UNESA	**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
DC Electrical Machines	8320103072	Compulsory Study Program Subjects	T=3	P=0	ECTS=4.77	4	January 2, 2023

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

Learning model	**Project Based Learning**

Program Learning Outcomes (PLO)

PLO study program that is charged to the course

PLO-9	Able to communicate in Indonesian and English well orally and in writing (General).

Program Objectives (PO)

PO - 1	Students have comprehensive skills about alternating current generators and motors, including: understanding, working principles of synchronous generators, their parts and functions; anchor winding and its quantities; magnitude; zero load, under load, regulating, external, and short circuit characteristics); losses, and efficiency, generator voltage regulation, and electric motor slip, as well as the operation of the electric generator line.

PLO-PO Matrix

P.O	PLO-9
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 knowledge about DC generators and DC motors, including: definition, working principles, types, parts and functions, armature windings and calculations of their quantities, characteristics, losses, voltage regulation and efficiency. Have the ability and responsibility in designing and selecting DC generators and DC motors according to load characteristics and general electrical installation regulations (PUIL) and applicable regulations. Understand maintenance management of DC Power, DC Motors, DC Generators, and Gen Sets.

References

Main :

1. [1] Stephen J. Chapman, 2012. Electric Machinary Fundamentals Fifth Edition. MCGraw-Hill: New York.
2. [2] Joko, 2016. Mesin Arus Searah. University Press: Surabaya

Supporters:

1. [3] Joko, 2021. Exsperiment Sheet Generator DC. LPPM Unesa Surabaya
2. [4] Joko, 2021. Exsperiment Sheet Motor DC. LPPM Unesa Surabaya
3. [5] Joko, 2019. Pemeliharaan dan perbaikan mesin Listrik. University Press, Unesa Surabaya
4. [6] PUIL 2011

Supporting lecturer	Prof. Dr. Ismet Basuki, M.Pd. Prof. Dr. Joko, M.Pd., M.T. Ibrohim, 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 meaning, working principles, types of synchronous generators, synchronous generator parts & their functions, and the principles of voltage generation in synchronous generators	1. Analyze and compare the meaning and function of DC generators and DC motors 2. Participative	**Criteria:** 1. Accuracy of conclusions made, max score 50 2. Participative, min 50% **Form of Assessment** : Participatory Activities, Portfolio Assessment		Online via VICON: Presentation, discussion, questions and answers followed by the task of searching the literature, discussion, analyzing and comparing the meaning & function of DC generators and DC motors, making conclusions and collecting the results individually on Google Drive, and reflection 2 X 50	**Material:** Understanding and function of DC generators and DC motors **References:** *[1] Stephen J. Chapman, 2012. Electric Machine Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Understanding and function of DC generators and motors **References:** *[2] Joko, 2016. Direct Current Machines. University Press: Surabaya*	4%
2	Students are able to identify, analyze and compare the types of DC generators and DC motors	1. Draw conclusions from the results of the analysis of the type of DC generator and type of DC motor, and the timeliness of uploading 2. Participation	**Criteria:** 1. Accuracy of conclusions made, max score 40 2. Accurate collection time, max score 10 3. Participative, min score 50% **Form of Assessment** : Participatory Activities, Portfolio Assessment		Presentations, discussions, questions and answers followed by the task of tracing sources of information, discussions, identifying, analyzing and comparing types of DC generators and types of DC motors, drawing conclusions. Individuals upload the conclusions from the discussion to Google Drive and reflect 2 X 50	**Material:** Types of DC generators and motors **References:** *[1] Stephen J. Chapman, 2012. Electric Machinery Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Types of DC generators and motors **References:** *[2] Joko, 2016. Direct Current Machines. University Press: Surabaya*	4%
3	Students are able to analyze and describe the parts of a DC generator and DC motor and their functions	1. The resulting conclusion identifies and analyzes the parts of a DC generator and DC motor and their functions 2. Presentation 3. Participation	**Criteria:** 1. Accuracy of results identifying and analyzing DC generator and DC motor parts and their functions, max score 40 2. Accuracy of presentation, max score 10 3. Participation, min score 50 **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Portfolio Assessment, Practice / Performance	Short lecturer presentations, discussions, questions and answers, students exploring sources of information, observation group assignments to identify and analyze the parts of DC generators and DC motors and their functions in the lab, class presentations, summarizing the results, and reflecting. The group conclusions are uploaded individually to Google Drive 2 X 50		**Material:** Parts of DC generators and DC motors **References:** *[1] Stephen J. Chapman, 2012. Electric Machinery Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Parts of DC generators and DC motors and their functions **References:** *[2] Joko, 2016. Direct Current Machines. University Press: Surabaya*	4%

4	Students are able to analyze and compare the working principles of DC generators and DC motors	1. Analyze and compare the working principles of DC generators - self-amplifying DC motors 2. Analyze and compare the working principles of DC generators - separate amplifier DC motors 3. Presentation 4. Participation	**Criteria:** 1. Accuracy of analysis results and comparison of working principles, max score 40\ 2. Accuracy of presentation results, max score 10 3. Participation, min score 50 **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Portfolio Assessment, Practice / Performance	Lecturer's short presentation, discussion, question and answer. students explore sources of information, discuss, observe in the lab, analyze, compare, draw conclusions about the working principles of DC generators and DC motors, present the results in class, and reflect. Conclusions are uploaded individually to Google Drive. 2 X 50		**Material:** Working principles of DC generators and motors **References:** *[1] Stephen J. Chapman, 2012. Electric Machine Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Working principles of DC generators and DC motors **References:** *[2] Joko, 2016. Direct Current Machines. University Press: Surabaya*	4%
5	Students are able to calculate quantities on 1-phase & 3-phase synchronous generators and conclude the results	1. Calculating windings, flux, voltage, current, voltage loss in DC motor generators 2. Make a DC generator and DC motor circuit 3. Participative	**Criteria:** 1. Accuracy of the results of calculating quantities, max score 40 2. Image accuracy, max score 10 3. Participative, min score 50 **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lecturer's short presentation, discussion, question and answer. students explore sources of information, group discussions calculate quantities for 1-phase & 3-phase synchronous generators, draw conclusions and reflect. Conclusions are uploaded individually on Google Drive 2 X 50		**Material:** Quantities in 1 phase/3 phase synchronous motor generators and examples/practice questions **References:** *[2] Joko, 2018. Alternating Current Machines. University Press: Surabaya* **Material:** Quantities in DC electric machines and examples of practice questions. **References:** *[1] Stephen J. Chapman, 2012. Electric Machine Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Quantities in DC motor generators **Reference:** *[2] Joko, 2016. Direct Current Machines. University Press: Surabaya*	4%

6	Able to analyze and compare the characteristics of various DC generators and DC motors	1. Analyze and compare the characteristics of self-amplifying generators and separate amplifiers 2. Analyze and compare the characteristics of self-amplifying and discrete DC motors 3. Analyze and compare the characteristics of self-amplifying DC generators and self-amplifying DC motors 4. Analyze and compare the characteristics of a separate amplifier DC Generator and a separate amplifier DC motor 5. Presentation 6. Participative	**Criteria:** 1. Accuracy in carrying out analysis and comparing characteristics accompanied by pictures of zero load, under load, external and short circuit characteristics, max score 40 2. Presentation, max score 10 3. Participatory, min score 50 **Forms of Assessment** : Participatory Activities, Portfolio Assessment, Practice / Performance	Lecturer's short presentation, discussion, question and answer. students explore sources of information, group discussions analyze and compare the characteristics of single-phase and three-phase synchronous generators, class presentations, draw conclusions, and reflect. Conclusions from group discussions (there are 4 sub-topics) are uploaded individually to Google Drive. 2 X 50		**Material:** Characteristics of DC generators **References:** *[1] Stephen J. Chapman, 2012. Electric Machinery Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Characteristics of DC generators **References:** *[2] Joko, 2016. Direct Current Machines. University Press: Surabaya*	4%
7	Able to calculate losses and efficiency of 1-phase - 3-phase generators and synchronous motors	1. Perform calculations of losses and efficiency of DC generators/motors and conclude the results 2. Presentation 3. Participative	**Criteria:** 1. Accuracy of calculations and summing up the results, max score 40% 2. Presentation accuracy, max score 10% 3. Participative, min score 50% **Forms of Assessment** : Participatory Activities, Portfolio Assessment, Practice / Performance	Lecturer's short presentation, discussion, question and answer. students explore sources of information, group discussions calculate losses and efficiency of 1-phase - 3-phase generators and synchronous motors, present and summarize the results. The conclusions of each group's discussion results are uploaded individually to Google Drive. 2 X 50		**Material:** Examples and practice questions **References:** *[1] Stephen J. Chapman, 2012. Electric Machinery Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Losses and efficiency of DC generators and motors **References:** *[2] Joko, 2016. Direct Current Machines. University Press: Surabaya*	4%
8	UTS		**Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Tests	2 X 50			16%

9	Students are able to calculate the voltage regulation of 1 phase and 3 phase synchronous generators, and evaluate their conformity with the rules and regulations (PUIL)	1. Carry out DC generator voltage regulation calculations, and evaluate their conformity with the rules and regulations (PUIL) 2. Presentation 3. Participative	**Criteria:** 1. Accuracy of calculations and summing up the results, max score 40% 2. Presentation accuracy, max score 10% 3. Participative, min score 50% **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment	Lecturer's short presentation, discussion, question and answer. students explore sources of information, group discussions calculate DC generator voltage regulations, and evaluate their conformity with the rules and regulations (PUIL), class presentations, summarizing the results, and reflection. Conclusions from group discussions that have been presented are uploaded individually to Google Drive 2 X 50		**Material:** Examples and practice questions **References:** *[3] Slobodan N. Vukosavic, 2013. Electrical Machines. Springer-Verlag: New York* **Material:** Provisions for generator voltage regulation **Reference:** *[6] PUIL 2011*	5%
10	Students are able to work in groups to complete actual projects related to DC motors according to the provisions/regulations, and present the results	1. Determining project topics, developing project designs, preparing project completion schedules, working on projects, testing project results, presenting project results, reflection 2. Project performance (dimensions, neatness, safety, functionality) 3. Participation	**Criteria:** 1. Accuracy in determining project topics, preparing project designs, preparing project completion schedules, working on projects, testing project results, presenting project results, reflecting, max score 40 2. Accuracy of product dimensions, safety, beauty, product functionality, max score 10 3. Participative, min score 50% **Form of Assessment** : Participatory Activities, Practice/Performance	Short lecturer presentations, discussions, questions and answers, assignments to search for sources of information, discussions, working on DC motor projects, presentations, summarizing results, and reflections 2 X 50		**Material:** Provisions for insulation resistance test results, working voltage. **Reference:** *[4] PUIL 2011* **Material:** DC generator repair **Reference:** *[4] Joko, 2021. DC Motor Experiment Sheet. LPPM Unesa Surabaya* **Material:** DC electric motor repair **Reference:** *[5] Joko, 2019. Maintenance and repair of electrical machines. University Press, Unesa Surabaya*	5%
11	Students are able to work in groups to complete actual projects related to DC generators according to the provisions/regulations, and present the results	1. Determining project topics, developing project designs, preparing project completion schedules, working on projects, testing project results, presenting project results, reflection 2. Project performance (dimensions, neatness, functionality) 3. Participation	**Criteria:** 1. Accuracy of project topics, developing project designs, preparing project completion schedules, working on projects, testing project results, presenting project results, reflection, max score 40 2. Accuracy of project results performance (dimensions, neatness, functionality), max score 10 3. Participative, min score 50% **Form of Assessment** : Participatory Activities, Practice/Performance	Short lecturer presentations, discussions, questions and answers, assignments to search for sources of information, discussions, working on DC generator repair projects, presentations, summarizing results, and reflections 2 X 50		**Material:** Provisions for insulation resistance test results, working voltage. **Reference:** *[4] PUIL 2011* **Material:** DC generator repair **Reference:** *[5] Joko, 2019. Maintenance and repair of electrical machines. University Press, Unesa Surabaya*	6%

12	Students are able to calculate DC motor quantities	1. Calculating turns, flux, voltage, current, voltage loss of DC motors 2. Create schematic drawings 3. Participation	**Criteria:** 1. Accuracy of calculating turns, flux, voltage, current, voltage loss of DC motors, max score 40 2. Presentation accuracy, max score 10% 3. Participative, min score. 50 **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Portfolio Assessment	Lecturer's short presentation, discussion, question and answer. students explore sources of information, have group discussions, calculate DC motor quantities, make presentations, draw conclusions and reflect. Conclusions are uploaded individually on Google Drive 2 X 50		**Material:** Examples and practice questions **References:** *[1] Stephen J. Chapman, 2012. Electric Machinery Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** DC motor quantities **References:** *[2] Joko, 2016. Direct Current Machines. University Press: Surabaya*	5%
13	Able to analyze the characteristics (zero load, load, external, short circuit) of generators and single phase asynchronous motors	1. Analyze and compare the characteristics of 1 phase - 3 phase asynchronous generators 2. Analyze and compare the characteristics of 1 phase - 3 phase synchronous motors 3. Analyze and compare the characteristics of a single phase synchronous generator with a single phase synchronous motor 4. Analyze and compare the characteristics of a 3 phase synchronous generator with a 3 phase synchronous motor 5. Presentation 6. Participation	**Criteria:** 1. Accuracy in carrying out analysis and comparing characteristics accompanied by pictures of zero load, under load, external and short circuit characteristics, max score 40 2. Presentation, max score 10 3. Participative, min score. 50 **Forms of Assessment** : Participatory Activities, Portfolio Assessment, Practice / Performance	Lecturer's short presentation, discussion, question and answer. students explore sources of information, group discussions analyze and compare the characteristics of 1-phase and 3-phase asynchronous motor generators, make class presentations, draw conclusions, and reflect. Conclusions from group discussions (there are 4 sub-topics) are uploaded individually to Google Drive. 2 X 50		**Material:** Characteristics of asynchronous electric motors **References:** *[3] Slobodan N. Vukosavic, 2013. Electrical Machines. Springer-Verlag: New York* **Material:** Characteristics of DC motors **References:** *[1] Stephen J. Chapman, 2012. Electric Machine Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Characteristics of DC motors **References:** *[2] Joko, 2016. Direct Current Machines. University Press: Surabaya*	5%
14	Students are able to calculate the losses and efficiency of DC motors	1. Perform calculations of losses and efficiency of DC motors and summarize the results 2. Presentation 3. Participation	**Criteria:** 1. accuracy of calculating losses and efficiency of DC motors and summarizing the results, max score 40% 2. Presentation accuracy, max score 10% 3. Participative, min score 50% **Form of Assessment** : Participatory Activities, Portfolio Assessment	Lecturer's short presentation, discussion, question and answer. students explore sources of information, group discussions calculate losses and efficiency of DC motors, present and summarize the results. The conclusions of each group's discussion results are uploaded individually to Google Drive. 2 X 50		**Material:** Examples and practice questions **References:** *[3] Slobodan N. Vukosavic, 2013. Electrical Machines. Springer-Verlag: New York* **Material:** Losses and efficiency of DC motors **References:** *[1] Stephen J. Chapman, 2012. Electric Machine Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Losses and efficiency of DC motors **References:** *[2] Joko, 2016. Direct Current Machines. University Press: Surabaya*	5%

15	Students are able to calculate the rotation speed of a DC motor and evaluate its compliance with the provisions/regulations	1.Carry out voltage regulation calculations for 1 phase & 3 phase asynchronous generators, calculate the rotation speed of DC motors and evaluate their conformity with the rules and regulations (PUIL) 2.Presentation 3.Participative	**Criteria:** 1.Calculating the rotation speed of a DC motor, evaluating its compliance with the rules and regulations (PUIL) 2.Presentation accuracy, max score 10% 3.Participative, min score 50% **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Practices / Performance	Lecturer's short presentation, discussion, question and answer. students explore sources of information, group discussions calculate the rotation speed of DC motors, and evaluate their conformity with the rules and regulations (PUIL), present and conclude the results. Conclusions from group discussions that have been presented are uploaded individually to Google Drive 2 X 50		**Material:** Examples and practice questions **References:** *[1] Stephen J. Chapman, 2012. Electric Machinery Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Rotation speed **References:** *[2] Joko, 2016. Direct Current Machine. University Press: Surabaya* **Material:** Terms of rotation speed **Reference:** *[6] PUIL 2011*	5%
16	UAS		**Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Tests				20%

Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
1.	Participatory Activities	38.17%
2.	Project Results Assessment / Product Assessment	19.84%
3.	Portfolio Assessment	16.5%
4.	Practice / Performance	13.5%
5.	Test	12%
		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.