UNESA	**Universitas Negeri Surabaya** **Vocational Faculty,** **D4 Mechanical Engineering Study Program**	**Document Code**

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Thermodynamics	xx214010216310	Compulsory Study Program Subjects	**T=0**	**P=0**	**ECTS=0**	2	February 1, 2024

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
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Learning model: **Project Based Learning**

Program Learning Outcomes (PLO)

PLO study program which is charged to the course

PLO-5	Demonstrate an attitude of responsibility, law abiding and discipline, in the life of society, nation, state and the progress of civilization based on Pancasila.
PLO-8	Designing components, systems and/or mechanical processes to meet expected needs with an analytical approach to engineering based on the latest manufacturing science and technology and considering technical standards, performance aspects, reliability and ease of application, and/or utilizing the potential of local and national resources with insight global.
PLO-9	Able to apply knowledge of mathematics, science and/or materials, and engineering to gain a thorough understanding of engineering principles.

Program Objectives (PO)

PO - 1	Students are able to understand the Unit Conversion system
PO - 2	Students are able to understand the principles of conservation of mechanical energy and thermodynamics
PO - 3	Students are able to understand the Laws of Thermodynamics and Energy Conservation
PO - 4	Students are able to understand control mass systems, fluid properties, fluid states, isobar, isovolume and polytropic processes
PO - 5	Students are able to understand control volume systems, mass rate equilibrium, energy, and analyze control volume systems at steady state.

PLO-PO Matrix

P.O	PLO-5	PLO-8	PLO-9
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. 2. Reynold, William C. and Perkin Henry C., 1977, Engineering Thermodynamics 2nd ed., McGraw-Hill. 3. Holman, 1980, Thermodynamics, 3rd ed., McGraw-Hill. 4. Kogakusha, Wood and Bernard D., 1982, Applications of Thermodynamics 2nd ed., Addison-Wesley. **Supporters:** 1. Studi kasus di dunia industri
Supporting lecturer	Prof. Dr. Muhaji, S.T., M.T. Prof. Dr. I Made Arsana, S.Pd., M.T. Dr. Mohammad Effendy, S.T., M.T. Diah Wulandari, S.T., M.T. Ferly Isnomo Abdi, S.T., 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	Get to know the SI and British unit systems and their quantity conversions	Students are able to convert quantities in SI and British units	**Criteria:** According to rubik **Form of Assessment** : Participatory Activities, Tests	Lectures, discussions and questions and answers. 2 X 50		**Material:** • Know SI and British units and the relationship between each quantity and the unit • Understand the meaning of atmospheric, gauge, and absolute pressure. **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	Understand the principles of conservation of mechanical and thermodynamic energy	Students understand the principles of work and energy balance	**Criteria:** 1.According to rubik. 2.5 **Form of Assessment** : Participatory Activities	Lectures, discussions and questions and answers. 2 X 50		**Materials:** • Calculating the expansion work of the cylinder piston system • Calculating heat transfer in the gas cooling process in the cylinder piston • Calculating heat transfer in the gas heating process in the cylinder piston **Reference:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey, 2011, Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	0%
3	Students are able to understand the Laws of Thermodynamics.	Students are able to understand one of the properties of thermodynamics regarding temperature which is related to the ability to differentiate hot and cold.	**Criteria:** According to rubik. **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, exercises and assignments. 2 X 50			5%

4	Students are able to understand job transfer.	Students understand energy interactions in the form of work transfer accompanied by changes in the properties of the system.	**Criteria:** According to rubik. **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment	Lectures, discussions, questions and answers, exercises and assignments. 2 X 50		**Material:** • Calculating work in heating ammonia at constant pressure • Calculating the mass of steam formed in heating water at constant volume • Calculating work in the process of stirring water at constant volume • Calculating work and heat transfer in the analysis of two series processes • Calculating heat transfer in the process mixing of gases in two tanks connected by a valve **Bibliography:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey, 2011, Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	10%
5	Understand control mass systems, fluid properties, fluid states, isobar, isovolume, and polytropic processes	Students are able to understand control mass systems, isobar and isovolume processes	**Criteria:** According to rubik. **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Practice / Performance, Tests	Lectures, discussions, questions and answers, exercises and assignments. 2 X 50		**Material:** • Calculating work in heating ammonia at constant pressure • Calculating the mass of steam formed in heating water at constant volume • Calculating work in the process of stirring water at constant volume • Calculating work and heat transfer in the analysis of two series processes • Calculating heat transfer in the process mixing of gases in two tanks connected by a valve **Bibliography:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey, 2011, Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	10%

6	Understand control mass systems, fluid properties, fluid states, isobar, isovolume, and polytropic processes	Students are able to understand control mass systems, isobar and isovolume processes	**Criteria:** According to rubik. **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Practice / Performance, Tests	Lectures, discussions, questions and answers, exercises and assignments. 2 X 50		**Material:** • Calculating work in heating ammonia at constant pressure • Calculating the mass of steam formed in heating water at constant volume • Calculating work in the process of stirring water at constant volume • Calculating work and heat transfer in the analysis of two series processes • Calculating heat transfer in the process mixing of gases in two tanks connected by a valve **Bibliography:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey, 2011, Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	10%
7	Understand control mass systems, fluid properties, fluid states, isobar, isovolume, and polytropic processes	Students are able to understand control mass systems, isobar and isovolume processes	**Criteria:** According to rubik. **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Practice / Performance, Tests	Lectures, discussions, questions and answers, exercises and assignments. 2 X 50		**Material:** • Calculating work in heating ammonia at constant pressure • Calculating the mass of steam formed in heating water at constant volume • Calculating work in the process of stirring water at constant volume • Calculating work and heat transfer in the analysis of two series processes • Calculating heat transfer in the process mixing of gases in two tanks connected by a valve **Bibliography:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey, 2011, Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	10%

8	Understand control mass systems, fluid properties, fluid states, isobar, isovolume, and polytropic processes	Students are able to understand control mass systems, isobar and isovolume processes	**Criteria:** According to rubik. **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Practice / Performance, Tests	Lectures, discussions, questions and answers, exercises and assignments. 2 X 50		**Material:** • Calculating work in heating ammonia at constant pressure • Calculating the mass of steam formed in heating water at constant volume • Calculating work in the process of stirring water at constant volume • Calculating work and heat transfer in the analysis of two series processes • Calculating heat transfer in the process mixing of gases in two tanks connected by a valve **Bibliography:** *Moran, Michael J., Howard N. Shapiro, Daisie D. Boettner, and Margareth B. Bailey, 2011, Fundamentals of Engineering Thermodynamics 7th ed., John Wiley & Sons.*	10%
9	Understand control volume systems, mass rate equilibrium, energy, and analyze control volume systems at steady state	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** according to rubik **Forms of Assessment** : Participatory Activities, Practice/Performance, Tests		Lectures, discussions, questions and answers, exercises and 100 assignments		5%
10	Understand control volume systems, mass rate equilibrium, energy, and analyze control volume systems at steady state	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** according to rubik **Forms of Assessment** : Participatory Activities, Practice/Performance, Tests		Lectures, discussions, questions and answers, exercises and 100 assignments		10%
11	Understand control volume systems, mass rate equilibrium, energy, and analyze control volume systems at steady state	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** according to rubik **Forms of Assessment** : Participatory Activities, Practice/Performance, Tests		Lectures, discussions, questions and answers, exercises and 100 assignments		5%
12	Understand control volume systems, mass rate equilibrium, energy, and analyze control volume systems at steady state	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** according to rubik **Forms of Assessment** : Participatory Activities, Practice/Performance, Tests		Lectures, discussions, questions and answers, exercises and 100 assignments		5%

13	Understand control volume systems, mass rate equilibrium, energy, and analyze control volume systems at steady state	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** according to rubik **Forms of Assessment** : Participatory Activities, Practice/Performance, Tests		Lectures, discussions, questions and answers, exercises and 100 assignments		2%
14	Understand control volume systems, mass rate equilibrium, energy, and analyze control volume systems at steady state	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** according to rubik **Forms of Assessment** : Participatory Activities, Practice/Performance, Tests		Lectures, discussions, questions and answers, exercises and 100 assignments		2%
15	Understand control volume systems, mass rate equilibrium, energy, and analyze control volume systems at steady state	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** according to rubik **Forms of Assessment** : Participatory Activities, Practice/Performance, Tests		Lectures, discussions, questions and answers, exercises and 100 assignments		5%
16	Understand control volume systems, mass rate equilibrium, energy, and analyze control volume systems at steady state	Students are able to understand the control volume system by analyzing the system in nozzles, diffusers, turbines, pumps, compressors and heat exchangers	**Criteria:** according to rubik **Forms of Assessment** : Participatory Activities, Practice/Performance, Tests		Lectures, discussions, questions and answers, exercises and 100 assignments		5%

Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
1.	Participatory Activities	35.52%
2.	Project Results Assessment / Product Assessment	15%
3.	Practice / Performance	23.02%
4.	Test	25.52%
		99.06%

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.