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
AC Electrical Machines	8320102071		**T=2**	**P=0**	**ECTS=3.18**	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	**Case Studies**

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 synchronous generators, synchronous and synchronous motors, including: definition, working principles, types, parts and functions, armature windings and calculations of their quantities, characteristics, losses, regulation and efficiency. Have the ability and responsibility in designing and selecting synchronous generators, synchronous and asynchronous motors according to load characteristics and general electrical installation regulations (PUIL) and applicable regulations. Understand AC Power, Generator and Gen Set maintenance management.

References

Main :

1. [1] Stephen J. Chapman, 2012. Electric Machinary Fundamentals Fifth Edition. MCGraw-Hill: New York.
2. [2] Joko, 2018. Mesin Arus Bolak Balik. University Press: Surabaya

Supporters:

1. [3] Slobodan N. Vukosavic, 2013. Electrical Machines. Springer-Verlag: New York
2. [4] PUIL 2011
3. [5] Joko, Ismet Basuki, Alfredo A.A.P., 2021. Perbaikan motor listrik berorientasi project based learning. University Press Uesa Surabaya

Supporting lecturer	Prof. Dr. Ismet Basuki, M.Pd. Prof. Dr. Joko, M.Pd., M.T. Yulia Fransisca, 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 the differences in the meaning and function of 1 phase / 3 phase synchronous and asynchronous motor generators	1.Conclusion of the results of analyzing the meaning and differences in the functions of synchronous/asynchronous generators and synchronous/asynchronous motors, both 1 phase and 3 phase 2.Participative	**Criteria:** 1.Accuracy of conclusions made, max score 50 2.Participative, min 50% **Form of Assessment** : Participatory Activities, Portfolio Assessment		Presentation, discussion, questions and answers followed by the task of searching the literature, discussion, analyzing and comparing the meaning & function of synchronous/asynchronous generators and synchronous/asynchronous motors, making conclusions to be collected individually on Google Drive, and reflection 2 X 50	**Material:** Understanding and function of 1-phase and 3-phase alternating current electric machines. **Reference:** *[1] Stephen J. Chapman, 2012. Electric Machine Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Definition and function of synchronous/asynchronous generators, 1-phase and 3-phase synchronous/asynchronous electric motors **References:** *[2] Joko, 2018. Alternating Current Machines. University Press: Surabaya*	4%

2	Able to identify, analyze and compare the types of synchronous/asynchronous generators and synchronous/asynchronous motors for 1 phase and 3 phase machines	1.Accuracy of conclusions and timeliness of collection 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		Online via VICON: presentation, discussion, questions and answers followed by group assignments searching the library, discussion, identifying, analyzing and comparing types of synchronous/asynchronous generators and 1-phase and 3-phase synchronous/asynchronous motors, making individual conclusions to be collected on Google Drive , and do 2 X 50 reflections	**Material:** Types of alternating current electric machines **References:** *[1] Stephen J. Chapman, 2012. Electric Machine Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Types of alternating current electrical machines **References:** *[2] Joko, 2018. Alternating Current Machines. University Press: Surabaya*	4%
3	Students are able to analyze the parts of generators and synchronous motors, generators and induction motors (asynchronous) 1 phase and 3 phases and their functions	1.The conclusion of the results is identifying and analyzing the parts of alternating current electrical machines and their functions 2.Presentation 3.Participation	**Criteria:** 1.Accuracy of the results of identifying and analyzing parts of alternating current electrical machines 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 parts of alternating current electrical machines and their functions in the lab, class presentations, and summarizing the results. The group conclusions are uploaded individually to Google Drive, and reflected 2 X 50		**Material:** Parts of alternating current electric machines **References:** *[1] Stephen J. Chapman, 2012. Electric Machine Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Parts of a single-phase alternating current electric machine and their functions **References:** *[2] Joko, 2018. Alternating Current Machine. University Press: Surabaya*	4%
4	Students are able to compare the working principles of synchronous generators - asynchronous generators; and synchronous motors - 1 phase & 3 phase asynchronous motors	1.Analyze and compare the working principles of 1 phase and 3 phase synchronous - asynchronous generators 2.Analyze and compare the working principles of 1 phase and 3 phase synchronous - asynchronous motors 3.Analyze and compare the working principles of synchronous generators - 1 phase and 3 phase synchronous motors 4.Analyze and compare the working principles of asynchronous generators - 1 phase and 3 phase asynchronous motors 5.Presentation	**Criteria:** 1.The accuracy of the conclusion is based on the results of the analysis of differences in working principles made, maximum 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, Practices / Performance	Lecturer's short presentation, discussion, question and answer. students explore sources of information, discuss, analyze, compare, class presentations (4 groups), and draw conclusions, and present the results in groups, and reflect. Conclusions are uploaded individually to Google Drive. 2 X 50		**Material:** Working principles of synchronous/asynchronous generators and motors **References:** *[1] Stephen J. Chapman, 2012. Electric Machinery Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Working principles of 1 phase and 3 phase synchronous and asynchronous generators and motors, 1 phase and 3 phase synchronous/asynchronous motors **References:** *[2] Joko, 2018. Alternating Current Machines. University Press: Surabaya*	4%
5	Students are able to calculate quantities for 1-phase & 3-phase synchronous generator-motors and conclude the results	1.Calculating windings, flux, voltage, current, voltage loss, power factor in 1 phase & 3 phase synchronous and asynchronous motor generators 2.Create an equivalent circuit 3.Participative	**Criteria:** 1.Accuracy of calculating results, max score 40 2.Equivalent 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 electrical machines and examples of practice questions. **References:** *[1] Stephen J. Chapman, 2012. Electric Machine Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Quantities in 1 phase/3 phase synchronous motor generators and examples/practice questions **References:** *[2] Joko, 2018. Alternating Current Machines. University Press: Surabaya*	4%

6	Able to understand and calculate losses, generator efficiency, synchronous generator voltage regulation	1.Analyze and compare the characteristics of 1 phase - 3 phase synchronous 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.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 synchronous generators **References:** *[1] Stephen J. Chapman, 2012. Electric Machinery Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Characteristics of 1 phase and 3 phase synchronous generators **References:** *[2] Joko, 2018. Alternating Current Machine. University Press: Surabaya* **Material:** Characteristics of synchronous generators **References:** *[3] Slobodan N. Vukosavic, 2013. Electrical Machines. Springer-Verlag: New York*	4%
7	Able to calculate losses and efficiency of 1-phase - 3-phase generators and synchronous motors	1.Calculating the losses and efficiency of a 1-phase-3-phase synchronous generator/motor and summarizing 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:** Losses and efficiency of synchronous generators and motors **References:** *[1] Stephen J. Chapman, 2012. Electric Machine Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Losses and efficiency of generators and synchronous motors **References:** *[2] Joko, 2018. Alternating Current Machines. University Press: Surabaya* **Material:** Examples and practice questions **References:** *[3] Slobodan N. Vukosavic, 2013. Electrical Machines. Springer-Verlag: New York*	4%
8	Able to calculate losses and efficiency of 1-phase - 3-phase generators and synchronous motors		**Form of Assessment** : Test	The results are uploaded to Google Drive 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 voltage regulation calculations for 1 phase & 3 phase synchronous generators and synchronous motor slip, 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, Practices / Performance	Lecturer's short presentation, discussion, question and answer. students explore sources of information, group discussions calculate the voltage regulation of 1 phase & 3 phase synchronous generators, 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:** *[3] Slobodan N. Vukosavic, 2013. Electrical Machines. Springer-Verlag: New York* **Material:** Provisions for generator voltage regulation and slip on electric motors **Reference:** *[4] PUIL 2011*	5%

10	Students are able to work in groups to solve actual problems related to 1 phase & 3 phase asynchronous electric motors according to the provisions/regulations, and present the results	1. Defining the problem. formulate a hypothesis, prepare a problem solving plan, make a drawing, create a problem solving procedure, solve a problem, carry out testing, interpret data and carry out hypothesis testing, draw conclusions, present results 2. Participation	**Criteria:** 1. Accuracy of formulating the problem. formulate a hypothesis, prepare a problem solving plan, create a picture, create a problem solving procedure, solve a problem, carry out testing, interpret data and carry out hypothesis testing, draw conclusions, max score 50 2. 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, solving problems with 1-phase and 3-phase synchronous motor damage, presentations, summarizing results, and reflection 2 X 50		**Material:** Provisions for insulation resistance test results, working voltage. **Reference:** *[4] PUIL 2011* **Material:** Electric motor repair **Reference:** *[5] Joko, Ismet Basuki, Alfredo AAP, 2021. Electric motor repair oriented to project based learning. Uesa University Press Surabaya*	5%
11	Students are able to work in groups to solve actual problems related to damage to 1 phase & 3 phase asynchronous electric motors according to the provisions/regulations, and present the results	1. Defining the problem. formulate a hypothesis, prepare a problem solving plan, make a drawing, create a problem solving procedure, solve a problem, carry out testing, interpret data and carry out hypothesis testing, draw conclusions, present results 2. Participation	**Criteria:** 1. Accuracy of problem formulation. formulate a hypothesis, prepare a problem solving plan, create a drawing, create a problem solving procedure, solve a problem, carry out testing, interpret data and carry out hypothesis testing, draw conclusions, present results, max score 50 2. Participative, min score 50 **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Practices / Performance	Short lecturer presentations, discussions, questions and answers, assignments to search for sources of information, group discussions to solve the problem of damage to 1-phase and 3-phase synchronous motors, presentations, summarizing the results, and reflection 2 X 50		**Material:** Provisions for insulation resistance test results, working voltage. **Reference:** *[4] PUIL 2011* **Material:** Electric motor repair **Reference:** *[5] Joko, Ismet Basuki, Alfredo AAP, 2021. Electric motor repair oriented to project based learning. Uesa University Press Surabaya*	6%
12	Students are able to calculate quantities for generators and 1-phase & 3-phase asynchronous motors	1. Calculating windings, flux, voltage, current, voltage loss, power factor in 1 phase & 3 phase synchronous and asynchronous motor generators 2. Create an equivalent circuit 3. Participation	**Criteria:** 1. Accuracy in calculating windings, flux, voltage, current, voltage loss, power factor in 1 phase & 3 phase synchronous and asynchronous motor generators, max score 30% 2. Create equivalent circuits, max score 10% 3. Participative, min score 50% 4. Presentation, max score 10% **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, group discussions calculate quantities for 1 phase & 3 phase asynchronous motor generators, 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:** Quantities of 1 phase and 3 phase induction motors **References:** *[2] Joko, 2018. Alternating Current Machine. 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 generators and motors **References:** *[1] Stephen J. Chapman, 2012. Electric Machinery Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Characteristics of 1 phase and 3 phase synchronous generators **References:** *[2] Joko, 2018. Alternating Current Machine. University Press: Surabaya* **Material:** Characteristics of asynchronous electric motors **References:** *[3] Slobodan N. Vukosavic, 2013. Electrical Machines. Springer-Verlag: New York*	5%
14	Students are able to calculate the losses and efficiency of 1-phase & 3-phase generators and asynchronous motors	1.Calculating the losses and efficiency of a 1-phase-3-phase synchronous generator/motor and summarizing the results 2.Presentation 3.Participation	**Criteria:** 1.Calculating the losses and efficiency of a 1-phase-3-phase synchronous generator/motor and summarizing the results, 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 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:** Losses and efficiency of asynchronous generators and motors **References:** *[1] Stephen J. Chapman, 2012. Electric Machine Fundamentals Fifth Edition. MCGraw-Hill: New York.* **Material:** Losses and efficiency of generators and asynchronous motors **References:** *[2] Joko, 2018. Alternating Current Machines. University Press: Surabaya* **Material:** Examples and practice questions **References:** *[3] Slobodan N. Vukosavic, 2013. Electrical Machines. Springer-Verlag: New York*	5%
15	Students are able to calculate the voltage regulation of asynchronous generators & asynchronous motor slip, and evaluate their conformity with provisions/regulations	1.Carry out voltage regulation calculations for 1-phase & 3-phase asynchronous generators, calculate the slip of 1-phase-3-phase induction motors, and evaluate their conformity with the rules and regulations (PUIL) 2.Presentation 3.Participative	**Criteria:** 1.Carry out voltage regulation calculations for 1-phase & 3-phase asynchronous generators, calculate the slip of 1-phase-3-phase induction motors, and evaluate their conformity 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 voltage regulation of 1 phase & 3 phase synchronous generators and 1 and 3 phase asynchronous motor slips, 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:** Tension and slip regulation provisions **Reference:** *[4] PUIL 2011*	5%

16	UTS	Can do UTS well, max score 100	**Form of Assessment** : Participatory Activities, Tests	UTS 2 X 50			20%

Evaluation Percentage Recap: Case Study

No	Evaluation	Percentage
1.	Participatory Activities	33.42%
2.	Project Results Assessment / Product Assessment	8.92%
3.	Portfolio Assessment	14.25%
4.	Practice / Performance	17.42%
5.	Test	26%
		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.