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

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Power System Analysis	2020103382	Compulsory Study Program Subjects	T=0	P=0	ECTS=0	5	February 27, 2024

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
	Unit Three Kartini, S.T., M.T., Ph.D	Unit Three , S.T., M.T., Ph.D	Dr. Lusia Rakhmawati, S.T., M.T.

Learning model	**Project Based Learning**	
Program Learning Outcomes (PLO)	**PLO study program which is charged to the course**	
	Program Objectives (PO)	
	PO - 1	Able to explain the basic introduction to electrical power system analysis
	PO - 2	Explain the 3 phase system
	PO - 3	Transmission line parameters and direct current power line introduction
	PLO-PO Matrix	

P.O
PO-1
PO-2
PO-3

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

P.O	Week															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PO-1																
PO-2																
PO-3																

Short Course Description	Introduction, Introduction to electric power systems, System Per Unit, Representation of power system components, Transmission line parameters, Introduction to direct current power lines, network modeling and calculations, Power flow solutions, symmetrical and unsymmetrical disturbances, transient stability, power system control, Basic concepts faults/short circuits, classification of types of short circuits, symmetric short circuit analysis, determination of safety capacity/circuit breaker, symmetric components, non-symmetric short circuit analysis, determination of positive, negative and zero sequence circuits, system stability analysis.
References	**Main :**

1. Diktat: Analisa Sistem Tenaga Listrik I dan II
2. Gross A., Charless. 1979. Power System Analisys . New York: John Wiley & sons
3. Moh. E. El-Hawary. 1986. Electrical Power System Design and Analisys . New York: McGraw-Hill Inc.
4. Stevenson Jr., William D. 1984. Elemen of Power System Analsys . New York: McGraw-Hill Inc.

Supporters:

1. Lazaar, Irwan. 1980. Electrical System Analysis and Design for Industrial Plants. New York. McGraw-Hill Book Company.
2. Grainger, John J. and Stevenson, William D. 1994. Power System Analysis. Singapore. McGraw-Hill

Supporting lecturer	Unit Three Kartini, S.T., M.T., Ph.D.

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	1. Students can and are able to understand, explain and provide a general description of the definition of symmetrical components and short circuit faults	1. Mention the types of short circuits in the system 2. Define the types of short circuits in the system	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Participatory Activities, Tests	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments		**Material:** System per unit **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.* **Material:** Basic background to electric power system analysis **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	1%

2	1. Calculating the breaker capacity (CB) in general 2. Calculating the breaker capacity (CB) due to short circuit current	1. Able to calculate short circuit current on generator without load 2. Able to calculate short circuit current on generator with load	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Participatory Activities, Tests	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments			2%
3	1. Determine the capacity of a breaker. 2. Calculate the capacity of a breaker due to the flow of short circuit current	1. Able to calculate the breaker capacity (CB) 2. Able to calculate the size of a breaker due to the flow of short circuit current	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Test	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments			1%

4	1. Understand symmetric components (positive sequence, negative sequence and zero) 2. Understand operator "a" on symmetric components	Explain direct current power lines	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Participatory Activities	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments		**Material:** Symmetrical Components **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	2%
5	Network modeling and calculations for power flow using the Gauss Seidel and Newton Raphson methods	Perform power flow calculations using the Gauss Seidel and Newton Raphson methods	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Test	Behaviorism/Direct learning/Lectures and discussions and assignments 2 X 50		**Material:** Electrical Power Flow **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	2%

6	Network modeling and calculations for power flow using the Gauss Seidel and Newton Raphson methods	Perform power flow calculations using the Gauss Seidel and Newton Raphson methods	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Test	Behaviorism/Direct learning/Lectures and discussions and assignments 2 X 50		**Material:** Power Flow Analysis **Bibliography:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	2%
7	Network modeling and calculations for power flow using the Gauss Seidel and Newton Raphson methods	Perform power flow calculations using the Gauss Seidel and Newton Raphson methods	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Test	Behaviorism/Direct learning/Lectures and discussions and assignments 2 X 50		**Material:** Newton Raphson Electrical Power Flow Analysis **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	5%

8	Short circuit 3 Ø: 1. short circuit 3 Ø to ground Directly 2. short circuit 3 Ø to ground through impedance	Midterm exam	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Test	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments		**Material:** UTS **Reference:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	20%
9	Explains symmetrical and asymmetrical disturbances	1. determine the positive sequence, negative sequence, and zero sequence, in the 3 Ø direct short circuit 2. determine the positive sequence, negative sequence, and zero sequence, in the 3 Ø short circuit via impedance	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Participatory Activities, Tests	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments		**Material:** Symmetrical Disorders **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	5%

10	Explains symmetrical and asymmetrical disturbances	1. determine the positive sequence, negative sequence, and zero sequence, in the 3 Ø direct short circuit 2. determine the positive sequence, negative sequence, and zero sequence, in the 3 Ø short circuit via impedance	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Participatory Activities, Tests	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments		**Material:** Symmetrical and unsymmetrical disturbances **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	5%
11	Explains symmetrical and asymmetrical disturbances	1. determine the positive sequence, negative sequence, and zero sequence, in the 3 Ø direct short circuit 2. determine the positive sequence, negative sequence, and zero sequence, in the 3 Ø short circuit via impedance	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Participatory Activities, Tests	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments		**Material:** Symmetrical and unsymmetrical disturbances **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	5%

12	Loss of synchronization on the system	1. Stable system 2. Unstable system	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Test	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments		**Material:** System stability **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	5%
13	Loss of synchronization on the system	1. Stable system 2. Unstable system	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Test	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments		**Material:** System stability **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	5%

14	Swing equation	The area criteria are the same	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Test	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments		**Material:** Equally Broad Criteria **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	5%
15	Swing equation	The area criteria are the same	**Criteria:** 1. The assessment criteria are carried out by looking at aspects: 2. • Participation: carried out by observing student activities (weight 2) 3. • UTS: carried out with an assessment during the middle of the semester (weight 2) 4. • UAS: carried out every semester to measure all indicators (weight 3) 5. • Task: carried out on each indicator (weight 3) 6. Student Final Grade: 7. Participation Score (2)%2 Lever Score (3)%2 UTS Score (2)%2 UAS Score (3) divided by 10. **Form of Assessment** : Test	Direct learning using the pulpit lecture method, exercises and giving 2 X 50 assignments		**Material:** Equally broad criteria **References:** *Stevenson Jr., William D. 1984. Elements of Power System Analysis. New York: McGraw-Hill Inc.*	5%
16			**Form of Assessment** : Test	Implementation is carried out offline/Offline 2 x 50			30%

Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
1.	Participatory Activities	11%
2.	Test	89%
		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.