# MECH302

## Heat and Mass Transfer

S2 Day 2015

*Dept of Engineering*

## Contents

# General Information

Unit convenor and teaching staff
Unit Convenor
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Credit points
3

Prerequisites
MECH301

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:

The student will be able to identify the characteristics of a heat transfer system and delineate between conduction, convection and radiation processes.
The student will be able to apply analytical tools in calculations of heat transfer for ideal and real world problems.
The student will gain an understanding of heat exchangers, their design, and their application to industrial problems.
Develop experimental techniques, collaborative work and teamwork skills in workshop and laboratories

# General Assessment Information

*The following conditions apply for satisfactorily passing this course:*

1. At least 50% marks overall

2. must submit at least 2 assignments and 1 lab reports

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

**Assignments (3)**

Three individual assignments will test the student's understanding of the course material taught up to the point each assignment is distributed. The student is expected to solve problems which test both the concepts taught as well as the technical capabilities of the students in analysing heat transfer problems. These assignments must be completed individually.

**Laboratories (2)**

Two individual lab reports written for two unique experiments. The first experiment will demonstrate the operation of heat exchangers.  Students will test different heat exchanger designs, acquire data and compare to theoretical calculations of heat exchanger performance. The second experiment will demonstrate experimental techniques used to take measurements of conduction and convection.

The students will write two individual lab reports discussing their findings and comparing to theory where appropriate. While the laboratories are done in groups, the reports are to be done individually.

**Mid Term Test (1)**

An in-class 1hr test assessing material delivered between weeks 1 and 7.

**Final Examination (1)**

Final examination assessing all material delivered throughout the course

# Assessment Tasks

| Name | Weighting | Due |
|---|---|---|
| Assignment | 15% | Week 4, Week 8, Week 11 |
| Laboratory reports | 15% | Week 12, Week 13 |
| Mid Term Test | 20% | Week 7 (10/09/2015) |
| Final examination | 50% | During final exam period |

## Assignment

Due: **Week 4, Week 8, Week 11**
Weighting: **15%**

3 Assignments x 5 marks each

On successful completion you will be able to:

- The student will be able to identify the characteristics of a heat transfer system and delineate between conduction, convection and radiation processes.
- The student will be able to apply analytical tools in calculations of heat transfer for ideal and real world problems.
- The student will gain an understanding of heat exchangers, their design, and their application to industrial problems.
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## Laboratory reports

Due: **Week 12, Week 13**
Weighting: **15%**

2 Laboratory Reports x 5 marks each

5 marks for active engagement in all the lab and tutorial sessions

On successful completion you will be able to:

- The student will be able to identify the characteristics of a heat transfer system and delineate between conduction, convection and radiation processes.
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and real world problems.
- The student will gain an understanding of heat exchangers, their design, and their application to industrial problems.
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## Mid Term Test

Due: **Week 7 (10/09/2015)**
Weighting: **20%**

Midterm test

On successful completion you will be able to:

- The student will be able to identify the characteristics of a heat transfer system and delineate between conduction, convection and radiation processes.
- The student will be able to apply analytical tools in calculations of heat transfer for ideal and real world problems.
- The student will gain an understanding of heat exchangers, their design, and their application to industrial problems.

## Final examination

Due: **During final exam period**
Weighting: **50%**

Final Examination

On successful completion you will be able to:

- The student will be able to identify the characteristics of a heat transfer system and delineate between conduction, convection and radiation processes.
- The student will be able to apply analytical tools in calculations of heat transfer for ideal and real world problems.
- The student will gain an understanding of heat exchangers, their design, and their application to industrial problems.

# Delivery and Resources

Primary text book:

1. “Heat Transfer” by J.P. Holman,

Supporting text books:

1. “Heat and Mass Transfer fundamentals and applications” by Y.A. Cengel

2. “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, basic definitions | Dr. Jiang | No tutorial | |
| 2 | Steady-state conduction, conduction equations through walls and cylinders | Dr. Jiang | Tutorial conduction | |
| 3 | Concept of thermal resistance networks and thermal circuits, analogy to Ohm’s law | Dr. Jiang | Tutorial conduction | |
| 4 | Overall heat transfer coefficient, thermal contact resistance | Dr. Jiang | Tutorial conduction | Assignment 1 due |
| 5 | Types of heat exchangers, effects of heat exchanger geometry, log-mean temperature difference method | Dr. Jiang | Tutorial conduction | |
| 6 | Overall heat transfer equations, fouling, heat transfer effectiveness/ NTU approach | Dr. Jiang | Tutorial heat exchangers | |
| 7 | Practical design of heat exchangers | Dr. Jiang | Tutorial heat exchangers | In class midterm test |
| 8 | Combined convection and conduction analysis, boundary layers | Dr. Kourmatzis | Tutorial heat exchangers | Assignment 2 due |
| 9 | Energy balance, the Nusselt and Prandtl Numbers, correlations for flat plates | Dr. Kourmatzis | Tutorial convection | |
| 10 | Thermal convection in pipe flows, empirical convection correlations | Dr. Kourmatzis | Tutorial convection | |
| 11 | Natural heat convection, the Grashof number, Practical steps in analysis of convection | Dr. Kourmatzis | Tutorial convection | Assignment 3 due |
| 12 | Heat flow in Mass transfer systems, Features of boiling, droplet evaporation | Dr. Kourmatzis | Tutorial convection | Report 1 due |
| 13 | Basics of radiative heat transfer: Black bodies, solar energy | Dr. Kourmatzis | Tutorial Phase change and radiation | Report 2 due |

# Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central. Students

should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html

Assessment Policy http://mq.edu.au/policy/docs/assessment/policy.html

Grading Policy http://mq.edu.au/policy/docs/grading/policy.html

Grade Appeal Policy http://mq.edu.au/policy/docs/gradeappeal/policy.html

Grievance Management Policy http://mq.edu.au/policy/docs/grievance_management/policy.html

Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html *The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.*

In addition, a number of other policies can be found in the Learning and Teaching Category of 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/support/student_conduct/

## Results

Results shown in *iLearn*, 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.

# 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

## IT Help

For help with University computer systems and technology, visit http://informatics.mq.edu.au/help/.

When using the University's IT, you must adhere to the Acceptable Use 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

- The student will be able to identify the characteristics of a heat transfer system and delineate between conduction, convection and radiation processes.
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- Develop experimental techniques, collaborative work and teamwork skills in workshop and laboratories

### Assessment tasks

- Assignment
- Laboratory reports
- Mid Term Test
- Final examination

## 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:

## Assessment task

- Laboratory reports

# Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

## Learning outcomes

- The student will be able to identify the characteristics of a heat transfer system and delineate between conduction, convection and radiation processes.
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- Final examination

# 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

- The student will be able to identify the characteristics of a heat transfer system and

delineate between conduction, convection and radiation processes.
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## Assessment tasks

- Assignment
- Laboratory reports
- Mid Term Test
- Final examination

# 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

- The student will be able to identify the characteristics of a heat transfer system and delineate between conduction, convection and radiation processes.
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## Assessment tasks

- Assignment
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# 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

- The student will be able to identify the characteristics of a heat transfer system and delineate between conduction, convection and radiation processes.
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## Assessment tasks

- Assignment
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# 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 outcome

- Develop experimental techniques, collaborative work and teamwork skills in workshop and laboratories

## Assessment task

- Laboratory reports

# Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

## Learning outcome

- Develop experimental techniques, collaborative work and teamwork skills in workshop and laboratories

## Assessment task

- Laboratory reports