UNESA	**Universitas Negeri Surabaya** **Faculty of Engineering,** **Mechanical Engineering Undergraduate Study Program**	**Document Code**

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Thermodynamics 1	2120102122	Compulsory Study Program Subjects	**T=2**	**P=0**	**ECTS=3.18**	3	August 22, 2023

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
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Learning model	**Case Studies**	
Program Learning Outcomes (PLO)	**PLO study program that is charged to the course**	
	PLO-5	Work independently and in groups
	PLO-11	Design and development of solutions that take into account the environment and sustainability
	PLO-14	Science and engineering knowledge
	Program Objectives (PO)	
	PO - 1	Students have good morals, ethics and personality when attending lectures.
	PO - 2	Students have an understanding of the concept of the First Law of Thermodynamics regarding the conservation of energy and the concept of control mass and control volume systems and SI and British unit conversions.
	PO - 3	Students have an understanding of control mass systems by introducing thermodynamic properties related to control mass systems, namely pressure, temperature, volume and specific internal energy.
	PO - 4	Students have an understanding of the ideal gas model for fluids in the gas phase and evaluate control volume systems such as nozzles, diffusers, turbines, compressors, pumps and an introduction to fluid properties related to control volume systems, namely enthalpy.
	PO - 5	Students are able to work together and be responsible in developing thermodynamic cycles according to applications in everyday life.
	PLO-PO Matrix	

P.O	PLO-5	PLO-11	PLO-14
PO-1			
PO-2			
PO-3			
PO-4			
PO-5			

PO Matrix at the end of each learning stage (Sub-PO)

P.O	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PO-1																
PO-2																
PO-3																
PO-4																
PO-5																

Short Course Description	This course is an understanding of the concept of the First Law of Thermodynamics regarding the conservation of energy and the concept of control mass and control volume systems. The discussion begins with an introduction to SI and British unit conversions, the concept of work and energy in thermodynamics, and energy balance in closed systems. Then the discussion is deepened for control mass systems with an introduction to thermodynamic properties related to control mass systems, namely pressure, temperature, specific volume and specific internal energy. The discussion of control mass systems is further deepened with the introduction of the ideal gas model for fluids in the gas phase. The next discussion is evaluating control volume systems such as nozzles, diffusers, turbines, compressors, pumps and introducing fluid properties related to control volume systems, namely enthalpy.	
References	**Main :**	

	1. Moran, Michael J., Howard N. Saphiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.
	Supporters:
	1. Cengel, Yunus A. and Boles, Michael A. 2010. Thermodynamics An Engineering Aproach 7th ed., McGraw-Hill. 2. Sonntag., Borgnakke., Van Wylen, 1998, Fundamental of Thermodynamics 7th ed., John Willey & Sons.
Supporting lecturer	Prof. Dr. Muhaji, S.T., M.T. Saiful Anwar, S.Pd., M.T. Dr. Aris Ansori, S.Pd., M.T. Ika Nurjannah, S.Pd., M.T.

Week-	Final abilities of each learning stage (Sub-PO)	Evaluation		Help Learning, Learning methods, Student Assignments, [Estimated time]		Learning materials [References]	Assessment Weight (%)
		Indicator	Criteria & Form	Offline (*offline*)	Online (*online*)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	1. Introduction: Understand the rules and general instructions for students 2. Understand the basic concepts of thermodynamics	Students are able to understand the definition of property, types of systems, SI and British unit systems.	**Criteria:** liveliness, duty **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers 2 X 50		**Material:** basic concepts of thermodynamics **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	5%
2	1. Understand the basic concepts of thermodynamics 2. Understand types of energy, conditions and equilibrium	Students are able to understand types of energy, conditions and equilibrium.	**Criteria:** student activeness in discussing and answering questions **Form of Assessment** : Participatory Activities	Case Method (reading, working in groups, presentation and discussion) 2 X 50		**Matter:** types of energy, states and equilibrium. **Bibliography:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	3%
3	1. Understand the basic concepts of thermodynamics 2. Able to understand the law of thermodynamics and the methodology for solving thermodynamic problems 3. Able to read properties table	1. Students are able to understand the law of thermodynamics along with the methodology for solving thermodynamic problems 2. Students are able to read the properties table	**Criteria:** student activeness during discussions **Form of Assessment** : Participatory Activities, Tests	Case Method (reading, working in groups, presentation and discussion) 2 X 50		**Matter:** types of energy, states and equilibrium **Bibliography:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	4%
4	Understand the properties of pure substances	Students understand the nature of pure substances and their phase changes	**Criteria:** 1. student activity during the learning process 2. able to solve two-phase problems (mixed quality) **Form of Assessment** : Participatory Activities	Case Method (direct learning, reading, presentation and discussion) 2 X 50		**Matter:** properties of pure substances **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.* **Material:** pure substance **References:** *Cengel, Yunus A. and Boles, Michael A. 2010. Thermodynamics An Engineering Approach 7th ed., McGraw-Hill.*	3%

5	1. Understand the properties of pure substances 2. Able to calculate and analyze the quality of two-phase mixtures	1. Students understand the nature of pure substances and their phase changes 2. Able to calculate and analyze the quality of two-phase mixtures by utilizing tables in the textbook	**Criteria:** student activeness when discussing and solving questions **Form of Assessment** : Participatory Activities, Tests	Case Method (reading, working in groups, presentation and discussion) 2 X 50		**Material:** pure substance (properties of pure substances) **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	6%
6	Understanding Energy and the first law of thermodynamics	Students understand the principles of energy and the use of the first law of thermodynamics	**Criteria:** Student activity during discussions **Form of Assessment** : Participatory Activities	Case Method (reading, direct learning, presentation and discussion) 2 X 50		**Matter:** energy principles and the use of the first law of thermodynamics **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	3%
7	Understanding Energy and the first law of thermodynamics	Students understand the principles of energy and the use of the first law of thermodynamics	**Criteria:** student activity **Form of Assessment** : Participatory Activities	Case Method (reading, working in groups, presentation and discussion) 2 X 50		**Matter:** energy principles and the use of the first law of thermodynamics **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	3%
8	UTS	1. Able to understand the law of thermodynamics and the methodology for solving thermodynamic problems 2. Able to calculate and analyze the quality of two-phase mixtures	**Criteria:** Full marks are obtained if you do all the questions correctly **Form of Assessment** : Test	Implementation of the 2 X 50 written test			10%

9	Understand the first law of thermodynamics for closed systems	1. Students are able to understand the principle of energy balance for closed systems 2. Students are able to understand and calculate the specific heat of an ideal gas, internal energy and thermodynamic processes	**Criteria:** student activeness during discussions and questions and answers **Form of Assessment** : Participatory Activities	Case Method (reading, working in groups, presentation and discussion) 2 X 50		**Material:** energy balance, specific heat of ideal gas, internal energy and thermodynamic processes **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	3%
10	Understand the first law of thermodynamics for closed systems	1. Students are able to understand the principle of energy balance for closed systems, 2. Students are able to understand and calculate the specific heat of ideal gases, internal energy and thermodynamic processes	**Criteria:** student activeness during discussions **Form of Assessment** : Participatory Activities	Case Method (reading, working in groups, presentation and discussion) 2 X 50		**Material:** Principles of energy balance in closed systems, specific heat of ideal gases, internal energy and thermodynamic processes. **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.* **Material:** Principles of energy balance in closed systems **References:** *Sonntag., Borgnakke., Van Wylen, 1998, Fundamentals of Thermodynamics 7th ed., John Willey & Sons.*	4%
11	Understand the first law of thermodynamics for closed systems	Students are able to understand the principles of energy balance for closed systems, specific heat of ideal gases, internal energy and thermodynamic processes	**Criteria:** student activeness during discussions **Form of Assessment** : Participatory Activities, Tests	Case Method (reading, working in groups, presentation and discussion) 2 X 50		**Material:** Principles of energy balance in closed systems **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	8%
12	Understand the first law of thermodynamics for open systems	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** student activity during lectures **Form of Assessment** : Participatory Activities	Case Method (reading, working in groups, presentation and discussion) 2 X 50		**Material:** control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors, and heat exchangers. **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	5%

13	Understand the first law of thermodynamics for open systems	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** student activity during lectures and solving questions **Form of Assessment** : Participatory Activities	Case Method (reading, working in groups, presentation and discussion) 2 X 50		**Material:** control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors, and heat exchangers. **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	8%
14	Understand the first law of thermodynamics for open systems	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** student activity during lectures **Form of Assessment** : Participatory Activities, Tests	Case Method (reading, working in groups, presentation and discussion) 2 X 50		**Material:** control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors, and heat exchangers. **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	10%
15	Understand the first law of thermodynamics for open systems	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** student activity during lectures **Form of Assessment** : Participatory Activities, Portfolio Assessment	Case Method (reading, working in groups, presentation and discussion) 2 X 50		**Material:** control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors, and heat exchangers. **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	10%

16	UAS	1. Able to understand and solve problems related to closed systems and their applications 2. Able to understand and solve problems related to open systems and their applications	**Criteria:** 1. Full marks are obtained if you do all the questions correctly 2. The score is not full, if there is an answer to a question that is not correct, the score is adjusted according to the score per point on the question **Form of Assessment** : Test	The final semester exam is carried out with a written test and presentation of the results of class project discussions		**Material:** control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors, and heat exchangers. **References:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey. 2011. Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.* **Material:** closed systems and open systems **References:** *Cengel, Yunus A. and Boles, Michael A. 2010. Thermodynamics An Engineering Approach 7th ed., McGraw-Hill.*	15%

Evaluation Percentage Recap: Case Study

No	Evaluation	Percentage
1.	Participatory Activities	56%
2.	Portfolio Assessment	5%
3.	Test	39%
		100%

Notes

1. **Learning Outcomes of Study Program Graduates (PLO - Study Program)** are the abilities possessed by each Study Program graduate which are the internalization of attitudes, mastery of knowledge and skills according to the level of their study program obtained through the learning process.
2. **The PLO imposed on courses** are several learning outcomes of study program graduates (CPL-Study Program) which are used for the formation/development of a course consisting of aspects of attitude, general skills, special skills and knowledge.
3. **Program Objectives (PO)** are abilities that are specifically described from the PLO assigned to a course, and are specific to the study material or learning materials for that course.
4. **Subject Sub-PO (Sub-PO)** is a capability that is specifically described from the PO that can be measured or observed and is the final ability that is planned at each learning stage, and is specific to the learning material of the course.
5. **Indicators for assessing** ability in the process and student learning outcomes are specific and measurable statements that identify the ability or performance of student learning outcomes accompanied by evidence.
6. **Assessment Criteria** are benchmarks used as a measure or measure of learning achievement in assessments based on predetermined indicators. Assessment criteria are guidelines for assessors so that assessments are consistent and unbiased. Criteria can be quantitative or qualitative.
7. **Forms of assessment:** test and non-test.
8. **Forms of learning:** Lecture, Response, Tutorial, Seminar or equivalent, Practicum, Studio Practice, Workshop Practice, Field Practice, Research, Community Service and/or other equivalent forms of learning.
9. **Learning Methods:** Small Group Discussion, Role-Play & Simulation, Discovery Learning, Self-Directed Learning, Cooperative Learning, Collaborative Learning, Contextual Learning, Project Based Learning, and other equivalent methods.
10. **Learning materials** are details or descriptions of study materials which can be presented in the form of several main points and sub-topics.
11. **The assessment weight** is the percentage of assessment of each sub-PO achievement whose size is proportional to the level of difficulty of achieving that sub-PO, and the total is 100%.
12. TM=Face to face, PT=Structured assignments, BM=Independent study.