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

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
HEAT TRANSFER	8320302123		T=2	P=0	ECTS=3.18	6	July 17, 2024

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
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Learning model: Case Studies

Program Learning Outcomes (PLO)

PLO study program which is charged to the course

PLO-10	Have an understanding of mathematics and basic mechanical engineering

Program Objectives (PO)

PO - 1	Have a basic understanding of mechanical engineering

PLO-PO Matrix

P.O	PLO-10
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 discusses the concepts of heat transfer, basic laws of heat transfer and their applications in the field of mechanical engineering, conduction heat transfer, convection heat transfer, radiation heat transfer, and heat exchangers.

References

Main :

1. Cengel, Y.A. 1998. Heat Transfer : A Practical Aproach. New York : Mc. Graw-Hill.
2. Holman, J.P. 1994. Perpindahan Kalor, Edisi Keenam, Alih Bahasa Ir. E. Jasjfi, Msc, Erlangga, Jakarta: Penerbit Erlangga.
3. Incropera, Frank P. dan Dewitt, David P. 2011. Fundamental of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.
4. Modul Radiator Trainer.
5. Modul Oil Cooler Trainer.
6. Modul Wire and Tube Heat Exchanger.

Supporters:

Supporting lecturer: Prof. Dr. I Made Arsana, S.Pd., M.T.
Dr. Mohammad Effendy, S.T., 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	Students are able to recognize the phenomenon of heat transfer in the surrounding environment	1. Students can explain examples of heat transfer events in everyday life 2. Students are able to classify the types of heat transfer 3. Students can differentiate and analyze types of heat transfer 4. Convey ideas/questions	**Criteria:** 1. Completeness of the report on the results of the task of analyzing heat transfer phenomena in the surrounding environment 2. Student activity in the lecture process **Form of Assessment** : Participatory Activities	Lectures, observations, discussions, questions and answers, exercises, scientific learning, and 2 X 50 assignments		**Material:** Introduction to heat transfer **References:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.* **Material:** Introduction to heat transfer **Bibliography:** *Holman, JP 1994. Heat Transfer, Sixth Edition, Translated by Ir. E. Jasjfi, MSc, Erlangga, Jakarta: Erlangga Publishers.*	5%
2	Students are able to master the basic laws of heat transfer	1. Students can explain the three (3) basic laws of heat transfer and their interaction with energy. 2. Students are able to formulate precise heat transfer formulas for conduction, convection and radiation 3. Students are able to analyze and solve problems related to conduction, convection and radiation heat transfer 4. Students are able to write units, quantities and dimensions correctly 5. Convey ideas/questions	**Criteria:** 1. Completeness of the assignment report on the results of the analysis of the basic laws of heat transfer 2. Student activity in the lecture process **Form of Assessment** : Participatory Activities	Lectures, observations, discussions, questions and answers, exercises, scientific learning, and 2 X 50 assignments		**Material:** Introduction to heat transfer **References:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.* **Material:** Introduction to heat transfer **Bibliography:** *Holman, JP 1994. Heat Transfer, Sixth Edition, Translated by Ir. E. Jasjfi, MSc, Erlangga, Jakarta: Erlangga Publishers.*	5%
3	Students are able to understand the basics of conduction	1. Students can explain the conduction rate equation 2. Students are able to understand the thermal properties of materials 3. Students are able to write the heat diffusion equation correctly 4. Students are able to describe boundary and initial conditions 5. Convey ideas/questions	**Criteria:** 1. Student activity during lectures 2. Completeness of the report on the results of the basics of conduction analysis task **Form of Assessment** : Participatory Activities, Practice/Performance	Lectures, observations, discussions, questions and answers, practice, scientific learning, and 2 X 50 assignments		**Material:** Basics of conduction **References:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.*	5%

4	Students are able to understand 1D steady conduction heat transfer on a plane wall	1. Students can explain the phenomenon of 1-D steady state conduction heat transfer 2. Students are able to understand 1D heat transfer on a plane wall 3. Students are able to write the 1D heat transfer formula on a plane wall correctly 4. Students are able to describe the thermal circuit on a plane wall 5. Students can analyze the thermal resistance circuit on a plane wall either in series or parallel 6. Students are able to solve 1D heat transfer problems on plane walls 7. Students are able to understand conduction and heat generation on plane walls	**Criteria:** 1. Student activity during lectures 2. Completeness of the report on the results of the 1D heat transfer analysis task on the plane wall **Form of Assessment** : Participatory Activities, Tests	Lectures, observations, discussions, questions and answers, exercises, scientific learning, and 2 X 50 assignments		**Material:** 1D Conduction **References:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.* **Material:** 1D Conduction **Reference:** *Cengel, YA 1998. Heat Transfer: A Practical Approach. New York : Mc. Graw-Hill.*	5%
5	Students are able to understand 1D steady conduction heat transfer in radial systems	1. Students are able to understand 1D heat transfer in a radial system 2. Students are able to write the 1D heat transfer formula in a radial system correctly 3. Students are able to describe the thermal circuit in a radial system 4. Students can analyze thermal resistance circuits in radial systems either in series or parallel 5. Students are able to solve 1D heat transfer problems in radial systems	**Criteria:** 1. Student activity during lectures 2. Completeness of the report on the results of the 1D heat transfer analysis task in the radial system **Form of Assessment** : Participatory Activities, Tests	Lectures, observations, discussions, questions and answers, exercises, scientific learning, and 2 X 50 assignments		**Material:** 1D Conduction **References:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.* **Material:** 1D Conduction **Reference:** *Cengel, YA 1998. Heat Transfer: A Practical Approach. New York : Mc. Graw-Hill.*	5%

6	Students are able to understand heat transfer in fins	1. Students are able to understand the concept of heat transfer in fins 2. Students can find out the types of fins 3. Students are able to analyze heat transfer at the fin 4. Students can calculate fin efficiency and performance correctly	**Criteria:** 1. Student activity during lectures 2. Completeness of the report on the results of the heat transfer analysis task on the fins **Form of Assessment** : Participatory Activities	Lectures, observations, discussions, questions and answers, exercises, scientific learning, and 3 X 50 assignments		**Material:** Heat transfer in fins Reference **:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.* **Material:** Heat transfer in fins Reference **:** *Cengel, YA 1998. Heat Transfer: A Practical Approach. New York : Mc. Graw-Hill.*	5%
7	Able to understand 2D steady conduction	1. Students are able to understand the method of separating variables 2. Students are able to analyze conduction shape factors and non-dimensional conduction rates 3. Students are able to understand the finite difference method (FDM) 4. Students are able to understand graphic methods	**Criteria:** 1. Student activity during lectures 2. Completeness of the report on the results of the 2D steady conduction analysis task **Form of Assessment** : Participatory Activities	Lectures, observations, discussions, questions and answers, exercises, scientific learning, and 3 X 50 assignments		**Material:** 2D steady conduction **References:** *Holman, JP 1994. Heat Transfer, Sixth Edition, Translated by Ir. E. Jasjfi, MSc, Erlangga, Jakarta: Erlangga Publishers.* **Material:** 2D steady conduction **References:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.*	5%

8	UTS	Can answer questions/questions about heat transfer according to the heat transfer book	**Criteria:** Can work according to the answer key = 100, if you can answer 50% answer key j = 50, P = ex	Paper based test 3 X 50		**Material:** 1-7 **References:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.* **Material:** 1-7 **References:** *Cengel, YA 1998. Heat Transfer: A Practical Approach. New York : Mc. Graw-Hill.* **Material:** 1-7 **References:** *Holman, JP 1994. Heat Transfer, Sixth Edition, Translated by Ir. E. Jasjfi, MSc, Erlangga, Jakarta: Erlangga Publishers.*	15%
9	Students are able to understand transient conduction (1)	1. Students can understand the lumped capacitance method and when to apply it 2. Students can understand the concept of transient conduction in flat walls 3. Students can understand the concept of transient conduction in a radial system 4. Students can understand the concept of transient conduction in a semi-infinite solidus	**Criteria:** 1. Student activity during discussions 2. Completeness of the report on the results of analysis tasks regarding transient conduction (1) **Form of Assessment** : Participatory Activities	Lectures, observations, discussions, questions and answers, exercises, scientific learning, and 3 X 50 assignments		**Material:** Transient conduction **References:** *Holman, JP 1994. Heat Transfer, Sixth Edition, Translated by Ir. E. Jasjfi, MSc, Erlangga, Jakarta: Erlangga Publishers.* **Material:** Transient conduction **References:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.*	5%

10	Students are able to understand transient conduction (2)	1. Students can understand and analyze constant temperature surfaces 2. Students can understand and analyze constant heat flux surfaces 3. Students can understand the concept of periodic heating 4. Students can understand the concept of finite difference methods for transient conduction 5. Convey ideas/questions	**Criteria:** 1. Student activity during discussions 2. Completeness of the report on the results of analysis tasks regarding transient conduction (2) **Form of Assessment** : Participatory Activities	Lectures, observations, discussions, questions and answers, exercises, scientific learning, and 3 X 50 assignments		**Material:** Transient conduction **References:** *Holman, JP 1994. Heat Transfer, Sixth Edition, Translated by Ir. E. Jasjfi, MSc, Erlangga, Jakarta: Erlangga Publishers.* **Material:** Transient conduction **References:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.*	5%
11	Students are able to understand heat transfer by convection	1. Students understand the concept of convection heat transfer 2. Students are able to differentiate and analyze types of convection heat transfer 3. Students know the application of convection in the industrial world 4. Students are able to analyze problems related to convection and solve them using empirical equations correctly	**Criteria:** 1. Student activity during lectures 2. Completeness of the report on the results of the convection analysis task **Form of Assessment** : Participatory Activities	scientific learning 3 X 50		**Material:** **Library** Convection : *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.*	5%
12	Students are able to carry out forced convection experiments on a radiator trainer	Students are able to analyze the experimental results of variations in fluid temperature entering the radiator trainer and analyze the experimental results of variations in the type of radiator fluid in the radiator trainer	**Criteria:** Completeness of the report on the results of the practical assignment in the report format: Title, objectives, tools and materials, theoretical study, work safety, work steps, practicum results data, data analysis, conclusion **Form of Assessment** : Project Results Assessment / Product Assessment	scientific learning 3 X 50		**Material:** Radiator trainer practicum **Library:** *Radiator Trainer Module.*	18%
13	Students are able to carry out forced convection experiments on an oil cooler trainer	Students are able to analyze experimental results of fluid temperature variations in the oil cooler trainer.	**Criteria:** Complete report on the results of the oil cooler trainer analysis task with report format: Title, Objective, tools and materials, theoretical study, work safety, work steps, practicum data, data analysis, conclusion **Form of Assessment** : Project Results Assessment / Product Assessment	scientific learning 3 X 50		**Material:** Oil cooler practicum **Library:** *Oil Cooler Trainer Module.*	18%

14	Students are able to carry out free convection experiments on wire and tube heat exchangers.	Students are able to analyze the results of free convection experiments on wire and tube heat exchangers.	**Criteria:** Completeness of the report on the results of the free convection experimental analysis task on wire and tube heat exchangers with report format: Title, Objective, tools and materials, theoretical study, work safety, work steps, practicum data, data analysis, conclusion **Form of Assessment** : Project Results Assessment / Product Assessment	scientific learning 3 X 50		**Material:** Wire and tube trainer **Library:** *Wire and Tube Heat Exchanger Module.*	18%
15	Students study heat transfer material in published journals	Students can present material from reviews of published journals in the field of heat transfer	**Criteria:** 1.Presents 1, 2 journals according to indicators 2.Provide opinions or responses to the journals being reviewed regarding content and development ideas **Form of Assessment** : Participatory Activities	Reading, Discussion and Presentation 3 X 50		**Material:** m **References:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.*	5%
16	UAS			Close book		**Material:** 9-15 **References:** *Cengel, YA 1998. Heat Transfer: A Practical Approach. New York : Mc. Graw-Hill.* **Material:** 9-15 **References:** *Holman, JP 1994. Heat Transfer, Sixth Edition, Translated by Ir. E. Jasjfi, MSc, Erlangga, Jakarta: Erlangga Publishers.* **Material:** 9-15 **References:** *Incropera, Frank P. and Dewitt, David P. 2011. Fundamentals of Heat and Mass Transfer. 7th Edition. John Wiley & Sons, Inc.*	15%

Evaluation Percentage Recap: Case Study

No	Evaluation	Percentage
1.	Participatory Activities	47.5%
2.	Project Results Assessment / Product Assessment	54%
3.	Practice / Performance	2.5%
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** abilities in the process and student learning outcomes are specific and measurable statements that identify the abilities 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.