Semester Lesson Plan (SLP)

	THE STATE UNIVERSITY OF SURABAYA **FACULTY OF MATHEMATICS AND NATURAL SCIENCES** **PHYSICS STUDY PROGRAM**	**Document Code**

SEMESTER LESSON PLAN

NAME OF COURSE	COURSE CODE	DISCIPLINE	COURSE UNIT		SEMESTER	DATE CREATED
GEOPHYSICAL MEASUREMENT METHODS		EARTH PHYSICS	T=2 units	P=?	8 (eight)	4 February 2021

AUTHORISATION	AUTHOR	COURSE COORDINATOR	HEAD OF PHYSICS STUDY PROGRAM
PHYSICS DEPARTMENT	Prof. Tjipto Prastowo, Ph.D.	Prof. Tjipto Prastowo, Ph.D.	Prof. Dr. Munasir, M.Si.

Learning Achievement	**Program Learning Outcome (PLO)**	
	PLO1	Able to demonstrate knowledge of Classical Physics and Modern Physics.
	PLO6	Able to improve their knowledge and continue their study in a higher education.
	PLO7	Able to communicate their ideas and/or research results through academic writing and speaking effectively.
	PLO10	Able to demonstrate good scientist manners, critical thinking and innovation skills in research and professional fields; and willing to do lifelong learning
	Course Learning Outcome (CLO)	
	CLO-1	Demonstrating independent, creative and honest characters in doing student assignments, mid and final exams.
	CLO-2	Understanding a systematic study on various methods commonly used in geophysical surveys for examination of sub-surface structures near and beneath the surface including measurements of physical anomalies in a local site.
	CLO-3	Applying a geophysical method selected to identify characteristics of sub-surface structures near and beneath the surface in a surveyed site accurately.
	CLO-4	Understanding differences in geophysical data collection and processing techniques between common geophysical methods in the framework of each method completes the other method and vice versa.
	Final competence in each step of learning (Sub-CLO)	
	Sub-CLO1	Being able to understand the importance of geophysics, length and time scales in geophyics, geophysical methods and techniques used in field measurements.
	Sub-CLO2	Being able to understand gravity method, heterogeneity in rock layers and minerals inside the Earth, vertical variation of density, identification of anomaly in gravity for examination of sub-surface structures near and beneath the surface.
	Sub-CLO3	Being able to understand seismology being part of science examining seismic wave propagation within the body of the Earth near and at the surface, various seismic methods (reflection, refraction, tomography), mechanisms of seismic energy release

		through earthquakes, differences in events of tectonic or volcanic origin, field surveys and corresponding measurements.
	Sub-CLO4	Being able to understand geodynamo processess in the Earth's outer core as the production of geomagnetic field, rock magnetism and mineral magnetics, secondary magnetic fields, susceptibility variation in rock layers, magnetic anomaly, survey methods and measurements of magnetic anomaly.
	Sub-CLO5	Being able to understand electricity in the Earth's crust, natural dan artificial sources of geoelectric method, resistivity and conductivity as two electric parameters, Wenner configuration, Schlumberger configuration, Wenner-Schlumberger configuration.
	Sub-CLO6	Being able to understand differences in geophysical measurement techniques between natural and artificial sources, a combined method of magnetic and electric approaches or in the form of electromagnetic induction, VLF dan GPR methods for identification of physical structures near the surface.
	Sub-CLO7	Being able to understand varying surveys and measurement techniques in applied geophysics for exploration of natural resources or other sources that are relevant.
	Sub-CLO8	Being able to create a poster relevant to lecture materials in Geophysical Methods.
Course Content	Geophysical Methods examine the solid Earth as a complex, physical system with a layered structure having different characteristics between rock layers constituting the structure of the Earth that can possibly be determined during field surveys by data collection, acquisition, and processing. These involve the applications of geophyiscal methods and measurement techniques, using either a single or a combined method, to accurately detect the presence of a physical anomaly under investigation. In this context, the roles of both 2D and 3D modeling for sub-surface structure determination (located near and below the surface at depth) are vital in identifying and characterising a physical system examined. The methods discussed include gravity, seismic (reflection, refraction, tomography), magnetic, geoelectric, electromagnetic induction approaches.	
Topic Discussions: Learning Materials	1. Geophysics: science of the Earth, length and time scales in geophyiscs, field measurements in geophysics, geophysical methods 2. Gravity Method: sub-surface structures near and beneath the Earth's surface, density variation and vertically stratified rock layers in the crust, gravity survey, gravity anomaly, anomaly measurements in gravity survey 3. Seismic Method: seismic reflection, seismic refraction, seismic tomography, elasticity and rigidity variations of sub-surface structure near and beneath the surface, seismic survey and corresponding measurements, seismic wave propagation, seismic energy release via tectonic and volcanic earthquakes, seismo-tectonic activity 4. Magnetic Method: the Earth as a giant magnetic source, geodynamo processes, the main field, secondary sources of magnetic field, susceptibility variation, magnetic stratification in the crustal rocks, magnetic survey, magnetic anomaly, magnetic anomaly measurements 5. Geoelectric Method: electricity of the Earth, resistivity and conductivity variations in a layered sub-surface structure beneath the surface, geoelectric survey, resistivity anomaly, conductivity anomaly, anomaly measurements 6. Electromagnetic Method: measurement techniques based on electromagnetic wave propagation into the ground with natural and artificial sources, electromagnetic induction, VLF and GPR methods for identification of sub-surface structure near the surface 7. Geophysical Methods in practice: errors in measurements, correction factors, data collection, data acquisition, data processing, data analysis 8. Video clips presentation on poster sessions	
References	**Primary:**	
	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.
	Secondary:
	Some power point files and/or course materials relevant to Geophysical Methods from the internet
Lecturers	Prof. Tjipto Prastowo, Ph.D.
Pre-requisites	Basic Physics 1 and Basic Physics 2

Week	**Final competence in each learning step (Sub-CLO)**	**Assessment**		**Learning Format, Methods, Instruction, (Time Allocation)**		**Learning Materials**	**Proportion (%)**
		Indicator	**Criteria & Format**	***offline***	***online***		
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
1	Being able to understand the importance of geophysics, length and time scales in geophyics, geophysical methods and techniques used in field measurements	Students can explain the importance of geophysics, length and time scales in geophyics, geophysical methods and techniques used in field measurements			Contextual Learning Discussion Q & A	• Geophysics: science of the Earth • Length and time scales in geophyiscs • Field measurements in geophysics • Geophysical Methods	
2	Being able to understand	Students can	Description on		Contextual Learning	• Gravity Method	

	gravity method, heterogeneity in rock layers and minerals inside the Earth, vertical variation of density, identification of anomaly in gravity for examination of sub-surface structures near and beneath the surface	explain gravity method, heterogeneity in rock layers and minerals inside the Earth, vertical variation of density, identification of anomaly in gravity for examination of sub-surface structures near and beneath the surface	student assignments: 1. Short article (in a group) describing issues in space physics and/or astronomy 2. Corresponding poster (in a group) 3. Individual presentation on relevant poster		Discussion Q & A	• Sub-surface structures near and beneath the Earth's surface • Density variation and vertically stratified rock layers in the crust • Gravity survey • Gravity anomaly • Anomaly measurements in gravity survey	
3	Being able to understand seismology being part of science examining seismic wave propagation within the body of the Earth near and at the surface, various seismic methods (reflection, refraction, tomography), mechanisms of seismic energy release through earthquakes, differences in events of tectonic or volcanic origin, field surveys and corresponding measurements	Students can explain seismology being part of science examining seismic wave propagation within the body of the Earth near and at the surface, various seismic methods (reflection, refraction, tomography),			Contextual Learning Discussion Q & A	• Seismic Method • Seismic reflection • Seismic refraction • Seismic tomography • Elasticity and rigidity variations of sub-surface structure near and beneath the surface • Seismic survey and corresponding measurements • Seismic wave propagation • Seismic energy release via tectonic and volcanic	

		mechanisms of seismic energy release through earthquakes, differences in events of tectonic or volcanic origin, field surveys and corresponding measurements				earthquakes • Seismo-tectonic activity	
4	Being able to understand seismology being part of science examining seismic wave propagation within the body of the Earth near and at the surface, various seismic methods (reflection, refraction, tomography), mechanisms of seismic energy release through earthquakes, differences in events of tectonic or volcanic origin, field surveys and corresponding measurements	Students can explain seismology being part of science examining seismic wave propagation within the body of the Earth near and at the surface, various seismic methods (reflection, refraction, tomography), mechanisms of seismic energy release through earthquakes, differences in			Contextual Learning Discussion Q & A	• Seismic Method • Seismic reflection • Seismic refraction • Seismic tomography • Elasticity and rigidity variations of sub-surface structure near and beneath the surface • Seismic survey and corresponding measurements • Seismic wave propagation • Seismic energy release via tectonic and volcanic earthquakes • Seismo-tectonic activity	

		events of tectonic or volcanic origin, field surveys and corresponding measurements					
5	Being able to understand seismology being part of science examining seismic wave propagation within the body of the Earth near and at the surface, various seismic methods (reflection, refraction, tomography), mechanisms of seismic energy release through earthquakes, differences in events of tectonic or volcanic origin, field surveys and corresponding measurements	Students can explain seismology being part of science examining seismic wave propagation within the body of the Earth near and at the surface, various seismic methods (reflection, refraction, tomography), mechanisms of seismic energy release through earthquakes, differences in events of tectonic or volcanic origin, field surveys and			Contextual Learning Discussion Q & A	• Seismic Method • Seismic reflection • Seismic refraction • Seismic tomography • Elasticity and rigidity variations of sub-surface structure near and beneath the surface • Seismic survey and corresponding measurements • Seismic wave propagation • Seismic energy release via tectonic and volcanic earthquakes • Seismo-tectonic activity	

		corresponding measurements					
6	Being able to understand geodynamo processess in the Earth's outer core as the production of geomagnetic field, rock magnetism and mineral magnetics, secondary magnetic fields, susceptibility variation in rock layers, magnetic anomaly, survey methods and measurements of magnetic anomaly	Students can explain geodynamo processess in the Earth's outer core as the production of geomagnetic field, rock magnetism and mineral magnetics, secondary magnetic fields, susceptibility variation in rock layers, magnetic anomaly, survey methods and measurements of magnetic anomaly	Student assignment 1 (short article): handed in Criteria for assessment are available		Contextual Learning Discussion Q & A	• Magnetic Method • The Earth as a giant magnetic source • Geodynamo processes • The main field • Secondary sources of magnetic field • Susceptibility variation • Magnetic stratification in the crustal rocks • Magnetic survey • Magnetic anomaly • Magnetic anomaly measurements	**15%**
7	Being able to understand electricity in the Earth's crust, natural dan artificial sources of geoelectric method, resistivity and conductivity as two electric parameters, Wenner configuration, Schlumberger configuration, Wenner-Schlumberger configuration	Students can explain electricity in the Earth' crust, natural dan artificial sources of geoelectric method, resistivity and conductivity as			Contextual Learning Discussion Q & A	• Geoelectric Method • Electricity of the Earth • Resistivity and conductivity variations in a layered sub-surface structure beneath the	

		two electric parameters, Wenner configuration, Schlumberger configuration, Wenner-Schlumberger configuration				surface • Geoelectric survey • Resistivity anomaly • Conductivity anomaly • Anomaly measurements in geoelectric survey	
8	**Mid Semester Exam**						**30%**
9	Being able to understand differences in geophysical measurement techniques between natural and artificial sources, a combined method of magnetic and electric approaches or in the form of electromagnetic induction, VLF dan GPR methods for identification of physical structures near the surface	Students can explain differences in geophysical measurement techniques between natural and artificial sources, a combined method of magnetic and electric approaches or in the form of electromagnetic induction, VLF dan GPR methods for identification of physical structures near the surface			Contextual Learning Discussion Q & A	• Electromagnetic Method • Measurement techniques based on electromagnetic wave propagation into the ground with natural and artificial sources • Electromagnetic induction • VLF and GPR methods for identification of sub-surface structure near the surface	
10	Being able to understand	Students can	Student assignment		Contextual Learning	• Electromagnetic	**15%**

	varying surveys and measurement techniques in applied geophysics for exploration of natural resources or other sources that are relevant	explain varying surveys and measurement techniques in applied geophysics for exploration of natural resources or other sources that are relevant	2 (relevant posters): handed in Criteria for assessment are available		Discussion Q & A	Method • Measurement techniques based on electromagnetic wave propagation into the ground with natural and artificial sources • Electromagnetic induction • VLF and GPR methods for identification of sub-surface structure near the surface	
11	Being able to understand varying surveys and measurement techniques in applied geophysics for exploration of natural resources or other sources that are relevant	Students can explain varying surveys and measurement techniques in applied geophysics for exploration of natural resources or other sources that are relevant			Contextual Learning Discussion Q & A	• Geophysical methods in practice • Errors in measurements • Correction factors • Data collection • Data acquisition • Data processing • Data analysis	
12	Being able to understand varying surveys and measurement techniques in applied geophysics for exploration of natural	Students can explain varying surveys and measurement techniques in			Contextual Learning Discussion Q & A	• Geophysical methods in practice • Errors in measurements • Correction factors	

	resources or other sources that are relevant	applied geophysics for exploration of natural resources or other sources that are relevant				• Data collection • Data acquisition • Data processing • Data analysis	
13	Being able to create a poster relevant to lecture materials in Geophysical Methods	Students can create a poster relevant to lecture materials in Geophysical Methods			Preparation for Poster Presentation for Project-Based Learning Discussion Q & A	Demo Poster on Geophysical Methods (with lecturers take the lead for the class demo)	
14	Being able to create a poster relevant to lecture materials in Geophysical Methods	Students can create a poster relevant to lecture materials in Geophysical Methods	Student assignment 3 (relevant clips): handed in Criteria for assessment are available		Poster Presentation for Project-Based Learning Discussion Q & A	Poster Presentation on Geophysical Methods (with students being active for class presentation)	
15	Being able to create a poster relevant to lecture materials in Geophysical Methods	Students can create a poster relevant to lecture materials in Geophysical Methods	Student assignment 3 (relevant clips): handed in Criteria for assessment are available		Poster Presentation for Project-Based Learning Discussion Q & A	Poster Presentation on Geophysical Methods (with students being active for class presentation)	
16	**Final Exam**						**40%**