MECH302

Heat and Mass Transfer

S2 Day 2019

School of Engineering

Contents

General Information

Unit convenor and teaching staff Lecturer Yijiao Jiang yijiao.jiang@mq.edu.au Contact via 02 9850 9535 Rm 312, Level 3, 9 Wally's Walk (E6A) Wednesday 12-2pm
Credit points 3
Prerequisites (39cp at 100 level or above) including MECH202
Corequisites
Co-badged status
Unit description The unit is designed to provide a comprehensive treatment of heat and mass transfer and a fundamental understanding of the different heat transfer modes (conduction, convection, and radiation) in practical engineering fields of interest. The students will learn how to apply the principles of heat transfer using numerical techniques to analyse existing thermo-fluid systems, and to develop designs which improve existing thermo-fluid systems. Knowledge from this unit together with the principles of Thermodynamics (MECH301) will help promote and develop sustainable engineering applications through their analysis and design as problems in heat and mass transfer.

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:

Analyse and interpret the characteristics of a heat transfer system undergoing conduction, convection and/or radiation processes with and without mass transfer.

Apply analytical tools in calculations of heat and mass transfer for ideal and real world problems.

Critically evaluate the experimental design and limitations of heat exchange systems.

Develop an ability to collect and analyse experimental data from heat transfer experiments.

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.

The following conditions apply for all assessments:

For assignments handed in late the following penalties apply: 0-24hrs -25%, 24-48hrs -50%, greater than 48hrs -100%.

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 clearly indicating requirements to achieve a particular standard. These will be released well in advance of the assessment due date or are specified below.

Weekly Tutorial Questions (10/100)

Each tutorial will typically consist of 4 questions. Students will receive 1 tutorial question to attempt prior to their timetabled tutorial session. The tutor will provide feedback on the attempt and 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. The maximum marks available for the first tutorial question is 0.5.

Students must individually attempt the second tutorial question during the tutorial (A maximum of 20mins will be allocated). This will be run as a weekly quiz. The tutor will check the answers and provide immediate feedback with a maximum of 0.5 marks following the grading standards indicated for the first tutorial question. The 3rd and 4th questions of each tutorial will not be assessed.

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 will be taken at the practical sessions.The student must be present in order to submit a lab report. The location of the practical sessions will be in F9C110. Precise details on time 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 1hr test assessing material delivered between weeks 1 and 7.

Final Examination: (50/100)

A final examination (3hrs) 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 December 2019. 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
Tutorials	10%	No	Weeks 3-7 & Weeks 9-13
Assignments 1-2	10%	No	Weeks 4, 13
Mid-term Test	15%	No	Week 7
Lab Reports 1-2	15%	No	Weeks 11, 12
Final Examination	50%	No	Exam Period

Tutorials

Due: **Weeks 3-7 & Weeks 9-13**
Weighting: **10%**

Weekly Tutorial Questions

On successful completion you will be able to:

- Apply analytical tools in calculations of heat and mass transfer for ideal and real world problems.

Assignments 1-2

Due: **Weeks 4, 13**
Weighting: **10%**

Assignments

On successful completion you will be able to:

- Apply analytical tools in calculations of heat and mass transfer for ideal and real world problems.
- Critically evaluate the experimental design and limitations of heat exchange systems.

Mid-term Test

Due: **Week 7**
Weighting: **15%**

Mid-term exam

On successful completion you will be able to:

- Analyse and interpret the characteristics of a heat transfer system undergoing conduction, convection and/or radiation processes with and without mass transfer.

Lab Reports 1-2

Due: **Weeks 11, 12**
Weighting: **15%**

Laboratory Reports

On successful completion you will be able to:

- Critically evaluate the experimental design and limitations of heat exchange systems.
- Develop an ability to collect and analyse experimental data from heat transfer experiments.

Final Examination

Due: **Exam Period**
Weighting: **50%**

Final Exam

On successful completion you will be able to:

- Analyse and interpret the characteristics of a heat transfer system undergoing conduction, convection and/or radiation processes with and without mass transfer.

Delivery and Resources

Required and Recommended Texts and/or Materials

There is no single core text for this course. However the following texts are recommended:

“Heat Transfer” by J.P. Holman

“A heat transfer textbook” by Leinhard and Leinhard.

Technology Used and Required

Heat transfer processes/equipment will be used in the practical session.

Unit Schedule

Week	Topic	Lecturer	Laboratory/Tutorial	Assessments
1	Introduction to heat transfer, basic modes of heat transfer, basic definitions	Dr. Jiang	No tutorial	

2	Steady-state conduction, conduction equations through walls and cylinders	Dr. Jiang	Tutorial? Heat Transfer Introduction	
3	Concept of thermal resistance networks and thermal circuits, analogy to Ohm's law	Dr. Jiang	Tutorial conduction 1	*Tutorial Prep* *and Quiz* *(weeks 3-7)*
4	Overall heat transfer coefficient, thermal contact resistance	Dr. Jiang	Tutorial conduction 2	Assignment 1 due
5	Types of heat exchangers, effects of heat exchanger geometry, log-mean temperature difference method	Dr. Jiang	Tutorial conduction 3	
6	Overall heat transfer equations, fouling, heat transfer effectiveness/NTU approach	Dr. Jiang	Tutorial heat exchangers	
7	Practical design of heat exchangers and Mid-Session Test	Dr. Jiang	Tutorial heat exchangers	In-class mid-session test
8	Introduction to heat convection. The Buckingham-pi Therorem	Dr. Jiang	Tutorial: Mid-Session Review	
9	Convection Analysis and thermal boundary layer theory	Dr. Jiang	Tutorial: convection introduction and Buckingham-pi **Prac Session 1**	*Tutorial Prep* *and Quiz* *(weeks 9-13)*
10	Thermal convection in pipe flows, empirical convection correlations	Dr. Jiang	Tutorial: forced convection **Prac Session 2**	
11	Natural heat convection, the Grashof number. Introduction to mass transfer and evaporation	Dr. Jiang	Tutorial: forced convectopm	Lab Report 1 due
12	Droplet evaporation and the basics of boiling Introduction of radiative heat transfer: black bodies, solar energy	Dr. Jiang	Tutorial natural convection	Lab Report 2 due
13	Revision	Dr. Jiang	Tutorial: mass transfer and radiation	Assignment 2 due

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). 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
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

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

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/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

Student Support

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

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

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.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- Critically evaluate the experimental design and limitations of heat exchange systems.
- Develop an ability to collect and analyse experimental data from heat transfer experiments.

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcome

- Critically evaluate the experimental design and limitations of heat exchange systems.

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Analyse and interpret the characteristics of a heat transfer system undergoing conduction, convection and/or radiation processes with and without mass transfer.
- Apply analytical tools in calculations of heat and mass transfer for ideal and real world problems.

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Analyse and interpret the characteristics of a heat transfer system undergoing conduction, convection and/or radiation processes with and without mass transfer.
- Apply analytical tools in calculations of heat and mass transfer for ideal and real world problems.

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Analyse and interpret the characteristics of a heat transfer system undergoing conduction, convection and/or radiation processes with and without mass transfer.
- Apply analytical tools in calculations of heat and mass transfer for ideal and real world problems.

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- Critically evaluate the experimental design and limitations of heat exchange systems.
- Develop an ability to collect and analyse experimental data from heat transfer experiments.

Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning outcome

- Develop an ability to collect and analyse experimental data from heat transfer experiments.