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. You will be introduced to the principles and calculation techniques used in chemical and environmental engineering.	PE1.1
2. You will learn what mass and energy balances and transfers are, how to formulate them and how to solve them.	PE1.2, PE1.3
3. You will learn about the different mechanisms of mass transfer.	PE1.3, PE1.4
4. We aim to improve your efficiency and consistency in problem solving, by practicing problem definition, data assemblage, data analysis and selection of appropriate solution methods. You will be able to face and solve simple to moderate problems usually faced by Chemical Engineering.	PE2.1
5. You will be exposed to background information on units and measurements, basic laws about the behaviour of gases, liquids and solids and some basic mathematical tools.	PE2.2

Teaching Strategies

Teaching strategies

The course has online and face-to-face components. The online materials cover the basic concepts (“building blocks”) that you need to understand properly to make sense of the more complex

concepts, examples and problems dealt with in lectures and tutorials.

The topics of MT and MEB will be taught in parallel to allow students the maximum time to absorb and understand the large number of new concepts introduced in this course. A heavy emphasis will be placed on solving practical problems to reinforce the theory covered in the lectures.

Tutorials run each week, both in-person and online with repeated content, primarily for not only reinforcing but also extending the material covered in lectures, so it is essential for you to attempt the tutorial problems. Tutorial solutions will be provided to assist in your learning. Please note that detailed answers to questions and tutorials will be given during class, as well as be posted online.

This course is focused on problem analysis and computational aspects and not on rote knowledge. Quiz and assignment will be conducted to assess your understanding of the topics and to provide you with feedback on your progress.

The rationale behind the approach to learning and teaching

“In terms of learning outcomes, what the student does is more important than what the teacher does”. It is critically important to successful learning that students obtain a lot of practicewith progressively harder problems over the duration of the course. The rationale behind the approach to learning and teaching is to start with simple examples (easy material) before introducing the generalized approach (more abstract ideas) necessary to solve new problem types.

Additional Course Information

Integrity and Respect

The UNSW Student Code of Conduct (https://student.unsw.edu.au/conduct) among other things, expects all students to demonstrate integrity in all the academic work and to treat all staff, students and visitors to the University with courtesy, tolerance and respect.

Time commitment

UNSW expects students to spend approximately 150 hours to successfully complete a 6 UOC course like CEIC2009. We expect 40 hours to be spent participating in face-to-face (or online) classes, 20 hours on attending the tutorials and Q&A, 30 hours completing online assignment, quiz and the final exam, with the remaining 50 hours provided for private study, working on the assessments and preparing for the final exam. Therefore, outside class you should be spending at least 7 hours per week working on CEIC2009.

Competence

Students are expected to enter CEIC2009 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.

To complete the CEIC2009 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 the course forum on CEIC2009. 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 at 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 Moodle.

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Quiz	20%	Week 4	1, 2, 3, 4, 5
2. Assignment	20%	Week 9	1, 2, 3, 4, 5
3. Final Exam	60%	Exam Period	1, 2, 3, 4, 5

Assessment 1: Quiz

Due date: Week 4

During Tutorial in Week 4. The progress test is intended primarily as formative assessment, but is counted towards the final mark at a significant level to encourage students to take it seriously and to discourage last-minute cramming. The quiz covers all content in the course up to Week 4. Online/in-person close-book quiz

Assessment 2: Assignment

Due date: Week 9

Assigned in Week 7 Lecture, submission at the end of Week 9. Assignment will be mainly to assess the understanding of concepts being taught. It could be the description of experiments or an essay. Rubrics will be released in Week 7 lectures.

Assessment 3: Final Exam

Due date: Exam Period

A final exam is given because the course learning outcomes include a significant level of technical learning that can be effectively assessed in an exam environment and because exams have high reliability. It is primarily designed to align with UNSW graduate attributes 2 and 3. The final exam is closed book. The exam covers all of the parts of the course.

Attendance Requirements

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

Course Schedule

Class sequence is listed below. The lectures will be face-to-face, and all course materials will be recorded for viewing on Moodle. Tutorial and Q&A times are listed at the end of this schedule.

View class timetable

Timetable

Date	Type	Content
Week 1: 12 September - 16 September	Lecture	MT Introduction to Mass Transfer.
	Lecture	MEB Introduction to Material Balance (MB).
	Tutorial	MT Tut 1
Week 2: 19 September - 23 September	Lecture	MT One-dimensional steady state mass transfer.
	Lecture	MEB Basic principles of MB.
	Tutorial	MEB Tut 1
Week 3: 26 September - 30 September	Lecture	MT Diffusion coefficient.
	Lecture	MEB Strategies to solve MB.

	Tutorial	MT Tut 2
Week 4: 3 October - 7 October	Lecture	MT Introduction to Mass Transfer Coefficient.
	Lecture	MEB MB with chemical reactions.
	Tutorial	QUIZ during the tutorial time.
	Assessment	Quiz
Week 5: 10 October - 14 October	Lecture	MT Mass transfer coefficient continued.
	Lecture	MEB Balances on multiple units.
	Tutorial	MEB Tut 2
Week 6: 17 October - 21 October	-- Select --	Flexibility week.
Week 7: 24 October - 28 October	Lecture	MT 3D unsteady state mass transfer.
	Lecture	MEB Ideal gases and change of phase.
	Tutorial	MT Tut 3
Week 8: 31 October - 4 November	Lecture	MT 3D unsteady state mass transfer continued.
	Lecture	MEB Including energy balances in the analysis.
	Tutorial	MEB Tut 3
Week 9: 7 November - 11 November	Lecture	MT Dealing with convention and developing correlations.
	Lecture	MEB Getting enthalpy and heats of solution.
	Tutorial	MT Tut 4

	Assessment	Assignment
Week 10: 14 November - 18 November	Lecture	MT Dealing with convention and developing correlations continued.
	Lecture	MEB Using MEB to solve practical problems.
	Tutorial	MEB Tut 4

Resources

Prescribed Resources

Prescribed text:

Felder, R.M., and Rousseau, R.W., "Elementary Principles of Chemical Processes", John Wiley & Sons, Singapore, 2000.

Himmelblau, D.M. and Riggs, J.B., "Basic Principles and Calculations in Chemical Engineering", 7th Edition,Prentice Hall, 2004.

Hines, A.L. and Maddox, R.N., "Mass Transfer: Fundamentals and Applications", Prentice-Hall, 1985.

Recommended Resources

Other resources:

Several useful texts and reference works are listed under the Leganto link on the Moodle page, entitled "Resources, including textbook and electronic reference works"

Students seeking additional resources can also obtain assistance from the UNSW Library. One starting point for assistance is:

http://www.library.unsw.edu.au/servicesfor/students.html

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.

Note: UNSW does not require a medical certificate for COVID-related absences of 7 days or less, however you must provide formal evidence from your local/state health provider (e.g. NSW Health) that clearly states your name and the date you tested positive (i.e. confirmation of your RAT registration, PCR test result). Longer absences due to extended 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 advice 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

Note: This course outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle should be consulted for the up to date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.

Image Credit

Dr Peter Wich

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	