	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
Transmission and Distribution Systems	2020103224		T=3	P=0	ECTS=4.77	6	July 18, 2024

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
	.....	.....	Dr. Lusia Rakhmawati, 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)
	PLO-PO Matrix

	P.O

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

Short Course Description		
References	**Main :**	

1.

1. W. Stevenson Jr. (2004). *Power System Analisys* . Diterjemahkan Kamal Idris. Jakarta: Penerbit Erlangga.
2. Hutauruk. (1985). Transmisi Daya Listrik. Jakarta: Penerbit Erlangga.
3. Artono Arismunandar& Sususmu Kuwahara. 1975. **Buku Pegangan Teknik Tenaga Listrik Jilid II** . Jakarta: PT. Pradnya Paramita.
4. Artono Arismunandar& Sususmu Kuwahara. 1975. **Buku Pegangan Teknik Tenaga Listrik Jilid III** . Jakarta: PT. Pradnya Paramita.
5. Departemen Energi dan Sumber Daya Mineral. 2004. **Sosialisasi Standar Latih Kompetensi (SLK) Tenaga Teknik Ketenagalistrikan Bidang Distribusi Tenaga Listrik** . Jakarta: Pusat Diklat Energi dan Ketenagalistrikan.
6. Makmun & Sri Lestari. 2007. ***Permasalahan Bidang Ketenagalistrikan di Indonesia*** . Jakarta: Fokus Media.
7. PLN Distribusi Jatim. 1997. **Konstruksi Jaringan Perusahaan Listrik Negara Distribusi Jawa Timur.**
8. Ray C. Mullirt. (1987). ***Electrical Wiring Commercial, Sixth Edition*** . Canada: Delmar Publisher Inc.
9. Stam H. N. C. 1993. **Keselamatan dan Kesehatan di Tempat Kerja** . Penebar Swadaya: Jakarta.
10. Standar Nasional Indonesia. 2000. **Persyaratan Umum Instalasi Listrik 2000** . Jakarta: Yayasan PUIL.
11. Standar Listrik Indonesia. 1988. **Gangguan pada Sistem Suplai yang diakibatkan oleh Peranti Listrik dan Perlengkapannya** . Jakarta: Departemen Pertambangan dan Energi.
12. Standar Listrik Indonesia. 1988. **Spesifikasi Desain untuk Jaringan Tegangan Menengah dan Jaringan Tegangan Rendah.** Jakarta: Departemen Pertambangan dan Energi.
13. T.A. Short. (2004). ***Electrical Distribution- HandBook*** . London: CRC Press.
14. Tri Wrahatnolo, Aditya C. Hermawan & Heru Subagyo. 2015. **Pembangunan dan Pemasangan Konstruksi SUTT/SUTET** . Surabaya; University Press.
15. Yamanaka. **Electric Wire & Cable** . Sinar Merbabu: Surabaya

Jurnal

1. IEEE Transaction on Power Apparatus and System
2. IEEE Transaction on Power Delivery
3. IEEE Spectrum
4. IEEE Power Engineer review.

Supporters:	

Supporting lecturer	Prof.Dr. Tri Wrahatnolo, M.Pd., M.T. Aditya Chandra Hermawan, S.ST., 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	After following the learning process, students have competency in: · Understanding national electricity policy · Understanding the growth of the electric power system, production, transmission and distribution, load studies, economical operation of the power system, protection and stability of the electric power system - Explaining the basic steps in improving quality, reliability and efficiency of electric power distribution · Understand basic concepts · Explain phases, complex power, power triangle, direction of power flow · Explain the relationship of voltage, current and power in a balanced three-phase circuit · Define important terminology in the system concept per unit- - Practice calculating voltage, current and power in a balanced three-phase circuit using a per unit system	Understanding: definition and understanding, National Electricity Policy, Growth of the electric power system, production, transmission and distribution, load studies, economical operation of the power system, system protection and stability of the electric power system The role of computers in statistics, improving the quality, reliability and efficiency of electric power distribution , Basic concepts: phase, complex power, power triangle, direction of power flow, Voltage, current and power in a balanced three-phase circuit, Concept and definition of system per unit, Practice questions to calculate voltage, current and power in a balanced three-phase circuit using system per unit.	**Criteria:** 1.- Participation assessment in discussions and questions and answers as well as enthusiasm in participating in demonstrations through providing examples of implementation 2.- Assignment Assessment	- Discussion - Demonstration through providing examples of application - Questions and Answers - Giving 3 X 50 assignments			0%

2	After following the learning process, students have competence in: · Defining important terminology for transmission line parameters: resistance, inductance, capacitance and susceptance · Explaining the meaning of resistance · Understanding the magnetic field that arises in transmission lines · Understanding the concepts of inductance - Explaining the concepts GMR and GMD concepts · Calculating resistance and conductance in single-phase and three-phase transmission lines · Understanding skin effects · Determining inductance in beam conductors, parallel lines. - Calculating the inductance of three phase lines	Students understand transmission line parameters: resistance, inductance, capacitance and susceptance, magnetic fields that arise in transmission lines, inductance concepts, GMR and GMD concepts, resistance and conductance in single-phase and three-phase transmission lines, skin effects effect), Inductance in beam conductors, parallel lines, and three-phase line inductance calculations.	**Criteria:** 1.Participation value with a range of 0 - 100 2.The score for solving questions for items 1 and 2 each has a score of 30, while item 3 has a score of 40.	Discussion, providing examples of application, assignments and problem based learning in the 3 X 50 theory class			0%
3	After following the learning process, students have competency in: · Understanding the electric fields that arise in transmission lines · Understanding the concepts of capacitance in transmission lines - Understanding capacitance in three-phase transmission lines · Explaining the influence of the earth on the capacitance of three-phase transmission lines · Determining Capacitance in beam conductors, parallel lines. - Practice calculating capacitance values on transmission lines	Understanding of the electric field that arises in transmission lines, the concepts of capacitance in transmission lines, capacitance in three-phase transmission lines, the influence of the earth on the capacitance of three-phase transmission lines, determining capacitance in beam conductors, parallel lines and calculating capacitance values in three-phase transmission lines phase.	**Criteria:** 1.Assessment of participation and anticipation in discussions and questions and answers through a checklist, with a score of 0-100 2.Assessment of understanding through completing tasks, score 0-100.	- Learning strategies use discussion, questions and answers and practice questions. 3 X 50			0%
4	After following the learning process, students have competence in: · Explaining the meaning of transmission line representation · Understanding the classification of transmission lines: short medium and long · Understanding power flow on short transmission lines - Practicing calculating power flow on short transmission lines - Understanding power flow on medium transmission lines · Practice calculating power flow on intermediate transmission lines	Understanding of the meaning of transmission line representation, classification of transmission lines: short medium and long, power flow on short transmission lines, calculation of power flow on short transmission lines, power flow on medium transmission lines and calculation of power flow on medium transmission lines.	**Criteria:** 1.- Assessment score for participation in discussions and questions and answers, 0-100 2.- Assessment score in solving questions 0-100	- Discussion and questions and answers - Solving 3 X 50 questions			0%

5	After following the learning process, students have competence in: · Explaining the meaning of long transmission line representation · Explaining the equivalent circuit on a long transmission line · Understanding power flow through a long transmission line · Explaining the steps to calculate power flow on a long transmission line · Transmission · Understanding the concept of transients transmission lines · Perform transient analysis: traveling waves and reflections	Understanding of: representation of long transmission lines, equivalent circuits on long transmission lines, power flow through long transmission lines, steps to calculate power flow on long transmission lines, power flow calculations using hyperbolic equations, concept of transmission line transients, transient analysis: traveling waves and reflection.	**Criteria:** 1.- Lectures, discussions and questions and answers, score 0-100 2.- Solving questions, score 0-100	- Lectures, discussions and questions and answers - Solving questions. 3 X 50			0%
6	After following the learning process, students have competency in: · Understanding the basic concepts of direct current transmission lines · Explaining the advantages and disadvantages of direct current transmission lines Understanding the application of direct current transmission lines	Understanding of the basic concepts of direct current transmission lines, the advantages and disadvantages of direct current transmission lines and the application of direct current transmission lines	**Criteria:** 1.The checklist assessment score uses a range of 0-100 2.Assignment/paper assessment score 0-100	Lectures, discussions and questions and answers 3 X 50			0%
7	After following the learning process, students have competency in: · Understanding the construction of transmission lines: overhead lines and ground cables · Explaining the construction of overhead transmission line towers · Explaining the construction of insulators and other components · Explaining the construction of conductors: ACSR, ACSA Explaining calculations tensile strength of conductors · Planning transmission line construction: overhead lines · Explaining electrical planning construction · Explaining mechanical planning construction · Explaining the selection of support towers · Explaining substations · Explaining overhead line construction · Understanding planning tasks	- Understanding of transmission line construction: overhead lines and ground cables), construction of overhead transmission line towers, construction of insulators and other components, conductor construction: ACSR, ACSA, and calculation of conductor tensile strength. - Planning and construction of SUTT and SUTET, main substation	**Criteria:** 1.Assessment of participation and enthusiasm in questions and answers and discussions, score 0-100 2.Assessment of planning reports. score 0-100	- Lectures, demonstrations, questions and answers and discussions - Giving assignments 3 X 50			0%

8	After following the learning process, students have competence in: 1. Knowing, classifying and analyzing data as well as communicating ideas and information about electric power distribution systems 2. Able to analyze problems, consumption and needs for electric power and development prospects 3. Know , classify, and analyze data as well as communicate ideas and information about the Basic Concepts of Electrical Power Distribution Systems 4. Able to analyze problems and resolve electrical power distribution networks 5. Calculate voltage losses, load point voltages, line end voltages, power losses, system efficiency and cross-sectional size 6. Able to analyze problems and solve direct current electric power distribution networks	Students' understanding of Electric Power Distribution Systems, problems, consumption and demand for electric power and development prospects, Basic Concepts of Electric Power Distribution Systems, solutions to electric power distribution networks, voltage losses, load point voltage, line end voltage, power losses, system efficiency and cross-sectional dimensions, problem analysis, and resolution of direct current electric power distribution networks.	**Criteria:** 1.Assessment of participation in lecture activities, discussions, questions and answers, practice questions, score 0-100 2.Assessment of task/question completion, score 0-100.	Lectures, discussions, questions and answers, practice questions and assignments. 3 X 50			0%
9	After following the learning process, students have competence in: 1. Calculating voltage losses, load point voltage, end of line voltage, power losses, system efficiency and cross-section sizes 2. Able to analyze problems and solve direct current electric power distribution networks 3. Calculate losses voltage, load point voltage, line end voltage, power losses, system efficiency and cross-sectional size 4. Able to analyze problems and solve direct current electric power distribution networks 5. Understand systems, primary distribution, distribution substations, distribution transformers, transformer banks, services consumers, and load types 6. Able to analyze problems and solve direct current electric power distribution networks	Student understanding of Alternating Current Electric Power Distribution Systems 1 Concept of alternating current distribution system 2 Single phase Distribution System 3 Single phase three wire Distribution System 4 Three phase three wire Distribution System 5 Three phase four wire Distribution System 6 Load asymmetry 7. Vector diagram of Primary Distribution Network System Loads 1 Definition of distribution function 2 Grouping of distribution networks 3 Classification of Distribution channels 4 Primary distribution system Secondary Distribution Network System 1 Primary Distribution System 2 Distribution substations 3 Distribution transformers 4 Transformer Banks 5 Consumer services 6 Types of loads	**Criteria:** 1.Assessment of participation in lectures, discussions, questions and answers, practice solving questions, score 0-100 2.Assessment of completion of assignments/questions with a score of 0-100.	Lectures, discussions, questions and answers, practice solving questions, and giving assignments. 3 X 50			0%

10	After following the learning process, students have competence in: 1. Calculating voltage losses, load point voltage, end of line voltage, power losses, system efficiency and cross-section sizes 2. Able to analyze problems and solve direct current electric power distribution networks 3. Calculate losses voltage, load point voltage, line end voltage, power losses, system efficiency and cross-sectional size 4. Able to analyze problems and solve direct current electric power distribution networks 5. Understand systems, primary distribution, distribution substations, distribution transformers, transformer banks, services consumers, and load types 6. Able to analyze problems and solve direct current electric power distribution networks	Student understanding of Alternating Current Electric Power Distribution Systems 1 Concept of alternating current distribution system 2 Single phase Distribution System 3 Single phase three wire Distribution System 4 Three phase three wire Distribution System 5 Three phase four wire Distribution System 6 Load asymmetry 7. Vector diagram of Primary Distribution Network System Loads 1 Definition of distribution function 2 Grouping of distribution networks 3 Classification of Distribution channels 4 Primary distribution system Secondary Distribution Network System 1 Primary Distribution System 2 Distribution substations 3 Distribution transformers 4 Transformer Banks 5 Consumer services 6 Types of loads	**Criteria:** 1. Assessment of participation in lectures, discussions, questions and answers, practice solving questions, score 0-100 2. Assessment of completion of assignments/questions with a score of 0-100.	Lectures, discussions, questions and answers, practice solving questions, and giving assignments. 3 X 50			0%

11	After following the learning process, students have competence in: 1. Calculating voltage losses, load point voltage, end of line voltage, power losses, system efficiency and cross-section sizes 2. Able to analyze problems and solve direct current electric power distribution networks 3. Calculate losses voltage, load point voltage, line end voltage, power losses, system efficiency and cross-sectional size 4. Able to analyze problems and solve direct current electric power distribution networks 5. Understand systems, primary distribution, distribution substations, distribution transformers, transformer banks, services consumers, and load types 6. Able to analyze problems and solve direct current electric power distribution networks	Student understanding of Alternating Current Electric Power Distribution Systems 1 Concept of alternating current distribution system 2 Single phase Distribution System 3 Single phase three wire Distribution System 4 Three phase three wire Distribution System 5 Three phase four wire Distribution System 6 Load asymmetry 7. Vector diagram of Primary Distribution Network System Loads 1 Definition of distribution function 2 Grouping of distribution networks 3 Classification of Distribution channels 4 Primary distribution system Secondary Distribution Network System 1 Primary Distribution System 2 Distribution substations 3 Distribution transformers 4 Transformer Banks 5 Consumer services 6 Types of loads	**Criteria:** 1.Assessment of participation in lectures, discussions, questions and answers, practice solving questions, score 0-100 2.Assessment of completion of assignments/questions with a score of 0-100.	Lectures, discussions, questions and answers, practice solving questions, and giving assignments. 3 X 50			0%
12	After following the learning process, students have competency in: 1. Able to prepare, collect, organize and analyze data and communicate ideas and information about above-ground distribution networks 2. Determine the impedance of above-ground distribution networks 3. Able to prepare, collect , organize and analyze data and communicate ideas and information about underground distribution networks 4. Determine the impedance of underground distribution networks	Understanding about: Overhead Lines, 1 Conductor Data 2 Network Impedance 3 Underground Distribution Network Interference, 1 Conductor/Cable Data 2 Network Impedance 3 Cable Reliability 4 Interference	**Criteria:** 1.Assessment of demonstration activities, discussions and questions and answers through observation. score 0-100 2.Assessment of task completion activities through an assessment sheet, score 0-100	Demonstrations, discussions, questions and answers and giving assignments. 3 X 50			0%

13	After following the learning process, students have competency in: 1. Able to prepare, collect, organize and analyze data and communicate ideas and information about above-ground distribution networks 2. Determine the impedance of above-ground distribution networks 3. Able to prepare, collect , organize and analyze data and communicate ideas and information about underground distribution networks 4. Determine the impedance of underground distribution networks	Understanding about: Overhead Lines, 1 Conductor Data 2 Network Impedance 3 Underground Distribution Network Interference, 1 Conductor/Cable Data 2 Network Impedance 3 Cable Reliability 4 Interference	**Criteria:** 1.Assessment of demonstration activities, discussions and questions and answers through observation. score 0-100 2.Assessment of task completion activities through an assessment sheet, score 0-100	Demonstrations, discussions, questions and answers and giving assignments. 3 X 50			0%
14	After following the learning process, students have competency in: 1. Able to prepare, collect, organize and analyze data and communicate ideas and information about above-ground distribution networks 2. Determine the impedance of above-ground distribution networks 3. Able to prepare, collect , organize and analyze data and communicate ideas and information about underground distribution networks 4. Determine the impedance of underground distribution networks	Understanding about: Overhead Lines, 1 Conductor Data 2 Network Impedance 3 Underground Distribution Network Interference, 1 Conductor/Cable Data 2 Network Impedance 3 Cable Reliability 4 Interference	**Criteria:** 1.Assessment of demonstration activities, discussions and questions and answers through observation. score 0-100 2.Assessment of task completion activities through an assessment sheet, score 0-100	Demonstrations, discussions, questions and answers and giving assignments. 3 X 50			0%
15	After following the learning process, students have competency in: 1. Able to identify, collect and analyze data and communicate ideas and information about the application of power capacitors in distribution networks 2. Able to calculate power factor improvements 3. Able to collect, identify, differentiate, operate and analyze data and communicate ideas and information about Distribution Network Planning 4. Able to create a distribution network design model at a location	Ability to identify, collect and analyze data and communicate ideas and information about the application of power capacitors in distribution networks; calculating power factor improvements; collect, identify, differentiate, operate and analyze data and communicate ideas and information about Distribution Network Planning; create a distribution network design model at a location.	**Criteria:** 1.Check list sheet for assessing student participation in discussions, demonstrations, questions and answers, and exercises, score 0-100 2.Assessment sheet for completing assignments, score 0-100	Discussion, demonstration, question and answer, practice, and completion of 3 X 50 assignments			0%
16							0%

Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
		0%

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.