



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

Document Code

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight	SEMESTER	Compilation Date
AC Electrical Machines	2030502032	Compulsory Study Program Subjects	T=2 P=0 ECTS=3.18	4	July 17, 2024
AUTHORIZATION	SP Developer		Course Cluster Coordinator		Study Program Coordinator
		Mahendra Widartono, 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	Students have knowledge about synchronous generators, including: definition, working principles, types, parts and functions, armature windings and calculations of their quantities, generator characteristics (zero load, load, regulator, external and short circuit), losses, generator efficiency, and voltage regulation, and parallel work.
PO - 2	Students have the ability and are responsible for designing and selecting synchronous generators according to load characteristics and general electrical installation regulations (PUIL).
PO - 3	Students have knowledge about synchronous motors, including: definition, working principles, types, principles & methods of starting and braking, reversing the direction of rotation, regulation of rotation speed, characteristics (rotation characteristics, torque characteristics, mechanical characteristics) armature reactions, losses and yield (efficiency), and slip.
PO - 4	Students have the ability and responsible attitude to design and select synchronous motors according to load characteristics and general electrical installation regulations (PUIL).
PO - 5	Students have knowledge about asynchronous motors, including: definition, working principles, types, principles & methods of starting & braking, reversing direction of rotation, regulation of rotation speed, characteristics (rotation characteristics, torque characteristics, mechanical characteristics) armature reactions, losses and yield (efficiency), and slip.

PLO-PO Matrix

	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td>P.O</td></tr> <tr><td>PO-1</td></tr> <tr><td>PO-2</td></tr> <tr><td>PO-3</td></tr> <tr><td>PO-4</td></tr> <tr><td>PO-5</td></tr> </table>	P.O	PO-1	PO-2	PO-3	PO-4	PO-5
P.O							
PO-1							
PO-2							
PO-3							
PO-4							
PO-5							

PO Matrix at the end of each learning stage (Sub-PO)

	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <th rowspan="2">P.O</th> <th colspan="16">Week</th> </tr> <tr> <th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>13</th><th>14</th><th>15</th><th>16</th> </tr> <tr><td>PO-1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>PO-2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>PO-3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>PO-4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>PO-5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </table>	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																
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Short Course Description Students have knowledge about synchronous generators, synchronous and asynchronous 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. Djoko Achyanto, 1990. Mesin-Mesin Listrik. Jakarta : Erlangga.
2. Joko, 2013. Bahan Ajar Mesin Arus Bolak Balik. Jurusan Teknik Elektro Fakultas Teknik Unesa Surabaya
3. Mislani. 1991. Mesin Tak Serempak. Surabaya: University Press IKIP Surabaya
4. O'Kelly, Denis. 1992. Performance and Control of Electrical Machines. London: McGraw-Hill
5. Supar M. Dkk. 2009. Pembangunan Tenaga Listrik. BSE, BNSP depdikas, Jakarta
6. Ts. Mhd. Sulaiman, Mabuchi Magarisawa. 1984. Mesin Tak Serempak Dalam Praktek. Jakarta: Pradya Paramita

Supporters:

Supporting lecturer Mahendra Widartono, 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	<ol style="list-style-type: none"> 1.Explain the meaning of a synchronous generator 2.Explain the working principle of a synchronous generator 3.Analyze the types of synchronous generators 4.Identify the parts of a synchronous generator and their functions 5.Analyze the principles of voltage generation in synchronous generators 	<p>Criteria:</p> <ol style="list-style-type: none"> 1.The cognitive domain consists of 5 items and the max score for each item is 10, so the total max. 50 2.The psychomotor domain consists of 7 items and the maximum score for each item is 5, so the total is max.35 3.The affective domain consists of 10 items and the max score for each item is 1.5, so the total is max. 15 <p>Form of Assessment : Participatory Activities</p>	Direct learning model Presentation Discussion Questions and answers Practice Assignment Reflection 2 X 50		<p>Material: synchronous generator Reference: <i>Djoko Achyanto, 1990. Electrical Machines. Jakarta : Erlangga.</i></p>	5%
2	Able to understand the meaning, working principles, types of synchronous generators, and parts of synchronous generators	<ol style="list-style-type: none"> 1.Explain the meaning of a synchronous generator 2.Explain the working principle of a synchronous generator 3.Describe the types of synchronous generators 4.Describe the parts and functions of a synchronous generator 5.Explain the principle of generating voltage in a synchronous generator 6.Explain the meaning of a synchronous generator 7.Explain the working principle of a synchronous generator 8.Describe the types of synchronous generators 9. Describe the parts and functions of a synchronous generator 10.Explain the principle of generating voltage in a synchronous generator 	<p>Criteria: test</p> <p>Form of Assessment : Participatory Activities</p>	Direct learning model Presentation Discussion Questions and answers Practice Assignment Reflection 2 X 50		<p>Material: synchronous generator Reference: <i>Djoko Achyanto, 1990. Electrical Machines. Jakarta : Erlangga.</i></p> <p>Material: synchronous generator Reference: <i>Joko, 2013. Teaching materials for alternating current machines. Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</i></p>	5%
3	Able to understand synchronous generator coils	<ol style="list-style-type: none"> 1. Identify the type of synchronous generator coil 2. Calculating the stroke of the synchronous generator coil 3. Make a picture of the synchronous generator coil connections 4. Analyzing synchronous generator coil connections 	<p>Criteria:</p> <ol style="list-style-type: none"> 1.The cognitive domain consists of 4 items and the max score for each item is 14, so the total max. 56 2.The psychomotor domain consists of 7 items and the maximum score for each item is 4, so the total is max. 28 3.The affective domain consists of 10 items and the max score for each item is 1.6, so the total is max. 16 <p>Form of Assessment : Participatory Activities</p>	Problem-based learning model Presentation Discussion Questions and answers Practice Assignment/practice Reflection 2 X 50		<p>Material: synchronous generator Reference: <i>Joko, 2013. Teaching materials for alternating current machines. Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</i></p>	5%

4	Able to analyze the characteristics of synchronous generators	<ol style="list-style-type: none"> 1. Analyze the zero load characteristics of synchronous generators 2. Analyze the load characteristics of synchronous generators 3. Analyze the short circuit characteristics of synchronous generators 4. Analyze the differences in the characteristics of separate and self-amplifying synchronous generators 	<p>Criteria:</p> <ol style="list-style-type: none"> 1. The cognitive domain consists of 4 items and the max score for each item is 14, so the total max. 56 2. The psychomotor domain consists of 7 items and the maximum score for each item is 4, so the total is max. 28 3. The affective domain consists of 10 items and the max score for each item is 1.6, so the total is max. 16 <p>Form of Assessment : Participatory Activities</p>	Problem-based learning model Presentation Discussion Questions and answers Practice Assignment/practice Reflection 2 X 50		<p>Material: characteristics of synchronous generators Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%
5	Able to analyze the characteristics of synchronous generators	<ol style="list-style-type: none"> 1. Analyze the zero load characteristics of synchronous generators 2. Analyze the load characteristics of synchronous generators 3. Analyze the short circuit characteristics of synchronous generators 4. Analyze the differences in the characteristics of separate and self-amplifying synchronous generators 	<p>Criteria:</p> <ol style="list-style-type: none"> 1. The cognitive domain consists of 4 items and the max score for each item is 14, so the total max. 56 2. The psychomotor domain consists of 7 items and the maximum score for each item is 4, so the total is max. 28 3. The affective domain consists of 10 items and the max score for each item is 1.6, so the total is max. 16 <p>Form of Assessment : Participatory Activities</p>	Problem-based learning model Presentation Discussion Questions and answers Practice Assignment/practice Reflection 2 X 50		<p>Material: characteristics of synchronous generators Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%
6	Able to understand losses, generator efficiency, synchronous generator voltage regulation and synchronous generator circuit work	<ol style="list-style-type: none"> 1. Explain the causes of losses in synchronous generators 2. Calculating losses in synchronous generators 3. Calculating efficiency in synchronous generators 4. Calculating voltage regulation of synchronous generators 5. Explain the working conditions of a synchronous generator circuit 	<p>Criteria:</p> <ol style="list-style-type: none"> 1. The cognitive domain consists of 5 items and the max score for each item is 10, so the total max. 50 2. The psychomotor domain consists of 7 items and the maximum score for each item is 5, so the total is max. 35 3. The affective domain consists of 10 items and the max score for each item is 1.5, so the total is max. 15 <p>Form of Assessment : Participatory Activities</p>	Problem-based learning model Presentation Discussion Questions and answers Practice Assignments Reflection 2 X 50		<p>Material: asynchronous motor Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%

7	Able to understand the meaning, working principles, types of synchronous motors, synchronous motor parts & their functions, and the principles of generating rotation in synchronous motors	<ol style="list-style-type: none"> 1.Explain the meaning of a synchronous motor 2.Explain the working principle of a synchronous motor 3.Analyze the types of synchronous motors 4.Identify the parts of a synchronous motor and their functions 5.Analyze the principle of generating rotation in a synchronous motor 	<p>Criteria:</p> <ol style="list-style-type: none"> 1.The cognitive domain consists of 5 items and the max score for each item is 10, so the total max. 50 2.The psychomotor domain consists of 7 items and the maximum score for each item is 5, so the total is max.35 3.The affective domain consists of 10 items and the max score for each item is 1.5, so the total is max. 15 <p>Form of Assessment : Participatory Activities</p>	Problem-based learning model Presentation Discussion Questions and answers Practice Assignments Reflection 2 X 50		<p>Material: asynchronous motor</p> <p>Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%
8	Able to analyze the characteristics, losses, efficiency and slip of synchronous motors	<ol style="list-style-type: none"> 1.Analyze the zero load characteristics of synchronous motors 2.Analyze the load characteristics of synchronous motors 3.Analyze the short circuit characteristics of synchronous motors 4.Analyze the differences in the characteristics of separate amplifier and self-amplifier synchronous motors 5.Calculating losses in synchronous motors 6.Calculating efficiency in synchronous motors 7.Calculating synchronous motor slip 	<p>Criteria:</p> <ol style="list-style-type: none"> 1.The cognitive domain consists of 8 items and the max score for each item is 7, so the total max. 56 2.The psychomotor domain consists of 7 items and the maximum score for each item is 4, so the total is max. 28 3.The affective domain consists of 10 items and the max score for each item is 1.6, so the total is max. 16 <p>Form of Assessment : Participatory Activities</p>	Problem-based learning model Presentation Discussion Questions and answers Practice Assignment/practice Reflection 2 X 50		<p>Material: asynchronous motor</p> <p>Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%
9	Able to analyze the characteristics, losses, efficiency and slip of synchronous motors	<ol style="list-style-type: none"> 1.Analyze the zero load characteristics of synchronous motors 2.Analyze the load characteristics of synchronous motors 3.Analyze the short circuit characteristics of synchronous motors 4.Analyze the differences in the characteristics of separate and self-amplifying synchronous motors 5.Calculating losses in synchronous motors 6.Calculating efficiency in synchronous motors 7.Calculating synchronous motor slip 	<p>Criteria:</p> <ol style="list-style-type: none"> 1.The cognitive domain consists of 8 items and the max score for each item is 7, so the total max. 56 2.The psychomotor domain consists of 7 items and the maximum score for each item is 4, so the total is max. 28 3.The affective domain consists of 10 items and the max score for each item is 1.6, so the total is max. 16 <p>Form of Assessment : Participatory Activities</p>	Problem-based learning model Presentation Discussion Questions and answers Practice Assignment/practice Reflection 2 X 50		<p>Material: asynchronous motor</p> <p>Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%

10	Able to understand the meaning, working principles, types of synchronous motors, asynchronous motor parts & their functions, and the principles of generating rotation in 3 phase asynchronous (induction) motors	<ol style="list-style-type: none"> 1.Explain the meaning of a 3 phase asynchronous motor 2.Explain the working principle of a 3 phase asynchronous motor 3.Analyze the types of 3 phase asynchronous motors 4.Identify the parts of an asynchronous motor and their functions 5.Analyze the principle of generating rotation in a 3 phase asynchronous motor 	<p>Criteria:</p> <ol style="list-style-type: none"> 1.The cognitive domain consists of 5 items and the max score for each item is 10, so the total max. 50 2.The psychomotor domain consists of 7 items and the maximum score for each item is 5, so the total is max.35 3.The affective domain consists of 10 items and the max score for each item is 1.5, so the total is max. 15 <p>Form of Assessment : Participatory Activities</p>	Problem-based learning model Presentation Discussion Questions and answers Practice Assignment/practice Reflection 2 X 50		<p>Material: asynchronous motor</p> <p>Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%
11	Able to understand the meaning, working principles, types of synchronous motors, asynchronous motor parts & their functions, and the principles of generating rotation in 3 phase asynchronous (induction) motors	<ol style="list-style-type: none"> 1.Explain the meaning of a 3 phase asynchronous motor 2.Explain the working principle of a 3 phase asynchronous motor 3.Analyze the types of 3 phase asynchronous motors 4.Identify the parts of an asynchronous motor and their functions 5.Analyze the principle of generating rotation in a 3 phase asynchronous motor 	<p>Criteria:</p> <ol style="list-style-type: none"> 1.The cognitive domain consists of 5 items and the max score for each item is 10, so the total max. 50 2.The psychomotor domain consists of 7 items and the maximum score for each item is 5, so the total is max.35 3.The affective domain consists of 10 items and the max score for each item is 1.5, so the total is max. 15 <p>Form of Assessment : Participatory Activities</p>	Problem-based learning model Presentation Discussion Questions and answers Practice Assignment/practice Reflection 2 X 50		<p>Material: asynchronous motor</p> <p>Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%
12	Able to analyze the characteristics, losses, efficiency and slip of a 3 phase asynchronous motor	<ol style="list-style-type: none"> 1.Analyzing the zero load characteristics of a 3 phase asynchronous motor 2.Analyzing the load characteristics of a 3 phase asynchronous motor 3.Analyze the short circuit characteristics of a 3 phase asynchronous motor 4.Analyzing the causes of power losses in 3-phase asynchronous motors 5.Calculating losses in a 3 phase asynchronous motor 6.Calculating the efficiency of a 3 phase asynchronous motor 7.Calculating the slip of a 3 phase asynchronous motor 	<p>Criteria:</p> <ol style="list-style-type: none"> 1.The cognitive domain consists of 7 items and the max score for each item is 8, so the total max. 56 2.The psychomotor domain consists of 7 items and the maximum score for each item is 4, so the total is max. 28 3.The affective domain consists of 10 items and the max score for each item is 1.6, so the total is max. 16 <p>Form of Assessment : Participatory Activities</p>	Problem-based learning model Presentation Discussion Questions and answers Practice Assignment/practice Reflection 2 X 50		<p>Material: asynchronous motor</p> <p>Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%

13	Able to understand the meaning, working principles, types, parts & functions, and principles of rotation generation, characteristics, efficiency and slip on single-phase alternating current (AC) motors	<ol style="list-style-type: none"> 1.Explain the meaning of a single phase AC motor 2.Explain the working principle of a single phase AC motor 3.Analyze the types of single phase AC motors 4.Identify the parts of a single phase AC motor and their functions 5.Identify the types of single phase AC motors 6.Analyze the principle of generating rotation in a single phase AC motor 7.Analyze the zero load, loaded and short circuit characteristics of a single phase AC motor 8.Calculating losses, efficiency and slip on a single phase AC motor 	<p>Criteria:</p> <ol style="list-style-type: none"> 1.The cognitive domain consists of 8 items and the max score for each item is 7, so the total max. 56 2.The psychomotor domain consists of 7 items and the maximum score for each item is 4, so the total is max. 28 3.The affective domain consists of 10 items and the max score for each item is 1.4, so the total is max. 14 <p>Form of Assessment : Participatory Activities, Tests</p>	Problem-based learning model PresentationDiscussionQuestions and answersPracticeAssignment/practiceReflection 2 X 50		<p>Material: asynchronous motor</p> <p>Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%
14	Able to design and select asynchronous motors according to load characteristics and PUIL honestly and responsibly	<ol style="list-style-type: none"> 1.Design and select synchronous generators according to needs and PUIL responsibly 2.Design and select asynchronous motors according to load characteristics and PUIL 2000 honestly and responsibly 	<p>Criteria:</p> <ol style="list-style-type: none"> 1.The cognitive domain consists of 2 items and the max score for each item is 25, so the total max. 50 2.The psychomotor domain consists of 7 items and the maximum score for each item is 5, so the total is max.35 3.The affective domain consists of 10 items and the max score for each item is 1.5, so the total is max. 15 <p>Form of Assessment : Participatory Activities</p>	Problem-based learning model PresentationDiscussionQuestions and answersPracticeAssignment/practiceReflection 2 X 50		<p>Material: asynchronous motor</p> <p>Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%

15	Able to understand maintenance management of DC Power, generators and gen sets	<ol style="list-style-type: none"> 1. Explain generator maintenance procedures 2. Prepare generator maintenance 3. Perform generator maintenance 4. Create a report generator report 5. Explain the procedures for operating a generator 6. Describe generator maintenance procedures 7. Preparing to carry out generator maintenance 8. Describe the implementation of generator maintenance 9. Describe the things that are done in making a generator maintenance report 10. Describe generator maintenance procedures 11. Carrying out generator maintenance 12. Reporting the results of generator maintenance 	<p>Criteria:</p> <ol style="list-style-type: none"> 1. The cognitive domain consists of 3 items and the max score for each item is 10, so the total max. 30 2. The psychomotor domain consists of 7 items and the maximum score for each item is 5, so the total is max. 60 3. The affective domain consists of 10 items and the maximum score for each item is 1, so the total is max. 10 <p>Form of Assessment : Participatory Activities</p>	<p>Problem-based learning model Presentation Discussion Questions and answers Practice Assignment/practice Reflection 2 X 50</p>	<p>Material: induction motor Reference: Joko, 2013. <i>Teaching materials for alternating current machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	5%
16	-	-	<p>Criteria: -</p> <p>Form of Assessment : Test</p>	-	<p>Material: UAS Library: Joko, 2013. <i>Teaching Materials for Alternating Current Machines.</i> Department of Electrical Engineering, Faculty of Engineering, Unesa Surabaya</p>	25%

Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
1.	Participatory Activities	72.5%
2.	Test	27.5%
		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** 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.

