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 2	2120102126		T=2	P=0	ECTS=3.18	4	July 16, 2024

AUTHORIZATION	**SP Developer**	**Course Cluster Coordinator**	**Study Program Coordinator**
	....	....	Ir. Priyo Heru Adiwibowo, S.T., M.T.

Learning model	**Case Studies**

Program Learning Outcomes (PLO)

PLO study program that is charged to the course

Program Objectives (PO)

PO - 1	Students can apply thermodynamic cycles to the industrial world

PLO-PO Matrix

P.O
PO-1

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																

Short Course Description

This course is an understanding of the Second Law of Thermodynamics regarding the concept of entropy and the application of thermodynamic cycles to the industrial world. The discussion begins with an introduction to the concepts of entropy, changes in entropy, and equilibrium entropy for control mass and control volume. Next is an introduction to the concept of exergy, exergy balance in control mass and control volume systems, and exergetic efficiency. Introduction of the Rankine cycle as a power producing cycle equipped with supporting equipment to optimize performance such as superheat, reheat and supercritical. Introduction of gas power systems such as Otto, Diesel, Dual and Brayton cycles which are equipped with reheat and intercooling.

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. materi PPT

Supporting lecturer

Prof. Dr. Muhaji, S.T., M.T.
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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. Students can understand the concepts of entropy, entropy changes and entropy equilibrium in systems 2. Students can calculate the entropy value in the system	1. Students are able to differentiate between reversible and irreversible processes 2. can understand the concepts of entropy, entropy changes and entropy equilibrium in systems 3. can calculate the entropy value in a control mass system	**Criteria:** 1. according to the rubric, be able to differentiate reversible and irreversible processes correctly 2. can explain the concepts of entropy, changes in entropy and equilibrium entropy in systems correctly **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, exercises and assignments 6 X 50			5%
2	1. Students can understand the concept of entropy in control mass systems 2. Students can calculate the entropy value in a control mass system	1. Students are able to differentiate between reversible and irreversible processes 2. can understand the concept of entropy in control mass systems 3. can calculate the entropy value in a control mass system	**Criteria:** 1. according to the rubric, be able to differentiate reversible and irreversible processes correctly 2. can understand the concept of entropy in control mass systems correctly **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, exercises and assignments 6 X 50			5%
3	1. Students can understand the concept of entropy in control volume systems 2. Students can calculate the entropy value in a control volume system	1. can understand the concept of entropy in control volume systems 2. can calculate the entropy value in a control volume system	**Criteria:** 1. can explain entropy in a control volume system correctly 2. can calculate the entropy value in a control volume system correctly **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, exercises and assignments 6 X 50			5%
4	1. Students can calculate and analyze entropy production in steam turbines 2. students can calculate the isentropic efficiency of a steam turbine	1. can calculate and analyze entropy production in steam turbines 2. can calculate the isentropic efficiency of a steam turbine	**Criteria:** 1. can calculate and analyze entropy production in steam turbines correctly 2. correctly calculate the isentropic efficiency of a steam turbine **Form of Assessment** : Participatory Activities	Lectures, discussions, assignments			5%

5	1. Students can calculate and analyze entropy production in compressors 2. students can calculate the isentropic efficiency of a compressor	1. can calculate and analyze entropy production in compressors 2. can calculate the isentropic efficiency of the compressor	**Criteria:** 1. calculate and analyze entropy production in the compressor correctly 2. correctly calculate the isentropic efficiency of the compressor **Form of Assessment** : Participatory Activities	Lectures, discussions, assignments			5%
6	1. Students can understand the concept of exergy in control mass systems 2. Students can calculate flue gas exergy and destruction exergy in the grill walls	1. Students are able to understand exergy concepts, changes and balance 2. can calculate flue gas exergy and damage exergy in the grill walls	**Criteria:** 1. Can explain exergy concepts, changes and balance correctly 2. Calculate flue gas exergy and destruction exergy in grill walls correctly **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, exercises and assignments 3 X 50			5%
7	1. Students can understand the concept of exergy in control volume systems 2. Students can calculate in a heat exchanger	1. can understand the concept of exergy in control volume systems 2. can Calculate eergy in a heat exchanger	**Criteria:** Calculate the exergy in the heat exchanger correctly **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, exercises and assignments 6 X 50			5%
8	1. Students can understand the concept of exergy in control volume systems 2. Students can calculate steam turbine exergy	1. can understand the concept of exergy in control volume systems 2. Can calculate steam turbine exergy	**Criteria:** explain the concept of exergy in a controlled volume system correctly **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, exercises and assignments 6 X 50			5%
9	Short Quiz 2	Short Quiz 2	**Criteria:** according to the rubric **Form of Assessment** : Test	Short Quiz 1 3 X 50			5%
10	Understanding the Rankine cycle as a power generating cycle	Students are able to understand the Rankline cycle and its supporting tools	**Criteria:** calculate the ideal Rankline cycle work on the turbine correctly **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, exercises and assignments 9 X 50			5%

11	1. students can calculate the Rankine cycle irreversibly 2. students can analyze the performance of the reheat cycle with an irreversible turbine	1. can calculate the Rankine cycle irreversibly 2. can analyze the performance of the reheat cycle with an irreversible turbine	**Criteria:** 1. calculate the irreversible Rankine cycle correctly 2. correctly analyze the performance of reheat cycles with irreversible turbines **Form of Assessment** : Participatory Activities	lectures, discussions, assignments			5%
12	1. students can calculate the regenerative cycle with an open tank heater 2. students can analyze the performance of the reheat-regenerative cycle with a two-tank heater	1. calculating regenerative cycles with open tank heaters 2. can analyze the performance of the reheat-regenerative cycle with a two-tank heater	**Criteria:** 1. calculate regenerative cycles with open tank heaters correctly 2. correctly analyze the performance of a reheat-regenerative cycle with a two-tank heater **Form of Assessment** : Participatory Activities	lectures, discussions, assignments			5%
13	1. Students can understand Otto's standard air cycle 2. Students can calculate and analyze the work of the Otto cycle	1. can understand Otto's standard air cycle 2. can calculate and analyze the work of the otto cycle	**Criteria:** 1. calculate and analyze the work of the otto cycle correctly 2. correctly explain Otto's standard air cycle **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, exercises and assignments 3 X 50			5%
14	1. Students can understand the diesel cycle 2. Students can calculate and analyze the work of the diesel cycle	1. can understand the diesel cycle 2. can calculate and analyze the work of the diesel cycle	**Criteria:** 1. calculate and analyze the work of the diesel cycle correctly 2. explain the diesel cycle correctly **Form of Assessment** : Participatory Activities	Lectures, discussions, questions and answers, exercises and assignments 3 X 50			5%
15	1. Understand the Brayton standard air cycle 2. Analyzing the ideal Brayton cycle in a turbine 3. Calculating the thermal efficiency of the Brayton cycle with regeneration	1. Students are able to understand the Brayton standard air cycle 2. Analyzing the ideal Brayton cycle in a turbine 3. Calculating the thermal efficiency of the Brayton cycle with regeneration	**Criteria:** 1. correctly explain the Brayton standard air cycle 2. Analyze the ideal Brayton cycle in a turbine correctly 3. Calculate the thermal efficiency of the Brayton cycle with proper regeneration **Form of Assessment** : Assessment of Project Results / Product Assessment, Practices / Performance	Lectures, discussions, questions and answers, exercises and assignments 6 X 50			15%

16	1. Understand the Brayton standard air cycle 2. Analyzing the ideal Brayton cycle in compressors 3. Calculating the thermal efficiency of the Brayton cycle with reheat and regeneration	1. Students are able to understand the Brayton standard air cycle 2. Analyzing the ideal Brayton cycle in compressors 3. Calculating the thermal efficiency of the Brayton cycle with reheat and regeneration	**Criteria:** 1. correctly explain the Brayton standard air cycle 2. Analyze the ideal Brayton cycle in a turbine correctly 3. Calculate the thermal efficiency of the Brayton cycle with correct reheat and regeneration **Form of Assessment** : Assessment of Project Results / Product Assessment, Practices / Performance	Lectures, discussions, questions and answers, exercises and assignments 6 X 50				15%

Evaluation Percentage Recap: Case Study

No	Evaluation	Percentage
1.	Participatory Activities	65%
2.	Project Results Assessment / Product Assessment	15%
3.	Practice / Performance	15%
4.	Test	5%
		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.