The Hong Kong University of Science and Technology

UG Course Syllabus

Energy Systems in a Sustainable World

MECH 1902

3 Credits

None

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Course Description

This course introduces how modern societies produce, convert, store, and use energy, and how engineering choices affect environmental, economic, and social sustainability. Students develop a systems view of energy—from planetary energy balance and thermodynamic limits to practical technologies such as hydropower, wind, solar photovoltaics, fossil-fuel power cycles with carbon capture, nuclear fission, biomass, batteries, hydrogen, and end-use systems in buildings, industry, and transportation.

Instruction combines lectures, in-class concept checks, short calculation exercises, and discussion of real-world case studies (including Hong Kong and regional examples). No prior university-level thermodynamics is required; key concepts (energy vs. power, unit conversion, the first and second laws, efficiency, and levelized cost of energy) are developed in class and applied throughout the term.

Key topics include: energy fundamentals and units; sustainability and climate change; water, wind, and solar resources; heat engines and power cycles; fossil fuels and CCUS; biomass; nuclear energy; building HVAC and heat pumps; industrial and transport energy use; and electricity/hydrogen storage.

Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

1. Explain fundamental energy concepts (energy, power, efficiency) and apply the first and second laws of thermodynamics to analyze energy conversion and transfer in representative systems.

2. Compare major energy resources and conversion technologies—fossil, nuclear, and renewable—in terms of operating principles, performance limits, environmental impacts, and sustainability trade-offs.

3. Quantify and compare energy flows using consistent units and appropriate metrics (e.g., capacity factor, coefficient of performance, and levelized cost of energy) to support technology and policy discussions.

4. Analyze energy demand and decarbonization opportunities in buildings, industry, and transportation, linking physical principles to practical constraints.

5. Evaluate technical claims about sustainable energy using evidence, and communicate findings clearly in written work and presentations.

Assessment and Grading

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

Assessments:

Homework sets (25%): Five short problem sets reinforcing unit conversion, energy balances, and technology comparisons. Due dates are announced on Canvas (typically one week after release).

In-class quizzes (30%): Three quizzes during the term; the best two quiz scores count toward the final grade. Quizzes are closed-book unless otherwise announced and focus on conceptual understanding aligned with lecture material.

Presentation / short report (5%): Individual work on an assigned energy system (definition, importance, operating principle, sustainability assessment, and future outlook). Grading criteria are posted on Canvas.

Final examination (40%): Comprehensive, closed-book unless otherwise announced; includes qualitative and quantitative questions covering the full course.

Assessment Task	Contribution to Overall Course grade (%)	Due date
Homework (5 sets)	30%	See Canvas *
In-class quizzes (best 2 of 3)	20%	See Canvas *
Presentation	5%	See Canvas *
Final examination	45%	Exam period

* Assessment marks for individual assessed tasks will be released within two weeks of the due date.

Mapping of Course ILOs to Assessment Tasks

Assessed Task	Mapped ILOs	Explanation
Homework	ILO 1, ILO 2, ILO 3	Problem sets assess unit discipline, thermodynamic reasoning, and quantitative comparison of energy technologies (ILOs 1–3).
In-class quizzes	ILO 1, ILO 2, ILO 3, ILO 4	Quizzes test conceptual mastery across fundamentals, technologies, and end-use sectors (ILOs 1–4).
Presentation	ILO 2, ILO 4, ILO 5	The report requires defining an energy system, explaining its operation and sustainability context, and communicating technical arguments clearly (ILOs 2, 4, 5).
Final examination	ILO 1, ILO 2, ILO 3, ILO 4, ILO 5	The final integrates analysis across resources, conversion technologies, end-use sectors, and critical evaluation of sustainability claims (all ILOs).

Grading Rubrics

Detailed rubrics for the presentation and homework expectations are provided on Canvas. Quiz and final-exam questions align with stated ILOs and lecture learning objectives.

Final Grade Descriptors:

Grades	Short Description	Elaboration on subject grading description
A	Excellent Performance	Demonstrates a comprehensive grasp of energy concepts, thermodynamic limits, and technology trade-offs. Applies quantitative reasoning accurately, evaluates sustainability claims with sound evidence, and communicates technical ideas clearly and precisely.
B	Good Performance	Shows solid understanding of core energy systems and laws, competence in standard calculations and comparisons, and the ability to analyze environmental and economic implications. Communicates effectively with minor gaps in depth or precision.
C	Satisfactory Performance	Possesses adequate knowledge of major energy technologies and terminology, handles familiar problems competently, and shows basic critical thinking about sustainability. Meets core requirements with some inconsistency in quantitative or written work.
D	Marginal Pass	Has threshold knowledge of energy fundamentals and technologies but with significant gaps in analysis, unit discipline, or communication. Benefits from the course but requires further development to apply concepts reliably.
F	Fail	Demonstrates insufficient understanding of energy systems and thermodynamic principles. Cannot perform basic quantitative comparisons or evaluate sustainability arguments. Does not meet minimum standards for further study in the discipline.

Course AI Policy

Generative AI tools (e.g., ChatGPT) may be used for study and brainstorming, but all submitted coursework must represent the student's own understanding. For homework and the presentation/report, students must disclose any substantive use of generative AI in a brief acknowledgement and verify all technical facts and numbers against course materials or reputable sources.

Use of generative AI is not permitted during in-class quizzes or the final examination unless explicitly authorized. Submitting AI-generated text or solutions without disclosure may be treated as academic misconduct.

Communication and Feedback

Assessment marks for individual assessed tasks will be communicated via Canvas within two weeks of submission. Feedback on assignments will include comments on strengths, areas for improvement, and common misconceptions. Students who have further questions about the feedback including marks should consult the instructor within five working days after the feedback is received.

Resubmission Policy

Resubmission of assessed work is generally not permitted except where required by university policy (e.g., approved academic accommodations).

Required Texts and Materials

No textbook is required. Lecture slides, practice materials, and supplementary readings are posted on Canvas.

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.

[Optional] Additional Resources

Recommended references (optional):
• David J.C. MacKay, Sustainable Energy — Without the Hot Air (free online: http://www.withouthotair.com/)
• Frank Kreith & Jan F. Kreider, Principles of Sustainable Energy (CRC Press, 2010)
• Jefferson W. Tester et al., Sustainable Energy: Choosing Among Options (MIT Press, 2nd ed., 2010)

Course materials also include lecture slides, homework solutions, and curated news/case links on emerging topics (e.g., renewables, storage, and industrial decarbonization).