Subject Guide – Thermodynamics for Mechanical Engineering

Shortened Name	TdME	**Semester**	1-2023
Class Time (weekly)	Tue, 13-16	**Lecture hours**	3h x 15w
Subject Code	090125120	**Assignment and self-study**	5h x 15w
ECTS credits	6	**Preparation for exams**	30
KMUTNB Credits	3(3-0-6)	**Total working hours/semester**	150

1 Revision date of this document, reasons for revision

- 26.06.2023

2 Course description

Phenomenology of thermodynamics; concepts of equilibrium, temperature, and reversibility; 1^{st} and 2^{nd} laws of thermodynamics; formulation of thermodynamic properties of substances and equation of state; application of thermodynamic principles to analysis of performance of engineering components and systems. Students will also take part in a research seminar.

3 Lecturer

- Dr. Ampol Likitchatchawankun

4 Expected learning outcomes (in accordance with the MAE program ELOs)

Primary LOs (primary content of class, knowledge is explicitly evaluated (for example, by exams), larger share of overall grade)

- Ability to define a technical task or problem, to analyze/structure it and formulate a strategy to solve it (GELO 1)
- Knowledge and understanding of scientific fundamentals relevant for the understanding of the behavior of solid body and fluids in engineering applications (SELO 2)

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Secondary LOs (not primary content of class, but implicitly taught and evaluated by application (for example, by project work or assignments), lower share of overall grade)

- Ability to independently conduct a literature study on a given topic, identify and acquire relevant sources, extract and sum up the essence in writing (GELO 5)
- Ability to present a project in front of a professional audience (GELO 6)

Note: These ELOs correspond to the Program ELOs (referenced in parentheses).

5 Assessment

Each student will be individually assessed based on the performance on homework assignments, written exams/quizzes, and seminar, with the overall grade resulting from the shares in the table below:

Evaluated items*	**shares**
Homework submission	10%
Quiz 1 (Midterm exam 1)	20%
Quiz 2 (Midterm exam 2)	20%
Quiz 3 (Pre-final exam)	20%
Quiz 4 (Final exam)	20%
**Seminars of related topics to this class with short reports	10%
Total	**100%**

*I reserve the right to make small changes to the grading breakdown

- All quizzes are closed-book and paper-based
- Each quiz consists of *Part A* (5 conceptual questions with short answers, drawing graphs, and simple mathematical derivation) and *Part B* (1 problem with multiple parts to assess the problem-solving skills. Necessary information such as tables for some properties)
- **Seminar: Participation of 4 seminars in topics related to Thermodynamics/Heat and Mass Transfer/ Transport and Interfacial Phenomena/ Energy Technology/ Renewable Energy hosted by TGGS/KMUTNB/Partner Universities.

6 Teaching materials

- Power-point presentation of each lecture is handed over (before each class)
- E-books are provided by email before the first day of the class

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- The links of relevant VDOs from youtube are also given

7 Books and references

1) *Fundamentals of Engineering Thermodynamics, 8thor 9thEdition, M.J. Moran and H. N Shapiro, D.D. Boettner, and M.B. Bailey, John Wiley & Sons, Publishers, 2014 or 2018* **(MAIN TEXTBOOK)**

   **Important note: Earlier editions of this book will work just as well.*

   *** For the reference to homework and discussion, I use the 8th edition.*

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8 Course schedule

Week	Date/Month	Activity, Class Title (Book Chapter)	Evalu-ation %	Class Hours
1	01/08	Introduction – concepts, properties, measurements, problem solving methodology (Ch1) Kinetic and Potential Energies; Energy transfer by work and heat (Ch2)		3
2	08/08	First law of thermodynamics; Thermodynamic cycles (Ch3)		3
3	15/08	Evaluating pressure, specific volume, and temperature; Phase diagrams (Ch3)		3
4	22/08	**Quiz I (Close system involving phase change)**	20%	3
5	29/08	Ideal gas model; Physics outlook: equipartition principles and specific heat, Polytropic processes; non-ideal gases and liquids (Ch3)		3
6	05/09	**Quiz II (Close system involving ideal gas)**	20%	3
7	12/09	Mass conservation equation for open systems; Applying mass balance to an open system (Ch4)		3
8	19/09	Energy conservation equation for open systems; Bernoulli's equation; throttling devices (Ch4)		3
9	26/09	Problem solving for hydroelectric power generation and steam turbines (Ch4) Second law of thermodynamics; Reversible vs. irreversible processes (Ch5)		3
10	03/10	**Quiz III (Open system)**	20%	3
11	10/10	Clausius inequality; Defining entropy; Understanding entropy; Phase diagrams with entropy (Ch6)		3
12	1710	Thermodynamic cycles with the T-s diagram; Tds equations; Entropy of ideal gases and incompressible fluids (Ch6)		3
13	24/10	Entropy for closed and open systems and problem solving (Ch6)		3
14	31/10	**Quiz IV (Entropy)**	20%	3
15	Not specific	**4 Seminars**	10%	3
	Throughout the semester	**Eight (8) homework submissions**	10%	-
		Sum	100%	45

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9 Content details

Chapter	Title	Lesson (L) Contents
1	Getting Started: Introductory Concepts and Definitions	• Defining Systems • Describing Systems and Their Behavior • Specific Volume, Pressure, Temperature • Engineering Design and Analysis • Methodology for Solving Thermodynamics Problems
2	Energy and the First Law of Thermodynamics	• Reviewing Mechanical Concepts of Energy • Broadening Our Understanding of Work and Energy • Energy Balance for Closed Systems • Energy Analysis of Cycles
3	Evaluating Properties	• p–v–T Relation • Phase Change • Retrieving Thermodynamic Properties • Evaluating Specific Internal Energy and Enthalpy • Specific Heats c_v and c_p • Ideal Gas and real gas • Polytropic Process Relations
4	Control Volume Analysis Using Energy	• Conservation of Mass and Energy for a Control Volume • Nozzles/Diffusers, Compressors/Pumps, Heat Exchangers, Throttling Devices • System Integration • Transient Analysis
5	The Second Law of Thermodynamics	• Statements of the Second Law • Irreversible and Reversible Processes • Second Law Aspects of Refrigeration and Heat Pump Cycles Interacting with Two Reservoirs • Carnot Cycle
6	Entropy	• The 1st and 2nd T dS Equations • Entropy Change of an Incompressible Substance and an ideal gas • Entropy Balance for Closed Systems • Entropy Rate Balances for Control Volumes • Heat Transfer and Work in Internally Reversible, Steady-State Flow Processes

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10 Details on Evaluation of Expected Learning Outcomes

		Quiz 1	Quiz 2	Quiz 3	Quiz 4	Seminar	Homework	Sums
		20%	**20%**	**20%**	**20%**	**10%**	**10%**	
GELO1	Ability to define a design task or problem, to analyze/structure it and formulate a strategy to solve it	10%	10%	10%	10%		10%	**50%**
SELO2	Knowledge and understanding of scientific fundamentals relevant for the understanding of the behavior of solid bodies and fluids in engineering applications	10%	10%	10%	10%			**40%**
GELO5	Ability to independently conduct a literature study on a given topic, identify and acquire relevant sources, extract and sum up the essence in writing					5%		**5%**
GELO6	Ability to present a project in front of a professional audience					5%		**5%**

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