The Hong Kong University of Science and Technology

UG Course Syllabus

MECH3300

Energy Conversion

3 Credits

Pre-/Co-requisites: MECH2310 Thermodynamics

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Course Description

This elective course for the BEng in Mechanical Engineering extends the fundamentals of classical thermodynamics to the analysis, evaluation, and design of practical energy-conversion systems. Building on MECH2310, students examine the thermodynamic principles governing power generation, jet propulsion, refrigeration, and air-conditioning, with applications spanning conventional and renewable energy technologies. The course emphasizes the systematic application of mass, energy, entropy, and exergy balances to real engineering cycles, the quantification of irreversibilities and efficiency limits, and the evaluation of system performance under realistic operating and environmental constraints. Through lectures, tutorials, and a project-based visual essay, students develop both the analytical foundation and the engineering judgment needed to assess and improve modern thermal energy systems.

Intended Learning Outcomes (ILOs)

On successful completion of this course, students should be able to:

ILO1: Select and define appropriate control volumes for analyzing classical power and refrigeration cycles, and determine energy interactions across system boundaries in terms of heat, work, and mass flow.

ILO2: Explain and calculate exergy and maximum useful work for specified thermodynamic states, and identify sources of irreversibility and exergy destruction in energy-conversion processes.

ILO3: Apply and justify appropriate assumptions and simplifications to formulate thermodynamic models of gas power cycles, vapor power cycles, refrigeration systems, and propulsion cycles.

ILO4: Solve and interpret the thermodynamic performance of energy-conversion systems using mass, energy, and entropy balances, and evaluate the influence of operating conditions and environmental considerations on system efficiency.

Assessment and Grading

This course will be assessed using criterion-referencing and grades will not be assigned using a curve. Detailed rubrics for the major assessed tasks are provided below, outlining the criteria used for evaluation.

Assessments:

Assessment Task	**Contribution to Overall Course grade (%)**	**Due date**
Mid-Term exam	30%	Mid-semester (date TBA)
Homework	25%	Two weeks after the assignment
In-course visual essay	10%	During scheduled in-course session (late semester)
Final examination	35%	University examination period

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Mid-Term exam	1,2,4	Tests the ability to define control volumes and energy interactions (1), compute exergy and identify irreversibilities (2), and solve and interpret cycle performance via mass, energy, and entropy balances (4).
Homework	1,2,3,4	Reinforces foundational cycle concepts and exergy analysis (1, 2), the formulation and justification of thermodynamic models (3), and the solution and interpretation of system performance (4).
In-course visual essay	4	Assesses the ability to understand and critically evaluate real-world / cutting-edge energy-conversion systems and analyze their efficiency and environmental impact (4), demonstrating higher-order analysis and evaluation.
Final examination	1,2,3,4	Comprehensively tests comprehension of cycle principles and exergy (1, 2), model formulation across cycle types (3), and the solution and interpretation of system performance under varying conditions (4).

Grading Rubrics

Problem-Solving Grading Rubric *(Homework, Mid-Term, and Final)*

Criteria	**4**	**3**	**2**	**1**	**0**
Problem Formulation & Modeling (Max: 4)	Control volume clearly defined; assumptions stated and fully justified; appropriate cycle model selected.	Sound formulation with minor gaps in stated assumptions.	Acceptable formulation; some assumptions missing or weakly justified.	Weak formulation; incorrect control volume or assumptions.	Formulation absent or incorrect.

Criteria	4	3	2	1	0
Application & Computation (Max: 3)	Correct, complete balances; accurate calculations with correct property data and units throughout.	Mostly correct balances with minor numerical/unit errors.	Basic application; analysis lacks depth or contains minor conceptual errors.	Misapplied balances; notable errors.	No valid analysis.
Interpretation of Results (Max: 3)	Insightful physical interpretation; efficiency and performance reasoning linked to engineering relevance.	Sound interpretation with some discussion of relevance.	Basic interpretation; limited engagement with context.	Weak or partly unsupported interpretation.	Interpretation absent or unsupported by results.

In-Course Visual Essay Grading Rubric

Criteria	4	3	2	1	0
Technical Content & Analysis (Max: 4)	Thermodynamically rigorous; insightful evaluation of efficiency limits and environmental trade-offs of a real/cutting-edge system.	Sound content with minor gaps; some critical evaluation.	Generally accurate but largely descriptive; limited analysis.	Weak or superficial content with notable errors.	Inaccurate, absent, or not submitted.
Visual Communication (Max: 3)	Visuals are clear, accurate, and reinforce the argument.	Mostly clear visuals with few errors.	Acceptable visuals with some clarity or formatting issues.	Cluttered or poorly organized visuals.	Uninformative or not submitted.
Originality & Sourcing (Max: 3)	Original synthesis supported by credible, well-cited sources.	Some original input with adequate sourcing.	Basic original input; limited sourcing.	Little originality; weak or missing sources.	No original insight or sources.

Final Grade Descriptors

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of thermodynamic energy-conversion principles, expertise in problem-solving, and outstanding critical thinking. Exhibits a high capacity for scholarship, going beyond core requirements to achieve learning goals in the broad field of thermal energy.

Grades	Short Description	Elaboration on subject grading description
B	Good Performance	Shows good knowledge and understanding of the main subject matter, competence in problem-solving, and the ability to analyze and evaluate issues related to thermodynamic energy conversion.
C	Satisfactory Performance	Possesses adequate knowledge of core thermodynamics, competence in dealing with familiar problems, and some capacity for analysis and critical thinking.
D	Marginal Pass	Has threshold knowledge of core thermodynamics, potential to achieve key professional skills, and the ability to make basic judgments.
F	Fail	Demonstrates insufficient understanding of the subject matter, lacks the necessary problem-solving skills, and shows limited ability to think critically or analytically. Does not meet the threshold requirements for development in the discipline.

Communication and Feedback

Homework and exam assessment marks will be provided via Canvas within two weeks of submission. Visual essay feedback will be released within two weeks of the in-course session. Students seeking clarification or further feedback, including marks, should consult the instructor/teaching team within one week of receiving the feedback or as specified.

Late Submission Policy

To ensure fairness for students who submit on time, late submissions are subject to penalty. Because answer keys are posted on Canvas after the deadline, homework submitted late will typically be capped at <50% of the maximum score, and submissions are not accepted once solutions have been released.

Required Texts and Materials

Thermodynamics — An Engineering Approach, Yunus Cengel & Michael Boles, McGraw-Hill Education.

Supplementary reading: *Thermodynamics of Heat Engines* (Wiley Online Books), Bernard Desmet, Wiley (2022); lecture notes and tutorial materials.

Additional Resources

Interactive learning tools on Canvas (HTML-based and Canvas-based) and selected online demonstrations of power, propulsion, and refrigeration cycles.

Course AI Policy

The use of generative AI tools to complete homework tasks is **NOT** permitted. The use of AI to explore the topic of the in-course visual essay is **encouraged**, with proper acknowledgement, provided all submitted work reflects the student's own understanding.

Academic Integrity

Students are expected to adhere to the University's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Please refer to *Academic Integrity | HKUST – Academic Registry* for the University's definition of plagiarism and ways to avoid cheating and plagiarism.