CEIC2002

Heat and Mass Transfer

Term Two // 2021

School of Chemical Engineering // UNSW Engineering

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Yansong Shen	ys.shen@unsw.edu.au	Via email or by Teams	401/SEB	54448

Lecturers

Name	Email	Availability	Location	Phone
Greg Leslie	g.leslie@unsw.edu.au	Via email or by Teams	532/SEB	56092

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

Credit Points 6

Summary of the Course

In this course, the principles of transport phenomena introduced previously in fluid flow are extended to heat and mass transport. Topics include: Introduction to conductive, convective and radiative mechanisms of heat transfer, Physical origins and rate equations, one-dimensional steady-state heat transfer with heat generation and chemical reactions, composite walls, contact resistance and extended surfaces, introduction to heat exchangers; log-mean temperature difference, effectiveness - NTU methods, Introduction to diffusive and convective mechanisms of mass transfer, Physical origins and rate equations, diffusion coefficients, one-dimensional steady-state mass transfer in common geometries, introduction to 3-D unsteady-state mass transfer, development and applications of heat and mass transfer coefficients for convection and two phase flow, applications of heat and mass transfers.

This course provides the knowledge infrastructure essential to the further learning of unit operations in CEIC3001, process modelling in CEIC3000, process design in CEIC3005 and CEIC4001. The material in this course is taught from an engineering design perspective. They are also important for plant and equipment design (CEIC3004 and FOOD3801).

Course Aims

The aim of this course is to develop your understanding of the various modes of heat transfer and mass transfer phenomena. Problem-solving skills that you have acquired in first year courses are extended with numerical problems that involve: developing and applying methods for the estimation of rates of heat/mass transfer, temperature distributions and concentration profiles; implementing appropriate assumptions to simplify solutions; and critically evaluating different calculation methods.

Course Learning Outcomes

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

Learning Outcome	EA Stage 1 Competencies
1. Explain fundamental concepts in heat and mass transfer	PE1.1, PE1.2, PE1.3
2. Apply various methods for estimating rates of heat/mass transfer involving solid, liquid and gaseous phases	PE2.1, PE1.3, PE2.2
3. Identify physical property data needed in solving heat and mass transfer problems	PE3.4, PE1.2, PE2.1

Teaching Strategies

This course is organized into 3hr/week of lectures and 3hr/week of tutorials. The lectures are used primarily for introducing the relevant theory on heat and mass transfer. A set of numerical problems has been prepared for each tutorial class. Regular quizzes will be conducted during the tutorials to assess your understanding of the topics and to provide you with feedback on your progress.

Heat and mass transfer theory is widely used in the design of processes and equipment in the chemical industry. Successful design requires a capacity for critical thinking and this can be facilitated through evaluation of different calculation methods. A heavy emphasis is therefore placed on solving numerical problems to reinforce the theory covered in the lectures. Each tutorial consists of a series of numerical problems with varying degrees of difficulty. Detailed solutions will be provided, as well as summaries of the lecture content, to encourage independent learning. A key concept introduced in this course is the analogy between heat and mass transfer.

Please note that the lecture summaries are intended as a guide to the topics and to assist with study preparation. To facilitate deeper learning, students are expected to consult the recommended textbooks for more detailed explanations.

In 2021 T2, lectures will be online; and tutorials will be hybrid (online + face-to-face).

- **Interactive lecture videos and online lessons *(lecturer facetime)* are used to introduce and highlight key concepts. To allow you to learn this material flexibly, we will provide much of the lecture material in sets of short video lessons via Moodle. We won't use most of the timetabled lecture slots for 3h lectures, but we will deliver some content or revision material followed by virtual Q/A sessions in MS Teams.**
- **Many example problems that are part of the interactive lecture videos and interactive tutorial videos; and you should attempt these problems as part of doing each lesson; they provide practice at doing the sorts of questions that will be part of the assessments and provide instant feedback on your progress in the course.**
- **Extensive sets of weekly tutorial problems will be used to encourage you to apply analytical and computational techniques introduced in the lessons. The weekly quizzes are to provide assessment and feedback to you on your progress. If you're keeping up with the weekly work, these will not require lots of additional study. Do not suggest watch all the lectures&tutorial videos at the end of term. We highly recommend sustained engagement with this material throughout the term, starting right from Week 1.**

Additional Course Information

Requisite knowledge

The topics of heat and mass transfer complement other areas such as material and energy balances (CEIC2000 and FOOD1130), as well as fluid flow (CEIC2001). These courses introduce core chemical and food engineering topics.

Expectations

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 CEIC2002. Success in CEIC2002 means continual work through the term, completing all lessons and tutorial questions in the corresponding weeks rather than getting behind and then hoping to catch up.

A typical week in CEIC2002 consists of approximately 12 hours of work on the material in this course:

- ~3 h of (pre-watch of) interactive lecture videos, live lecturer facetime etc.
- ~3 h working on the tutorial material (watch of interactive tutorial video, preparation and participation).
- ~6 h to review, study or work on study materials.
- 25 min weekly quiz.

Moodle has the activities for each week clearly laid out to help you keep pace.

Assessment

Assessment Tasks

Assessment task	Weight	Due Date	Student Learning Outcomes Assessed
Quiz 1 (Heat transfer)	10%	Week 1-4	1, 2, 3
Quiz 2 (Mass Transfer)	10%	Week 7-10	1, 2, 3
Mid-semester exam (Heat transfer)	40%	02/07/2021	1, 2, 3
Final exam (Mass transfer)	40%	Exam period	1, 2, 3

Assessment Details

Assessment 1: Quiz 1 (Heat transfer)

Start date: Week 1-4

Details:

To assess understanding of heat transfer topics and to provide feedback. Open-book tests (one online quiz per week in week 1-4) and approx. 25 min duration in each.

Assessment 2: Quiz 2 (Mass Transfer)

Start date: Week 7-10

Details:

To assess understanding of mass transfer topics and to provide feedback. Open-book tests (one online quiz per week in week 1-4) and approx. 25 min duration in each.

Assessment 3: Mid-semester exam (Heat transfer)

Start date: 02/07/2021

Details:

Summative assessment for the heat transfer part of the course. Formal exam because it has high reliability and precision. Assessed on the basis of technical accuracy, speed of calculations, clarity of presentation and ability to exercise good engineering judgement. Open-book exam of approx. 2 hr duration for test and 0.5 hr for submission.

Assessment 4: Final exam (Mass transfer)

Start date: Exam period

Details:

Summative assessment for the mass transfer part of the course. Formal exam because it has high reliability and precision. Assessed on the basis of technical accuracy, speed of calculations, clarity of presentation and ability to exercise good engineering judgement. Open-book exam of 2 hr duration.

Attendance Requirements

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

Course Schedule

View class timetable

Timetable

Date	Type	Content
O Week: 25 May - 28 May		
Week 1: 31 May - 4 June	Online Activity	**Lecture, 3h/week** Intro to course; Conduction (HT1, HT2, HT3) **Tutorial, 3h/week** HT1-3 **Quiz** Mini Quiz 1 (HT1-3)
Week 2: 7 June - 11 June	Online Activity	**Lecture, 3h/week** Conduction (HT4) ; Convection (HT5, HT6) **Tutorial, 3h/week** HT4-6 **Quiz** Mini Quiz 2 (HT4-6)
Week 3: 14 June - 18 June	Online Activity	**Lecture, 3h/week** Convection (HT7, HT8) **Tutorial, 3h/week** HT7-8 **Quiz** Mini Quiz 3 (HT7-8)
Week 4: 21 June - 25 June	Online Activity	**Lecture, 3h/week** Condensation & boiling (HT9); Heat exchangers (HT10)

		Tutorial, 3h/week HT9-10 **Quiz** Mini Quiz 4 (HT9-10)
Week 5: 28 June - 2 July	Online Activity	**Lecture, 3h/week** Revision (HT) **Tutorial, 3h/week** HT1-10 **Quiz** /
Week 6: 5 July - 9 July	Online Activity	Flexibility Week
Week 7: 12 July - 16 July	Online Activity	**Lecture, 3h/week** Molar & mass flux (MT1); Fick's law (MT2) **Tutorial, 3h/week** MT 1-2 **Quiz** Mini Quiz 5 (MT 1-2)
Week 8: 19 July - 23 July	Online Activity	**Lecture, 3h/week** Diffusion coefficients (MT3); Diffusive transfer in 1D & 3D (MT4) **Tutorial, 3h/week** MT 3-4 **Quiz** Mini Quiz 6 (MT 3-4)
Week 9: 26 July - 30 July	Online Activity	**Lecture, 3h/week** Mass transfer coefficients (MT5, MT6) **Tutorial, 3h/week** MT 5-6

		Quiz Mini Quiz 7 (MT 5-6)
Week 10: 2 August - 6 August	Online Activity	**Lecture, 3h/week** Mass transfer correlations (MT7), Two-phase systems (MT8); revision **Tutorial, 3h/week** MT 7-8 **Quiz** Mini Quiz 8 (MT 7-8)

Resources

Recommended Resources

The recommended text books are:
• J.P. Holman, Heat Transfer, McGraw-Hill (6th or higher edition preferred).
• J.M. Coulson & J.F. Richardson with J.R. Backhurst and J.H. Harker, Chemical Engineering Volume 1: Fluid Flow, Heat Transfer and Mass Transfer, Butterworth Heinemann.

Additional materials will be handed out in class and placed on Moodle. You should check Moodle at least twice a week for any messages.
Students seeking resources can also obtain assistance from the UNSW Library. One starting point for assistance is:
http://www.library.unsw.edu.au/servicesfor/students.html

Course Evaluation and Development

The School of Chemical Engineering evaluates each course each time it is run through (i) myExperience Surveys, and (ii) Focus Group Meetings. As part of the myExperience process, your student evaluations on various aspects of the course are graded; the Course Coordinator prepares a summary report for the Head of School. Any problem areas are identified for remedial action, and ideas for making improvements to the course are noted for action the next time that the course is run. Focus Group Meetings are conducted each term. Student comments on each course are collected and disseminated to the Lecturers concerned, noting any points which can help improve the course. All of the activities in this course have been designed in response to student feedback.

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 10% 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 **not** be required to provide **any** documentary evidence to support absences from any classes missed **because of COVID-19 public health measures such as isolation**. UNSW will **not** be insisting on medical certificates from anyone deemed to be a positive case, or when they have recovered. Such certificates are difficult to obtain and put an unnecessary strain on students and medical staff.

Applications for special consideration **will** be required for assessment and participation absences – but no documentary evidence **for COVID 19 illness or isolation** will be required.

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

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	