MECH3002

Heat and Mass Transfer

Session 2, In person-scheduled-weekday, North Ryde 2022

School of Engineering

Contents

General Information

Unit convenor and teaching staff
Lecturer
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Rm 312, 9WW
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Tutor
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12-2pm Thursdays

Credit points
10

Prerequisites
(MECH2002 or MECH202 and (20cp at 2000 level or above)) or admission to MEngMechEng

Corequisites

Co-badged status

Unit description
This unit examines the principles of heat and mass transfer. The unit covers knowledge in theories related to the analysis of different heat transfer modes such as conduction, convection, and radiation. At the end of the unit, students are expected to demonstrate the ability to apply the principles of heat and mass transfer to analyse local and overall heat and mass transfer coefficients and to design experiments to improve existing heat and mass transfer engineering systems.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

ULO1: Characterise heat transfer systems undergoing conduction, convection and/or radiation processes with and without mass transfer.

ULO2: Apply analytical equations, dimensional analysis, and empirical correlations to formulate solutions for heat and mass transfer systems.

ULO3: Design heat and mass transfer systems and critically evaluate their performance and limitations in the context of real-world applications.

ULO4: Design and manufacture a realistic and effective heat transfer system through problem-solving and critical thinking.

General Assessment Information

In order to pass this unit a student must obtain a mark of 50 or more for the unit (i.e. obtain a passing grade P/ CR/ D/ HD). There are no hurdle assessments.

Students enrolled in this unit with all written assessments will have the following university standard late penalty applied. Please see https://students.mq.edu.au/study/assessment-exams/assessments for more information.

Unless a Special Consideration request has been submitted and approved, a 5% penalty (of the total possible mark) will be applied each day a written assessment is not submitted, up until the 7th day (including weekends). After the 7th day, a grade of '0' will be awarded even if the assessment is submitted. This is to allow the timely release of assessments to the rest of the class. Submission time for all written assessments is set at 11:55 pm. A 1-hour grace period is provided to students who experience a technical concern.

For any late submission of time-sensitive tasks, such as scheduled tests/exams, and scheduled practical labs, students need to submit an application for Special Consideration.

In this unit, late submissions will accepted as follows:

- Weekly quiz, two asssignments and two practical labs – YES, Standard Late Penalty applies
- Mid-session test and final examination – NO, unless Special Consideration is Granted

All assessments will be graded according to standards set in the marking rubrics. Students will receive a numerical grade for each assessment which will be representative of a fail (0-49%), pass (50-64%), credit (65-74%), distinction (75-84%) or high distinction (85-100%) as defined by the university standards based assessment guidelines. The definitions of these standards will be posted on the iLearn page. All marking rubrics specific to each assessment will be released on the iLearn page indicating requirements to achieve a particular standard. These will be released well in advance of the assessment due date or are specified below.

Weekly Quiz (10/100)

Each tutorial will typically consist of 4 questions. In addition, students will also receive 1 tutorial question as a weekly quiz . Students must individually attempt the weekly quiz and submit the answer on iLearn by that week. The tutor will allocate either a fail grade for incorrect

methodology and incorrect answer, a pass grade for sound methodology but incorrect answer, or up to a high distinction grade for sound methodology and correct answer. A maximum of 1 mark (out of 100 available for the unit) is available for each of the tutorial sessions from weeks 3-7 and 9-13.

Assignments (10/100)

Assignment 1: (5/100)

This individually marked assignment will test the student's ability to apply and critically interpret the course material related to introductory concepts in heat transfer by conduction. The assignment will involve a combination of analytical calculations, design and report writing.
A rubric will be provided with the assessment handout.

Assignment 2: (5/100)

This individually marked assignment will test the student's ability to conceptually design an experimental system for heat convection. The student will design a system based on analytical calculations, whilst making considerations for suitable equipment, develop a series of theoretical results and suggest methods of experimental improvement. A rubric will be provided with the assessment handout.

Practical Laboratory Sessions (15/100)

Two individual lab reports written for two unique experiments. Attendance of practical classes is **MANDATORY** before submitting the lab reports. Lab reports submitted without attending the practical session will get a grade of '0' even if the assessment is submitted by the due date. A special consideration request must be submitted and approved if any student is unable to attend a practical session to organize alternative arrangements. Precise details on time and location will be advised via the iLearn page. Both laboratory reports will be assessed according to a rubric to be made available on the iLearn page.

Laboratory Report 1: (7/100)

The first experiment will demonstrate the operation of heat exchangers. Students will test a particular heat exchanger design, acquire data, and compare to theoretical calculations of heat exchanger performance. A laboratory report is then handed in.

Laboratory Report 2: (8/100)

The second experiment will demonstrate experimental techniques used to take measurements of conduction and convection. The data collected will be presented and interpreted along with some theoretical calculations. A laboratory report is then handed in.

Mid-Session & Final Examinations (65/100)

Mid-Session Test: (15/100)

An in-class 1-h test assessing material delivered between weeks 1 and 6.

Final Examination: (50/100)

A final examination (3h) assessing all material (weeks 1-13) delivered throughout the unit.

If you receive special consideration for the final exam, a supplementary exam will be scheduled in the supplementary examination period. By making a special consideration application for the final exam you are declaring yourself available for a resit during the supplementary examination period and will not be eligible for a second special consideration approval based on pre-existing commitments. Please ensure you are familiar with the policy prior to submitting an application. Approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignment 2	5%	No	Week 12
Final Examination	50%	No	TBA
Weekly Tutorial Questions	10%	No	Week 3-7 and Week 9-13
Practical Lab Report 2	8%	No	Week 11
Practical Lab Report 1	7%	No	Week 8
Assignment 1	5%	No	Week 4
Mid-Session Test	15%	No	Week 7

Assignment 2

Assessment Type [1]: Design Task
Indicative Time on Task [2]: 8 hours
Due: **Week 12**
Weighting: **5%**

Understand and apply theory learned in the lectures to create a thermal product

On successful completion you will be able to:

- Characterise heat transfer systems undergoing conduction, convection and/or radiation processes with and without mass transfer.
- Apply analytical equations, dimensional analysis, and empirical correlations to formulate solutions for heat and mass transfer systems.
- Design heat and mass transfer systems and critically evaluate their performance and limitations in the context of real-world applications.

- Design and manufacture a realistic and effective heat transfer system through problem-solving and critical thinking.

Final Examination

Assessment Type [1]: Examination
Indicative Time on Task [2]: 3 hours
Due: **TBA**
Weighting: **50%**

3-h final examination assessing all materials delivered throughout the unit.

On successful completion you will be able to:

- Characterise heat transfer systems undergoing conduction, convection and/or radiation processes with and without mass transfer.
- Apply analytical equations, dimensional analysis, and empirical correlations to formulate solutions for heat and mass transfer systems.

Weekly Tutorial Questions

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 8 hours
Due: **Week 3-7 and Week 9-13**
Weighting: **10%**

One tutorial quiz to be completed prior to the timetabled tutorial session, and one tutorial quiz to be completed during the tutorial session

On successful completion you will be able to:

- Characterise heat transfer systems undergoing conduction, convection and/or radiation processes with and without mass transfer.
- Apply analytical equations, dimensional analysis, and empirical correlations to formulate solutions for heat and mass transfer systems.

Practical Lab Report 2

Assessment Type [1]: Practice-based task
Indicative Time on Task [2]: 4 hours
Due: **Week 11**

Weighting: **8%**

Free and forced convection

On successful completion you will be able to:

- Characterise heat transfer systems undergoing conduction, convection and/or radiation processes with and without mass transfer.
- Apply analytical equations, dimensional analysis, and empirical correlations to formulate solutions for heat and mass transfer systems.
- Design heat and mass transfer systems and critically evaluate their performance and limitations in the context of real-world applications.

Practical Lab Report 1

Assessment Type [1]: Practice-based task
Indicative Time on Task [2]: 4 hours
Due: **Week 8**
Weighting: **7%**

Shell and tube heat exchanger

On successful completion you will be able to:

- Characterise heat transfer systems undergoing conduction, convection and/or radiation processes with and without mass transfer.
- Apply analytical equations, dimensional analysis, and empirical correlations to formulate solutions for heat and mass transfer systems.
- Design heat and mass transfer systems and critically evaluate their performance and limitations in the context of real-world applications.

Assignment 1

Assessment Type [1]: Design Task
Indicative Time on Task [2]: 8 hours
Due: **Week 4**
Weighting: **5%**

Understand and apply heat transfer conduction principles in new situations.

On successful completion you will be able to:

- Characterise heat transfer systems undergoing conduction, convection and/or radiation processes with and without mass transfer.
- Apply analytical equations, dimensional analysis, and empirical correlations to formulate solutions for heat and mass transfer systems.
- Design and manufacture a realistic and effective heat transfer system through problem-solving and critical thinking.

Mid-Session Test

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 1 hours
Due: **Week 7**
Weighting: **15%**

1-hour test assessing materials delivered between weeks 1-5

On successful completion you will be able to:

- Characterise heat transfer systems undergoing conduction, convection and/or radiation processes with and without mass transfer.
- Apply analytical equations, dimensional analysis, and empirical correlations to formulate solutions for heat and mass transfer systems.

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[1] If you need help with your assignment, please contact:

- the academic teaching staff in your unit for guidance in understanding or completing this type of assessment
- the Writing Centre for academic skills support.

[2] Indicative time-on-task is an estimate of the time required for completion of the assessment task and is subject to individual variation

Delivery and Resources

There is no single core text for this course. However the following texts are recommended: “Heat Transfer” by J.P. Holman, “Heat and Mass Transfer fundamentals and applications” by Y.A.

Cengel, and “A heat transfer textbook” by Leinhard and Leinhard.

Unit Schedule

Week	Topic	Lecturer	Laboratory/Tutorial	Assessments
1	Introduction to heat transfer, basic modes of heat transfer, steady-state conduction,	Dr. Jiang	No tutorial	
2	Conduction equations, thermal resistance network	Dr. Jiang	Tutorial	
3	Overall heat transfer coefficient, thermal contact resistance	Dr. Jiang	Tutorial	*Tutorial Prep and Quiz (weeks 3-7)*
4	Types of heat exchangers, effects of heat exchanger geometry, log-mean temperature difference method	Dr. Jiang	Tutorial	Assignment 1 due
5	Overall heat transfer equations, fouling, heat transfer effectiveness/NTU approach	Dr. Jiang	Tutorial **Prac Session 1**	
6	Practical design of heat exchangers, introduction to heat convection, Buckingham-pi Therorem	Dr. Jiang	Tutorial	
7	Thermal boundary layers, **Mid-Session Test**	Dr. Jiang	Tutorial	In class Mid-session test
8	Convection analysis, external forced convection	Dr. Jiang	Tutorial: Mid-session test Review	Lab Report 1 due
9	Internal forced convection	Dr. Jiang	Tutorial **Prac Session 2**	*Tutorial Prep and Quiz (weeks 9-13)*
10	Natural convection	Dr. Jiang	Tutorial	
11	Mass transfer, boiling, condensation, evaporation	Dr. Jiang	Tutorial	Lab Report 2 due
12	radiative heat transfer, black bodies, solar energy	Dr. Jiang	Tutorial	Assignment 2 due
13	Revision	Dr. Jiang	Tutorial	

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://policies.mq.edu.au). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Assessment Procedure
- Complaints Resolution Procedure for Students and Members of the Public
- Special Consideration Policy

Students seeking more policy resources can visit Student Policies (https://students.mq.edu.au/support/study/policies). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

To find other policies relating to Teaching and Learning, visit Policy Central (https://policies.mq.edu.au) and use the search tool.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/admin/other-resources/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Academic Integrity

At Macquarie, we believe academic integrity – honesty, respect, trust, responsibility, fairness and courage – is at the core of learning, teaching and research. We recognise that meeting the expectations required to complete your assessments can be challenging. So, we offer you a range of resources and services to help you reach your potential, including free online writing and maths support, academic skills development and wellbeing consultations.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

The Writing Centre

The Writing Centre provides resources to develop your English language proficiency, academic writing, and communication skills.

- Workshops
- Chat with a WriteWISE peer writing leader
- Access StudyWISE
- Upload an assignment to Studiosity
- Complete the Academic Integrity Module

The Library provides online and face to face support to help you find and use relevant information resources.

- Subject and Research Guides
- Ask a Librarian

Student Services and Support

Macquarie University offers a range of Student Support Services including:

- IT Support
- Accessibility and disability support with study
- Mental health support
- Safety support to respond to bullying, harassment, sexual harassment and sexual assault
- Social support including information about finances, tenancy and legal issues

Student Enquiries

Got a question? Ask us via AskMQ, or contact Service Connect.

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Changes from Previous Offering

The unit is offered back to the same as the offerings prior to the COVID, detailed as follows:

1. The final examiation period is changed to 3h with 50 % weighting.
2. The weekly lectures, tutorials, and practicals are delivered in person.
3. For those students who are unable to get back to campus in time, they are requested

to contact the convenor as soon as possible.

Engineers Australia Competency Mapping

EA Competency Standard		Unit Learning Outcomes
Knowledge and Skill Base	1.1 Comprehensive, theory-based understanding of the underpinning fundamentals applicable to the engineering discipline.	1
	1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing.	
	1.3 In-depth understanding of specialist bodies of knowledge	1, 2
	1.4 Discernment of knowledge development and research directions	
	1.5 Knowledge of engineering design practice	3
	1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice.	
Engineering Application Ability	2.1 Application of established engineering methods to complex problem solving	3, 4
	2.2 Fluent application of engineering techniques, tools and resources.	
	2.3 Application of systematic engineering synthesis and design processes.	4
	2.4 Application of systematic approaches to the conduct and management of engineering projects.	
Professional and Personal Attributes	3.1 Ethical conduct and professional accountability.	
	3.2 Effective oral and written communication in professional and lay domains.	3,4
	3.3 Creative, innovative and pro-active demeanour.	
	3.4 Professional use and management of information.	
	3.5 Orderly management of self, and professional conduct.	
	3.6 Effective team membership and team leadership	4