



MODULE HAND BOOK

MECHANICAL ENGINEERING VOCATIONAL EDUCATION STUDY PROGRAM

FACULTY OF ENGINEERING – UNIVERSITAS NEGERI PADANG

COURSE NAME	CODE	Course classification	CU		Sem	Version
			Theory	Pract		
Thermodynamics	MES1.61.3102	Study program compulsory course/ MEVE core course	2	0	3	1
Responsible	Dr. Remon Lapis, M.T., M.Sc dan Andre Kurniawan., S.T.,M,T			Signature		
INFORMATION	Dean		Head of Department		Coordinator of study program	
	<u>Dr. Fahmi Rizal, M.Pd., M.T</u> NIP. 195912041985031004		<u>Drs. Purwantono, M.Pd</u> NIP. 196308041986031002		<u>Drs. Purwantono, M.Pd</u> NIP. 196308041986031002	
Program Learning Outcome	Program learning outcome of Mechanical engineering vocational education:					
	<ol style="list-style-type: none"> 1. Possess a good ability to apply the basic science (mathematics and natural sciences) and other disciplines in profesional jobs / projects (Knowledge-understanding) <ol style="list-style-type: none"> 1.1. possess a good understanding and can apply the basic concept of mathematics to solve various technical problems 1.2. possess a good understanding and can apply basic the concept of physic to solve various technical problems 1.3. possess a good understanding and can apply basic the concept of chemistry to solve various technical problems 2. Possess a critical and creative thingking in identifying, formulating, problem solving and evaluating various problems in mechanical engineering using the most appropriate and effective scientific method (<i>Engineering analysis, investigations and assessment</i>): <ol style="list-style-type: none"> 2.1. problem identification skills 					

- 2.2. problem analysis skills
- 2.3. problem evaluation skills
- 3. Possess a good ability in designing, manufacturing and operating machines (**Engineering design**)
 - 3.1. able to formulate ideas/concepts into a technical drawing, design and budget plans
 - 3.2. able to operate various machines and other engineering equipment with the correct standard operating procedure
 - 3.3. able to design a machine or machinery system based on a valid scientific theory
 - 3.4. able to realize a concept/design into a prototype, manufacturing process and engineering system
- 4. Possess a good ability to design, organize and evaluate the education and learning process in *mechanical engineering vocational education*. (**Education design**)
 - 4.1. able to design curriculum and learning process by considering various aspects
 - 4.2. able to organize, control, evaluate and improve the quality of the learning process
 - 4.3. able to develop an interesting, effective and efficient learning medias
- 5. Possess a good ability to adapt to development in science and technology and apply it into professional jobs by considering any non-technical aspects. (**Engineering practice**)
 - 5.1. able to innovate and develop technology in the field of mechanical engineering by considering social, economic and environmental aspects
 - 5.2. able to carry out the optimization process and increase the efficiency of machines or machining system.
 - 5.3. able to improve the performance of machine/ machinery system by applying the information technology
- 6. Possess a good softskil and spirit of lifelong learning (**Transferable skill / softskill**)
 - 6.1. possess a religious character
 - 6.2. possess a spirit of nasionalisme, social sensitivity and environmental consevation orientation
 - 6.3. possess the ability to communicate effectively and work together in teamwork
 - 6.4. possess the ability to transfer science and technology to society to improve the quality of life
 - 6.5. possess a good characters of entrepreneur

Course learning outcomes	Course learning outcomes	
	CLO	PLO
	1. Understand the basic concepts of thermodynamics such as: systems and system boundaries, pure substances and their characteristics, states, equilibrium, processes, cycles, the first law of thermodynamics, the second law of thermodynamics, entropy and enthalpy etc	1.1, 1.2, 1.3, 2.1, 2.2, 2.3

	2. Understand the basic concepts and relationships between energy, heat and work and their applications in mechanical engineering	1.2, 1.3, 2.1, 2.2, 2.3
	3. Understand the basic concepts and power analysis of various power cycles (Carnot, Otto, Diesel, etc.) and coolant cycles and their applications in mechanical engineering	1.2, 1.3, 2.1, 2.2, 2.3
	4. Understand the basic concepts of reactions and thermo-chemical balance in the combustion process and the formation of materials (fuels, gas mixtures, etc.)	1.2, 1.3, 2.1, 2.2, 2.3
	5. able to investigate, formulate, analyze and apply various problems in the field of thermodynamics.	1.2, 1.3, 2.1, 2.2, 2.3
Course description	This course provides basic knowledge of thermodynamics which is the basis for the field of mechanical engineering and machinery systems, including: system concepts and system boundaries, pure substances and their characteristics, conditions, equilibrium, processes, thermo-chemical reactions, various types of cycles, the first law of thermodynamics, the second law of thermodynamics, entropy, enthalpy, the relationship between heat-energy and work, and their applications in mechanical engineering.	
References	Main Reference (RU) :	
	1. Yunus A Cengel, “ <i>Thermodynamics: an engineering approach</i> ”, Edisi ke-2, Mc.Graw-Hills, 2014	
	2. J.P Holmann, “ <i>Thermodynamics</i> ”, McGraww-Hill International Book	
	Additional References (RP)	
	1. Bernard Challen et al, , “ <i>Diesel Engine</i> ”, Edisi 2 Butterworth Heinemann, 1999	
	2. Sungkono. D, “ <i>Motor Bakar Torak</i> ”, ITS Press, 2011	
Learning media	Software:	Hardware:
		Computer, LCD Projector and whiteboards and other devices
Teaching team		
Assessment	Mid Test, Final Test, Individual task & team, group discussion and presentation	
Prerequisite courses	No	

Course subjects

Week	Expected competencies	Topics	Method and strategy for learning	Assignment	Criterion / Assessment indicator	References
(1)	CLO-1: [PLO: 1.1-2,2.1-3] Students are able to explain the basic concepts of	Introduction of thermodynamics: The concept of thermodynamics and energy, units in	Subject explanation [1x80'] Question-answer [1x10'] Discussion [1x10']	Students make a summary and description of the presented topics in the resume book	Be able to explain the concepts of thermodynamics and energy, units in thermodynamics,	RU-1

Week	Expected competencies	Topics	Method and strategy for learning	Assignment	Criterion / Assessment indicator	References
	thermodynamics.	thermodynamics, systems and conditions, temperature, pressure			systems and conditions, temperature, pressure. <i>Score: 7%</i>	
(2)	CLO-2: [PLO: 1.1-2,2.1-3] Students are able to explain the concept of energy, energy transfer and energy analysis (energy transfer and energy analysis)	Classification of energy (mechanical, heat, work), the first law of thermodynamics, energy conversion efficiency, energy and the environment	Review previous subject [5'] Subject explanation [1x75'] Question-answer [1x10'] Group discussion on the application of energy in a machine [1x10']	<ul style="list-style-type: none"> students make a summary and description of the material presented in the resume book students discuss in groups about the application of energy in a machine 	Able to explain forms of energy (mechanical, heat, work), the first law of thermodynamics, energy conversion efficiency, energy and the environment. <i>Score: 7%</i>	RU-1 and RU-2
(3)	CLO-1: [PLO: 1.1-2,2.1-3] Students are able to explain the properties of pure substances	Definition and characteristics of pure substances, phases, property diagrams and phase changes, property tables, ideal gases	Review previous subject [15'] Subject explanation [1x90'] Question-answer [1x15'] Assignment [1x30']	<ul style="list-style-type: none"> students make a summary and description of the material presented in the resume book students do the individual task 	Able to explain definitions and characteristics of pure substances, phases, property diagrams and phase changes, property tables, ideal gases <i>Score : 7%</i>	RU-1 and RU-2
(4)	CLO-2: [PLO: 1.1-2,2.1-3] Students are able to explain energy analysis in closed systems (energy analysis of closed systems)	Thermodynamic cycle in closed system energy balance, specific heat, internal energy, enthalpy for gases, fluids and solids	Review previous subject [15'] Subject explanation [1x90'] Question-answer [1x15'] Assignment [1x30']	<ul style="list-style-type: none"> students make a summary and description of the material presented in the resume book students do the individual task 	Able to explain the energy balance in a closed system, specific heat, internal energy, enthalpy for gases, fluids and solids <i>Score : 8%</i>	RU-1 and RU-2
(5)	CLO-2: [PLO: 1.1-2,2.1-3]	Conservation of mass laws, mass balance in steady	Review previous subject [15']	<ul style="list-style-type: none"> students make a summary and 	Able to explain the law of conservation of	RU-1 and RU-2

Week	Expected competencies	Topics	Method and strategy for learning	Assignment	Criterion / Assessment indicator	References
	Students are able to explain energy and mass analysis in open systems (energy analysis of control volume)	flow, work and energy in moving fluids, energy analysis in steady flow, turbine-compressors, heat exchangers	Subject explanation [1x90'] Question-answer [1x15'] Assignment [1x30']	description of the material presented in the resume book • students do the individual task	mass, mass balance in steady flow, work and energy in moving fluids, energy analysis in steady flow, turbine-compressors, heat exchangers. <i>Score : 8 %</i>	
(6)	CLO-1: [PLO: 1.1-2,2.1-3] Students are able to explain the basic concepts of the second law of thermodynamics (the second law of thermodynamics)	The basic concept of the second law of thermodynamics, thermal reservoirs, heat engines, refrigerator-heat pumps, reversible-irreversible processes, cycles and carnot engines	Review previous subject [15'] Subject explanation [1x90'] Question-answer [1x15'] Assignment [1x30']	• students make a summary and description of the material presented in the resume book	Able to explain the basic concepts of the second law of thermodynamics, thermal reservoirs, heat engines, refrigerator-heat pumps, reversible-irreversible processes, cycle and carnot engines. <i>Score: 7%</i>	RU-1 and RU-2
(7)	CLO-4: [PLO: 1.1-2,2.1-3] Students are able to explain the basic concept of entropy (concept of entropy)	The concept of entropy, isentropic processes, diagrams of properties involving entropy, entropy balances	Subject explanation [1x90'] Question-answer [1x20'] Resume scientific articles [1x40']	• students make a summary and description of the material presented in the resume book • Resume scientific articles	Able to explain the concept of entropy, isentropic processes, nature diagrams involving entropy, entropy balance <i>Score : 7%</i>	RU-1 and RU-2
(8)	Mid Test (UTS)					
(9)	CLO-3: [PLO: 1.1-2,2.1-3] Students are able to	Basics of power cycle analysis, carnot cycle, Otto cycle, Diesel Cycle	Subject explanation [1x60'] Discussion and Group discussion [1x60']	• students make a summary and description of the	able to explain the basics of power cycle analysis, carnot cycle,	RU-1 and RU-2 RP-1 and

Week	Expected competencies	Topics	Method and strategy for learning	Assignment	Criterion / Assessment indicator	References
	explain the basic concepts of steam power cycle-I (gas power cycle-I)		Question-answer [1x30']	material presented in the resume book <ul style="list-style-type: none"> Group discussions and presentations: types and characteristics of various cycles with reference to various scientific articles 	Otto cycle, Diesel cycle <i>Score : 7%</i>	RP-2
(10)	CLO-3: [PLO: 1.1-2,2.1-3] Students are able to explain the basic concepts of steam power cycle-II (gas power cycle-II)	Strirling Cycle, Brayton Cycle, Brayton Cycle with regeneration, intercooling, jet propulsion cycle, Turbojet engine	Subject explanation [1x60'] Discussion and Group discussion [1x60'] Question-answer [1x30']	<ul style="list-style-type: none"> tudents make a summary and description of the material presented in the resume book Group discussions and presentations: types and characteristics of various cycles with reference to various scientific articles 	Able to explain Stirling Cycle, Brayton Cycle, Brayton Cycle with regenerator, intercooling, jet propulsion cycle, turbojet engine <i>Score: 7%</i>	RU-1 and RU-2 RP-1 and RP-2
(11)	CLO-3: [PLO: 1.1-2,2.1-3] Students are able to understand the basic concepts of refrigeration cycles.	Cooling cycle and heat pump, reverse carnot cycle, analysis of the second law of the cooling cycle, selection of refrigerants, heat pumps syste	Review previous subject [3x5' = 15'] Subject explanation [1x90'] Question-answer [1x15'] Group assignment to explain the concept of cooling cycle [1x30']	<ul style="list-style-type: none"> students make a summary and description of the material presented in the resume book Assignment: identify pump utilization in the surrounding environmentMembu at ringkasan dan diskripsi tentang 	Understand the types of pumps, their characteristics and utilization <i>Score: 7%</i>	RU-1 and RU-2 RP-1

Week	Expected competencies	Topics	Method and strategy for learning	Assignment	Criterion / Assessment indicator	References
				materi yang disampaikan dalam buku resume		
(12)	CLO-4: [PLO: 1.1-2,2.1-3] Students are able to understand the basic concepts and analysis of gas mixtures	Gas mixture composition, P-V-T chart for gas mixtures, properties of gas mixtures	Review previous subject [3x5' = 15'] Subject explanation [1x105'] Question answer [1x30']	<ul style="list-style-type: none"> students make a summary and description of the material presented in the resume book 	understand gas mixture composition, P-V-T chart for gas mixtures, properties of gas mixtures <i>Score: 7%</i>	RU-1 and RU-2
(13)	CLO-4: [PLO: 1.1-2,2.1-3] Mahasiswa mampu memahami konsep dasar reaksi kimia termodinamika-1 (chemical reaction-1)	Fuel and combustion, theoretical and actual combustion processes, enthalpy formation and combustion	Review materi oleh mahasiswa [3x5' = 15'] Penjelasan materi [1x105'] Diskusi dan tanya jawab [1x30']	<ul style="list-style-type: none"> students make a summary and description of the material presented in the resume book 	Fuel and combustion, theoretical and actual combustion processes, enthalpy formation and combustion <i>Score: 7%</i>	RU-1 dan RU-2 RP-1
(14)	CLO-4, 5: [PLO: 1.1-2,2.1-3, 6.3] Students are able to understand the basic concepts of thermodynamic chemical reactions-2 (chemical reaction-2)	Analysis of law I of thermodynamic reaction systems, adiabatic flame temperature, changes in entropy of change systems, law 2 of reaction system analysis, criteria for chemical equation reactions, phase equilibrium,	Group presentation [1x120'] Question answer [1x20'] Conclusion [1x10']	<ul style="list-style-type: none"> Preparing group presentation material on non-conventional energy (4 groups) Group discussion on renewable energy technologies 	Able to analyze first law of thermodynamic reaction systems, adiabatic flame temperature, changes in entropy of change systems, law 2 of reaction system analysis, chemical equation reaction criteria, equilibrium phase <i>Score: 7%</i>	RU-1 and RU-2
(15)	CLO-2, 4, 5: [PLO: 1.1-2,2.1-3, 6.3]	Stagnation properties, sound velocity and number	Group presentation [1x120']	<ul style="list-style-type: none"> Preparing group presentation 	Able to explain the nature of stagnation,	RU-1 and RU-2

Scoring and grading system

Score	Quality	Quality score	Designation	Score	Quality	Quality score	Designation
85 – 100	A	4.0	Outstanding	55 – 59	C	2.0	Acceptable
80 – 84	A-	3.6	Excellent	50 – 54	C-	1.6	Poor
75 – 79	B+	3.3	Very good	40 – 49	D	1.0	Poor
70 – 74	B	3.0	Good	≤ 39	E	0.0	Fail
65 – 69	B-	2.6	Good	-	T	-	Tertunda
60 – 64	C+	2.3	Acceptable				

