	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
Geophysical Measurement Methods	4520102142	Study Program Elective Courses	T=2	P=0	ECTS=3.18	6	July 18, 2024

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-4	Develop yourself continuously and collaborate.
PLO-5	Able to demonstrate as a good scientist, critical thinking skills and innovation in research and professional fields.
PLO-8	Able to make decisions based on data and information in order to fulfill and evaluate responsibilities according to their duties.
PLO-10	Analyze physical systems by applying mathematics and computing/ICT tools.
PLO-12	Have the ability to improve their knowledge and be able to continue their studies to a higher level.
PLO-14	Formulate physical systems as physical models using mathematics
PLO-15	Solve problems in physical systems comprehensively using mathematics and computational tools.

Program Objectives (PO)	
PO - 1	Realizing an independent, creative and honest character in carrying out lecture assignments, UTS and UAS Geophysical Measurement Methods.
PO - 2	Mastering the structured study of various methods commonly used in geophysical surveys to reveal information about subsurface and near-surface structures at survey locations which includes measuring local physical quantity anomalies.
PO - 3	Apply one of the geophysical methods in the decision-making process regarding accurate identification and characterization of subsurface and near-surface structures at geophysical survey locations.
PO - 4	Understand the differences in field data collection and processing techniques between one geophysical method and another in the context that one method is complementary to another.

PLO-PO Matrix

P.O	PLO-4	PLO-5	PLO-8	PLO-10	PLO-12	PLO-14	PLO-15
PO-1	✔	✔					✔
PO-2			✔	✔	✔	✔	
PO-3		✔	✔	✔	✔	✔	
PO-4			✔	✔	✔	✔	

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						✔	✔		✔	✔	✔	✔				

Short Course Description	Geophysical Measurement Methods study the Earth as a physical system with a layered and complex structure with differences in physical characteristics between layers of crustal rock that form the structure of the Earth which can be determined through field surveys, survey data collection and processing techniques that involve the application of geophysical methods, both single methods and combination methods. Although data collection (both single and combined methods) relies on field surveys, the role of modeling (both 2D and 3D) of subsurface and near-surface structures is crucial in the process of identifying and characterizing the physical system being studied. The geophysical methods studied in lectures are gravity methods, seismic methods (reflection, refraction, tomography), magnetic methods, geoelectric methods, and electromagnetic methods.
References	**Main :**

1. Telford, M. W., Geldart, L. P., Sheriff, R. E. and Keys, D. A. 1990. Applied Geophysics. 2nd Edition. New York: Cambridge University Press, US. pp.1-744.
2. Blakely, R. J. 1995. Potential Theory in Gravity and Magnetic Applications. Cambridge: Cambridge University Press, UK. pp.1-512.
3. Hinze, W. J., von Frese, R. R. B. and Saad, A. H. 2013. Gravity and Magnetic Explorations: principles, practices, and applications. University Printing House: Cambridge University Press, UK. pp.1-512.
4. Reynolds, J. M. 1997. An Introduction to Applied and Environmental Geophysics. Chichester: John Wiley and Sons Ltd., UK. pp.1-711.
5. Glatzmaier, G. A. 2001. Convection in the core and the generation of the Earth's magnetic field. An American Museum of Natural History Book. The New Press, New York: US. pp.62-67.
6. Stein, S. and Wysession, M. 2003. An Introduction to Seismology, Earthquake, and Earth Structure. Malden, MA: Blackwell Publishing, US. pp.1-498.
7. Everett, M. E. 2013. Near-surface Applied Geophysics. 2nd Edition. New York: Cambridge University Press, US. pp.1-422.

Supporters:

1. Semua sumber yang relevan yaitu power point, handbook, modul, dan internet

Supporting lecturer	Prof. Tjipto Prastowo, Ph.D. Arie Realita, M.Si. Muhammad Nurul Fahmi, S.Si., M.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	Able to understand the importance of geophysics, motion scales and time scales relevant to geophysics and measurement methods commonly used in geophysics	Students are able to explain the importance of geophysics, motion scales and time scales that are relevant to geophysics and measurement methods commonly used in geophysics	**Criteria:** Non-test **Form of Assessment** : Participatory Activities	Lectures, Discussions, Questions and Answers 2 X 50		**Material:** Understanding geophysics, motion scale and geophysical time scale Geophysical Measurement Methods **Library:** *Telford, MW, Geldart, LP, Sheriff, RE and Keys, DA 1990. Applied Geophysics. 2nd Edition. New York: Cambridge University Press, US. pp. 1-744.*	3%
2	Able to understand gravity methods, heterogeneity of Earth's rock and mineral layers, variations in density of Earth's rock and mineral layers, measurement of local gravitational anomalies as an indication of the characteristics of subsurface or near-surface structures	Students are able to explain the gravity method, heterogeneity of Earth's rock and mineral layers, variations in density of Earth's rock and mineral layers, measurement of local gravitational anomalies as an indication of the characteristics of subsurface or near-surface structures.	**Criteria:** Assignment of short articles and scientific posters (in groups) related to lectures on Geophysical Measurement Methods and video clips of poster presentations (individually) **Form of Assessment** : Project Results Assessment / Product Assessment	Lectures, Discussions, Questions and Answers 2 X 50		**Material:** Gravitational methods Earth's rock and mineral layers Density variations as a measure of vertical stratification Gravitational anomalies Measurement of gravitational anomalies **References:** *Blakely, RJ 1995. Potential Theory in Gravity and Magnetic Applications. Cambridge: Cambridge University Press, UK. pp. 1-512.*	3%

3	Able to understand seismology as a science that studies the propagation of seismic waves (under and near the surface), various seismic methods (reflection, refraction, tomography), mechanisms for releasing seismic energy via seismic activity, differences between tectonic earthquakes and volcanic earthquakes, seismic survey and measurement methods	Students are able to explain seismology as a science that studies the propagation of seismic waves (below and near the surface), various seismic methods (reflection, refraction, tomography), mechanisms for releasing seismic energy via seismic activity, differences between tectonic earthquakes and volcanic earthquakes, methods of surveying and seismic measurements	**Criteria:** Doing tasks on time **Form of Assessment** : Participatory Activities	Lectures, Discussions, Questions and Answers 2 X 50		**Material:** Seismic methods Variations in rock elasticity, Seismic reflection, Seismic refraction, Seismic tomography, Seismic waves, Seismic activity, and seismic energy Tectonic and volcanic earthquakes Seismic surveys and measurements **References:** *Stein, S. and Wysession, M. 2003. An Introduction to Seismology, Earthquakes, and Earth Structure. Malden, MA: Blackwell Publishing, US. pp. 1-498.*	3%
4	Able to understand seismology as a science that studies the propagation of seismic waves (under and near the surface), various seismic methods (reflection, refraction, tomography), mechanisms for releasing seismic energy via seismic activity, differences between tectonic earthquakes and volcanic earthquakes, seismic survey and measurement methods	Students are able to explain seismology as a science that studies the propagation of seismic waves (below and near the surface), various seismic methods (reflection, refraction, tomography), mechanisms for releasing seismic energy via seismic activity, differences between tectonic earthquakes and volcanic earthquakes, methods of surveying and seismic measurements	**Criteria:** Doing tasks on time **Form of Assessment** : Participatory Activities	Lectures, Discussions, Questions and Answers 2 X 50		**Material:** Seismic methods, Variations in rock elasticity, Seismic reflection, Seismic refraction, Seismic tomography, Seismic waves, Seismic activity and seismic energy Tectonic and volcanic earthquakes Seismic surveys and measurements **References:** *Stein, S. and Wysession, M. 2003. An Introduction to Seismology, Earthquakes, and Earth Structure. Malden, MA: Blackwell Publishing, US. pp. 1-498.*	3%

5	Able to understand seismology as a science that studies the propagation of seismic waves (under and near the surface), various seismic methods (reflection, refraction, tomography), mechanisms for releasing seismic energy via seismic activity, differences between tectonic earthquakes and volcanic earthquakes, seismic survey and measurement methods	Students are able to explain seismology as a science that studies the propagation of seismic waves (below and near the surface), various seismic methods (reflection, refraction, tomography), mechanisms for releasing seismic energy via seismic activity, differences between tectonic earthquakes and volcanic earthquakes, methods of surveying and seismic measurements	**Criteria:** Doing tasks on time **Form of Assessment** : Participatory Activities	Lectures, Discussions, Questions and Answers 2 X 50		**Material:** Seismic methods Variations in rock elasticity, Seismic reflection, Seismic refraction, Seismic tomography, Seismic waves, Seismic activity, and seismic energy Tectonic and volcanic earthquakes Seismic surveys and measurements **References:** *Stein, S. and Wysession, M. 2003. An Introduction to Seismology, Earthquakes, and Earth Structure. Malden, MA: Blackwell Publishing, US. pp. 1-498.*	3%
6	Able to understand the geodynamo process of the Earth‘s outer core as a source of the Earth‘s magnetism (main magnetic field), the magnetism of the Earth‘s rock and mineral layers as an external magnetic field, variations in the susceptibility of the Earth‘s rock and mineral layers, local magnetic anomalies, methods of surveying and measuring local magnetic anomalies	Students are able to explain the geodynamo process of the Earth‘s outer core as the source of the Earth‘s magnetism (main magnetic field), the magnetism of the Earth‘s rock and mineral layers as an external magnetic field, variations in the susceptibility of the Earth‘s rock and mineral layers, local magnetic anomalies, methods of surveying and measuring local magnetic anomalies	**Criteria:** 1.Collection of short articles related to lectures on Geophysical Measurement Methods 2.Group article assessment rubric 3.Group marks are given when articles are collected **Form of Assessment** : Project Results Assessment / Product Assessment	Lectures, Discussions, Questions and Answers 2 X 50		**Material:** Magnetic methods, Earth Magnetism, Geodynamo processes, Magnetic fields, Main Magnetism of rock layers and Earth minerals Variations in susceptibility of rock layers, External magnetic fields Magnetic anomalies Survey and measurement of magnetic anomalies **References:** *Glatzmaier, GA 2001. Convection in the core and the generation of the Earth‘s magnetic field. An American Museum of Natural History Book. The New Press, New York: US. pp. 62-67.*	3%

7	Able to understand the electrical properties of rocks in the Earth's crust, natural and artificial sources using the geoelectric method, resistivity and conductivity as two electrical parameters, Wenner configuration, Schlumberger configuration, Wenner-Schlumberger configuration	Students are able to explain the electrical properties of rocks in the Earth's crust, natural and artificial sources using the geoelectric method, resistivity and conductivity as two electrical parameters which are a measure of the stratification of rock layers, Wenner configuration, Schlumberger configuration, Wenner-Schlumberger configuration	**Criteria:** Doing tasks on time **Form of Assessment** : Participatory Activities	Lectures, Discussions, Questions and Answers 2 X 50		**Material:** Geoelectric methods, Earth Electricity Variations in resistivity and conductivity of subsurface rock layers, Geoelectric surveys Resistivity anomalies, Conductivity anomalies, Geoelectric Anomaly Measurements **Bibliography:** *Telford, MW, Geldart, LP, Sheriff, RE and Keys, DA 1990. Applied Geophysics. 2nd Edition. New York: Cambridge University Press, US. pp. 1-744.*	3%
8	Able to understand USS questions well	Students are able to solve USS questions well	**Criteria:** 100 marks if the USS questions are answered well and correctly **Forms of Assessment** : Participatory Activities, Project Results Assessment / Product Assessment, Tests	Written test, discussion of USS 2 X 50 questions		**Material:** UTS **Library:** *All relevant sources, namely power points, handbooks, modules and the internet*	20%
9	Able to understand the differences between geophysical measurement techniques from natural and artificial sources, a combination of integrated methods of magnetism and electricity in the form of electromagnetic induction methods, VLF and GPR methods for identifying near-surface structures	Students are able to explain the differences between geophysical measurement techniques from natural and artificial sources, a combination of integrated methods of magnetism and electricity in the form of electromagnetic induction methods, VLF and GPR methods for identifying near-surface structures	**Criteria:** Doing tasks on time **Form of Assessment** : Participatory Activities	Lectures, Discussions, Questions and Answers 2 X 50		**Material:** Concept of natural and artificial sources of geophysical measurements, Concept of identification and characterization of near-surface structures, Variations in permittivity of near-surface soil layers, Electromagnetic Induction Method VLF Method, GPR Method **References:** *Hinze, WJ, von Frese, RRB and Saad, AH 2013. Gravity and Magnetic Explorations: principles, practices, and applications. University Printing House: Cambridge University Press, UK. pp. 1-512.*	4%

10	Able to understand various survey and measurement methods in applied geophysics for the purposes of natural resource exploration and other relevant needs	Students are able to explain various surveys and measurement methods in applied geophysics for the purposes of natural resource exploration and other relevant needs	**Criteria:** Doing tasks on time **Form of Assessment** : Project Results Assessment / Product Assessment	Contextual Learning Discussion Questions and answers 2 X 50		**Material:** Concept of natural and artificial sources of geophysical measurements, Concept of identification and characterization of near-surface structures, Variations in permittivity of near-surface soil layers, Electromagnetic Induction Method VLF Method, GPR Method **References:** *Hinze, WJ, von Frese, RRB and Saad, AH 2013. Gravity and Magnetic Explorations: principles, practices, and applications. University Printing House: Cambridge University Press, UK. pp. 1-512.*	4%
11	Able to understand various survey and measurement methods in applied geophysics for the purposes of natural resource exploration and other relevant needs	Students are able to explain various surveys and measurement methods in applied geophysics for the purposes of natural resource exploration and other relevant needs	**Criteria:** Doing tasks on time **Form of Assessment** : Participatory Activities	Contextual Learning Discussion Questions and answers 2 X 50		**Material:** Concept of natural and artificial sources of geophysical measurements, Concept of identification and characterization of near-surface structures, Variations in permittivity of near-surface soil layers, Electromagnetic Induction Method VLF Method, GPR Method **References:** *Hinze, WJ, von Frese, RRB and Saad, AH 2013. Gravity and Magnetic Explorations: principles, practices, and applications. University Printing House: Cambridge University Press, UK. pp. 1-512.*	4%

12	Able to understand various survey and measurement methods in applied geophysics for the purposes of natural resource exploration and other relevant needs	Students are able to explain various surveys and measurement methods in applied geophysics for the purposes of natural resource exploration and other relevant needs	**Criteria:** Doing tasks on time **Form of Assessment** : Participatory Activities	Contextual Learning Discussion Questions and answers 2 X 50		**Material:** Concept of natural and artificial sources of geophysical measurements, Concept of identification and characterization of near-surface structures, Variations in permittivity of near-surface soil layers, Electromagnetic Induction Method VLF Method, GPR Method **References:** *Telford, MW, Geldart, LP, Sheriff, RE and Keys, DA 1990. Applied Geophysics. 2nd Edition. New York: Cambridge University Press, US. pp. 1-744.*	4%
13	Able to understand various posters on Geophysical Measurement Methods with the theme of the application of geophysical methods in the field of natural resource exploration	Students are able to explain various Geophysical Measurement Methods posters with the theme of the application of geophysical methods (both single and combination methods) in the field of natural resource exploration	**Criteria:** Full marks take into consideration the quality of the poster and poster presentation if the poster is presented at the end of the semester **Form of Assessment** : Project Results Assessment / Product Assessment	• Poster Presentation • Discussion • Questions and answers 2 X 50		**Material:** Demo Poster on Geophysical Measurement Methods (active lecturer) **Literature:** *All relevant sources, namely power points, handbooks, modules and the internet* **Material:** Demo Poster on Geophysical Measurement Methods (active lecturer) **Literature:** *All relevant sources, namely power points, handbooks, modules and the internet*	4%
14	Able to understand various posters on Geophysical Measurement Methods with the theme of the application of geophysical methods in the field of natural resource exploration	Students are able to explain various Geophysical Measurement Methods posters with the theme of the application of geophysical methods (both single and combination methods) in the field of natural resource exploration	**Criteria:** Full marks take into consideration the quality of the poster and poster presentation if the poster is presented at the end of the semester **Form of Assessment** : Participatory Activities	• Poster Presentation • Discussion • Questions and answers 2 X 50		**Material:** Poster on Geophysical Measurement Methods (active students) **Literature:** *All relevant sources, namely power points, handbooks, modules and the internet*	4%

15	Able to understand various posters on Geophysical Measurement Methods with the theme of the application of geophysical methods in the field of natural resource exploration	Students are able to explain various Geophysical Measurement Methods posters with the theme of the application of geophysical methods (both single and combination methods) in the field of natural resource exploration	**Criteria:** Full marks take into consideration the quality of the poster and poster presentation if the poster is presented at the end of the semester **Form of Assessment** : Project Results Assessment / Product Assessment	• Poster Presentation • Discussion • Questions and answers 2 X 50		**Material:** Poster on Geophysical Measurement Methods (active students) **Literature:** *All relevant sources, namely power points, handbooks, modules and the internet*	4%
16	Able to complete UAS properly and correctly	Able to complete UAS properly and correctly	**Criteria:** Assess all student projects **Form of Assessment** : Project Results Assessment / Product Assessment	Projects and discussions		**Material:** UAS **Literature:** *All relevant sources, namely power points, handbooks, modules and the internet*	30%

Evaluation Percentage Recap: Project Based Learning

No	Evaluation	Percentage
1.	Participatory Activities	37.67%
2.	Project Results Assessment / Product Assessment	54.67%
3.	Test	6.67%
		99.01%

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.