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

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Selection and Use of Electric Motors	8320102085		**T=2**	**P=0**	**ECTS=3.18**	4	July 18, 2024

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
	Prof. Dr. Joko, M.Pd. MT. dan Prof. Dr. Ismet Basuki, M.Pd.	.....	Dr. Nur Kholis, S.T., M.T.

Learning model	**Case Studies**	
Program Learning Outcomes (PLO)	**PLO study program that is charged to the course**	
	PLO-1	Able to demonstrate religious, national and cultural values, as well as academic ethics in carrying out their duties
	PLO-2	Demonstrate the character of being tough, collaborative, adaptive, innovative, inclusive, lifelong learning and entrepreneurial spirit
	PLO-3	Develop logical, critical, systematic and creative thinking in carrying out specific work in their field of expertise and in accordance with work competency standards in the field concerned
	PLO-4	Develop yourself continuously and collaborate.
	PLO-8	Have extensive knowledge in the fields of general knowledge, social and humanities (General).
	PLO-11	Have extensive knowledge in the fields of mathematics, science and electrical engineering so that you can solve complex problems typical of electrical engineering and electronics engineering skills programs by following the rules of scientific writing (SSC2.2).
	PLO-13	Able to design circuits, devices and products in the electrical and electronics engineering expertise program (SSC3.1).
	Program Objectives (PO)	
	PO - 1	Able to analyze, evaluate, and conclude electric motor loads according to their characteristics (basic selection, load type, basic equations of drive system, load torque, load moment of inertia, load torque vs speed curve, speed vs time curve, and motor working environment)
	PO - 2	Able to analyze, evaluate and conclude the characteristics of electric motors (power/voltage rating, temperature rise, insulation class, classes of duty, motor type, DC-AC motor characteristics, electric motor load)
	PO - 3	Able to carry out analysis, evaluation and selection of starting and braking of electric motors (understanding and objectives of starting and braking of electric motors, automatic DC motor starting and polyphase induction motor starting, induction motor starting with other methods, synchronous motor starting, DC electric motor braking and electric braking induction motor)
	PO - 4	Able to analyze, evaluate and select electric motor rotation speed settings (methods of regulating the rotation speed of electric motors, regulating the rotation speed of DC motors working in parallel, short-circuiting series-shunt DC motors, regulating the rotation speed of cage-wound rotor induction motors)
	PO - 5	MIDTERM EXAM
	PO - 6	Able to analyze, evaluate and select DC motor control hardware (type of hardware, thyristor circuit, DC motor speed regulation, thyristor controlled by a rectifier converter, thyristor introduced by a converter, wave rectifier, phase control inverter, regenerative phase control, separate control cycle, chopper control, and 1DC motor position control)
	PO - 7	Able to analyze, evaluate and select solid state motor control-induction motor rotation speed (inverter method, frequency inverter control, thyrister voltage control, harmonic elimination, select 3 phase inverter, control inverter circuit, Cycloconverter phase controller, Cyclonverter frequency and voltage controller, regulation of rotation speed of induction motors, regenerative braking, steering of cage rotor and winding rotor induction motors)
	PO - 8	Choosing an electric motor economically for the needs of driving commercial production machines
	PO - 9	Designing commercial production machine drive systems (yarn spinning machines, bread kneading machines, fresh drink mixing machines, and electric vehicle propulsion machines)
	PLO-PO Matrix	

P.O	PLO-1	PLO-2	PLO-3	PLO-4	PLO-8	PLO-11	PLO-13
PO-1	✔			✔	✔	✔	
PO-2	✔			✔	✔	✔	
PO-3	✔			✔	✔	✔	
PO-4	✔			✔	✔	✔	
PO-5	✔			✔	✔	✔	
PO-6	✔			✔	✔	✔	
PO-7	✔			✔	✔		
PO-8	✔			✔	✔	✔	
PO-9	✔			✔	✔	✔	✔

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	✔	✔														
PO-2			✔	✔												
PO-3					✔	✔										
PO-4							✔									
PO-5																
PO-6								✔	✔	✔						
PO-7											✔					
PO-8												✔				
PO-9													✔	✔	✔	✔

Short Course Description	Analyze, evaluate, select and use electric motors according to daily needs, including electric motor load characteristics and electric motor characteristics, starting and braking of electric motors, regulation of electric motor rotation speed, DC motor control hardware, solid state motor control- induction motor speed, choosing motors for industry, and choosing economical electric motors. Apart from that, he is able to design drive systems for 2-wheeled electric vehicles, 4-wheeled electric vehicles, as well as design drive systems for production machines in the bakery and fresh drink industries, and design drive systems for yarn spinning production machines.

References

Main :

1. Austin Hughes, 2006. Electric Motors and Drivess. Foundamentals, Types, And Apilcations. Third Edition. Published by Elsevier Ltd. All rights reserved.
2. Fang Qi, Daniel Scharfenstein, Claude Weis, 2019. Motor Handbook. Institute for Power Electronics and Electrical Drives. RWTH Aachen University
3. Joko, 2015. Mesin Arus Searah. University Press Universitas Negeri Surabaya
4. Joko, 2018. Mesin Arus Bolak Balik. Surabaya: University Press Universitas Negeri Surabaya
5. Joko, 2024. Pengaturan dan Penggunaan Motor Listrik. Bahan Ajar Prodi S1 Pendidikan Teknik Elektro
6. Joko, 2019. Pemeliharaan dan Perbaikan Mesin Listrik. University Press Universitas Negeri Surabaya

Supporters:

1. Baharuddin, Deny HaryantoS., Olnes Y.H., 2021. Penggunaan dan pengaturan motor listrik. CV Pena Persada, Purwokerto.
2. https://perpustakaan.poltektegal.ac.id/index.php?p=fstream-pdf&fid=23350&bid=4209070
3. https://repository.unej.ac.id/bitstream/handle/123456789/11935/Skripsi.pdf?sequence=1
4. https://repository.its.ac.id/1463/1/2112039028%262112039035-non%20degree%20thesis.pdf
5. https://proceeding.unpkediri.ac.id/index.php/inotek/article/download/2490/1553/8546
6. https://repository.its.ac.id/104655/1/10211910000023-Project_Report.pdf
7. https://repository.its.ac.id/81327/1/08311640000084_Undergraduate_Thesis.pdf
8. https://publication.petra.ac.id/index.php/teknik-mesin/article/download/6954/6364

Supporting lecturer	Prof. Dr. Ismet Basuki, M.Pd. Prof. Dr. Joko, M.Pd., M.T. Dr. Ir. Achmad Imam Agung, M.Pd. Fendi Achmad, S.Pd., M.Pd.

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 analyze, evaluate and conclude the load characteristics of electric motors	Tracing sources of information, conducting analysis and evaluation, conducting group and class discussions, concluding the load characteristics of electric motors, and being participatory	**Criteria:** 1.Accuracy of information sources, max score 15 2.Accuracy of group and classical discussions, max score 10 3.Accuracy of analysis, max score 5 4.Accuracy of evaluation, max score 5 5.Conclusion accuracy, max score 15 6.Participative, min score 50 **Form of Assessment** : Participatory Activities	Lecturer's short presentation about the load characteristics of electric motors; tracing sources of information, conducting analysis and evaluation, group discussions followed by classical discussions; conclude as a bill, and reflect 2 X 50		**Material:** Load Characteristics of Electric Motors **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program* **Material:** Electric Motor Load Characteristics **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved.*	5%

2	Able to analyze, evaluate and conclude the load characteristics of electric motors	Tracing sources of information, conducting analysis and evaluation, conducting group and class discussions, concluding the load characteristics of electric motors, and being participatory	**Criteria:** 1.Accuracy of information sources, max score 15 2.Accuracy of group and classical discussions, max score 10 3.Accuracy of analysis, max score 5 4.Accuracy of evaluation, max score 5 5.Conclusion accuracy, max score 15 6.Participative, min score 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lecturer's short presentation about the load characteristics of electric motors; tracing sources of information, conducting analysis and evaluation, group discussions followed by classical discussions; conclude as a bill, and reflect 2 X 50		**Material:** Load Characteristics of Electric Motors **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program* **Material:** Electric Motor Load Characteristics **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved.*	5%
3	Able to analyze, evaluate and conclude the characteristics of electric motors	Searching for sources of information, analyzing and evaluating, group discussions and class discussions, concluding the characteristics of electric motors, and being participative	**Criteria:** 1.Accuracy of information sources, max score 15 2.Accuracy of group and classical discussions, max score 10 3.Accuracy of analysis, max score 5 4.Accuracy of evaluation, max score 5 5.Conclusion accuracy, max score 15 6.Participative, min score 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lecturer presentation on electric motor load characteristics; group assignments to search for sources of information; group discussion continued classically; conclude as individual bills, and reflect 2 X 50		**Material:** Load Characteristics of Electric Motors **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program* **Material:** Electric Motor Load Characteristics **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved.* **Material:** Characteristics of electric motors **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program* **Material:** Characteristics of electric motors **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved.*	5%
4	Able to analyze, evaluate and conclude the characteristics of electric motors	Searching for sources of information, analyzing and evaluating, group discussions and class discussions, concluding the characteristics of electric motors, and being participative	**Criteria:** 1.Accuracy of information sources, max score 15 2.Accuracy of group and classical discussions, max score 10 3.Accuracy of analysis, max score 5 4.Accuracy of evaluation, max score 5 5.Conclusion accuracy, max score 15 6.Participative, min score 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lecturer presentation on electric motor load characteristics; group assignments to search for sources of information; group discussion continued classically; conclude as individual bills, and reflect 2 X 50		**Material:** Load Characteristics of Electric Motors **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program* **Material:** Electric Motor Load Characteristics **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved.* **Material:** Characteristics of electric motors **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program* **Material:** Characteristics of electric motors **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved.*	5%

5	1. Able to carry out analysis, evaluation and selection of starting and braking on DC electric motors 2. Able to carry out analysis, evaluation and selection of starting and braking on cage rotor and winding rotor induction electric motors	Searching for sources of information, analyzing and evaluating, selecting the starting type according to the type of electric motor, group discussions and class discussions, making conclusions, and being participatory	**Criteria:** 1. Accuracy of results searching for information sources, max score. 10 2. Accuracy of identifying and evaluating results, maximum score 10 3. Accuracy in group and class discussions, max score 5 4. Accuracy in selecting starting and braking according to electric motors, max score 15 5. Conclusion accuracy, max score 10 6. Participative, min score 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Short presentations and discussions; assignment to trace sources of information, carry out analysis and evaluation followed by group and classical discussions; summing up the results as a bill; and do 2 X 50 reflections		**Material:** Starting and braking **References:** *Fang Qi, Daniel Scharfenstein, Claude Weis, 2019. Motorcycle Handbook. Institute for Power Electronics and Electrical Drives. RWTH Aachen University* **Material:** Starting and braking **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program* **Material:** Characteristics of synchronous and asynchronous motors **Reference:** *Joko, 2018. Alternating Current Machines. Surabaya: University Press, Surabaya State University* **Material:** Speed regulation and braking of DC motors **Reference:** *Joko, 2015. Direct Current Machines. University Press Surabaya State University*	5%
6	1. Able to carry out analysis, evaluation and selection of starting and braking on DC electric motors 2. Able to carry out analysis, evaluation and selection of starting and braking on cage rotor and winding rotor induction electric motors	Searching for sources of information, analyzing and evaluating, selecting the starting type according to the type of electric motor, group discussions and class discussions, making conclusions, and being participatory	**Criteria:** 1. Accuracy of results searching for information sources, max score. 10 2. Accuracy of identifying and evaluating results, maximum score 10 3. Accuracy in group and class discussions, max score 5 4. Accuracy in selecting starting and braking according to electric motors, max score 15 5. Conclusion accuracy, max score 10 6. Participative, min score 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Short presentations and discussions; assignment to trace sources of information, carry out analysis and evaluation followed by group and classical discussions; summing up the results as a bill; and do 2 X 50 reflections		**Material:** Starting and braking **References:** *Fang Qi, Daniel Scharfenstein, Claude Weis, 2019. Motorcycle Handbook. Institute for Power Electronics and Electrical Drives. RWTH Aachen University* **Material:** Starting and braking **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program* **Material:** Characteristics of synchronous and asynchronous motors **Reference:** *Joko, 2018. Alternating Current Machines. Surabaya: University Press, Surabaya State University* **Material:** Speed regulation and braking of DC motors **Reference:** *Joko, 2015. Direct Current Machines. University Press Surabaya State University*	5%
7	Able to analyze, evaluate and choose how to regulate the rotation speed of DC electric motors and wind-cage rotor induction motors	Searching for sources of information; group discussions, conducting analysis, conducting evaluations, and concluding on choosing methods, conducting class discussions; draw conclusions; and participatory	**Criteria:** 1. Suitability of the information sources searched, max score 5 2. Group discussion accuracy, max score 5 3. Accuracy of analysis and evaluation, max score 10 4. Group discussion accuracy, max score 5 5. Accuracy in choosing how to regulate motor rotation speed, max score 15 6. Conclusion accuracy, max score 10 7. Participative, min score 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lecturer's short presentation and discussion; group assignments to explore sources of information, group discussions to analyze, evaluate and choose methods, class presentations; make conclusions about how to regulate the rotation speed of the motor; and do 2 X 50 reflections		**Material:** Electrical Motor Drive **Bibliography:** *Fang Qi, Daniel Scharfenstein, Claude Weis, 2019. Motor Handbook. Institute for Power Electronics and Electrical Drives. RWTH Aachen University* **Material:** Regulation of rotation speed of DC electric motors and wound-cage rotor induction motors **Reference:** *Joko, 2024. Setting and Use of Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program*	5%

8	UTS meeting materials 1-7	1.1. Evaluate motor load characteristics 2.2. Evaluate the characteristics of electric motors 3.3. Choose how to start and brake DC motors and AC motors 4.4. Analyze how to regulate the rotation speed of DC motors and AC motors\ 5.5. Innovate ways to regulate the speed of DC motors and AC motors 6.6. Participative	**Criteria:** 1.Accuracy of evaluation, max score 10 2.Accuracy in selecting electric motor characteristics, max score 10 3.Accuracy in choosing how to start and brake, maximum score 10 4.Accuracy of analysis of how to set rotation speed, max score 10 5.Innovations made in controlling motorbike speed, maximum score 10 6.Participative, min score 50 **Form of Assessment** : Participatory Activities, Tests	Presentation 2 X 50			15%
9	Able to analyze, evaluate, and select DC motor control hardware (a variety of hardware, thyristor circuits, DC motor speed regulation. Thyristors are controlled by rectifier converters and introduced converters, wave rectifiers, phase control inverters, regenerative phase control, separate control cycles , chopper control, and DC motor position control.	Searching for sources of information; conduct group discussions; carry out analysis and evaluation; selecting DC motor control hardware; do classic presentations; draw conclusions; and participatory	**Criteria:** 1.Information source accuracy, max score. 10 2.Group and classical discussions, max score 10 3.Accuracy of analysis and evaluation results, max score 10 4.Accuracy of selecting DC motor controller hardware, max score 10 5.Conclusion accuracy, max score 10 6.Participative, min score 50 **Form of Assessment** : Participatory Activities, Tests	Short presentations and discussions; assignment to search for sources of information followed by group discussions to analyze, evaluate and select hardware; classic presentation; draw conclusions; and do 2 X 50 reflections		**Material:** DC motor control device **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program* **Material:** DC motor control hardware **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved.*	5%
10	Able to analyze, evaluate, and select DC motor control hardware (a variety of hardware, thyristor circuits, DC motor speed regulation. Thyristors are controlled by rectifier converters and introduced converters, wave rectifiers, phase control inverters, regenerative phase control, separate control cycles , chopper control, and DC motor position control.	Searching for sources of information; conduct group discussions; carry out analysis and evaluation; selecting DC motor control hardware; do classic presentations; draw conclusions; and participatory	**Criteria:** 1.Information source accuracy, max score. 10 2.Group and classical discussions, max score 10 3.Accuracy of analysis and evaluation results, max score 10 4.Accuracy of selecting DC motor controller hardware, max score 10 5.Conclusion accuracy, max score 10 6.Participative, min score 50 **Form of Assessment** : Participatory Activities	Short presentations and discussions; assignment to search for sources of information followed by group discussions to analyze, evaluate and select hardware; classic presentation; draw conclusions; and do 2 X 50 reflections		**Material:** DC motor control device **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program* **Material:** DC motor control hardware **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved.*	5%

11	Able to analyze, evaluate and select solid state controllers for cage rotor and winding rotor induction motors.	Conduct analysis and evaluation, select solid state controllers for cage rotor and wound rotor induction motors, draw conclusions, and participate	**Criteria:** 1.Accuracy of analysis and evaluation results, max score. 20 2.Accuracy in selecting solid state controllers for cage rotor and wound rotor induction motors, max score 20 3.Conclusion accuracy, max score 10 4.Participative, min score 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Short presentations and discussions; group assignments to explore sources of information, group discussions to analyze, evaluate and select solid state controllers for cage rotor and winding rotor induction motors; class discussion, drawing conclusions; and do 2 X 50 reflections		**Material:** Split state controller for cage rotor and wound rotor induction motors **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program* **Material:** Solid state cage rotor and wound rotor induction motor controllers **Reference:** *Joko, 2024. Setting and Use of Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program*	5%
12	Choosing an electric motor economically for the needs of driving commercial production machines	Standardization of electrical machines; electric motors for cranes; electric motors for explosive environments; electric motor for compressor drive; electric motor for water supply; electric motors for rolling mills; protection and maintenance of electric motors; electric motor problems and their causes; and participatory	**Criteria:** 1.Accuracy in choosing an electric motor according to its use and capacity, max score 30 2.Accuracy in selecting electric motor protection and maintenance, max score. 10 3.Accuracy in analyzing electric motor disturbances and their causes, max score. 10 4.Participative, min score. 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Short presentations and discussions; assignment to search for sources of information, group discussions to analyze and carry out evaluations to choose an electric motorbike economically; class discussion; make a summary; and do 2 X 50 reflections		**Material:** Protection and maintenance of electric motors; Electric motor problems and their causes **Reference:** *Joko, 2019. Maintenance and Repair of Electrical Machines. University Press Surabaya State University* **Material:** Choosing an electric motor for industry and choosing an electric motor economically. **Reference:** *Joko, 2024. Setting and Using Electric Motors. Teaching Materials for the Undergraduate Electrical Engineering Education Study Program*	5%
13	1.Design a bread dough mixer machine drive system 2.Create a drink mixer machine drive system design 3.Designing two-wheeled and three-wheeled electric vehicle drive systems	Formulate drive system designs, formulate problems, formulate alternative solutions, create designs, create work systems, determine tool and material requirements, draw design drawings, conduct discussions, draw conclusions, create a bibliography, and be participatory	**Criteria:** 1.Design title accuracy, max score 5 2.Accuracy of problem formulation, max score 5 3.Accuracy of alternative solutions, max score 5 4.System design accuracy, max score 10 5.Accuracy of design work system, max score 5 6.Requirements for tools and materials, max score 5 7.Accuracy and completeness of design drawings, max score 5 8.Accuracy of discussion, max score 10 9.Conclusion accuracy, max score 2.5 10.Bibliography recency, max score 2.5 11.Participative, min score 50 **Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment	Lecturer's short presentation, group discussion to explore sources of information followed by group discussion, compiling a design, uploading the design results as an invoice, presenting the design at the final exam, and reflecting 2 X 50		**Material:** Design and construction of a bread dough mixing machine based on Arduino Uno and Android **Library:** *https://perpustakaan.poltektegal.ac.id/...* **Material:** Design of a Bakery Dough Mixer Using a 1/2 HP DC Motor with a Pid Controller **Library:** *https://repository.unej.ac.id/...* **Material:** Design of a kothok coffee stirrer machine with four stirrers and a portable stove heater. **Library:** *https://repository.its.ac.id/...* **Material:** Design and Construction of an Electric-Based Crystal Ginger Stirrer with a Capacity of 5 Kg **Library:** *https://proceeding.unpkediri.ac.id/...* **Material:** Design of an electric motorbike using a used beat body and chassis **Library:** *https://repository.its.ac.id/...* **Material:** Electric tricycle design to support mobility in the city for people with disabilities **Library:** *https://repository.its.ac.id/...* **Material:** Planning an electric drive system for a three-wheeled motorbike **Reference:** *https://publication.petra.ac.id/...*	5%

14	1. Design a bread dough mixer machine drive system 2. Create a drink mixer machine drive system design 3. Designing two-wheeled and three-wheeled electric vehicle drive systems	Formulate drive system designs, formulate problems, formulate alternative solutions, create designs, create work systems, determine tool and material requirements, draw design drawings, conduct discussions, draw conclusions, create a bibliography, and be participatory	**Criteria:** 1. Design title accuracy, max score 5 2. Accuracy of problem formulation, max score 5 3. Accuracy of alternative solutions, max score 5 4. System design accuracy, max score 10 5. Accuracy of design work system, max score 5 6. Requirements for tools and materials, max score 5 7. Accuracy and completeness of design drawings, max score 5 8. Accuracy of discussion, max score 10 9. Conclusion accuracy, max score 2.5 10. Bibliography recency, max score 2.5 11. Participative, min score 50 **Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment	Lecturer's short presentation, group discussion to explore sources of information followed by group discussion, compiling a design, uploading the design results as an invoice, presenting the design at the final exam, and reflecting 2 X 50		**Material:** Design and construction of a bread dough mixing machine based on Arduino Uno and Android **Library:** *https://perpustakaan.poltektegal.ac.id/...* **Material:** Design of a Bakery Dough Mixer Using a 1/2 HP DC Motor with a Pid Controller **Library:** *https://repository.unej.ac.id/...* **Material:** Design of a kothok coffee stirrer machine with four stirrers and a portable stove heater. **Library:** *https://repository.its.ac.id/...* **Material:** Design and Construction of an Electric-Based Crystal Ginger Stirrer with a Capacity of 5 Kg **Library:** *https://proceeding.unpkediri.ac.id/...* **Material:** Design of an electric motorbike using a used beat body and chassis **Library:** *https://repository.its.ac.id/...* **Material:** Electric tricycle design to support mobility in the city for people with disabilities **Library:** *https://repository.its.ac.id/...* **Material:** Planning an electric drive system for a three-wheeled motorbike **Reference:** *https://publication.petra.ac.id/...*	5%
15	1. Design a bread dough mixer machine drive system 2. Create a drink mixer machine drive system design 3. Designing two-wheeled and three-wheeled electric vehicle drive systems	Formulate drive system designs, formulate problems, formulate alternative solutions, create designs, create work systems, determine tool and material requirements, draw design drawings, conduct discussions, draw conclusions, create a bibliography, and be participatory	**Criteria:** 1. Design title accuracy, max score 5 2. Accuracy of problem formulation, max score 5 3. Accuracy of alternative solutions, max score 5 4. System design accuracy, max score 10 5. Accuracy of design work system, max score 5 6. Requirements for tools and materials, max score 5 7. Accuracy and completeness of design drawings, max score 5 8. Accuracy of discussion, max score 10 9. Conclusion accuracy, max score 2.5 10. Bibliography recency, max score 2.5 11. Participative, min score 50 **Form of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment	Lecturer's short presentation, group discussion to explore sources of information followed by group discussion, compiling a design, uploading the design results as an invoice, presenting the design at the final exam, and reflecting 2 X 50		**Material:** Design and construction of a bread dough mixing machine based on Arduino Uno and Android **Library:** *https://perpustakaan.poltektegal.ac.id/...* **Material:** Design of a Bakery Dough Mixer Using a 1/2 HP DC Motor with a Pid Controller **Library:** *https://repository.unej.ac.id/...* **Material:** Design of a kothok coffee stirrer machine with four stirrers and a portable stove heater. **Library:** *https://repository.its.ac.id/...* **Material:** Design and Construction of an Electric-Based Crystal Ginger Stirrer with a Capacity of 5 Kg **Library:** *https://proceeding.unpkediri.ac.id/...* **Material:** Design of an electric motorbike using a used beat body and chassis **Library:** *https://repository.its.ac.id/...* **Material:** Electric tricycle design to support mobility in the city for people with disabilities **Library:** *https://repository.its.ac.id/...* **Material:** Planning an electric drive system for a three-wheeled motorbike **Reference:** *https://publication.petra.ac.id/...*	5%
16			**Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Practice / Performance, Tests	UAS (presenting the results of the design created)			15%

Evaluation Percentage Recap: Case Study

No	Evaluation	Percentage

1.	Participatory Activities	51.25%
2.	Project Results Assessment / Product Assessment	11.25%
3.	Portfolio Assessment	20%
4.	Practice / Performance	3.75%
5.	Test	13.75%
		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.