Semester Lesson Plan

	UNIVERSITAS NEGERI SURABAYA **FACULTY OF MATHEMATICS AND NATURAL SCIENCES** **PHYSICS STUDY PROGRAM**	**Document Code**

SEMESTER LESSON PLAN

COURSE	CODE	DISCIPLINE	COURSE UNIT		SEMESTER	CREATED DATE
THERMODYNAMICS			**T=3**	**P=0**	3	30 November 2019

OTORISASI	Semester Learning Plan Developer	Course Classroom Coordinator	Head of the Study Program
	Lydia Rohmawati, M.Si	**Dr. Asnawi, M.Si**	**Prof. Dr. Munasir, M.Si.**

Program Learning Outcomes (PLO)	**PLO in the Course**	
	PLO-1	Able to demonstrate knowledge of Classical Physics and Modern Physics
	PLO-2	Able to formulate a physical systems as physical model by using mathematics
	PLO-3	Able to solve problems in physical systems comprehensively by using mathematics and computational tools.
	Course Learning Outcomes (CLO)	
	CLO1	Mastering structured studies on the concepts and laws of thermodynamics
	CLO2	Solve physics problems related to the concepts and laws of thermodynamics through a mathematical approach, either individually or in groups
	CLO3	Have a scientific attitude, critical thinking and innovative skills to qualitatively analyze problems or situations that involve the concepts and laws of thermodynamics
	CLO4	Able to work in groups in the discussion process related to the law of thermodynamics concepts that are being discussed during the lesson
	Sub-Course Learning Outcomes (Sub-CLO)	
	Sub-CLO1	After following the material on temperature and the zero law of thermodynamics, students can understand well knowledge of temperature and the zero law of thermodynamics, by assessing the results of the questions and answers with a minimum of 80% correct
	Sub-CLO2	After following the simple thermodynamic system lectures, students are able to formulate and formulate mathematical equations of several systems from thermodynamics independently or in groups with student assignment assessments with a success rate of 80%
	Sub-CLO3	Physics students can think critically and work scientifically for several work systems on thermodynamics correctly, after being given material about thermodynamic work with an assessment in the form of a task with an understanding level of 80%
	Sub-CLO4	After following heat material and the first law of thermodynamics, students can innovate in research and formulate mathematically from heat material and the first law of thermodynamics with an assessment with a success rate of 80%

	Sub-CLO5	After attending a thermodynamic lecture with ideal gas material, students can describe the characteristics of the ideal gas with its mathematical equation, with a minimum 80% correct assessment of the assignment at the end of the lecture.
	Sub-CLO6	After attending thermodynamics lectures with the second law material of thermodynamics, 3rd-semester students majoring in physics can formulate and describe the mathematical formulation of the 2nd law of thermodynamics skillfully and correctly with a group assignment assessment with the short processing time
	Sub-CLO7	3rd-semester students majoring in physics will be able to innovate in research related to the Carnot cycle and the thermodynamic temperature scale correctly, after following the presentation of thermodynamics course material with an observation level of 80% correct
	Sub-CLO8	After learning entropy material, students can formulate mathematical equations of the thermodynamic entropy system, with a quiz assessment value of at least 80% correct
A Short Course Description	The thermodynamics course discusses the concepts/principles/theories / basic laws of thermodynamics (physics content knowledge) which underlies thermodynamic study materials in-depth covering temperature and the zero law of thermodynamics, some simple thermodynamic systems, work, heat, and the first law of thermodynamics, ideal gas, the second law of thermodynamics, Carnot cycle and thermodynamic temperature scale, and entropy, and able to communicate scientifically and work effectively both independently and in groups, with assessment in the form of assignments, mid test and final exam.	
Learning Materials	**1. Temperature and the Zero Law of Thermodynamics** **2. Some Simple Thermodynamic Systems** **3. Work** **4. Heat and the First Law of Thermodynamics** **5. Ideal gas** **6. Second Law of Thermodynamics** **7. Carnot Cycle and Thermodynamic Temperature Scale** 8. **Entropy**	
References	**Main references :**	
	1. Mark W. Zemansky and Richard H.Dittman. 1997. Heat and Thermodynamics, Seventh Edition, McGraw- Hill,Companies, Inc	
	Supported references :	
	2. Darmawan B. 1990. Termodinamika. Jurusan Fisika FMIPA-ITB 3. Yunus A.Cengel and Michael Boles.1994.*Thermodynamics An Engineering Approach*, Second Edition, McGraw-Hill,Inc	
Lecturers	Dra. Suliyanah, M.Si Dr. Frida Ulfah Ermawati, M.Sc Dr. Asnawi, M.Si Lydia Rohmawati, M.Si	
Requirements course	Basic Physics 1	

Week-	**Course Learning Outcomes (Sub-CLO)**	**Assessment**		**Learning Forms, Learning methods, Student Assignment, [Estimated time]**		**Learning materials [References]**	**The weight of assessment (%) Indicator**
		Indicator	**Criteria&Form**	**offline**	**online**		

(1)	(2)	(3)	(4)	(5)	(6)	(2)	(3)
1-2	After following the material on temperature and the zero law of thermodynamics, students can understand well knowledge of temperature and the zero law of thermodynamics, by assessing the results of the questions and answers with a minimum of 80% correct	▪ Explaining Macroscopic and Microscopic Views ▪ Thermodynamics Scope ▪ Zero Law of Thermodynamics and Thermal Equilibrium ▪ The concept of temperature ▪ Thermometer and Temperature Measurement ▪ Comparison of Multiple Thermometers ▪ Ideal Gas Temperature ▪ Multiple Thermometer Scales	▪ Criteria: Quantitative ▪ Form: Test & Non-test	▪ Form of Learning: Lecture ▪ Method Learning: Question and answer, discussion, and presentation ▪ Student Assignment: Assigning individual and group assignments [6 x 50 Minutes]		Temperature and the Zero Law of Thermodynamics [1,2]	Sub-CLO1: 5%

3	After following the simple thermodynamic system lectures, students are able to formulate and formulate mathematical equations of several systems from thermodynamics independently or in groups with student assignment assessments with a success rate of 80%	▪ Thermodynamic equilibrium ▪ Equation of Circumstances ▪ Hydrostatic System ▪ Mathematical Theorems ▪ Stretched Wire ▪ Thin membrane surface ▪ Electrochemical cells ▪ Dielectric Coating ▪ Paramagnetic Stems ▪ Intensive and Extensive Coordinates	▪ Criteria: Quantitative ▪ Form: Test & Non-test	▪ Form of Learning: Lecture ▪ Method Learning: Question and answer, discussion, and presentation ▪ Student Assignment: Assigning individual and group assignments [3 x 50 Minutes]		Several Simple Thermodynamic Systems [1,2]	sub-CLO2: 5%
4-5	Physics students can think critically and work scientifically for several work systems on thermodynamics correctly, after being given material about thermodynamic work with an assessment in the form of a task with an understanding level of 80%	▪ Work ▪ Kuasistatic process ▪ Work on Hydrostatic Systems ▪ P-V diagram ▪ Work in a path dependent hydrostatic system ▪ Calculating $\int p\, dV$ for the Polasistatic Process ▪ Work on changes in wire length, changes in surface area of films, transfer of charge in electrochemical cells, changes in total polarization in dielectric solids,	▪ Criteria: Quantitative ▪ Form: Test & Non-test	▪ Form of Learning: Lecture ▪ Method Learning: Question and answer, discussion, and presentation ▪ Student Assignment: Assigning individual and group assignments [6 x 50 Minutes]		Work [1,2]	sub-CLO3: 5%

		changes in total magnetization in paramagnetic solids ▪ General Work ▪ Alloy System					
6-7	After following heat material and the first law of thermodynamics, students can innovate in research and formulate mathematically from heat material and the first law of thermodynamics with an assessment with a success rate of 80%	▪ Work and Heat ▪ Adiabatic work ▪ Inner-Energy Function ▪ Mathematical Formulation of the First Law of Thermodynamics ▪ The concept of heat ▪ Differential Forms of the First Law of Thermodynamics ▪ Heat Capacity and Measurements ▪ Specific Calories of Water: Calories ▪ Hydrostatic System Equations ▪ Cuasistatic Flow of Heat; Heat Reservoir ▪ Heat Conduction ▪ Thermal Conductivity and Measurements ▪ Heat Convection ▪ Thermal radiation; Black thing ▪ Kirchhoff's law; Radiation Heat ▪ Stephen's Law Boltzmann	▪ Criteria: Quantitative ▪ Form: Test & Non-test	▪ Form of Learning: Lecture ▪ Method Learning: Question and answer, discussion, and presentation ▪ Student Assignment: Assigning individual and group assignments [6 x 50 Minutes]		Heat and the First Law of Thermodynamics [1,2]	sub-CLO4: 5%
8	**Mid Test**						***UTS*** sub-CLO1: 5% ; sub-CLO2: 5% ; sub-CLO3: 5% ; sub-CLO4: 5%

9-10	After attending a thermodynamic lecture with ideal gas material, students can describe the characteristics of the ideal gas with its mathematical equation, with a minimum 80% correct assessment of the assignment at the end of the lecture.	▪ Equations for Ideal Gas Conditions ▪ Energy-In Real Gas ▪ Ideal gas ▪ Experiments to determine heat capacity ▪ The quasistatic Adiabatic Process ▪ Measurement γ Dengzn Ruchhardt Method ▪ Longitudinal Wave Velocity ▪ Microscopic view ▪ Ideal Gas Kinetic Theory	▪ Criteria: Quantitative ▪ Form: Test & Non-test	▪ Form of Learning: Lecture ▪ Method Learning: Question and answer, discussion, and presentation ▪ Student Assignment: Assigning individual and group assignments [6 x 50 Minutes]		Ideal Gas Law [1,2]	sub-CLO5: 20%
11-12	After attending thermodynamics lectures with the second law of thermodynamics, 3rd-semester students majoring in physics can formulate and describe the mathematical formulation of the 2nd law of thermodynamics skillfully and correctly with a group assignment assessment with the short processing time	▪ Convert Work into Heat And Vice versa ▪ Gasoline Engine, Diesel Engine, Steam Engine, Stirling Engine ▪ Heat engine; Kelvin-Planck Statement of the Second Law of Thermodynamics ▪ Refrigerator; Clausius's Statement of the Second Law of Thermodynamics ▪ The equivalence of the Kelvin-Planck and Clausius Statements ▪ Inversion and Irreversibility ▪ External and Internal Mechanical Inversibility ▪ External and Internal Thermal Inversibility	▪ Criteria: Quantitative ▪ Form: Test & Non-test	▪ Form of Learning: Lecture ▪ Method Learning: Question and answer, discussion, and presentation ▪ Student Assignment: Assigning individual and group assignments [6 x 50 Minutes]		2nd law of thermodynamics [1,2]	sub-CLO6: 20%

		▪ Chemical Irreversibility ▪ Multiple State of Reversibility					
13-14	3rd-semester students majoring in physics will be able to innovate in research related to the Carnot cycle and the thermodynamic temperature scale correctly, after following the presentation of thermodynamics course material with an observation level of 80% correct	▪ Carnot Cycle ▪ Some Examples of Carnot Cycles ▪ Carnot Refrigerator ▪ Carnot and Collorary Theorem ▪ Thermodynamic Regulated Scale ▪ Absolute Zero and Carnot Efficiency ▪ Ideal Gas Equality and Thermodynamic Temperature	▪ Criteria: Quantitative ▪ Form: Test & Non-test	▪ Form of Learning: Lecture ▪ Method Learning: Question and answer, discussion, and presentation ▪ Student Assignment: Assigning individual and group assignments [6 x 50 Minutes]		the Carnot cycle and the thermodynamic temperature scale [1,2]	sub-CLO7: 20%
15	After learning entropy material, students can formulate mathematical equations of the thermodynamic entropy system, with a quiz assessment value of at least 80% correct	▪ Entropy ▪ The Caratheodory Principle ▪ Ideal Gas Entropy ▪ TS diagram ▪ Entropy and Inverse ▪ Entropy and Irreversibility ▪ Heat and Entropy in reverse processes ▪ Entropy and the State of Equilibrium ▪ The Principle of Entropy Increase ▪ Application of the Entropy Principle ▪ Entropy and Disorder ▪ Exact Differentials	▪ Criteria: Quantitative ▪ Form: Test & Non-test	▪ Form of Learning: Lecture ▪ Method Learning: Question and answer, discussion, and presentation ▪ Student Assignment: Assigning individual and group assignments [3 x 50 Minutes]		Entropy [1,2]	sub-CLO8: 20%
16	**Final Exam**						***UAS***

		sub-CLO5: 20% ; sub-CLO6: 20% ; sub-CLO7: 20% ; sub-CLO8: 20%