CEIC2002

Heat and Mass Transfer

Term 2, 2023

Course Overview

Staff Contact Details

Convenors

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

Lecturers

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

Questions about the this course should normally be asked during the scheduled class so that everyone can benefit from the answer and discussion.

Course Details

Units of Credit 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.

Analogies between heat and mass transfer mechanisms are drawn. Analysis of unsteady-state heat and mass transfer via solution of the Navier-Stokes equations are introduced as are graphical methods and extension to multi-dimensional problems.

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 workshops. 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 workshop class. Regular quizzes will be conducted during the workshops 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 workshop 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.

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 workshop 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 lecture.
- ~3 h working on the workshop material (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 task	Weight	Due Date	Course Learning Outcomes Assessed
1. Quiz 1 (Heat Transfer)	10%	Weeks 1 - 4	1, 2, 3
2. Quiz 2 (Mass Transfer)	10%	Weeks 7 - 10	1, 2, 3
3. Mid-semester Exam (Heat Transfer)	40%	Week 5	1, 2, 3
4. Final Exam (Mass Transfer)	40%	Exam period	1, 2, 3

Assessment 1: Quiz 1 (Heat Transfer)

Due date: Weeks 1 - 4

This assessment will assess the understanding of heat transfer topics and to provide feedback. Open-book tests of equal value and approx. 25 min duration in each weekly quiz.

Assessment 2: Quiz 2 (Mass Transfer)

Due date: Weeks 7 - 10

This assessment will assess the understanding of mass transfer topics and to provide feedback. Open-book tests of equal value and approx. 25 min duration in each weekly quiz.

Assessment 3: Mid-semester Exam (Heat Transfer)

Due date: Week 5

Summative assessment for the heat transfer part of the course. This is a formal exam as it has high reliability and precision. The mid-semester exam is assessed on the basis of technical accuracy, speed of calculations, clarity of presentation and ability to exercise good engineering judgement. This is a closed-book exam of approx. 2 hr duration.

Assessment 4: Final Exam (Mass Transfer)

Due date: Exam period

Summative assessment for the mass transfer part of the course. The final exam is assessed on the basis of technical accuracy, speed of calculations, clarity of presentation and ability to exercise good engineering judgement. The final exam is a closed-book exam of 2 hr duration. Students will be required to undertake the final exam in person.

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: 22 May - 26 May	Online Activity	
Week 1: 29 May - 2 June	Blended	**Lecture, 3h/week** Intro to course; Conduction (HT1, HT2, HT3) **Workshop, 3h/week** HT1-3 **Quiz** Mini Quiz 1 (HT1-3)
Week 2: 5 June - 9 June	Blended	**Lecture, 3h/week** Conduction (HT4) ; Convection (HT5, HT6) **Workshop, 3h/week** HT4-6 **Quiz** Mini Quiz 2 (HT4-6)
Week 3: 12 June - 16 June	Blended	**Lecture, 3h/week** Convection (HT7, HT8) **Workshop, 3h/week** HT7-8 **Quiz** Mini Quiz 3 (HT7-8)

Week 4: 19 June - 23 June	Blended	**Lecture, 3h/week** Condensation & boiling (HT9); Heat exchangers (HT10) **Workshop, 3h/week** HT9-10; and Revision (HT1-10) (online) **Quiz** Mini Quiz 4 (HT9-10)
Week 5: 26 June - 30 June	Assessment	Mid-semester Exam (Heat Transfer)
Week 6: 3 July - 7 July	Homework	Flexibility Week
Week 7: 10 July - 14 July	Blended	**Lecture, 3h/week** Molar & mass flux (MT1); Fick's law (MT2) **Workshop, 3h/week** MT 1-2 **Quiz** Mini Quiz 5 (MT 1-2)
Week 8: 17 July - 21 July	Blended	**Lecture, 3h/week** Diffusion coefficients (MT3); Diffusive transfer in 1D & 3D (MT4) **Workshop, 3h/week** MT 3-4 **Quiz** Mini Quiz 6 (MT 3-4)
Week 9: 24 July - 28 July	Blended	**Lecture, 3h/week** Mass transfer coefficients (MT5, MT6) **Workshop, 3h/week** MT 5-6

		Quiz Mini Quiz 7 (MT 5-6)
Week 10: 31 July - 4 August	Blended	**Lecture, 3h/week** Mass transfer correlations (MT7), Two-phase systems (MT8); revision **Workshop, 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 not required unless specifically requested for an individual assessment task; 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 respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect. Please make it easy for the markers who are looking at your work to see your achievement and give you due credit.

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) and will not be accepted more than 5 days late. For some activities including Exams, Quizzes, Peer Feedback, 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 for **all** special consideration requests (including COVID-19-related requests), students will need documentary evidence to support absences from any classes or assessments.

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.

To help describe what we are looking for, here are some things that we consider to be quite acceptable (even desirable!) actions for many assessments, and some that we consider to be unacceptable in most circumstances. Please check with the instructions for your assessments and your course coordinator if you're unsure. As a rule of thumb, if you don't think you could look the lecturer in the eye and say "this is my own work", then it's not acceptable.

Acceptable actions	Unacceptable actions
✓ reading/searching through material we have given you, including lecture slides, course notes, sample problems, workshop problem solutions ✓ reading/searching lecture transcripts ✓ reading/searching resources that we have pointed you to as part of this course, including textbooks, journal articles, websites ✓ reading/searching through your own notes for this course ✓ all of the above, for any previous courses ✓ using spell checkers, grammar checkers etc to improve the quality of your writing ✓ studying course material with other students	✗ asking for help with an assessment from other students, friends, family ✗ asking for help on Q&A or homework help websites ✗ searching for answers to the specific assessment questions online or in shared documents ✗ copying material from any source into your answers ✗ using generative AI tools to complete or substantially complete an assessment for you ✗ paying someone else to do the assessment for you

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.

Artificial intelligence tools such as ChatGPT, CodePilot, and built-in tools within Word are modern tools that are useful in some circumstances. In your degree at UNSW, we're teaching you skills that are needed for your professional life, which will include how to use AI tools responsibly plus lots of things that AI tools cannot do for you. AI tools already are (or will soon be) part of professional practice for all of us. However, if we were only teaching you things that AI could do, your degree would be worthless, and you wouldn't have a job in 5 years.

Whether the use of AI tools in an assessment is appropriate will depend on the goals of that assessment. As ever, you should discuss this with your lecturers – there will certainly be assessments where the use of AI tools is encouraged, as well as others where it would interfere with your learning and place you at a disadvantage later. Our goal is to help you learn how to ethically and professionally use the tools available to you. To learn more about the use of AI, see this discussion we have written where we analyse the strengths and weaknesses of generative AI tools and discuss when it is professionally and ethically appropriate to use them.

While AI may might provide useful tools to help with some assessments, UNSW's policy is quite clear that taking the output of generative AI and submitting it as your own work will never be appropriate, just as paying someone else to complete an assessment for you is serious misconduct.

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 for information about key dates, access to services, and lots more information
- Engineering Student Life - Current Student Resources for information about everything from getting to campus to our first year guide
- Student Support and Success for our UNSW team dedicated to helping with university life, visas, wellbeing, and academic performance
- Academic Skills to brush up on some study skills, time management skills, get one-on-one support in developing good learning habits, or join workshops on skills development
- Student Wellbeing, Health and Safety for information on the UNSW health services, mental health support, and lots of other useful wellbeing resources
- Equitable Learning Services for assistance with long term conditions that impact on your studies
- IT Service Centre for everything to do with computing, including installing UNSW licensed software, access to computing systems, on-campus WIFI and off-campus VPNs

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. Most 6 UoC courses will involve approximately 10-12 hours per week of work on your part. If you're not sure what to do in these hours of independent study, the resources on the UNSW Academic Skills pages offer some suggestions including: making summaries of lectures, read/summarise sections from the textbook, attempt workshop problems, reattempting workshop problems with some hints from the solutions, looking for additional problems in the textbook.

Full-time enrolment at university means that it is a *full-time* occupation for you and so you would typically need to devote 35 hours per week to your studies to suceed. Full-time enrolment at university is definitely incompatible with full-time employment. Part-time/casual employment can certainly fit into your study schedule but you will have to carefully balance your study obligations with that work and decide how much time for leisure, family, and sleep you want left after fullfilling your commitments to study and work. Everyone only gets 168 hours per week; overloading yourself with both study commitments and work commitments leads to poor outcomes and dissatisfaction with both, overtiredness, mental health issues, and general poor quality of life.

On-campus class attendance

In 2023, most classes at UNSW are running in a face-to-face mode only. Attendance is expected as is participation in the classes. As an evidence-driven engineer or scientist, you'll be interested to know that education research has shown students learn more effectively when they come to class, and less effectively from lecture catch-up recordings. If you have to miss a class due to illness, for example, we expect you to catch up in your time, and within the coming couple of days.

For most courses that are running in an "in person" mode:

- Lectures are normally recorded to provide an opportunity to review material after the lecture; lecture recordings are not a substitute for attending and engaging with the live class.
- Workshops/tutorials are not normally recorded as the activities that are run within those sessions normally cannot be captured by a recording. These activities may also include assessable activities in some or all weeks of the term.
- Laboratories are not recorded and require in-person attendance. Missing laboratory sessions may require you to do a make-up session later in the term; if you miss too many laboratory sessions, it may be necessary to seek a Permitted Withdrawal from the course and reattempt it next year, or end up with an Unsatisfactory Fail for the course.
- Assessments will often require in-person attendance in a timetabled class or a scheduled examination.

This course outline will have further details in the Course Schedule and Assessment sections.

Class numbers are capped in each class to ensure appropriate facilities are available, to maintain student:staff ratios, and to help maintain adequate ventilation in the spaces. Only students enrolled in each specific 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 classes.

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 have COVID-19 or have been advised to self-isolate by NSW health or government authorities.

Asking Questions

Asking questions is an important part of learning. Learning to ask good questions and building the confidence to do so in front of others is an important professional skill that you need to develop. The best place to ask questions is during the scheduled classes for this course, with the obvious exception being questions that are private in nature such as special consideration or equitable learning plans. Between classes, you might also think of questions — some of those you might save up for the next class (write them down!), and some of them you might ask in a Q&A channel on Teams or a Q&A forum on Moodle. Please understand that staff won't be able to answer questions on Teams/Moodle immediately but will endeavour to do so during their regular working hours (i.e. probably not at midnight!) and when they are next working on this particular course (i.e. it might be a day or two). Please respect that staff are juggling multiple work responsibilities (teaching more than one course, supervising research students, doing experiments, writing grants, …) and also need to have balance between work and the rest of their life.

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

Pilot Hall with experiment rigs // UNSW Chemical Engineering

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	