MECH3002

Heat and Mass Transfer

Session 2, In person-scheduled-weekday, North Ryde 2024

School of Engineering

Contents

General Information

Unit convenor and teaching staff
Lecturer
Yijiao Jiang
yijiao.jiang@mq.edu.au
Contact via 02 9850 9535
Rm145 3 Management Drive
12-2pm Mondays

Tutor
Haimei Xu
haimei.xu@mq.edu.au
Contact via 0430 620 518

Credit points
10

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

Corequisites

Co-badged status
MECH6002

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://teche.mq.edu.au/2022/07/standardised-late-submission-rules-come-into-force-for-s2-2022-onwards/

Unless a Special Consideration request has been submitted and approved, a penalty of 5% of the total possible mark of the task 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' (zero) will be awarded even if the student submits the assessment. This is to allow for the release of assessment feedback to the remaining class. Submission time for written assessments is set at **11:55 pm on Sunday of the due week**. A 1-hour grace period is provided to students who experience a technical concern.

Where a student has a special consideration application for an extension approved, then the rules are applied to the new approved due date for that student.

In this unit, late submissions will be 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. Students will receive 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 (15/100)

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: (10/100) This assignment will test students's ability to conceptually design a practical system for heat convection. Students will design a system based on analytical calculations, whilst making considerations for suitable prototype, develop a series of theoretical results and suggest methods of the improvement in practical application. 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' (zero) 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 practical will demonstrate the operation of heat exchangers. Students will test a particular heat exchanger design, acquire data, and compare to theoretical evalution of heat exchanger performance. A laboratory report is then handed in.

Laboratory Report 2: (8/100) The second practical 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 (60/100)

Mid-Session Test: (15/100)

An in-class 1-h test assessing material delivered between weeks 1 and 5.

Final Examination: (45/100)

A final examination (2h) 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	Due
Weekly Quiz	10%	Week 3-7 and Week 9-13
Assignment 1	5%	Week 4
Assignment 2	10%	Week 13
Laboratory Report 1	7%	Week 8
Laboratory Report 2	8%	Week 11
Mid-Session Test	15%	Week 7
Final Examination	45%	Examination Period

Weekly Quiz

Assessment Type: Quiz/Test

Indicative Time on Task: 7 hours

Due: Week 3-7 and Week 9-13

Weighting: 10%

One tutorial quiz to be completed prior to the timetabled tutorial session

On successful completion students will be able to: • Characterise heat transfer systems undergoin processes with and without mass transfer. • Apply analytical equations, dimensional analy solutions for heat and mass transfer systems.

Assignment 1

Assessment Type: Design Task

Indicative Time on Task: 6 hours

Due: Week 4

Weighting: 5%

Understand and apply heat transfer conduction principles in new situations.

On successful completion students 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 problemsolving and critical thinking.

Assignment 2

Assessment Type: Design Task

Indicative Time on Task: 10 hours

Due: Week 13

Weighting: 10%

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

On successful completion students 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: Practice-based task

Indicative Time on Task: 5 hours

Due: Week 8

Weighting: 7%

Shell and tube heat exchanger

On successful completion students 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 2

Assessment Type: Practice-based task

Indicative Time on Task: 5 hours

Due: Week 11

Weighting: 8%

Free and forced convection

On successful completion students 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.

Mid-Session Test

Assessment Type: Quiz/Test

Indicative Time on Task: 1 hours

Due: Week 7

Weighting: 15%

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

On successful completion students 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.

Final Examination

Assessment Type: Examination

Indicative Time on Task: 2 hours

Due: Examination Periode

Weighting: 45%

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

On successful completion students 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.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignment 1	5%	No	2024-08-18
Mid-Session Test	15%	No	2024-09-02
Assignment 2	10%	No	2024-11-03
Final Examination	45%	No	Exam Period
Practical Lab Report 2	8%	No	2024-09-15
Practical Lab Report 1	7%	No	2024-10-20
Weekly SGTA (Small Group Teaching Activity) Questions	10%	No	11:55pm Sunday Week 3-7 & 9-13

Assignment 1

Assessment Type [1]: Design Task

Indicative Time on Task [2]: 6 hours
Due: **2024-08-18**
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: **2024-09-02**
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.

Assignment 2

Assessment Type [1]: Design Task
Indicative Time on Task [2]: 10 hours
Due: **2024-11-03**
Weighting: **10%**

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]: 2 hours
Due: **Exam Period**
Weighting: **45%**

2-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.

Practical Lab Report 2

Assessment Type [1]: Practice-based task
Indicative Time on Task [2]: 5 hours
Due: **2024-09-15**
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]: 5 hours
Due: **2024-10-20**
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.

Weekly SGTA (Small Group Teaching Activity) Questions

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 7 hours
Due: **11:55pm Sunday Week 3-7 & 9-13**
Weighting: **10%**

One SGTA (Small Group Teaching Activity) quiz to be completed prior to the timetabled SGTA session, and one SGTA quiz to be completed during the SGTA 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.

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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: “HeatTransfer” 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

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	*Weekly Quiz* *(Week 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**	*Weekly Quiz* *(Week 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	
13	Revision	Dr. Jiang	Tutorial	Assignment 2 due

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 connect.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 Advocacy provides independent advice on MQ policies, procedures, and processes

Student Enquiries

Got a question? Ask us via the Service Connect Portal, 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.

Unit information based on version 2024.04 of the Handbook