	Universitas Negeri Surabaya **Vocational Faculty,** **D4 Electrical Engineering Study Program**	**Document Code**

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Setup and Use of Electric Motors	2030502042	Compulsory Study Program Subjects	T=2	P=0	ECTS=3.18	5	August 21, 2023

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
	Prof. Dr. Joko, M.Pd. MT.	.....	Mahendra Widyartono, S.T., M.T.

Learning model	**Project Based Learning**

Program Learning Outcomes (PLO)

PLO study program that is charged to the course

Program Objectives (PO)

PO - 1	Analyze, evaluate, select and use electric motors according to 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-speed of induction motors, selecting motors for industry, and choose an electric motor economically

PLO-PO Matrix

P.O
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	Students have the ability to analyze, evaluate, select and use electric motors according to the load characteristics of electric motors and characteristics of electric motors, starting and braking of electric motors, regulation of rotational speed of electric motors, DC motor control hardware, solid state motor control-speed of induction motors, choosing motors for industry, and choosing electric motors economically

References

Main :

1. Austin Hughes, 2006. Electric Motors and Drivess. Foundamentals, Types, And Apilcations. Third Edition. Published by Elsevier Ltd. All rights reserved. http://www.emic-bg.org/files/Electric_Motors___Drives.pdf
2. Fang Qi, Daniel Scharfenstein, Claude Weis, 2019. Motor Handbook. Institute for Power Electronics and Electrical Drives. RWTH Aachen University https://www.infineon.com/dgdl/Infineon-motorcontrol_handbook-AdditionalTechnicalInformation-v01_00-EN.pdf? fileId=5546d4626bb628d7016be6a9aa637e69
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. O&rsquoKelly, Denis. 1992. Performance and Control of Electrical Machines . London: McGraw-Hill

Supporters:

1. Baharuddin, Deny HaryantoS., Olnes Y.H., 2021. Penggunaan dan pengaturan motor listrik. CV Pena Persada, Purwokerto.
2. Joko, Agus Budi S, Parama D.W., Alfredo A. P.P. 2022. Pemeliharaan dan perbaikan motor listrik berbasis model pembelajaran berbasisi proyek. Unesa University Press.

Supporting lecturer	Prof. Dr. Joko, M.Pd., M.T. Mahendra Widyartono, 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	Able to understand the various load characteristics of electric motors	Searching for sources of information, group discussions, summarizing material and group presentations	**Criteria:** 1. Accuracy of information sources, group discussions, summarizing material and group presentations, max score 50 2. Participation, min score 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Presentations, lecture contracts, discussions and questions and answers, assignments to search for sources of information, group discussions, summarizing material, group presentations using PPT, and reflection 2X50		**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. http://www.emic-bg.org/.....*	5%

2	Able to understand the various load characteristics of electric motors	1. Summarize and present the basic content of motor selection, load types, basic drive system equations, load torque, load moment of inertia, load torque vs speed curve, speed vs time curve, and motor working environment 2. Presentation, expressing ideas, answering and defending ideas, punctuality, and cooperation	**Criteria:** 1. Accuracy of the content of the summary and presentation material, max score 40 2. Presentation, expressing ideas, answering and defending ideas, punctuality, and cooperation. Max score 10 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lecturer's short presentation, question and answer, tracing sources of information, discussion, summarizing, group presentation, discussion and reflection 2X50		**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. http://www.emic-bg.org/...*	5%
3	Able to understand the various characteristics of electric motors	Summarize, create and present material on power/voltage ratings and temperature rise of motors, insulation classes, classes of duty, types of motors, characteristics of DC and AC motors, loads on electric motors	**Criteria:** 1. Accuracy of summary, PPT and presentation max score 100, max score 50 2. participation, min score 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Presentations, discussions, questions and answers, assignments to search for sources of information, summarizing, making PPTs and group presentations, and reflections 2 X 50		**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. http://www.emic-bg.org/.....*	6%
4	Able to understand the characteristics of electric motors	1. Accuracy of PPT contents 2. PPT appearance 3. Presentation 4. Put forward ideas and ideas 5. Defending ideas 6. Answer 7. Participative	**Criteria:** 1. PPT content accuracy, max score 60 2. PPT appearance, min score 20 3. Put forward ideas, max score 10 4. Defending ideas, max score 5 5. Accuracy in answering, score 5 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Group presentations, discussions, questions and answers, and reflections 2 X 50		**Material:** Characteristics of electric motors **References:** *Fang Qi, Daniel Scharfenstein, Claude Weis, 2019. Motor Handbook. Institute for Power Electronics and Electrical Drives. RWTH Aachen University https://www.infineon.com/...?fileId=5546d4626bb628d7016be6a9aa637e69*	6%
5	Starting and Braking Electric Motorcycles	1. Definition and purpose of starting and braking of electric motors 2. Starting DC motors 3. Automatic starting of DC motors 4. Starting polyphase induction motor 5. Starting an induction motor is another method 6. Synchronous motor starting 7. Electric motorbike braking 8. DC motor electric braking 9. Electric braking of induction motors 10. Participative	**Criteria:** Accuracy of summary content, max score 100 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lecturer's short presentation, discussion, question and answer, assignment summarizes and creates a powerpoint for starting and braking a 2 X 50 electric motor		**Material:** Starting and braking of DC motors **Reference:** *Joko, 2015. Direct Current Machines. University Press Surabaya State University* **Material:** Starting and braking of AC motors **Reference:** *Joko, 2018. Alternating Current Machines. Surabaya: University Press Surabaya State University*	5%

6	Starting and Braking Electric Motorcycles	1. Definition and purpose of starting and braking of electric motors 2. Starting DC motors 3. Automatic starting of DC motors 4. Starting polyphase induction motor 5. Starting an induction motor is another method 6. Synchronous motor starting 7. Electric motorbike braking 8. DC motor electric braking 9. Electric braking of induction motors 10. Participative	**Criteria:** 1. PPT content accuracy, max score 60 2. PPT appearance, max score 20 3. Presentation, expressing opinions, answering, defending ideas, collaborating, max score 20 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Group presentations, discussions, questions and answers, and reflections 2 X 50		**Material:** Starting and braking of DC motors **Reference:** *Joko, 2015. Direct Current Machines. University Press Surabaya State University* **Material:** Starting and braking of AC motors **Reference:** *Joko, 2018. Alternating Current Machines. Surabaya: University Press Surabaya State University*	5%
7	Able to regulate the rotation speed of the electric motor	1. Method of regulating the rotation speed of an electric motor 2. Regulates the rotation speed of DC motors working in parallel 3. DC shunt motor armature short circuit 4. Regulation of the rotation speed of a series DC motor 5. Cage rotor induction motor speed regulation 6. Winding rotor induction motor speed regulation	**Criteria:** 1. Accuracy of summary content, max score 60 2. PPT appearance, max score 20 3. Presentation and presentation, max score 20 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Short lecture presentations, discussions, questions and answers, assignments to trace sources of information, summarize and create PPTs and presentations 2 X 50		**Material:** Regulation of electric motor rotation speed. **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved. http://www.emic-bg.org/...* **Material:** DC motor speed regulation **Reference:** *Joko, 2015. Direct Current Machines. University Press Surabaya State University*	5%
8	UTS		**Form of Assessment** : Participatory Activities, Tests	UTS-1st elementary school meeting material. 7th meeting 2 X 50			13%
9	Able to understand DC motor control hardware	1. Various Hardware 2. Thyristor Circuit 3. DC Motor Speed Regulation 4. The thyristor is controlled with a rectifier converter 5. Thyristor is recognized by the converter 6. Wave rectifier 7. Phase control inverter 8. Regenerative phase control 9. Separate control cycle 10. Chopper control 11. DC Motor position control	**Criteria:** Accuracy of summary content, max score 100 **Form of Assessment** : Participatory Activities, Portfolio Assessment		Lecturer short presentations, discussions, assignments to explore sources of information, summarize, make PPT and present 2 X 50	**Material:** DC motor rotation speed control hardware **Reference:** *Fang Qi, Daniel Scharfenstein, Claude Weis, 2019. Motor Handbook. Institute for Power Electronics and Electrical Drives. RWTH Aachen University https://www.infineon.com/...?fileId=5546d4626bb628d7016be6a9aa637e69*	5%

10	Able to understand DC motor control hardware	1.Various Hardware 2.Thyristor Circuit 3.DC Motor Speed Regulation 4.The thyristor is controlled with a rectifier converter 5.Thyristor is recognized by the converter 6.Wave rectifier 7.Phase control inverter 8.Regenerative phase control 9.Separate control cycle 10.Chopper control 11.DC Motor position control	**Criteria:** 1.PPT content accuracy, max score 80 2.Presentation, ideas, ideas, defending opinions, cooperation and performance, max score 20 **Form of Assessment** : Participatory Activities, Portfolio Assessment		Group presentations, discussions, questions and answers, and reflections 2 X 50	**Material:** DC motor rotation speed control hardware **Reference:** *Fang Qi, Daniel Scharfenstein, Claude Weis, 2019. Motor Handbook. Institute for Power Electronics and Electrical Drives. RWTH Aachen University https://www.infineon.com/...?fileId=5546d4626bb628d7016be6a9aa637e69*	5%
11	Able to understand solid state motor control-induction motor rotation speed	1.Background 2.Inverters 3.Inverter method 4.Control frequency inverter 5.Thyrister voltage control 6.Harmonic elimination 7.Choose a 3 phase inverter 8.Control inverter circuit 9.Cycloconverter phase controller 10.Cyclonverter frequency and voltage controller 11.Setting the rotation speed of the induction motor 12.Regenerative braking 13.Steering of cage rotor induction motors 14.Winding rotor induction motor driving 15.Participative, min score 50	**Criteria:** 1.The accuracy of the contents of the summary, ppt, and presentation is a maximum score of 50 2.Participative, min score 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment		Lecturer short presentations, discussions, questions and answers, assignments to search for sources of information, summarizing, making PPTs and group presentations	**Material:** Solid state motor control-induction motor rotation speed. **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved. http://www.emic-bg.org/...* **Material:** Solid state motor control-induction motor rotation speed **Reference:** *O&rsquoKelly, Denis. 1992. Performance and Control of Electrical Machines. London: McGraw-Hill*	5%
12	Able to understand solid state motor control-induction motor rotation speed	1.Background 2.Inverters 3.Inverter method 4.Control frequency inverter 5.Thyrister voltage control 6.Harmonic elimination 7.Choose a 3 phase inverter 8.Control inverter circuit 9.Cycloconverter phase controller 10.Cyclonverter frequency and voltage controller 11.Setting the rotation speed of the induction motor 12.Regenerative braking 13.Steering of cage rotor induction motors 14.Winding rotor induction motor driving	**Criteria:** 1.Accuracy of presentation content, maximum score 60 2.PPT appearance, max score 20 3.Presentation, ability to convey ideas, opinions, answer, defend ideas, and collaborate, max score 20 **Form of Assessment** : Participatory Activities, Portfolio Assessment		Group presentations, discussions, questions and answers, reflections	**Material:** Solid state motor control-induction motor rotation speed. **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved. http://www.emic-bg.org/...* **Material:** Solid state motor control-induction motor rotation speed **Reference:** *O&rsquoKelly, Denis. 1992. Performance and Control of Electrical Machines. London: McGraw-Hill*	5%

13	Able to understand how to choose electric motors for industry	1. Introduction 2. Electrical equipment for applications in the textile industry 3. Standardization of electrical machines 4. Selection of electric machines 5. Equipment for electric motor applications 6. Electric motor for crane 7. Electric motors for explosive environments 8. Electric motor for compressor drive 9. Electric motor for water supply 10. Electric motors for rolling mills 11. Protection and maintenance of electric motors 12. Electric motor problems and their causes	**Criteria:** Accuracy in making summaries, max score 100 **Form of Assessment** : Participatory Activities, Portfolio Assessment		Short lecturer presentations, discussions, questions and answers, assignments to search for information sources, summarize, make PPTs and present 2 X 50	**Material:** Selection of motors for industry **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved. http://www.emic-bg.org/...* **Material:** Maintenance and repair of electric motors **References:** *Joko, Agus Budi S, Parama DW, Alfredo APP 2022. Maintenance and repair of electric motors based on a project-based learning model. Unesa University Press.*	5%
14	Able to understand how to choose electric motors for industry	1. Introduction 2. Electrical equipment for applications in the textile industry 3. Standardization of electrical machines 4. Selection of electric machines 5. Equipment for electric motor applications 6. Electric motor for crane 7. Electric motors for explosive environments 8. Electric motor for compressor drive 9. Electric motor for water supply 10. Electric motors for rolling mills 11. Protection and maintenance of electric motors 12. Electric motor problems and their causes	**Criteria:** 1. PPT content accuracy, max score 60 2. PPT display, max score 20 3. Appearance, presentation of material. expressing ideas, answering, defending opinions, and cooperation, max score 20 **Form of Assessment** : Participatory Activities, Portfolio Assessment		Group presentations, discussions, questions and answers, and reflections 2 X 50	**Material:** Selection of motors for industry **Reference:** *Austin Hughes, 2006. Electric Motors and Drives. Foundations, Types, And Applications. Third Edition. Published by Elsevier Ltd. All rights reserved. http://www.emic-bg.org/...* **Material:** Maintenance and repair of electric motors **References:** *Joko, Agus Budi S, Parama DW, Alfredo APP 2022. Maintenance and repair of electric motors based on a project-based learning model. Unesa University Press.*	5%

15	Able to choose an electric motorbike from an economic perspective	1.Maintenance of electrical energy 2.Factors affecting the efficiency of induction motors 3.Factors affecting system efficiency 4.High efficiency motor 5.Economical rotation speed controller 6.Performance of various variable rotation speed controls 7.Development of rotational speed control which tends to change 8.Speed changer control selection ratio	**Criteria:** 1.Summary accuracy, max score 60 2.PPT content accuracy, max score 20 3.Appearance, ability to express opinions, answer, defend ideas, cooperation, max score 20 **Form of Assessment** : Participatory Activities		Lecturer short presentations, discussions, questions and answers, assignments to explore sources of information, summarizing, group presentations, and reflections 2 X 50	**Material:** Choosing a motorbike from an economic perspective. **Reference:** *O&rsquoKelly, Denis. 1992. Performance and Control of Electrical Machines. London: McGraw-Hill*	5%
16			**Form of Assessment** : Test	UAS 2 X 50			15%

Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
1.	Participatory Activities	45%
2.	Portfolio Assessment	33.5%
3.	Test	21.5%
		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.