MECH6001

Industrial Applications of Thermodynamics

Session 1, In person-scheduled-weekday, North Ryde 2025

School of Engineering

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General Information

Unit convenor and teaching staff
Associate Professor Nazmul Huda
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3 Management Drive, Room 164
Wednesdays 3.00 - 5.00 PM

Credit points
10

Prerequisites

Corequisites

Co-badged status

Unit description
This unit delves into the fundamental principles of thermodynamics. It encompasses a comprehensive understanding of concepts such as energy, enthalpy, entropy, energy transfer, mass, and energy balance, as well as the laws governing thermodynamics. The unit also delves into the design principles that underpin thermo-fluid systems. Upon completion of this unit, students will showcase their proficiency in enhancing the design of practical thermo-fluid systems. Additionally, they will display an intricate grasp of energy systems and their industrial applications in power generation, HVAC, and other relevant industries deploying heat engines.

Learning in this unit enhances student understanding of global challenges identified by the United Nations Sustainable Development Goals (UNSDGs) Affordable and Clean Energy; Industry, Innovation and Infrastructure

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: Articulate and interpret the Laws of Thermodynamics and Energy systems including properties of substances, state and equilibrium

ULO2: Utilize the concepts of energy, enthalpy, entropy, entropy balance, energy balance, and energy transfer to analyze and assess thermodynamic systems.

ULO3: Examine the transfer of mass and energy in both closed and open systems, considering both steady and unsteady states.
ULO4: Evaluate gas power cycles, vapor and combined power cycles, refrigeration cycles, and air-conditioning cycles. Apply thermodynamic principles to enhance and optimize the design of these existing cycles.
ULO5: Demonstrate proficiency in teamwork and written communication by effectively participating in technical report writing and laboratory activities.
ULO6: Demonstrate proficiency in relevant industry focused problem solving

General Assessment Information

Student Responsibilities

Be familiar with University policy and College procedures and act in accordance with those policies and procedures.

It is the responsibility of the student to retain a copy of any work submitted. Students must produce these documents upon request. Copies should be retained until the end of the grade appeal period each term.

The student is to perform the required due diligence for their assessment grade and rectify as soon as possible upon finding any errors.

Late Assessment Submission Penalty

Students enrolled in Session-based units with 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. 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, performance assessments/presentations, and/or scheduled practical assessments/labs, students need to submit an application for Special Consideration.

Practical Component

Attendance of practical classes is mandatory before submitting the lab report. 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.

Resubmission option

Resubmission of any assessment task is not allowed under any circumstances.

Notifications

Formal notification of assessment tasks, grading rubrics, and due dates will be posted on iLearn. Although all reasonable measures to ensure the information is accurate, The University reserves the right to make changes without notice. Each student is responsible for checking iLearn for changes and updates.

Assignment submissions and plagiarism policies

All assignments and reports must be submitted electronically through iLearn (in pdf format). Submissions will undergo plagiarism checkers using the Turnitin software and any work deemed to have a 30% or higher similarity score may incur an academic penalty. For more details on the policies of academic penalties relating to academic honesty, please refer to the policies and procedures section below.

Submissions are expected to be typed set in a logical layout and sequence. Markers WILL NOT grade poorly organized or illegible scans or drafts. The expected workload includes the preparation of final copies and clear diagrams.

Grading and passing requirements for unit

For further details about grading, please refer below to the policies and procedures section.

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).

The unit will be graded according to the Macquarie University Grading policy. The following grades will be used according to the listed numerical range:

ASSESSMENT GRADES AND STATUS

GRADE	RANGE	STATUS ('Standard Grade' in AMIS)	DESCRIPTION
HD	85-100	Pass	Provides consistent evidence of deep and critical understanding in relation to the learning outcomes. There is substantial originality, insight, or creativity in identifying, generating, and communicating competing arguments, perspectives or problem-solving approaches; critical evaluation of problems, their solutions, and their implications; creativity in the application as appropriate to the program.

D	75-84	Pass	Provides evidence of integration and evaluation of critical ideas, principles, and theories, distinctive insight, and ability in applying relevant skills and concepts in relation to learning outcomes. There is a demonstration of frequent originality or creativity in defining and analyzing issues or problems and providing solutions; and the use of means of communication appropriate to the program and the audience.
CR	65-74	Pass	Provides evidence of learning that goes beyond replication of content knowledge or skills relevant to the learning outcomes. There is a demonstration of substantial understanding of fundamental concepts in the field of study and the ability to apply these concepts in a variety of contexts; convincing argumentation with appropriate coherent justification; communication of ideas fluently and clearly in terms of the conventions of the program.
P	50-64	Pass	Provides sufficient evidence of the achievement of learning outcomes. There is a demonstration of understanding and application of fundamental concepts of the program; routine argumentation with acceptable justification; communication of information and ideas adequately in terms of the conventions of the program. The learning attainment is considered satisfactory or adequate or competent or capable in relation to the specified outcomes.
F	0-49	Fail	Does not provide evidence of attainment of learning outcomes. There is missing or partial or superficial or faulty understanding and application of the fundamental concepts in the field of study; missing, undeveloped, inappropriate or confusing argumentation; incomplete, confusing, or lacking communication of ideas in ways that give little attention to the conventions of the program.

Final Examinations

Final examinations will typically take place at the end of the semester. For further information, please refer to the Examination Timetable website on www.mq.edu.au

If you receive special consideration for the final exam, a supplementary exam will be scheduled by the faculty during a supplementary exam period, typically about 3 to 4 weeks after the normal exam 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
Practical session focused on thermodynamic applications	12%	No	Week 10 and 12
Problem based activities	12%	No	Week 1 to 12
In class quiz/test	10%	No	Week 7

Name	Weighting	Hurdle	Due
Final Examination	50%	No	Exam Period
Assignment based on thermodynamic system design/ problem solving activity	16%	No	Week 13

Practical session focused on thermodynamic applications

Assessment Type [1]: Lab report
Indicative Time on Task [2]: 10 hours
Due: **Week 10 and 12**
Weighting: **12%**

Laboratory report based on the practical classes

On successful completion you will be able to:

- Demonstrate proficiency in teamwork and written communication by effectively participating in technical report writing and laboratory activities.

Problem based activities

Assessment Type [1]: Practice-based task
Indicative Time on Task [2]: 10 hours
Due: **Week 1 to 12**
Weighting: **12%**

Students will demonstrate their learning and application of theoretical concepts by contributing to discussion, problem-solving activities, and exercises during classes.

On successful completion you will be able to:

- Articulate and interpret the Laws of Thermodynamics and Energy systems including properties of substances, state and equilibrium
- Utilize the concepts of energy, enthalpy, entropy, entropy balance, energy balance, and energy transfer to analyze and assess thermodynamic systems.
- Examine the transfer of mass and energy in both closed and open systems, considering both steady and unsteady states.

- Evaluate gas power cycles, vapor and combined power cycles, refrigeration cycles, and air-conditioning cycles. Apply thermodynamic principles to enhance and optimize the design of these existing cycles.
- Demonstrate proficiency in relevant industry focused problem solving

In class quiz/test

Assessment Type [1]: Quiz/Test
Indicative Time on Task [2]: 10 hours
Due: **Week 7**
Weighting: **10%**

In class quiz/test on problem solving activity

On successful completion you will be able to:

- Articulate and interpret the Laws of Thermodynamics and Energy systems including properties of substances, state and equilibrium
- Utilize the concepts of energy, enthalpy, entropy, entropy balance, energy balance, and energy transfer to analyze and assess thermodynamic systems.
- Examine the transfer of mass and energy in both closed and open systems, considering both steady and unsteady states.
- Evaluate gas power cycles, vapor and combined power cycles, refrigeration cycles, and air-conditioning cycles. Apply thermodynamic principles to enhance and optimize the design of these existing cycles.
- Demonstrate proficiency in relevant industry focused problem solving

Final Examination

Assessment Type [1]: Examination
Indicative Time on Task [2]: 30 hours
Due: **Exam Period**
Weighting: **50%**

Final Examination

On successful completion you will be able to:

- Articulate and interpret the Laws of Thermodynamics and Energy systems including

properties of substances, state and equilibrium
- Utilize the concepts of energy, enthalpy, entropy, entropy balance, energy balance, and energy transfer to analyze and assess thermodynamic systems.
- Examine the transfer of mass and energy in both closed and open systems, considering both steady and unsteady states.
- Evaluate gas power cycles, vapor and combined power cycles, refrigeration cycles, and air-conditioning cycles. Apply thermodynamic principles to enhance and optimize the design of these existing cycles.
- Demonstrate proficiency in relevant industry focused problem solving

Assignment based on thermodynamic system design/ problem solving activity

Assessment Type [1]: Design Task
Indicative Time on Task [2]: 15 hours
Due: **Week 13**
Weighting: **16%**

Assignment based on thermodynamic system design/ problem solving activity

On successful completion you will be able to:
- Articulate and interpret the Laws of Thermodynamics and Energy systems including properties of substances, state and equilibrium
- Utilize the concepts of energy, enthalpy, entropy, entropy balance, energy balance, and energy transfer to analyze and assess thermodynamic systems.
- Examine the transfer of mass and energy in both closed and open systems, considering both steady and unsteady states.
- Evaluate gas power cycles, vapor and combined power cycles, refrigeration cycles, and air-conditioning cycles. Apply thermodynamic principles to enhance and optimize the design of these existing cycles.
- Demonstrate proficiency in teamwork and written communication by effectively participating in technical report writing and laboratory activities.

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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

Primary Text: Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles

Supporting Texts: 1. Engineering Thermodynamics (4th Edition) by Rogers and Mayhew 2. Principles of Engineering Thermodynamics (7th Edition) by Moran, Shapiro, Boettner and Bailey

Unit Schedule

Week	Lecture Topics	Key Topics to be Covered
1	Introduction and Basic Concepts	Thermodynamics and Energy, Dimension and Units, Different Applications and definitions related to Thermodynamics, Processes and Cycle
2	Energy, Energy Transfer and General Energy Analysis	Forms of energy, Energy transfer by work and heat, First law of Thermodynamics, Energy efficiency
3	Properties of pure substances	Properties of pure substances, Phase change processes, Property diagram and property tables, Equation of state
4	Energy Analysis of Closed Systems	Closed system, Moving boundary work, Energy balance for Closed systems, Internal energy, enthalpy and specific heats.
5	Mass and Energy Analysis of Control Volumes	Conservation of mass, Flow work and Energy of a Flowing Fluid, Energy Analysis of Steady flow systems, Energy Analysis of Unsteady flow process
6	The Second Law of Thermodynamics	The Second Law, Thermal energy reservoir, Heat engines, Refrigerators and Heat pumps, Reversible and Irreversible Processes, The Carnot Cycle

7	Entropy	Entropy, Entropy diagrams, Entropy change, Entropy balance,
8	Exergy	Exergy, Exergy change of a system, Exergy transfer by heat, work and mass, Exergy balance.
9	Gas Power Cycles	Analysis of Power Cycles, The Carnot Cycle, Otto Cycle, Diesel Cycle, Stirling and Ericsson Cycles, Brayton Cycle
10	Vapor and Combined Power Cycles	Rankine Cycle, Efficiency of Rankine Cycle, Regeneration, Cogeneration, Combined Gas-Vapor Power Cycles
11	Refrigeration Cycles	Refrigeration and Heat Pumps, Reversed Carnot Cycle, Refrigeration Cycles
12	Gas Vapor Mixture and Air Conditioning	Gas Mixtures, Properties of Gas Vapor Mixtures, Properties of Air, Air-Conditioning Processes
13	Review	Overall Review

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/

Academic Success

Academic Success 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.

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, 2, 3, 4, 5, 6
	1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing.	1, 2, 3, 4, 5, 6
	1.3 In-depth understanding of specialist bodies of knowledge	1, 2, 3, 4, 5, 6
	1.4 Discernment of knowledge development and research directions	
	1.5 Knowledge of engineering design practice	1, 2, 3, 4, 6
	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	1, 2, 3, 4, 6
	2.2 Fluent application of engineering techniques, tools and resources.	1, 2, 3, 4, 6
	2.3 Application of systematic engineering synthesis and design processes.	1, 2, 3, 4, 6

	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.	5
	3.2 Effective oral and written communication in professional and lay domains.	5
	3.3 Creative, innovative and pro-active demeanour.	
	3.4 Professional use and management of information.	5
	3.5 Orderly management of self, and professional conduct.	5
	3.6 Effective team membership and team leadership	5

Unit information based on version 2025.03 of the Handbook