	Universitas Negeri Surabaya Faculty of Mathematics and Natural Sciences Undergraduate Physics Study Program	Document Code

SEMESTER LEARNING PLAN

Courses	CODE	Course Family	Credit Weight			SEMESTER	Compilation Date
Magnetic Electricity	4520103114	Compulsory Study Program Subjects	T=3	P=0	ECTS=4.77	4	August 18, 2023

AUTHORIZATION	SP Developer	Course Cluster Coordinator	Study Program Coordinator
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Learning model	**Project Based Learning**	
Program Learning Outcomes (PLO)	**PLO study program that is charged to the course**	
	PLO-11	Design and conduct experiments in physics learning by applying scientific methods
	Program Objectives (PO)	
	PO - 1	Have the ability to think critically and use appropriate concepts to qualitatively analyze problems or situations involving physics, in this case electricity and magnetism
	PO - 2	Demonstrate a responsible attitude towards work in their field of expertise independently
	PO - 3	Have the ability to use physics concepts and appropriate mathematical/computational methods to obtain solutions to quantitative problems in solving magnetic electricity problems
	PO - 4	Mastering the materials, structures and concepts of physics and their application in technology
	PO - 5	Implementing high-level thinking processes (critical, creative, logical, and problem solving) in studying physical processes and phenomena, especially magnetic electricity, both inductively and deductively
	PO - 6	Using symbolic and numerical language creatively in describing electrical and magnetic processes and phenomena qualitatively and quantitatively
	PO - 7	Able to work independently or collaborate in groups on lecture assignments and practical activities in the laboratory
	PLO-PO Matrix	

P.O	PLO-11
PO-1	
PO-2	
PO-3	
PO-4	
PO-5	
PO-6	
PO-7	

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																
PO-4																
PO-5																
PO-6																
PO-7																

Short Course Description	So this Magnetic Electricity Lecture includes a discussion of the concepts: Vector analysis, gradient, divergence, curl, Stokes' theorem, electric field, Coulomb's law, electric field, Gauss's law, electric potential, electric dipole, electric energy multipole, field energy density, Laplace's equation and Poisson's equation, boundary conditions, shadow method, variable separation method. dielectric materials: polarization vector, polarization charge, displacement vector D, Gauss's law for D. Electric Current: flow of electric charge, continuity equation. Magnetic fields: Lorentz force, Biot-Savart law, vector potential, Ampere's law, magnetic dipole moment, switch potential, magnetization, magnetic poles, Ampere's law for H, magnetic materials, hysteresis. Magnetic effects, displacement currents, Maxwell's equations. Learning is carried out using the case study method and carrying out activities in the laboratory (the process of collecting data, reporting and presenting the results of laboratory activities).
References	**Main :**
	1. David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition 2. TIM. Buku Panduan Praktikum Lisrik Magnet. TIM Listrik Manget, 2018
	Supporters:
	1. Mahmud Zaki, 2000. Medan Elektromagnetik (Bagian I). Jurusan Fisika FMIPA ITS. 2. Reitz, JR. & Milford, FJ. 1990. Foundations of Elektromagnetic Theory. Third Edition Addison-Wesley Publishing Company Reading Masschusetts MenloPark. California
Supporting lecturer	Diah Hari Kusumawati, S.Si., M.Si. Abd. Kholiq, S.Pd., M.T. Dr. Rohim Aminullah Firdaus, S.Pd, M.Si Dr. Fitriana, S.Si.

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	Analyze the concepts of electrostatic fields in solving questions and problems in natural events.	1.Applying the concept of interaction force of point charges which is a fundamental law of electricity 2.Calculate the electric field strength in a vacuum around an electric charge	**Criteria:** Able to work on questions about interaction forces on charges and electric field strength (Quantitative) **Form of Assessment** : Participatory Activities	Form: Lecture • Discussion • Problem Solving • Independent assignment • Power point media (PPT 2x50 minutes	2 x 50 minute discussions	**Material:** Electrostatic fields **Bibliography:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Coulomb law **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	3%
2	Analyze the concepts of electrostatic fields in solving questions and problems in natural events.	Analyzing electric field strength for continuously distributed charges.	**Criteria:** Able to explain and determine electric field strength (Quantitative and independent assignment) **Form of Assessment** : Participatory Activities	Form: Lecture • Discussion • Problem Solving • Independent assignment • Power point media (PPT 2x50 minutes	2 x 50 minute discussions	**Material:** Electric field **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Continuous charge distribution **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	3%

3	Analyze electric field strength by applying Gauss's Law and the curl operator.	1. Apply Gauss's Law to calculate electric field strength 2. Apply the concept of Divergence and Curl to determine the electric field strength. 3. Comparing the results of electric field calculations with mathematical methods and Gauss's Law	**Criteria:** Able to explain and determine electric field strength (Quantitative and independent assignment) **Form of Assessment** : Participatory Activities	Form: Lecture • Discussion • Problem solving • Independent assignment • Power point media (PPT) 2x50 minutes	Independent assignments 2x50 minutes	**Material:** Divergence and curl of electrostatic fields **Reference:** *Mahmud Zaki, 2000. Electromagnetic Fields (Part I). ITS FMIPA Physics Department.* **Material:** Gauss's Law field lines and Applications of Gauss's Law **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Curl of electric fields. **Bibliography:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	3%
4	1. Analyze and carry out measurements related to charging and discharging capacitors 2. Analyze the electric field strength by applying Gauss's Law and the curl operator.	1. Able to analyze and carry out measurements related to charging and discharging capacitors or Faraday's Law 2. Comparing the results of electric field calculations with mathematical methods and Gauss's Law	**Criteria:** 1. Able to analyze and carry out measurements related to charging and discharging capacitors or Faraday's Law 2. Able to explain and determine electric field strength using Gauss's Law (Quantitative and independent assignment) **Forms of Assessment** : Participatory Activities, Portfolio Assessment, Practical Assessment	Practice 3x50 minutes	Independent assignments 2x50 minutes	**Material:** Capacitors **Library:** *TIM. Magnetic Electrical Practical Guidebook. Manget Electricity TEAM, 2018*	10%

5	Analyze the concept of electric potential of charge with different methods	Analyzing electric potential with Laplace and Poisson's equations	**Criteria:** Can identify electric potential using Laplace and Poisson's equations well and independently **Form of Assessment** : Participatory Activities	Form: Lecture • Discussion • Problem solving • Independent assignment • Power point media (PPT) 2x50 minutes	2 x 50 minute discussions	**Material:** Electric potential **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Poisson's and Laplace's equations **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Potential of localized charge distribution **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	4%
6	1. Analyze the concept of electric potential of charge with different methods 2. Analyze and carry out measurements related to RLC or electric current balance circuits	1. Determines the electric potential from localized charge distribution 2. Able to analyze and carry out measurements related to RLC or Electric Current Balance circuits	**Criteria:** 1. Able to carry out RLC or electric current balance circuit practicum according to the module well and report the practicum results in the form of a practicum report 2. Can solve problems related to fields, potential, charge distribution at the boundary between media and multipole expansion well and independently **Form of Assessment** : Participatory Activities, Practical Assessment	Form: Lecture • Discussion • Problem solving • Independent assignment • Power point media (PPT) 2x50 minutes	2 x 50 minute discussions	**Material:** Electrostatics in boundary conditions **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Multipole Expansion **Bibliography:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	10%
7	Analyze the concept of electric potential of charge with different methods	Analyze the relationship between field, potential, and charge distribution at the boundary between media	**Criteria:** Can solve problems related to fields, potential, charge distribution at the boundary between media and multipole expansion well and independently **Form of Assessment** : Participatory Activities	Practicum 3x50 minutes	Independent assignments 2x50 minutes	**Material:** RLC circuit **Library:** *TIM. Magnetic Electrical Practical Guidebook. Manget Electricity TEAM, 2018*	3%

8	1. Analyze the concepts of electrostatic fields in solving questions and problems in natural events. 2. Analyze the electric field strength by applying Gauss's Law and the curl operator 3. Analyze the concept of electric potential of charge with different methods	Maximum score if the questions are done well and correctly	**Criteria:** Quantitative, test **Form of Assessment** : Test	Midterm 2x50 minutes	Independent assignments 2x50 minutes	**Material:** Chapters 1-3 **Bibliography:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	15%
9	Determine the potential energy of discrete charges and continuous distributed charges	1. Determines the potential energy of a discrete charge from an infinite position to a specified distance from the charge 2. Determining the potential energy from discrete charges to the case of continuous distributed charges	**Criteria:** Identify potential energy for discrete charges under various conditions **Form of Assessment** : Participatory Activities	Form: Lecture • Discussion • Problem solving • Independent assignment • Power point media (PPT) 2x50 minutes		**Material:** Discrete charge potential energy **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Electrostatic field energy **Bibliography:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	3%

10	Analyzing several methods for calculating electrical potential energy for physical systems adapted to the coordinate system	1. Determining the potential in areas far from the charge source using the multipole expansion method 2. Explain the uniqueness of the solution of electrostatic problems with theorems on potential limits and charge limits	**Criteria:** Determine the solution to electrostatic problems with multipole expansion and potential and charge limit theorems **Form of Assessment** : Participatory Activities	Form: Lecture • Discussion • Problem solving • Independent assignment • Power point media (PPT) 2x50 minutes	Independent assignment, making a poster on magnetism material 2x50 minutes	**Material:** Multipole Expansion **Bibliography:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Uniqueness of solutions to electrostatic problems • Theorem I uniqueness of potential limits • Theorem II uniqueness of charge limits **References:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Variable separation method o Cartesian coordinates o Spherical coordinates o Cylindrical coordinates **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Shadow method • Induced charge • Potential energy **References:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	4%

11	Analyzing several methods for calculating electrical potential energy for physical systems adapted to the coordinate system	1. Analyze mathematically the physical system of electrical potential energy (from the shape and symmetry of the system in question) adjusted to the selection of a particular coordinate system and the variables used 2. Explains other methods of determining potential for charge distribution systems and grounded conductor surfaces as well as determining potential energy	**Criteria:** Create a resume, explain and discuss potential energy physical systems for charge distribution systems **Form of Assessment** : Participatory Activities	Form: Lecture • Discussion • Problem solving • Independent assignment • Power point media (PPT) 2x50 minutes	Continue making posters 2x50 minutes	**Material:** Multipole Expansion **Bibliography:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Uniqueness of solutions to electrostatic problems • Theorem I uniqueness of potential limits • Theorem II uniqueness of charge limits **References:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Variable separation method o Cartesian coordinates o Spherical coordinates o Cylindrical coordinates **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	4%
12	Apply the concept of potential and multipole expansion of static (magnetostatic) fields and the underlying laws	1. Explain the concept of magnetic materials and magnetic field lines 2. Applying the concept that charges moving in a magnetic field will experience Lorentz forces 3. Explain the concept of current and current density in a physical system with a magnetic field 4. Linking current and magnetic fields	**Criteria:** Create a resume, describe and discuss magnetic materials and the laws underlying magnetic characteristics as well as the relationship between current and magnetic fields **Form of Assessment** : Participatory Activities	3 x 50 minute discussions	Independent Assignment 2x50 minutes	**Material:** Faraday's Law **Reference:** *TIM. Magnetic Electrical Practical Guidebook. Manget Electricity TEAM, 2018*	4%

13	Apply the concept of potential and multipole expansion of static (magnetostatic) fields and the underlying laws	1. Apply/apply divergence and curl operators to magnetic field equations to determine the magnetic field of a physical 2. Applying Ampere's Law in calculating magnetic fields in differential and integral form 3. Apply the definition of magnetic vector potential to solve the fundamental differential law of magnetostatics 4. Relates the relationship between magnetic field, potential and current density at the boundary surface between two media 5. Determining the multipole expansion, especially the dipole term in the magnetic vector potential	**Criteria:** Determining the multipole expansion in the magnetic vector potential **Form of Assessment** : Participatory Activities	Form: Lecture • Lecture • Discussion • Problem solving • Practice questions • Power point media (PPT) 2x50 minutes	Presentation of product results 2x50 minutes	**Material:** Magnetic field 1. Introduction 2. Lorentz force 3. Current distribution force 4. Biot-Savart law **Bibliography:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Magnetostatic differential equations and Ampere's law 1. Divergence of magnetic fields 2. Curl of magnetic fields 3. Ampere's law **Bibliography:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Vector potential • Magnetostatic boundary conditions • Magnetic dipole moment **References:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	5%

14	Analyze concepts related to electrical motion, Ohm's law, Faraday's and Lenz's laws and obtain solutions to electromagnetic wave equations and the propagation of energy and momentum.	1. Analyzing the relationship between the movement of charges in a closed path traversed by the electric field itself which is an empirical constant 2. Analyzing the concept of Faraday's law of induction and Lenz's principle in constant magnetic fields and magnetic fields changing with time 3. Determines the magnetic field energy of a field that changes with time	**Criteria:** Explain the magnetic concept of charges moving in closed paths, constant fields and fields that change with time **Form of Assessment** : Participatory Activities	Form: Lecture • Discussion • Problem Solving • Practice questions • Power point media (PPT) 2x50 minutes	Presentation of poster results 2x50 minutes	**Material:** Electrodynamics • Electromotive force and ohm's law 1. Electromotive force 2. Ohm's law **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Faraday's law of induction 1. Electromagnetic induction 2. Inductance. 3. Magnetic field energy **Bibliography:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Maxwell: • Inconsistencies in the electromagnetic equations • Maxwell's equations **Reference:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition* **Material:** Electromagnetic waves • Wave equations • Plane waves • Energy and momentum propagation **References:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	4%
15	Determining the inconsistency of Maxwell's equations and describing the electromagnetic wave equation from Maxwell's equations (case study)	1. Explaining inconsistencies in the electromagnetic equation (Ampere's law) 2. Explaining Maxwell's equations as a result of "improving" Ampere's law 3. Able to explain, describe and communicate about the applications of electromagnetic waves	**Criteria:** 1. Able to describe the form and application of electromagnetic waves in everyday life 2. Identify the mathematical form of Maxwell's equation in electromagnetic waves **Forms of Assessment** : Participatory Activities, Portfolio Assessment, Practical Assessment	3x50 minute discussion	Independent assignments 2x50 minutes	**Material:** Electric Current Balance **Library:** *TIM. Magnetic Electrical Practical Guidebook. Manget Electricity TEAM, 2018*	10%

16	UAS	Presentation of each group's products as UAS scores	**Criteria:** Presentation of the results of a review of material on the application of electromagnetic waves in everyday life **Form of Assessment** : Test	Presentation of the results of discussion on the application of electromagnetic waves with products in the form of posters 2x50 minutes	Poster Product Presentation 4x50 minutes	**Material:** UAS **Reader:** *David j Griffiths, 2013, Introduction to Electrodynamics, Fourth edition, Prentice Hall, International edition*	15%

Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
1.	Participatory Activities	51.66%
2.	Portfolio Assessment	6.66%
3.	Practical Assessment	11.66%
4.	Test	30%
		99.98%

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.