	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
Heat and Mass Transfer 2	2120102135		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)
	PLO-PO Matrix
	P.O
	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

Short Course Description	This course is an advanced aspect of heat transfer and its applications. The material discussed is heat transfer by forced convection, free convection, boiling and condensation, and heat exchangers with various applications and problems faced in everyday life.
References	**Main :**
	1. Incopera, P. Frank dkk. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS
	Supporters:
Supporting lecturer	Prof. Dr. I Made Arsana, S.Pd., M.T. Dr. Mohammad Effendy, S.T., M.T. Handini Novita Sari, 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	Able to understand the basic concepts of convection heat transfer	1. Be able to study the basics of convection boundary layers2. Able to differentiate between local and average convection coefficients3. Able to identify laminar and turbulent flow4. Be able to explain the boundary layer equation	**Form of Assessment** : Participatory Activities	1. Learning model: Problem Based Learning.2. Method: Discussion, question and answer, assignment.3. Approach: scientific.4. Explore information about the basics of 2 X 50 convection heat transfer		**Material:** basic concepts of convection heat transfer **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	0%
2	Students are able to master concepts, analyze and solve problems related to heat transfer by forced convection, free convection, boiling and condensation, and heat exchangers with various applications in daily life.	1. Be able to explain Boundary Layer Similarity: The Normalized Boundary Layer Equations. 2. Be able to explain the dimensionless number parameters of convection heat transfer. 3. Be able to explain the boundary layer analogy.		a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 X 50		**Material:** basic concepts of convection heat transfer **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	5%
3	Students are able to understand convection heat transfer in external flow	1. Able to explain empirical methods2. Able to calculate convection heat transfer in parallel flow on a flat plate 3. Able to practice the concept of convection calculation methodology 4. Able to calculate convection heat transfer in flow across a cylinder	**Form of Assessment** : Participatory Activities	a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 x 50		**Material:** Convection in external flows **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	0%
4	Students are able to understand convection heat transfer in external flow	1. Able to calculate heat transfer by convection in a spherical shape2. Able to analyze heat transfer by convection in the flow through the pipe arrangement3. Able to identify heat transfer through Impinging Jets 4. Able to identify heat transfer in Packed Beds	**Form of Assessment** : Participatory Activities	a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 X 50		**Material:** Convection in external flows **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	5%
5	Able to understand convection heat transfer in internal flow	1. Able to combine the relationship between hydrodynamics and thermal in deep flow convection 2. Able to analyze heat transfer using energy balance 3. Able to calculate heat transfer in pipes with laminar flow	**Form of Assessment** : Participatory Activities	- Hydrodymics - Thermal-energy balance - heat transfer in pipes with laminar flow 3 X 50		**Material:** Convection in internal flows **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	0%

6	Able to understand convection heat transfer in internal flow	1. Able to analyze convection heat transfer in turbulent flow in pipes2. Able to solve heat transfer problems in Noncircular Tubes and the Concentric Tube Annulus3. Able to analyze the increase in heat transfer in internal flow 4. Able to calculate flow in narrow channels 5. Able to analyze heat transfer convection mass transfer	**Form of Assessment** : Participatory Activities	a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 X 50		**Material:** Convection in internal flows **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	5%
7	Able to understand convection heat transfer in internal flow	1. Able to analyze convection heat transfer in turbulent flow in pipes2. Able to solve heat transfer problems in Noncircular Tubes and the Concentric Tube Annulus3. Able to analyze the increase in heat transfer in internal flow 4. Able to calculate flow in narrow channels 5. Able to analyze heat transfer convection mass transfer	**Form of Assessment** : Participatory Activities	a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 X 50		**Material:** Convection in internal flows **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	5%
8	UTS	Students are able to answer all questions correctly	**Form of Assessment** : Test	2 X 50		**Material:** Basics of convection, convection in internal and external flows. **Reference:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	15%
9	Able to understand free convection heat transfer	1. Be able to explain the basics of free convection heat transfer2. Be able to explain the basic equations for laminar boundary layers3. Able to explain similarity Considerations 4. Able to calculate laminar free convection heat transfer on vertical surfaces	**Form of Assessment** : Participatory Activities	a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 X 50		**Material:** free convection **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	5%
10	Able to understand free convection heat transfer	1. Be able to explain the effects of turbulence on free convection 2. Able to analyze free convection heat transfer in external flow 3. Able to calculate free convection heat transfer in flat plate channels 4. Able to explain empirical relationships in free convection 5. Able to identify combinations of free and forced convection	**Form of Assessment** : Participatory Activities	a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 X 50		**Material:** free convection **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	5%

11	Able to understand the theory of boiling and condensation	1. Be able to explain the dimensionless number parameters of boiling and condensation2. Able to explain pool boiling 3. Able to explain pool boiling correlations	**Form of Assessment** : Participatory Activities	a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 X 50		**Material:** Boiling and condensation **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	5%
12	Able to understand the theory of bioling and condensation	1. Be able to explain forced convection boiling2. Be able to explain the mechanism of condensation 3. Able to explain the condensation of laminar layers on a flat plate 4. Able to explain the condensation of turbulent layers on a flat plate	**Form of Assessment** : Participatory Activities	a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 X 50		**Material:** Boiling and condensation **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	5%
13	Able to understand the theory of bioling and condensation	1. Able to calculate the condensation layer on the radial system2. Able to calculate condensation on horizontal pipes 3. Able to calculate dropwise condensation	**Form of Assessment** : Participatory Activities	a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 X 50		**Material:** Boiling and condensation **References:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	5%
14	Able to understand heat exchangers and their types	1. Be able to explain the types of heat exchange devices 2. Able to calculate the Overall Heat Transfer Coefficient 3. Able to analyze heat exchange equipment using the Use of the Log Mean Temperature Difference method	**Form of Assessment** : Project Results Assessment / Product Assessment	a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 x 50			10%
15	Able to analyze APK problems and calculate APK performance from a case example	1. Able to analyze heat exchangers using The EffectivenessNTU Method 2. Able to correct the performance of heat exchangers	**Form of Assessment** : Project Results Assessment / Product Assessment	a. Approach: Scientific b. Model: Base Learning (Problem Based Learning) 3 x 50			15%
16	UAS	Students are able to answer all questions correctly	**Form of Assessment** : Test	2 x 50		**Material:** Heat exchanger **Reference:** *Incopera, P. Frank et al. 2011. Fundamentals of Heat and Mass Transfer. JOHN WILEY & SONS*	20%

Evaluation Percentage Recap: Case Study

No	Evaluation	Percentage
1.	Participatory Activities	40%
2.	Project Results Assessment / Product Assessment	25%
3.	Test	35%
		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.