APPENDIX

A.1.2.1
EVIDENCE OF BP-GEOPH CURRICULUM

CURRICULUM DOCUMENT 2021

GEOPHYSICS STUDY PROGRAM
FACULTY OF MATHEMATICS AND NATURAL SCIENCE
GADJAH MADA UNIVERSITY

Compositor:

Physical Department Curriculum Team

FACULTY OF MATHEMATICS AND NATURAL SCIENCE
GADJAH MADA UNIVERSITY
2021

GEOPHYSICS STUDY PROGRAM

1. Study Program Identity

The geophysics study program identity is explained below:

Study Program	: Geophysics Study Program
Major/Department	: Physics Department
Faculty	: Faculty of Mathematics and Natural Science
University	: Gadjah Mada University
SK Number of Study Program Establishment(*)	: 22/DIKTI/Kep/1985
SK Date of Study Program Establishment	: 1 May 1985
First Time of Offer	: 1974/75 as a geophysics field interest, 1 May 1985 as a Geophysics Study Program
Latest Accreditation	: A
SK BAN-PT Number	: 1033/SK/BAN-PT/Akred/S/IV/2019
Study Program Address	: Sekip Utara Bls 21 Bulaksumur Yogyakarta 55281 Indonesia
Study Program Telephone Number	: +62 274 545183
Study Program Facsimile Number	: +62 813 2929 0060
Study Program Homepage	: https://geofisika.ugm.ac.id
Study Program E-mail	: Geofisika.ugm.ac.id

2. Curriculum Evaluation and Study Trace

Along with the development of science and technology, the 2016 curriculum of the geophysics study program has actually implemented independent learning (Merdeka Belajar) indirectly through courses with a total (13 credits), consists of internship (2 SKS), Geophysical workshop (2 SKS), Student Service Learning (3SKS), and Thesis (6 SKS). The 2016 curriculum of the geophysics study program emphasizes 6 pillars of students assessment, that are attitudes, understanding of basic sciences, understanding of geophysical methods, application of geophysical methods and its analysis, modeling, and interpretation, and managerial and soft skills. The six pillars are assessed and distributed in the courses from beginning to the end of the semester, so the geophysical graduate has professional and intellectual personalities, as well as capable to process, analyze, creating geophysical data models, and correlating them to the geological data.

In general, from the tracer data study, the 2016 curriculum has graduated geophysics students with an average study time of 4 years 9 months (the fastest graduates was 3 years 10 months and

the longest was 8 years 5 months) with GPA average of 3.40 (the highest GPA was 3.87 and the lowest GPA was 2.58). The majority of geophysics study program alumni have a waiting period to get a job for 1 - 6 months (Figure 2) which indicates a fairly high uptake for geophysical graduates. The result of study tracer also shows geophysics study program satisfactory contributions in student self-development in the working world.

To accelerate and increase the absorption of labor for geophysical graduates, in the Merdeka Belajar Kampus Merdeka (MBKM) 2021 curriculum, the geophysics study program provides 1 semester for student to develop themselves and study outside campus through student exchange programs, internship, research, and teaching from ministry of education and culture. Geophysics study program has also accommodated several fields of scientific study, which consist of basic sciences, earth sciences, geophysics, data acquisition, processing and modeling, computers and IT, as well as soft skills which are implemented in compulsory and elective courses. So that through the 2021 MBKM curriculum, graduates will get a job quickly in accordance with the fields of study, competencies, and soft skills that have been carried out during the study.

Figure 2. Graph of geophysics tracer study respondents that use the 2016 curriculum.

3. Fundamental and Curriculum Planning

Fundamental of geophysics study program UGM 2021 curriculum is explained below:

1. Legal law No. 20, published in 2003 about the National Education System (SISDIKNAS).
2. Legal law No. 12, published in 2012 about Higher Education (DIKTI).
3. Government regulation No. 67/2013 About Statuta UGM.
4. Government regulation No. 4/2014 About the management of higher education.
5. President regulation No. 8/2012 about Implementation of the Indonesian National Qualification Framework IQF (KKNI) junto Number 44 Year 2015.
6. Government regulation No. 57/2021 about the National Education Standard of Indonesia.
7. Regulation of the Minister of Education and Culture No.73/2013 About KKNI (DIKTI) implementation.
8. Regulation of the Minister of Education and Culture No.50/2014 About University Quality Assurance System (JAMU DIKTI).
9. Regulation of the Minister of Education and Culture No.81/2014 About Diploma certification, Suplement Diploma, and DIKTI Professional certificate.
10. Regulation of the Minister of Education and Culture No.87/2014 About Study Program Accreditation and University.
11. Regulation of the Minister of Education and Culture Nomor 3/2020 About National Standart of University.
12. Kep. Dirjen Dikti, Kementerian Pendidikan dan Kebudayaan republik Indonesia, No. 84/E/KPT/2020 tentang Pedoman Pelaksanaan Mata Kuliah Wajib pada kurikulum Pendidikan tinggi
13. Peraturan Rektor UGM No.14 tahun 2020 tentang Kerangka dasar Kurikulum di UGM
14. Foresighting sciences study document in Faculty of Mathematics and Natural Science, Senate FMIPA UGM 2016.
15. Curriculum Guidebook, Dirjen Dikti, Kemenristekdikti 2019.
16. Scientific Mandate of FMIPA UGM.
17. MBKM Guidebook, Ditjen Dikti, Kemendikbud, 2020.
18. “Pengamatan Ke Depan Keilmuan di FMIPA UGM” Document, 2016.
19. “Adaptasi Disrupsi Edukasi bidang MIPA dalam Era Industri 4.0” Document, 2019.
20. UGM strategic plan, FMIPA.
21. Input from Alumni and Stakeholders from tracer study.
22. Internal Evaluation of 2016 Curriculum.
23. Bloom’s Taxonomy.
24. PSG Foresighting study..

4. Vision, Mission, Objectives, Strategy, and University Values

4.1. Vision and Mission Geophysics Study Program

Vision: Geophysics Study Program UGM as a global partner for Indonesian better life and mankind in education, research, and service in the geophysical field with an environmental perspective.

Mission: Geophysics Study Program has the following mission:

1. Develop an integrated undergraduate, postgraduate, and doctoral learning process.
2. Develop research and learning laboratories.
3. Improving the quality and quantity of education, research, community service, service, and cooperation.
4. Improve the ability to compete in the international job market.

4.2. Educational Objectives

The UGM Geophysics Study Program has educational objectives in the form of:

1. The realization of human beings who are good in intellectuality and morality.
2. The realization of a geophysical knowledged society that actively participates in civil society
3. Mastering the leading science and technology in the field of Geophysics,
4. Have a high commitment to various social roles in applying science and technology
5. Take an active role in the global sustainable development movement (hamemayu hayuning bawono langgeng).

4.3. Curriculum Objectives

The 2021 geophysics study program UGM curriculum objectives are:

1. Realization of research-based learning.
2. The achievement of increasing reputation and international accreditation in the fields of education, research, and community service and fully guaranteed quality in its TRI-DHARMA.
3. The achievement of increasing international cooperation networks.
4. The achievement of developing a role in solving the nation's problems with an approach of local wisdom and excellence to the world level.
5. The achievement of continuous improvement of cooperation capacity and business development.
6. The achievement of TRI-DHARMA universities that support UGM's vision as "World Class University imbued with nation cultural values based on Pancasila as the state ideology and dedicated to the national interest and humanity" and Socio-science and technology entrepreneurial University.
7. The achievement of freedom to develop students' abilities through Freedom of Learning.

4.4. Profession/Employment for Graduates Jobs

The UGM Geophysics Study Programs' work fields are:

1. Energy, oil, gas and mineral industries and exploration services.
2. Mapping industry.
3. Research and development institutions.
4. Mitigation of natural disaster risk institutions.
5. Environmental preservation institutions.
6. Defense and security institutions.
7. Educational institutions.

8. Consulting and independence institutions.
9. Software and database development industry.
10. Entrepreneur.

4.5. Graduates Profile

Graduates profile of UGM Geophysics Study Program as follow:

1. Design the geophysical survey and mapping.
2. Manager/Implementer/Quality Assurance of Geophysical measurement and data collection.
3. Analyze and process the geophysical data.
4. Interpret and create geophysical data models.
5. Researcher, developer, educator in geophysical field.
6. Exploration of natural resources based on geophysical methods.
7. Implementing geophysical science-based disaster risk reduction.
8. Implementing geophysics-based environmental conservation.
9. Geophysics consultant.
10. Earth science software developer.
11. Geophysics entrepreneur.
12. Lifelong learner in geophysics.

5. Graduates Standard Competencies

Graduate standard competency (Expected Learning Outcome (ELO)) geophysics undergraduate study program is prepared based on the Permenristek Dikti No. 44 of 2015 which includes: (1) Attitudes, (2) Knowledge, (3) Skills (General and Specific), and (4) Personal Development/Work Experience.

The competencies are explained as 6 pillars graduate standard competency that become main expected learning outcomes, as follow:

1) Attitude

Good Attitude: Graduates are honest, disciplined, curious, critical, confident, independent, emotionally mature, cooperative, and trustworthy. Upholding norms, values, morals, religion, general ethics and professional ethics, and actively playing a role in the global sustainable development movement and behaving professionally **(G1)**.

2) Knowledge

Mastery of knowledge: Graduates are able to apply basic science (mathematics, physics, chemistry, biology, geology), and geophysics in general and its relation to other sciences such as geology, geodesy, geochemistry, geography, computing and information technology **(G2).**

3) General Skills

Operational and comprehensive skills: Graduates are able to apply all geophysical methods (seismic, gravitational, magnetic, electrical, electromagnetic and thermal methods) for energy exploration (eg oil and gas, coal, geothermal), mining materials (eg: iron, copper, gold, silver, tin) and groundwater and disaster mitigation **(G3).**

4) **Specific Skills**

Application and analytical skills: Graduates are able to carry out and manage a geophysical survey which includes scientific steps in the acquisition, processing and interpretation of data for natural resource exploration both for energy (eg oil and gas, coal, for energy exploration (eg oil and natural gas, coal, geothermal), mining materials (eg iron, copper, gold, silver, tin) as well as groundwater and disaster mitigation. **(G4)**.

5) **Advanced Specific Skills**

Synthesis and Evaluation Skills: Graduates are able to interpret geophysical data in the form of integrated forward and inverse problems that have ambiguous characters, carry out interpretations by making models and/or solving simple forward and inverse problems and advanced in using computers for both purposes solving geophysical problems as well as for communication and internet access **(G5).**

6) **Self-Development/Lifelong Learning**

Managerial skills and self-development: Graduates are able to update their competencies, by lifelong learning in line with the latest geophysical conditions to compete nationally and internationally by upholding UGM values (Pancasila: Divinity, Humanity, Unity, Democracy, Justice, and Science: universality, objectivity, freedom, respect for reality and truth) **(G6)**.

Expected learning outcomes based on Permendikbud no 49 of 2014 for undergraduate program (S1) consist of 4 things: 1) attitude; 2) knowledge; 3) general skills; 4) specific skills. Moreover, geophysical study programs include self-development in expected learning outcomes. The relationship between graduate competence and Bloom's taxonomy can be seen in Figure 5, and is described as follows:

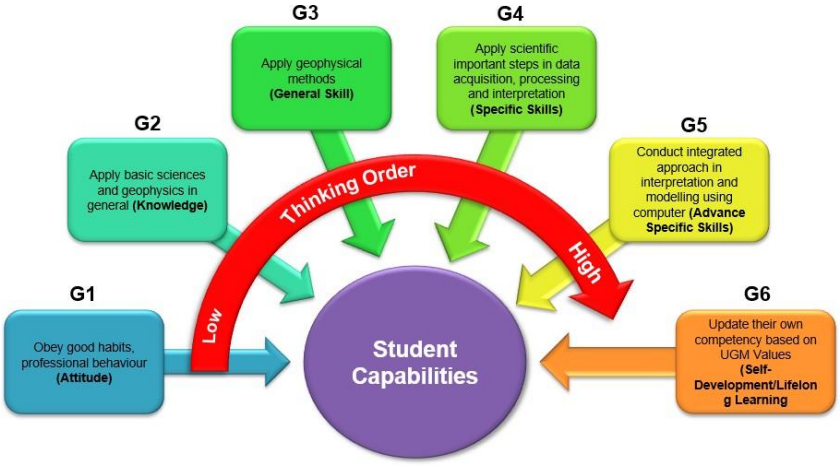

Figure 5. The relationship between graduate competence and Bloom's Taxonomy

G1. Attitude

G1.1. Honest, disciplined, curious, critical, confident, independent, emotionally mature, cooperative, and trustworthy.

G.1.2. Obey (uphold) norms, values, morals, religion, general ethics and professional ethics, and actively play a role in the *global sustainable development* (hamemayu hayuning bawono langgeng)

G2. Knowledge

G.2.1. Capable to explain, discuss, and apply basic science (mathematics, physics, chemistry, biology, geology).

G.2.2. Capable to explain, and discuss geophysics in general and its relation to other sciences such as geology, geodesy, geochemistry, geography, computing, information technology.

G.2.3. Capable to explain, and discuss the concepts of all geophysical methods (including seismic, gravitational, magnetic, electrical, electromagnetic, thermic).

G.2.4. Capable to explain, and discuss scientific steps of data acquisition, data processing, and interpretation.

G.2.5. Capable to explain, and discuss the concept of natural resource exploration for energy (eg oil and gas, coal, geothermal) and mining materials (iron, copper, gold, silver, tin) and groundwater using geophysical methods.

G.2.6. Capable to explain, and discuss the processes that cause natural disasters such as earthquakes, tsunamis, volcanic eruptions, landslides.

G3. General Skill

G.3.1. Capable to operationally apply all geophysical methods (among others seismic, gravity, magnetic, electrical, electromagnetic, thermic)

G.3.2. Capable to operationally apply scientific steps of data acquisition, data processing, and interpretation

G.3.3. Capable to operationally apply exploration of natural resources for energy (eg: oil and gas, coal, geothermal) and mining materials (eg: iron, copper, gold, silver, tin) and groundwater using geophysical methods

G.3.4. Capable to operationally implement monitoring, surveillance and early warning system of natural phenomena such as earthquakes, tsunamis, volcanic eruptions

G.3.5. Capable to implement operationally monitoring, surveillance and early warning systems of global phenomena and their implications, such as the rotation and rotation of the earth, movements of the continental crust/plate, as well as movements of the earth's interior.

G.3.6. Capable to operationally apply interpretation model and one of the solutions to simple inverse problems

G.3.7. Capable to apply geophysical research methods.

G4. Specific Skill

G.4.1. Capable to comprehensively design geological surveys and all geophysical methods.

G.4.2. Capable to prepare and carry out geological and/or geophysical data acquisition carefully and accurately with all kinds of difficulties that must be overcome both in the laboratory and in the field.

G5. Advanced Specific Skill

G.5.1. Capable to carry out geophysical data processing which is often incomplete and not evenly distributed.

G.5.2. Capable and skilled in the use of computers both for the purposes of solving geophysical problems as well as for communication and internet access.

G.5.3. Capable to perform integrated geophysical interpretation using several forward and inverse modeling methods to minimize uncertainty.

G.6. Self-development

G.6.1. Capable to update their competence with life-long learning

G.6.2. Capable to compete nationally and internationally.

G.6.3. Capable to uphold UGM values (Pancasila: Divinity, Humanity, Unity, Democracy, Justice, and Science: universality, objectivity, freedom, respect for reality and truth)

6. Field of Study Determination

The study field of UGM Geophysics study program is based on analysis of the alumni tracking result, graduate employment, graduate job profiles, graduate competency standards, community needs and the development of science and technology in the current industrial 4.0 era. Fields of study in the UGM Geophysics Study Program include:

1) Basic science (Physics, Mathematics, Chemistry, Biology).
2) Earth science (Geology, Geodesy, Geography, Geostats).
3) Geophysical Sciences (General and exploration).
4) Acquisition, processing, interpretation and modeling of data.
5) Computers and information technology.
6) Softkills.

The grouping of geophysics undergraduate study programs according to the field of study is presented in Table 6. below.

Table 6. Map of geophysics study program courses based on the field of study

Basic Sciences (total **41 Credits**)	**Earth Sciences** (total **31 Credits**)
Compulsory: ● General Chemistry I (3 credits) ● Basic Physics I (3 credits) ● Lab. Work of Basic Physics I (1 credit) ● Mathematics for Physics I (3 credits) ● Calculus I (3 credits) ● Basic Physics II (3 credits) ● Lab. Work of Basic Physics II (1 credits) ● Wave (2 credits) ● Lab. Work of Wave (1 credits) ● Mechanics I (2 credits) ● Mathematics for Physics II (3 credits) ● Calculus II (3 credits) ● Mathematics for Physics III (3 credits) ● Mechanics of Continuous Media (2 credits) **Electives :** ● Thermodynamics (3 credits) ● General Biology (3 credits)	**Compulsory :** Introduction to Geophysics (2 credits) Basic Geology (2 credits) Lab. Work of Basic Geology (1 credits) Structural Geology (2 credits) Mapping (2 credits) Mapping Field Work (1 credits) Tectonics of Indonesia (2 credits) Geology Field Work (2 credits) **Electives:** Petrology (2 credits) Lab. Work of Petrology (1 credits) Geochemistry (2 credits) Global Positioning Systems (GPS) (2 credits) Geostatistics (3 credits) Stratigraphy (2 credits) Geodynamics (2 credits) Petroleum Geology (2 credits)

● Heat and Mass Transfer (2 credits)	Petroleum Geology Lab. Work (1 credit)
Geophysics (total **44 Credits)** **Compulsory :** ● Electromagnetics Geophysics (2 credits) ● Geoelectric and Electromagnetic Methods (3 credits) ● Seismic Methods (3 credits) ● Seismology (2 credits) ● Lab. Work of Seismology (1 credits) ● Gravity and Magnetics Methods (3 credits) ● Physics of Volcanology (2 credits) **1. Electives:** ● Rock Mechanics (2 credits) ● Geophysical Fluid Mechanics (2 credits) ● Environmental Geophysics (2 credits) ● Geothermal Exploration (2 credits) ● Energy (2 credits) ● Rock Physics (2 credits) ● Meteorology and Climatology (2 credits) ● Inversion Method (2 credits) ● Seismic Stratigraphy (2 credits) ● Marine Geophysical Exploration (2 credits) ● Aero and Satellites Geophysics (2 credits) ● Volcanological Seismology (2 credits) ● Seismic Attributes (2 credits) ● Methane Hydrates Exploration(2 credits)	**Data acquisition, processing, interpretation and modeling** (total **17 Credits**) **Compulsory:** ● Geophysical Analysis Methods (3 credits) ● Lab. Work of Geophysical Analysis Method (1 credit) ● Workshop on Geophysics (2 credits) ● Seismic Method Field Work (1 credit) ● Non-Seismic Field Work (1 credit) ● Undergraduate Thesis (6 credits) **Electives:** ● Geothermal Exploration Field Work (1 credit) ● Capita selecta (2 credits)
Computers and information technology (total **25 Credits)** **Compulsory** ● Computational Methods (2 credits) ● Lab. Work of Computation Methods (1 credit) ● Programming (3 credits) ● Geophysical Electronics (2 credits) ● Lab. Work of Geophysical Electronics (1 credit) **Electives:** ● Geophysical Instrumentation (2 credits) ● Lab. Work of Geophysical Instrumentation (1 credit) ● Geophysical Computer Programming (2 credits)	***Soft skills*** (total **26 Credits**) **Compulsory:** Pancasila State's Ideology (2 credits) Religion (2 credits) Civics (2 credits) Internship (2 credits) Scientific Writing and Presentations (3 credits) Laboratory Assisstancy (1 credits) **Electives:** Physical Education and HSE (1 credits) Project Management (2 credits) Ethics and Communication in Geoscience (2 credits) Philosophy of Science (2 credits)

• Digital Transformation (2 credits) • Spectral Analysis of Digital Signal (2 credits) • Lab. Work of Spectral Analysis of Digital Signal (1 credit) • Numerical Solution (2 credits) • Lab. Work of Numerical Solution (1 credit) • Geographical Information Systems (2 credits) • Lab. Work of Geographic Information System (1 credit)	Entrepreneurship and Management (2 credits) Assistance (1 credits)

From table 6.1, the distribution of student credits can be visualized in the pie diagram on figure 6.1. The percentage distribution of credits for courses in the Geophysics undergraduate study program is dominated by geophysics by 24%, basic science by 22%, earth sciences by 17%, computers and IT, and data acquisition, processing and interpretation by 14%, and soft skills by 9%.

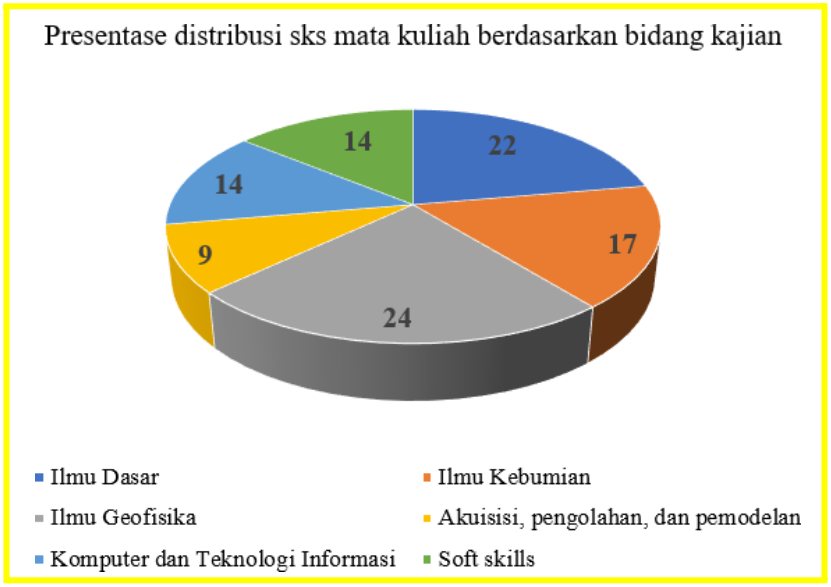

Figure 6.1. Credits distribution based on field of study

7. Course Formation and Credits Weight

Based on the vision, mission, objectives, and strategies of geophysics undergraduate study program; UGM values as well as graduates competency standard and field of study, the compulsory and elective courses in the geophysics undergraduate study program is offered as follow:

7.1. List of Compulsory Courses per Semester

A list of compulsory courses in each semester and the prerequisites are presented in Table 7.1.

Table 7.1. Compulsory courses offered each semester

Sem	Code		Courses	Credits	ECTS	Prerequisites
1	MFF	1011	Basic Physics I	3	4.98	
1	MFF	1013	Lab. Work of Basic Physics I	1	1.66	MFF-1011*)
1	MFF	1020	Mathematics for Physics I	3	4.98	
1	MKK	1101	General Chemistry I	3	4.98	
1	MFG	1101	Introduction to Geophysics	2	3.32	
1	MMM	1101	Calculus I	3	4.98	
1	UNU	100X	Religion	2	3.32	
1	MII21	1201	Programming	3	4.98	
Total credits Semester 1				20	33.2	
2	MFF	1012	Basic Physics II	3	4.98	MFF-1011
2	MFF	1014	Lab. Work of Basic Physics II	1	1.66	MFF-1012*)
2	MFF	1401	Mechanics I	2	3.32	MFF-1011, MFF-1020
2	MFF	1021	Mathematics for Physics II	3	4.98	MMM-1101, MFF-1020
2	MFF	1405	Wave	2	3.32	MFF-1011
2	MFG	1406	Lab. Work of Wave	1	1.66	MFF-1405 *)
2	MFG	1104	Basic Geology	2	3.32	MKK-1101, MFG-1101
2	MFG	1105	Lab. Work of Basic Geology	1	1.66	MFG-1104*)
2	MMM	1102	Calculus II	3	4.98	MMM-1101
2	UNU	1010	Pancasila State's Ideology	2	3.32	
Total credits Semester 2				20	33.2	
3	MFG	1106	Structural Geology	2	3.32	MFG-1104
3	MFG	2102	Mapping	2	3.32	MFG-1101
3	MFG	2103	Lab. Work of Mapping	1	1.66	MFG-2102 *)
3	MFG	2105	Electromagnetics Geophysics	2	3.32	MFG-1101, MFF-1012, MFF-1405
3	MFG	2106	Geophysical Analysis Method	3	4.98	MFF-1405, MFF-1401, MMM-1102, MFF-1021
3	MFG	2107	Lab. Work of Geophysical Analysis Method	1	1.66	MFG-2106*)

Sem	Code		Courses	Credits	ECTS	Prerequisites
3	MFF	2024	Mathematics for Physics III	3	4.98	MMM-1101, MFF-1020, MFF-1021
3	MFG	1102	Computation Methods	2	3.32	
3	MFG	1103	Lab. Work of Computation Method	1	1.66	MFG-1102*)
3	UNU	3000	Civics	2	3.32	
Total credits Semester 3				19	31.54	
4	MFG	2101	Geological Field Work	2	3.32	MFG-1104, MFG 1106
4	MFG	2108	Geophysical Electronics	2	3.32	MFG-2105, MFF-1012
4	MFG	2109	Lab. Work of Geophysical Electronics	1	1.66	MFG-2108 *)
4	MFG	2120	Geoelectric and Electromagnetic Method	3	4.98	MFG-2105, MFG-2106
4	MFG	2117	Seismic Method	3	4.98	MFG-2106, MFF-1405
4	MFG	2118	Lab. Work of Seismic Method	1	1.66	MFG-2117 *)
4	MFG	2111	Mechanics of Continuous Media	2	3.32	MFG-1401,
4	UNU	222005	Indonesian Language	2	3.32	UNU222005
Total credits Semester 4				16	26.56	
5	MFG	3115	Tectonics of Indonesia	2	3.32	MFG-2101
5	MFG	3111	Physics of Volcanology	2	3.32	MFG-2120, MFG-2117
5	MFG	3109	Seismology	2	3.32	MFG-2111
5	MFG	3110	Lab. Work of Seismology	1	1.66	MFG-3109*)
5	MFG	3113	Gravity and Magnetic Method	3	4.98	MFF-2024, MFG-1103
5	MFG	3114	Non-Seismic Method	1	1.66	MFG-3113*)
5	MFG	4943	Laboratory Assistant***)	1	1.66	Minimum 60 credits
Total credits Semester 5				12	19.92	
6	MFG	3121	Geophysics Field Camp	2	3.32	MFG-2102, MFG-2108, MFG-3109, MFG-3111, MFG-3113, MFG-3114, MFG-3115
6	MFG	3122	Internship	2	3.32	Minimum 80 credits

Sem	Code		Courses	Credits	ECTS	Prerequisites
6	UNU	222001	Student Service Learning (KKN) ***)	3	4.98	Minimum 100 credits
Total credits Semester 6				6	9.96	
7	MBKM		Courses of Independent Learning-campus *Merdeka (Internship)*	20	33.2	Minimum 100 credits
Total credits Semester 7				20	33.2	
8	MFG	4101	Undergraduate Thesis***)	6	9.96	Minimum 120 credits
Total credits Semester 8				6	9.96	

*) Taken at the same time as or after the appropriate theory course.
**) UNU-1000: Islam; UNU-1001: Catholic; UNU-1002: Christian; UNU-1003: Hinduism; UNU-1004: Buddha; UNU-1005: Confucianism.
***) Offered in every semester

7.2. List of Elective Courses per Semester

A list of elective courses in each semester and the prerequisites are presented in table 7.2.

Table 7.2. Elective courses offered in each semester

Sem		Code	Courses	Credits	ECTS	Prerequisite
Even	MFF	1051	Thermodynamics	3	4.98	
Even	MFG	3112	Physics of Volcanology Field Work	1	1.66	MFG 3111 *)
Even	MFG	4621	Assistance	1	1.66	Minimum 60 credits
Even	MFG	4701	General Biology	2	3.32	
Even	MFG	4703	Petrology	2	3.32	
Even	MFG	4704	Lab Work of Petrology	1	1.66	MFG-4703*)
Even	MFG	4705	Physical Education and HSE	1	1.66	
Even	MKK	4707	Geochemistry	2	3.32	MKK-1101
Even	MFG	4709	Global Positioning System (GPS)	2	3.32	MFF-1012
Even	MFG	4711	Geostatistics	3	4.98	MMM-1102
Even	MFG	4713	Project Management	2	3.32	Minimum 60 credits
Even	MFG	4715	Rock Mechanics	2	3.32	MFF-1401
Even	MFG	4717	Geophysical Fluid Mechanics	2	3.32	MFG-2111
Even	MFG	4719	Geophysical Instrumentation	2	3.32	MFG-2108

Sem		Code	Courses	Credits	ECTS	Prerequisite
Even	MFG	4720	Lab. Work of Geophysical Instrumentation	1	1.66	MFG-4719*)
Even	MFG	4721	Environmental Geophysics	2	3.32	All methods
Even	MFG	4723	Geophysical Computer Programming	2	3.32	MFG-2106
Even	UNU	163200	Digital Transformation	2	3.32	
Even	MFG	4725	Ethics and Communication in Geoscience	2	3.32	
Even	MFG	4727	Geothermal Exploration	2	3.32	Methods
Even	MFG	4728	Geothermal Exploration Field Work	1	1.66	MFG-4727*)
Total Credits				39	64.74	
Odd	MFF	1015	Philosophy of Physics	2	3.32	
Odd	MFG	3103	Entrepreneurship and Management	2	3.32	
Odd	MFG	4601	Energy	2	3.32	
Odd	MFG	4603	Rock Physics	2	3.32	MFF-1012
Odd	MFG	4605	Meteorology and Climatology	2	3.32	MFG-2111
Odd	MFG	4607	Inversion Method	2	3.32	MFF-1021
Odd	MFG	4609	Spectral Analysis of Digital Signals	2	3.32	MFG-2106
Odd	MFG	4610	Lab. Work of Spectral Analysis of Digital Signals	1	1.66	MFG-4609*)
Odd	MFG	4611	Numerical Solution	2	3.32	MI21-1201
Odd	MFG	4612	Lab. Work of Numerical Solution	1	1.66	MFF-4611*)
Odd	MFG	4613	Stratigraphy	2	3.32	MFG-2106
Odd	MFG	4615	Geodynamic	2	3.32	MFG-1101
Odd	MFG	4617	Petroleum Geology	2	3.32	MFG-2106
Odd	MFG	4618	Lab. Work of Petroleum Geology	1	1.66	MFG-4617*)
Odd	MFG	4619	Stratigraphic Seismic	2	3.32	MFG-2117
Odd	MFG	4621	Assistance	1	1.66	Minimum 60 credits
Odd	MFG	4623	Heat and Mass Transfer	2	3.32	MFF-1051
Odd	MFG	4625	Marine Geophysical Exploration	2	3.32	All
Odd	MFG	4627	Capita Selecta	2	3.32	Minimum 60 credits

Sem		Code	Courses	Credits	ECTS	Prerequisite
Odd	MFG	4629	Aero and Satellite Geophysics	2	3.32	MFG-2102
Odd	MGF	4631	Geographic Information System	2	3.32	MFG-2102
Odd	MFG	4632	Lab Work of Geographic Information System	1	1.66	MFG-4631*)
Odd	MFG	4633	Volcanological Seismology	2	3.32	MFG-3109
Odd	MFG	4645	Seismic Attribute	2	3.32	MFG-2117
Odd	MFG	4647	Methane Hydrate Exploration	2	3.32	MFG-2117
Odd	MFG	4649	Artificial Intelligence for Geoscience	2	3.32	MFG-1102
Total Credits				50	83	

*) Taken together or after appropriate theoretical courses.

8. Matrices and Curriculum Map

Relationship map between compulsory courses (MKW) and elective courses (MKP) with Fields/Study Materials, learning outcome (CP), and Graduate Profiles are presented in Figure 8.1. Tables 8.1 and 8.2 contain a matrix of linkages between compulsory courses (MKW) and elective courses (MKP) with learning outcome, while the list of compulsory courses (MKW) and elective courses (MKP) can be seen in Table 9.2.1 and Table 9.2.2. The compulsory and elective course curriculum map is shown in Figure 8.2.

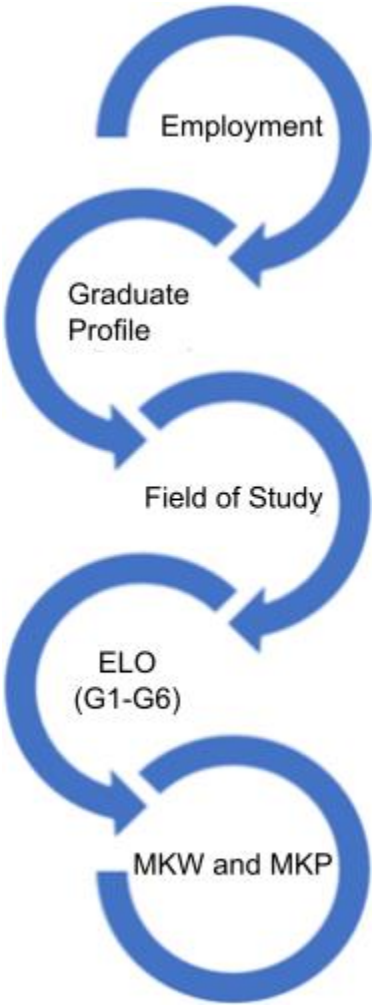

Figure 8.1 Relationship Map between Compulsory Courses (MKW) and Elective Courses (MKP) with the Field of Study, Learning Outcome, and Graduate Profile

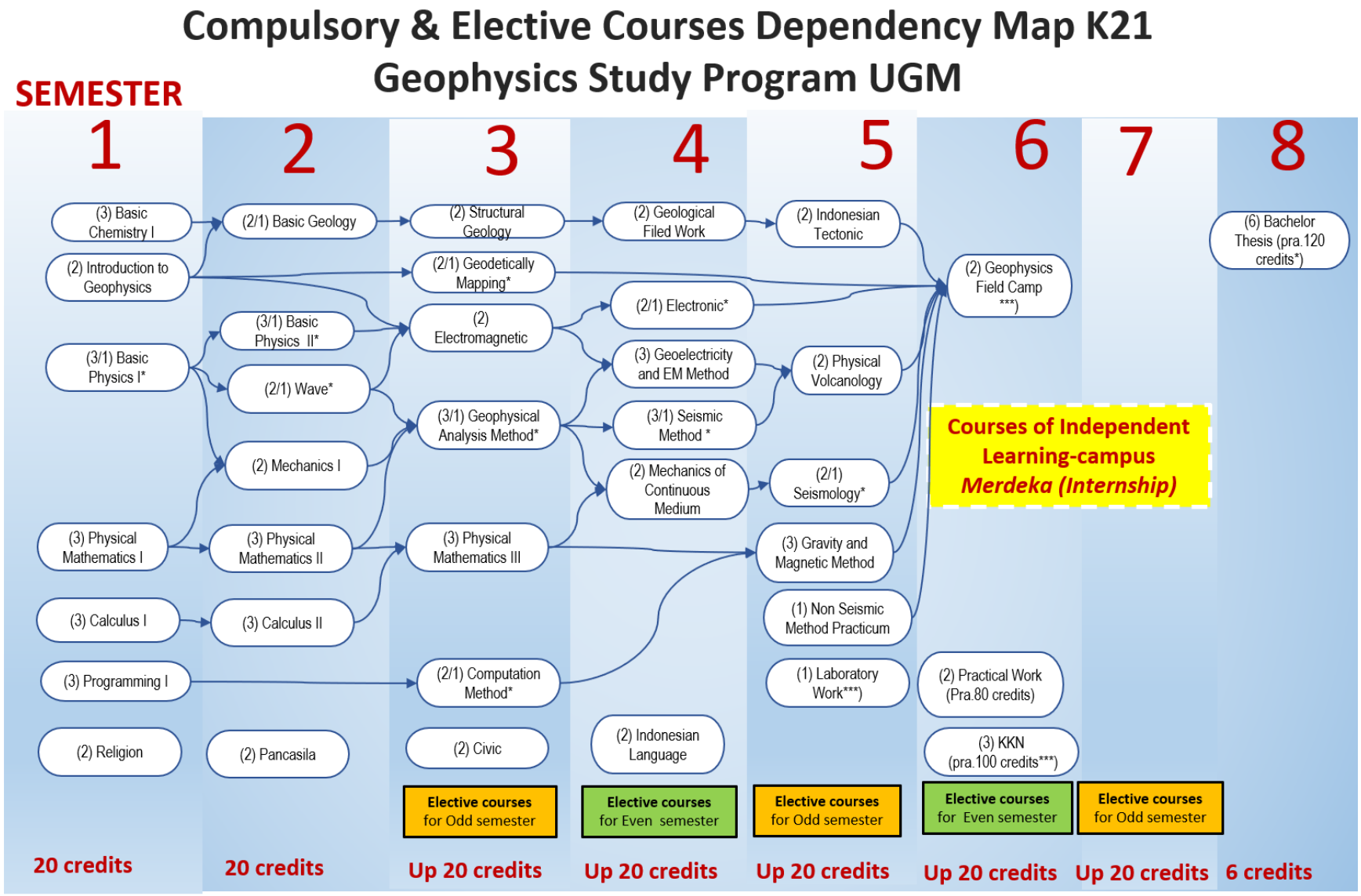

Figure 8.2. Map of Compulsory and Elective Courses Curriculum

Table 8.1. Matrix of linkage between compulsory subjects (MKW) and graduate learning outcomes

Compulsory Courses – MKW						Attitude	Knowledge	General Skills	Special Skills		Self Development
Sem			Code	Courses	Credits	G1	G2	G3	G4	G5	G6
1	MKW	MKK	1101	General Chemistry I	3	X	X				
1	MKW	MFG	1101	Introduction to Geophysics	2	X	X				
1	MKW	MFF	1011	Basic Physics I	3		X				
1	MKW	MFF	1013	Basic Physics Lab Work I	1	X	X	X			
1	MKW	MFF	1020	Mathematics for Physics I	3	X	X				
1	MKW	MMM	1101	Calculus I	3		X				
1	MKW	UNU	100X	Religion	2	X					X
1	MKW	MII21	1201	Programming	3	X	X	X			
2	MKW	MFG	1104	Basic Geology	2	X	X	X			
2	MKW	MFG	1105	Basic Geology Lab. Work	1	X	X	X			
2	MKW	MFF	1012	Basic Physics II	3		X				
2	MKW	MFF	1014	Basic Physics Lab. Work II	1	X	X	X			
2	MKW	MFF	1405	Wave	2	X	X				
2	MKW	MFG	1406	Wave Lab. Work	1	X	X	X			
2	MKW	MFF	1401	Mechanics I	2		X				
2	MKW	MFF	1021	Mathematics for Physics II	3	X	X				
2	MKW	MMM	1102	Calculus II	3		X				
2	MKW	UNU	1010	Pancasila State's Ideology	2	X	X				X
3	MKW	MFG	1106	Structural Geology	2	X	X	X			
3	MKW	MFG	2102	Mapping	2		X	X			
3	MKW	MFG	2103	Mapping Field Work	1	X	X	X			
3	MKW	MFG	2105	Electromagnetics Geophysics	2		X				
3	MKW	MFG	2106	Geophysical Analysis Methods	3	X		X		X	
3	MKW	MFG	2107	Geophysical Analysis Methods Lab. Work	1	X		X		X	
3	MKW	MFF	2024	Mathematics for Physics III	3	X	X				
3	MKW	MFG	1102	Computation Methods	2	X	X	X			
3	MKW	MFG	1103	Computation Methods Lab Work	1	X	X	X			
3	MKW	UNU	3000	Civics	2	X					X
4	MKW	MFG	2101	Geological Field Work	2	X	X	X	X		
4	MKW	MFG	2108	Geophysical Electronics	2		X	X			
4	MKW	MFG	2109	Geophysical Electronics Lab Work	1	X	X	X			

Compulsory Courses – MKW						Attitude	Knowledge	General Skills	Special Skills		Self Development
Sem			Code	Courses	Credits	G1	G2	G3	G4	G5	G6
4	MKW	MFG	2120	Geoelectric and Electromagnetic Method	3			X	X	X	
4	MKW	MFG	2117	Seismic Method	3		X	X	X	X	
4	MKW	MFG	2118	Seismic Methods Lab work	1	X		X	X	X	
4	MKW	MFG	2111	Mechanics of Continuous Media	2	X	X	X			
4	MKWK	UNU	222005	Indonesian Language	2	X	X				X
5	MKW	MFG	3115	Tectonics of Indonesia	2	X	X	X			
5	MKW	MFG	3111	Physics of Volcanology	2		X	X	X		
5	MKW	MFG	3109	Seismology	2	X	X	X	X	X	
5	MKW	MFG	3110	Seismology Lab Work	1	X		X	X	X	
5	MKW	MFG	3113	Gravity and Magnetics Methods	3	X	X	X	X	X	
5	MKW	MFG	3114	Non Seismic Methods Field Work	1	X		X	X	X	X
5	MKW	MFG	4943	Laboratory Work***)	1	X	X	X	X	X	X
6	MKW	MFG	3121	Workshop of Geophysics	2	X	X	X	X	X	X
6	MKW	MFG	3122	Internship	2	X	X	X	X	X	X
6	MKW	UNU	4500	Student Service Learning ***)	3	X	X	X	X	X	X
6	MKW	UNU	222001	Community Communication ***)	2	X	X	X	X	X	X
6	MKW	UNU	222002	Application of appropriate technology ***)	2	X	X	X	X	X	X
8	MKW	MFG	4101	Undergraduate Thesis***)	6	X	X	X	X	X	X
				Total	100						

***) Offered every semester

Table 8.2. Matrix of linkage between elective subjects (MKP) and graduate learning outcomes

Elective Courses – MKP						Attitude	Knowledge	General Skills	Special Skills		Self Development
Sem			Code	Courses	Credits	G1	G2	G3	G4	G5	G6
Even	MKP	MFF	1051	Thermodynamics	3	X	X				
Even	MKP	MFG	3112	Physical Volcanology Lab work	1	X	X	X	X		
Even	MKP	MFG	4701	General Biology	2	X	X				
Even	MKP	MFG	4703	Petrology	2		X	X	X		
Even	MKP	MFG	4704	Petrology Lab Work	1	X	X	X			
Even	MKP	MFG	4705	Physical Education and HSE	1	X	X				X
Even	MKP	MKK	4707	Geochemistry	2		X	X			
Even	MKP	MFG	4709	Global Positioning System (GPS)	2		X	X			
Even	MKP	MFG	4711	Geostatistics	3	X	X	X			
Even	MKP	MFG	4713	Project Management	2	X	X				X
Even	MKP	MFG	4715	Rocks Mechanics	2	X	X	X			
Even	MKP	MFG	4717	Geophysical Fluid Mechanics	2		X	X			
Even	MKP	MFG	4719	Geophysical Instruments	2	X	X	X			
Even	MKP	MFG	4720	Geophysical Instruments Lab Work	1	X		X			
Even	MKP	MFG	4721	Environmental Geophysics	2		X	X	X		
Even	MKP	UNU	163200	Digital Transformation	2				X	X	X
Even	MKP	MFG	4725	Ethics and Communication in Geoscience	2		X	X			
Even	MKP	MFG	4727	Geothermal Exploration	2	X	X				X
Even	MKP	MFG	4728	Geothermal Exploration Field Work	1				X	X	
Odd	MKP	MFG	4601	Energy	2	X			X	X	
Odd	MKP	MFF	1015	Philosophy of Physics	2		X				
Odd	MKP	MFG	4603	Rock Physics	2		X				
Odd	MKP	MFG	3103	Entrepreneurship and Management	2		X	X	X		X
Odd	MKP	MFG	4605	Meteorology and Climatology	2	X	X				X

Elective Courses – MKP						Attitude	Knowledge	General Skills	Special Skills		Self Development
Sem			Code	Courses	Credits	G1	G2	G3	G4	G5	G6
Odd	MKP	MFG	4607	Inversion Method	2		X		X	X	
Odd	MKP	MFG	4609	Spectral Analysis of Digital Signal	2	X	X			X	X
Odd	MKP	MFG	4610	Spectral Analysis of Digital Signal Lab Work	1			X		X	
Odd	MKP	MFG	4611	Numerical Solution	2	X		X		X	
Odd	MKP	MFG	4613	Stratigraphy	2	X	X	X			
Odd	MKP	MFG	4612	Numerical Solution Lab Work	1	X		X			
Odd	MKP	MFG	4615	Geodynamics	2		X	X			
Odd	MKP	MFG	4617	Petroleum Geology	2	X	X		X		
Odd	MKP	MFG	4618	Petroleum Geology Lab Work	1		X	X			
Odd	MKP	MFG	4619	Stratigraphic Seismic	2	X	X	X			
Odd	MKP	MFG	4621	Assistance	1			X	X		X
Odd	MKP	MFG	4623	Heat and Mass Transfer	2	X					X
Odd	MKP	MFG	4625	Marine Geophysical Exploration	2	X	X				
Odd	MKP	MFG	4627	Capita Selecta	2	X					X
Odd	MKP	MFG	4629	Aero and Satellite Geophysics	2	X	X	X	X	X	
Odd	MKP	MGF	4631	Geographic Information System	2		X	X	X		
Odd	MKP	MFG	4632	Geographic Information System Lab Work	1	X		X	X	X	
Odd	MKP	MFG	4633	Volcanological Seismology	2	X	X	X	X		
Odd	MKP	MFG	4645	Seismic Attribute[5]	2	X	X				X
Odd	MKP	MFG	4647	Methane Hydrate Exploration	2		X		X	X	
Odd	MKP	MFG	3101	Scientific Writing and Presentation	2		X	X			
Odd	MKP	MFK	4649	Artificial Intelligence for Geoscience	2	X	X				X
				Total	100						

9. Semester Teaching Plan (RPS)

9.1. Preparation of the 2021 Curriculum

The 2021 curriculum is structured based on several changes from the previous curriculum (2016 Curriculum). Some of these changes include:

1. Adding courses (elective)
2. Elimination of courses
3. Merging several courses
4. *Merdeka Belajar* program

The changes to the courses mentioned above are carried out by taking into account the demands of student competencies that must be achieved in the current era and in the next 5-10 years. Meanwhile, the merging of courses is carried out with the aim of efficiency in the number of credits that must be provided, especially for compulsory subjects. *Merdeka Belajar* Program is held to fulfill the Minister of Education and Culture Regulation Number 3 of 2020 concerning the National Standard for Higher Education, which includes provisions concerning *Merdeka Belajar - Kampus Merdeka* program. Any changes in courses (addition, elimination, and merging of courses) in their implementation will require a transition mechanism and course equivalence. For this reason, a Transitional Regulation and Equivalence Regulation of courses are needed so that students who go through the transition period from the 2016 Curriculum to the 2021 Curriculum will easily adjust. The mechanism for implementing the *Merdeka Belajar* Program refers to the *Merdeka Belajar* Guidebook – *Kampus Merdeka*, Directorate General of Higher Education, Ministry of Education and Culture, 2020.

9.2. 2021 Curriculum Compulsory Courses and Elective Courses

Compulsory and elective courses held by the Geophysics undergraduate study program in the 2021 curriculum are shown in **Table 9.2.1** and **Table 9.2.2 below**. Elective courses are offered according to different semesters, can be odd or even semester.

Table 9.2.1 Compulsory Courses

No	Courses	Credits		No	Courses	Credits
Semester 1				Semester 2		
1	General Chemistry I	3		1	Basic Geology	2
2	Introduction to Geophysics	2		2	Basic Geology Lab. Work	1
3	Basic Physics I	3		3	Basic Physics II	3
4	Basic Physics Lab Work I	1		4	Basic Physics Lab. Work II	1
5	Mathematics for Physics I	3		5	Wave	2
6	Calculus I	3		6	Wave Lab. Work	1
7	Religion	2		7	Mechanics I	2

8	Programming	3		8	Mathematics for Physics II	3
				9	Calculus II	3
				10	Pancasila State's Ideology	2
Total Compulsory Course Credits		20		Total Compulsory Course Credits		20
Semester 3				Semester 4		
1	Structural Geology	2		1	Geological Field Work	2
2	Mapping	2		2	Geophysical Electronics	2
3	Mapping Field Work	1		3	Geophysical Electronics Lab Work	1
4	Electromagnetics Geophysics	2		4	Seismic Methods	3
5	Geophysical Analysis Methods	3		5	Geoelectric and Electromagnetic Method	3
6	Geophysical Analysis Methods Lab. Work	1		6	Seismic Methods Lab work	1
7	Mathematics for Physics III	3		7	Mechanics of Continuous Media	2
8	Computation Methods	2		8	Indonesian Language	2
9	Computation Methods Lab Work	1				
10	Civics	2				
Total Compulsory Course Credits		19		Total Compulsory Course Credits		16
Semester 5				Semester 6		
1	Tectonics of Indonesia	2		1	Workshop of Geophysics	2
2	Physics of Volcanology	2		2	Internship	2
3	Seismology	2		3	Student Service Learning ***)	3
4	Seismology Lab Work	1		4	Community Communication ***)	2
5	Gravity and Magnetics Methods	3		5	Application of appropriate technology ***)	2
6	Non Seismic Methods Field Work	1				
7	Laboratory Assistant***)	1				
8	Scientific Writing and Presentation	2				
Total Compulsory Course Credits		14		Total Compulsory Course Credits		7

		Semester 8		
		1	Undergraduate Thesis	6
		Total Compulsory Course Credits		6

Table 9.2.2 Elective Courses

No	Courses	Credits		No	Courses	Credits
Odd Semester				Even Semester		
1	Energy	2		1	Thermodynamics	3
2	Philosophy of Physics	2		2	Physical Volcanology Field Work	1
3	Rock Physics	2		3	General Biology	2
4	Entrepreneurship and Management	2		4	Petrology	2
5	Meteorology and Climatology	2		5	Petrology Lab Work	1
6	Inversion Method	2		6	Physical Education and HSE	1
7	Spectral Analysis of Digital Signal	2		7	Geochemistry	2
8	Spectral Analysis of Digital Signal Lab Work	1		8	Global Positioning System (GPS)	2
9	Numerical Solution	2		9	Geostatistics	3
10	Stratigraphy	2		10	Project Management	2
11	Numerical Solution Lab Work	1		11	Rocks Mechanics	2
12	Geodynamics	2		12	Geophysical Fluid Mechanics	2
13	Petroleum Geology	2		13	Geophysical Instruments	2
14	Petroleum Geology Lab Work	1		14	Geophysical Instruments Lab Work	1
15	Stratigraphic Seismic	2		15	Environmental Geophysics	2
16	Assistance	1		16	Digital Transformation	2
17	Heat and Mass Transfer	2		17	Ethics and Communication in Geoscience	2
18	Marine Geophysical Exploration	2		18	Geothermal Exploration	2
19	Capita Selecta	2		19	Geothermal Exploration Field Work	1
20	Aero and Satellite Geophysics	2				
21	Geographic Information System	2				

No	Courses	Credits	
Odd Semester			
22	Geographic Information System Lab Work	1	
23	Volcanological Seismology	2	
24	Seismic Attribute[5]	2	
25	Methane Hydrate Exploration	2	
26	Scientific Writing and Presentation	2	
27	Artificial Intelligence for Geoscience	2	

Description:

[1] In semester 1, students take a compulsory course package of 19 credits.
[2] Elective courses that students can take in semester 2 or 4 or 6 or 8.
[3] Elective courses that students can take in semester 3 or 5 or 7.
[4] Elective courses that students can take in semester 4 or 6 or 8.
[5] Elective courses that students can take in semester 5 or 7.
[6] Elective courses that students can take in semester 6 or 8.
[7] Elective courses that students can take in semester 7.
[8] Elective courses that students can take in semester 6 or 7.

9.3. Concentration or fields of interest

The Geophysics study program offers 5 concentrations or fields of interest that students can take when choosing elective courses. Each concentration or field of interest contains elective courses that will equip students with knowledge, skills and professionalism in their respective field of interest. Students are advised to take elective courses according to their field of interest. Table 9.3 below is a breakdown of the field interests offered in the 2021 geophysics study program curriculum:

Table 9.3 Concentration or fields of interest

Fields of Interest	Courses in Odd Semester	Courses in Even Semester
Oil and Gas Exploration	Stratigraphy, Petroleum Geology, Stratigraphic Seismic, Inversion Method, Marine Geophysics, Spectral Analysis of Digital Signal, Rock Physics, Rock Mechanics, Seismic Attribute, Methane Hydrate Exploration, Capita Selecta	Petrography, Geophysical Instruments, Rock Mechanics, Geostatistics, Numerical Solution, GPS, Project Management, Seismic Migration, Energy
Fields of Interest	Courses in Odd Semester	Courses in Even Semester
Geothermal Exploration	Geothermal Exploration, Volcano Seismology, Heat and Mass Transfer,	Petrology, Geophysical Instruments, Geochemistry, Numerical Solution, GPS,

	Inversion Method, Rock Physics, Rock Mechanics, Spectral Analysis of Digital Signal, Capita Selecta	GIS, Thermodynamic, Project Management, Energy
Geotechnical, Mining and Environment	Meteorology, Inversion Methods, Marine Geophysics, Rock Physics, Rock Mechanics, GIS, Aero and Satellite Geophysics, Spectral Analysis of Digital Signal, Capita Selecta	Petrology, Environment Geophysics, Geophysical Instruments, Geostatistics, GPS, Fluid Mechanics, Project Management
Seismology, Volcanoes and Disasters	Inversion Method, Heat and Mass Transfer, Spectral Analysis of Digital Signal, GIS, Aero and Satellite Geophysics, Environmental Geophysics, Geochemistry	Petrology, Volcano Seismology, Physical Volcanology Lab work, Geophysical Instruments, Geodynamics, Thermodynamics, Geochemistry, GPS, Project Management
Computational System, Information and Earth Instrumentation	Numerical Solution, GIS, Inversion Method, Spectral Analysis of Digital Signal, Aero and Satellite Geophysics	Digital Transformation, Geostatistics, Geophysical Computer Programming, Geophysical Instrument, GPS, Project Management

10. *Merdeka Belajar* Program Implementation Mechanism

The implementation of the *Merdeka Belajar* Program in the 2021 Curriculum is based on the *Merdeka Belajar* Guidebook – *Kampus Merdeka*, Directorate General of Higher Education, Ministry of Education and Culture, 2020. A significant difference from the Geophysics Study Program 2021 curriculum with the previous curriculum is that students are freed in semester 7 to **choose the *Merdeka Belajar* program**, namely studying off campus which is equivalent to a max of 20 credits. In the 8th semester, students must return to study at their home campus. The *Merdeka Belajar* program is an option that students can choose or not choose. Students who do not choose the *Merdeka Belajar* program are following the conventional (regular) program.

2021 *Merdeka Belajar* Curriculum in Geophysics Study Program offers students to study outside campus only in semester 7, which is carried out under the guidance of lecturers, with activities that can be chosen as follows:

1. **Student Exchange**: taking classes or semesters at foreign and domestic universities, based on a cooperation agreement that has been made previously, with the appropriate number of credits offered by partners.
2. **Internship**, which is an internship in a company, non-profit foundation, multilateral organization, government institution, or start-up company. Internship activities are guided by 2 people, supervisors from companies (non-profit foundations, multilateral organizations, government institutions, or start-ups) and lecturers from campuses.

3. **Research**: student research activities in institutions/companies/start-ups in the field of research. Research activities are guided by 2 people, researchers at institutions/institutions/companies/start-ups and lecturers from campus.
4. **Campus teaching program**, which is a program from the Ministry of Education and Culture in which students will be placed in elementary schools throughout Indonesia and assist the teaching and learning process at these schools.

As for the concept of *Merdeka Belajar* program, taking the internship route in industry or in government agencies must be carried out with clear objectives, with the following provisions:

1. Activities carried out in Semester 7, are valued for a maximum of 20 credits.
2. Each activity is rewarded in the form of credits, which is agreed with the **Partner Agency.**
3. The grade given to students after completing *Merdeka Belajar* program outside the campus, is assessed based on the level of mastery in each activity.

For **example**, the Implementation of *Merdeka Belajar* program (max 20 credits) by carrying out an Internship at the BPPTKG (Geological Disaster Technology Research and Development Center),the assessment is based on several aspects of activities that have been previously determined (Table 10)**.**

Table 10. Example of assessment of internship activities at BPPTKG.

No	Activity	Credits	Grade
1	**Data Acquisition/Data Mining**		
	- Aspects of the ability to collect primary data (field surveys) or secondary data	3	
	- Aspects of understanding various digital data formats	3	
	- Aspects of the ability to display visual data	3	
2	**Instrumentation/ Processing**		
	- Aspects of understanding the working principle of geophysical instrument	3	
3	**Modeling/Interpretation**		
	- Aspects of interpretation of geophysical data into geological models	4	
	- Aspects of mastering simple Matlab/Python scripts	4	
	Total	20	

The mechanisms that must be passed in the implementation of the independent learning program are as follows:

1. Faculty of Mathematics and Natural Sciences UGM and Partners mapped the competencies that must be achieved by the 7th semester courses, which must be translated into the competencies of *Merdeka Belajar* courses.

2. Faculty of Mathematics and Natural Sciences UGM communicates with prospective partner institutions, such as universities, both at home and abroad, companies/industry or government agencies to find common ground for independent course competencies with activities offered by potential partners.
3. Faculty of Mathematics and Natural Sciences UGM plans with partners detailed activities for independent courses at partner institutions, regarding the number of working hours that students must carry out, for example for 20 credits it must be equivalent to 20 hours of activity/week.
4. The Faculty of Mathematics and Natural Sciences UGM is willing to be a partner for other study programs, both within UGM and outside UGM, with the same implementation mechanism.

11. Curriculum Implementation Management and Internal Quality Assurance System (SPMI)

11.1. Courses Shift Rules

The credits of compulsory and elective courses that can be taken by students following the 2021 curriculum is a minimum of 144 credits, which consists of:

1. Total number of credits of compulsory courses: 100 credits for students who take Student Service Learning (KKN) 3 credits (for senior students)
2. Minimum total credits of elective courses that can be taken is 44 credits.
3. The MKWK Indonesian Language (UNU222005) course must be taken by students from batch 2021 and the next batch
4. The 2021 Geophysics Study Program curriculum facilitates students to choose Merdeka Belajar program to study in semester 6 and above, or choose a conventional program. If in semester 6 and above students take the Merdeka Belajar Program, then the elective courses in semester 6 and above will be replaced with activities outside the campus. If students choose the conventional program, students can take elective courses offered at the Geophysics Study Program.

11.2. Course Equavalencies Rules

Compulsory equivalencies courses apply to students prior to classes 2021 or who use the 2016 Curriculum (see Table 11.2). The equivalency regulations consist of:

1. The number of credits of compulsory courses for graduation is regulated separately (especially for transitional students), but the total number of credits for compulsory and elective courses remains at least 144 credits.
    a. Students from the class before 2021 who wish to **repeat** compulsory courses that have been combined in the 2021 Curriculum, must take combined/new compulsory courses according to the 2021 Curriculum.

Example: Students from the class before 2021 who wish to **repeat** Basic Geology Lab work in the 2021/2022 academic year, the compulsory equivalency course in SIMASTER that can be taken is Geology Lab work.

b. Students before the 2021 class who wish to **repeat** compulsory courses whose number of credits are reduced in the 2021 Curriculum, must take compulsory courses according to the SKS in the 2021 Curriculum.
   Example: Students from the class before 2021 who wish to repeat Geophysical Electromagnetic in 2021/2022 academic year, the number of credits for the Electromagnetic Geophysics course in accordance with the 2021 Curriculum is 2 credits.

If something has not been regulated here it will be regulated later by the authorities.

Table 11.2. Equivalence of courses from the 2016 Curriculum to the 2021 Curriculum

2016 Curriculum				Kurikulum 2021			
Code		Course	Credits	Code		Course	Credits
MFG	1905	Basic Geology Lab work	1	MFG	1105	Geology Lab work	1
MFG	2907	Structural Geology Lab work	1				
MFG	3631	Electromagnetic	3	MFG	2105	Electromagnetic	2
MFG	3927	Gravity and Magnetic Method	3	MFG	2113	Gravity and Magnetic Method	3
MFG	3922	Geophysical Analysis Method I	2	MFG	2106	Geophysical Analysis Method	3
MFG	3929	Geophysical Analysis Method II	2				
MFG	3923	Geophysical Analysis Method Lab work I	1	MFG	2107	Geophysical Analysis Method Lab work	1
MFG	3930	Geophysical Analysis Method Lab work II	1				
MFG	3917	Seismic Method I	2	MFG	2117	Seismic Method	3
MFG	3918	Seismic Method II	2				
MFG	3924	Seismic Method Lab work I	1	MFG	2118	Seismic Method Lab work	1
MFG	3932	Seismic Method Lab work II	1				
MFG	4935	Workshop on Geophysics	2	MFG	3121	Workshop on Geophysics	2
MFG	3931	Internship	1	MFG	3122	Internship	2
MFG	4937	Laboratory Work	1	MFG	4943	Laboratory Work	1

MFG	4934	Physical Volcanology Lab work	1	MFG	3112	Physical Volcanology Lab work	1
MFG	3101	Scientific Writing and Presentation	2	UNU		Indonesian Language	2

11.3. Teaching Method

The teaching methods implemented in the Geophysics undergraduate study program consist of: class lecturing, field lecturing, practice, seminars, guest lecturing and blended learning. While the assessment assessment models used are mid/final tests, assignments, pre/post tests, quizzes and group tests. Table 11.3 presents the relationship between learning outcomes and learning methods as well as the assessment model implemented in the Geophysics undergraduate study program.

Table 11.3. Teaching Methods and Assessment Methods

No	6 Teaching Pillars	Teaching Methods C = Class lecturing F = Field Lecturing P = Practicing S = Seminar Gu = Guest Lecturing B = Blended Learning	Assessment Methods T = Mid/Final Test H = Homework P = Pre/Post Test, Quiz Gr = Group Test
1	Attitude	F, P, S, Gu	H, P, Gr
2	Knowledge	C, F, P, S, Gu, B	T, H, P, Gr
3	General Skills	C, F, P, S, Gu, B	T, H, P
4	Special Skills	C, F, P, S, Gu, B	T, H, P, Gr
5	Advance Special Skills	C, F, P, S, Gu, B	T, H, P, Gr
6	Self-development/Work Experience	S, Gu, B	P, Gr

11.4. Assessment Methods

The final grade in each course is stated with the letter grade A, A-, A/B, B+, B, B-, C, D, and E, which corresponds to the numeric value 4.00; 3.75; 3.50; 3.25; 3.00; 2.75; 2.00; 1.00 and 0.00. Table 11.4 presents the suitability of grades with sub-sections of course assessment in general, namely:

Table 11.4. Assessment Methods

No	Letter Grade	Grade Range	Final Grade	Student's Ability Against the Subsections of the Courses Taken			
				Theory/Concept	General Question	Applicable Questions	Concept Development
1	A	3.76 – 4.00	4.00	Yes	Yes	Yes	Yes
2	A-	3.51 – 3.75	3.75	Yes	Yes	Yes	Enough
3	A/B	3.26 – 3.50	3.50	Yes	Yes	Yes	Average
4	B+	3.01 – 3.25	3.25	Yes	Yes	Enough	Low
5	B	2.76 – 3.00	3.00	Yes	Enough	Average	No
6	B-	2.51 – 2.75	2.75	Enough	Average	Low	No
7	C	1.76 – 2.00	2.00	Average	Low	No	No
8	D	0.51 – 1.00	1.00	Low	No	No	No
9	E	0.00 – 0.50	0.00	No	No	No	No

11.5. Study Program Quality Assurance System

The implementation of the Internal Quality Assurance System (SMPI) at Gadjah Mada University has covered all levels of study, starting from the Vocational School (originally D3) to the S3 (Doctoral Degree). Each cycle, which is done once a year, collects quite large data from the results of the Internal Quality Audit (AMI). The data is obtained based on the Study Program Self Evaluation (EDPS) which must be filled in by all study programs before the AMI cycle takes place. The Geophysics Study Program obtained AUN certification in 2016-2020 and in the 2021 timeframe it will apply for international accreditation (ASIIN). The Geophysics Study Program has also always received “A” grade accreditation since 2004-2026.

Several stages in implementing the internal quality assurance system at UGM are as follows:

1. Socialization of Internal Quality Assurance System (SPMI)

   The initial stage in implementing the higher education quality assurance system at UGM is socialization. At this stage, it is very important to emphasize and build mutual awareness about the importance of implementing SPMI at UGM. SPMI's activities in addition to being a mandate from Government Regulation No. 9 2005 concerning National Education Standards, also morally higher education institutions must always maintain and improve their quality so that the quality of graduates produced is always maintained. Graduate users (stakeholders) are satisfied with the performance and quality of UGM graduates.
2. Technical Assistance for Study Programs

Study programs as the spearhead in implementing SPMI at UGM at an early stage need to be given guidance and technical assistance in terms of understanding the meaning of its internal quality assurance system and the points contained in the SPMI standard so that it will make it easier to make academic documents and quality documents. Technical assistance is very important at the beginning of building a good documentation system, because not all study program managers have the same knowledge, understanding, and seriousness in documenting all activities, from planning, implementing, monitoring, and evaluating in study programs.

3. Socialization of Internal Quality Audit (AMI) and Study Program Self Evaluation (EDPS) Instruments to study programs and auditors.

   In the third stage, the implementation of SPMI at UGM is the socialization of AMI and EDPS instruments, both to study programs as audited and auditors who will carry out audits. Socialization is carried out to build the same perception and commitment between study programs and auditors in building a quality system in study programs. The impression that the internal quality audit (AMI) initiated by Quality Assurance Office (KJM) only burdens study programs must be removed because AMI is actually a means to build the quality of study programs. KJM only prepares systems, instruments and facilitates the implementation of SPMI at UGM.

4. Filling in the EDPS by the head of the study program assisted by the Technical Assistance team

   Prior to the audit, study programs are required to fill out the Study Program Self Evaluation (EDPS) which has been designed and prepared online by KJM. Each level of S-1 (Bachelor Degree), S-2 (Master Degree), S-3 (Doctoral Degree), and diploma has made EDPS. Likewise, for management evaluation, a Self Evaluation of the Faculty (EDF)/ Postgraduate School (SPs)/ Vocational School (SV) and a Description of Self Evaluation (D-EDF/ SPs/ SV) have been made. In the early stages of filling out, KJM will send a Technical Assistance Team to assist study programs in filling out the EDPS online. These materials and documents that have been filled in to the EDPS will be used by the auditor as a reference for auditing the study program.

5. Implementation of AMI: one study program is audited by 3 auditors

   Internal Quality Audit (AMI) is carried out by 3 appointed auditors. One of the senior auditors was appointed as Lead Auditor. In order to streamline audit time, it is necessary to divide the tasks among the three auditors. Each auditor looks at several standards and then the lead auditor will combine the findings of the three. The findings obtained are not simply combined, but discussed first by the three auditors to get the same perception before being submitted to the audited. Equalization of perception is very important so that there are no differences of opinion when presenting before the Head of Study Program as audited, especially in terms of categorization of findings, such as Heavy Incompatibility (KTS-Berat), Light Incompatibility (KTS-Ringan) or OB (Observation) and the substance of the findings.

6. Corrective Action / Corrective Action to Improve the Quality of Study Programs.

   The findings obtained from the audit results will not be useful, if it is not followed by corrective actions. The study program is greatly benefited and helped by the audit because based on the results of the audit, a work program can be made to improve the quality of the study program.

7. Management Review Meeting (Faculty/SPs/SV) Discusses Improving the Quality of Study Programs

The forum used to discuss the follow-up to the findings in the study program is the management review meeting (RTM) at the department and faculty level. If the faculty does not have a department, it means that the RTM is directly implemented at the faculty level to discuss findings in the study program. In this RTM will be discussed one by one the findings obtained. The priority scale for follow-up to improve study programs is based on the severity of the findings. If there are severe findings (KTS-Berat), these findings will be a top priority in improving the quality of study programs. The urgency of KTS-Ringan can be seen, which one is urgent and has the potential to disrupt the quality of study programs. Observational findings can be handled immediately so that they do not drag on and can interfere with the quality improvement process in other sectors.

8. University-level Management Review Meeting (RTM).

   If the findings obtained in the study program cannot be completed at the department and faculty level, they will be brought to the university level to be discussed in the university RTM. The findings that are followed up by university are usually general in nature covering all study programs at the university, for example: policies regarding the availability of lecturers or professors, passing grade standards for new student admissions, number of student admissions, etc. In implementing the internal quality assurance system (SPMI), it is necessary to know whether the SPMI has been implemented properly or not and an internal audit is necessary. This audit is very important because it is an important part of the quality assurance cycle, starting from the study program level to the university level.

(Source: copied from https://adoc.pub/sistem-penjaminan-mutu-internal-ugm-sejarah-implementasi-dan.html regarding UGM INTERNAL QUALITY ASSURANCE SYSTEM, History, Implementation, and Development).

12. Syllabus of Geophysics Study Program Courses

I. Compulsory Courses

1. Introduction to Geophysics

MFG 1101 Introduction to Geophysics (2 SKS MKW Sem: 1)

Prerequisite: -

Objective and competency

To introduce new students about what, how, and what is geophysics used for. This course's aim is also to motivate and strengthen the determination of students to study in geophysics and introduce them to the general topic of earth physics. Students who took this course seriously hope to have spirit, determination, insight and adequate knowledge to follow basic science and geophysics in the next semester.

Syllabus:

Geophysics Science: Definition, object, problems, coverage, objective and benefits of geophysics. Observation, measurement, processing and interpreting geophysics data and phenomenon. Basic

science and other geoscience roles, and teamwork on geophysics observation. History about development of geophysics and geophysics branches. Geophysics trend in next 5-10 years.
General Geophysics: Earth and Solar system. Shape, size and composition of the Earth. Earth rotation and revolution. Earth structure: exosphere, atmosphere, hydrosphere, lithosphere, upper mantle or asthenosphere, lower mantle, outer core and inner core. Earth gravitational field: pendulum and gravity meter, geoid, isostasy, tides. Seismology: seismograph and seismometer, earthquake mechanism (focal mechanism) and its spread, internal structure of the Earth, micro earthquake, tsunami. Geomagnetism and rock magnetism: compass and magnetometer, main magnetic field and outer magnetic field, daily variation and westward drift, rock magnetism, paleomagnetism and seafloor spreading. Geo Radioactivity: absolute dating, age of the Earth. Earth's internal heat: heat, heat gradient and surface heat flux, temperature change with depth. Geophysics exploration: Earth potential as mineral and natural resources warehouse. Geophysical exploration methods: groundwater and geothermal exploration, oil and gas exploration, mineral and ore bodies exploration. Environment geophysics: earth as source of disaster and bless. Geophysics role in environmental reservation, observation and mitigation of natural disaster.

References:

1. William Lowrie, 2000, Fundamental of Geophysics, CMB.
2. Mahfi, A., 1996, Diktat Pengantar Geofisika, Lab. Geofisika Jur. Fisika FMIPA-UGM
3. Compact Disks: a.l. Earth Quest, PC in Space, PlanetariumGold

2. Basic Chemistry I

MKK-1101 Basic Chemistry 1 (3 SKS MKW Sem: 1)

Prerequisite: -

Syllabus:

1. Introduction, Molecules, Ion, chemical equation, chemical reaction
2. Reactions in solution, energy change in chemical reaction
3. Atom structure, periodic table Struktur Atom, Tabel Periodik;

4. Ionic bond vs covalent bond, molecular geometry and covalent bond model

References:

1. James E. Brady, Frederick A. Senese, 2009, Chemistry: The Study of Matter and Its Changes edisi-5.
2. Raymond Chang, Kenneth A. Goldsby, 2012, Chemistry, Edisi-11.
3. Ralph H. Petrucci, William S. Harwood, F. Geoffrey Herring, 2002, General Chemistry: Principles and Modern Applications, edisi-8

3. Basic Physics I

MFF 1011 Basic Physics 1 (3 SKS MKW Sem:1)

Prerequisite:-

Syllabus:
Physics measurement and quantity, kinematic, Dynamic 1: Concept of force, Dynamic II: work and energy, particle system, Rigid body dynamic I*:* Torque and moment of inertia, rigid body dynamic II: Rotational and translational equilibrium, gravitation, fluid, vibration, wave, temperature, heat and Thermodynamics law I, entropy and Thermodynamics law II

References:

1. Halliday, D., Resnick, Rand Walker, J., 2014, Fundamental of Physics, Fundamental of Physics Extended, tenth edition, John Wiley & Sons, Inc, USA.
2. Tipler, P.A., 2008, Physics for Scientists and Engineers, sixth edition, W. H. Freeman and Company, New York, USA
3. Raymond A. Serway, dan John Jewett, 2014, Physics for Scientists and Engineers, Brooks/Cole Cengage Learning, Singapore.

4. Basic Physics Lab work I

MFF 1013 Basic Physics Practium (1 SKS MKW Sem: 1)

Prerequisite:-

Syllabus:

Measurement methods, free fall movement, oscillation, pendulum, organa pipe, Kundt pipe, viscometer**,** Fluid flow in porous media

References:

1. Staf LFD , 2011, Buku Panduan Praktikum Fisika Dasar I (Sem.I).
2. Prestone D. W., Kane & M. Sternheim 1983, Experiments in Physics : A Lab Manual, John Wiley & Sons.

5. Calculus I

MMM 1101 Calculus I (3 SKS MKW Sem: 1)

Prerequisite: -

Objective and Competency:

1. Students are able to understand the definition of function and proficient in organizing questions related to the nature of real numbers
2. Students are able to calculate limits and derivatives and implement it.

Syllabus:

1. A set: definition, aljabar, nature of sets
2. Real number system: nature of real number, inequality, absolute value
3. Function (one variable): definition, aljabar, function composition, inverse function
4. Coordinate system and function graphs
5. Limit: Definition and nature of limit, unidirectional limit, infinite limit, euler number
6. Continuity: definition, nature of continuity

7. Derivative: Definition, nature of derivative, function composition derivative, inverse function derivative, parametric derivative, trigonometry derivative, cyclometry function, hyperbolic function, exponential function, implicit derivative, logarithm function, logarithm derivative, higher order derivative. geometric mean derivation, differential.
8. Derivative application: maximum/minimum, up/down, convex/concave, stationary point, extreme function in daily life.
9. Taylor/MacLaurin series and application.

References:

1. Abe Mizrahiand Michael Sullivan, 1990. Calculus and Analytic Geometry, Wadsworth.
2. James Stewart, 1999, Calculus, 4th edition, Brooks/Cole Pub.Comp.
3. Robert A. Adam and Cristhoper Essex, 2010. Calculus, A complex Course, Pearson.
4. Tim Pengajar Kalkulus, Diktat Kuliah Kalkulus I, FMIPA, UGM.

6. Programming

MII 1201 Programming (3 SKS MKW Sem: 1)

Prerequisite: -

Syllabus:

1. Compiler vs interpreter dan how it works
2. Introduction to Computational Thinking and Algorithm
3. Data type and variable declaration
4. Arithmetic operation and logic
5. Branching and looping
6. Basic Data Structure: array, struct, strings, pointer and file
7. Introduction to Function: Definition, local and global variable, parameter function
8. Recursive function
9. Simple Sorting Algorithm: Bubble Sort, Insertion Sort, Selection Sort
10. Advance Sorting Algorithm: Quick Sort, Merge Sort
11. Searching Algorithm Binary, Sequential and Hashing
12. Problem Solving

References:

1. Thomas H. Cormen, Charles E. Leiserson, et.al., Introduction to Algorithms, third edition, 2014.
2. Adam Drozdek, Data Structures and Algorithms in C ++, 2012, ISBN 0-534-37597-9.
3. Munir, R., 2004, Algoritma dan Pemrograman, Informatika, Bandung.

7. Islamic Religion Education

UNU 1000 Islamic Religious Education (2 SKS MKW Sem: 1)

Prerequisite: -

Syllabus:

Human and religion: Belief in God Almighty does not go through an evolutionary process, but through revelation, religious expression. The basics of Islamic teachings. Classification of humans according to the Qur'an. The history of Prohpet Muhammad (pbuh). Seven groups of people who are protected by Allah (Hadith).

References:

Ali, M., 1975: Ke-esaan Tuhan Dalam Al Qur'an, AnNida.

8. Catholic Religion Education

UNU 1001 Catholic Religious Education (2 SKS MKW Sem: 1)

Prerequisite: -

Objective and Competency:

1. Increase students' knowledge and understanding of the teachings of Catholicism so that students' faith and devotion to God will grow.
2. Prepare students to live based on religious moral values, as a moral-social mission.
3. Prepare students to be more sensitive and caring in living together in the community, and to be more involved in church life in building a culture of defenders of life (pro-life).
4. Empowering students to take advantage of research results for the development of a holistic and inclusive Catholic religious education as an integrated knowledge system and to build a life together (learning to live together) in a pluralist society, so that they are able to appreciate cooperation between religious communities in devoting knowledge and technology and art for the national/public interest.
5. Helping students find forms of integration between faith and science, so that students have a broad, virtuous, wise, rational and dynamic view as a consequence of their faith involvement, both in personal life as well as in community and state life.
6. Further processing of students' faith experiences as preparation for the world of work.
7. Encouraging students to internalize Catholic faith and moral values in building their lives as Catholics who are mature, tough, missionary and dialogical, with the pattern of the Person of Jesus Christ so that students will become 100% Catholic and 100% citizens.

Syllabus:

Introduction - The Call of Human Life According to the Bible, Human Relations, Religion and Faith in Pluralism, Community Church and Faith, Church Social Teaching. Reasoning the Church's Social Teaching

References:

1. Curran, Charles E, Catholic Social Teaching 1891-Present:Historical, Theological and Ethical Analysis, Washington D.C. Georgetown University Press, 2002.
2. DeBerri, Edward P. and Hug, James E , Catholic Social Teaching Our Best Kept Secret, Washington, DC, 200017, Center of Concern, 2005.
3. Dewan Karya Pastoral Keuskupan Agung Semarang, Merajut Persaudaraan Sejati Lintas Iman, Yogyakarta, Kanisius, 2014.
4. Dijkstra Johannes, SJ, Menjadi Garam Dunia Sejati, Jakarta, Yayasan Bhumiksara, 2006.
5. Habeahan Salman, Membangun Hidup Berpolakan Pribadi Yesus, Yogyakarta, Yayasan Pustaka Nusatama, 2006.

6. Hadiwardoyo, Purwa Al, MSF, Intisari Keempat Injil, Yogyakarta, Kanisius, 2015.
7.__, Intisari Kisah Para Rasul, Yogyakarta, Kanisius, 2016
8.__, Sikap Gereja Katolik terhadap Masalah Sosial.
9. Haryanto, Ignatius dan Benedanto Pax, Terbuka terhadap Sesama Umat Beragama, Aktualisasi Ajaran Sosial Gereja tentang Agama yang Inklusif, Yogyakarta, Kanisius, 2004.
10. Kirchberger, Georg, Misi Gereja Dewasa Ini, Jakarta, Lembaga Pembentukan Berlanjut Arnold Janssen dan Penerbit Celesty Hieronika, 1999.
11. Knitter Paul F, Introducing Theologies of Religions, New York, Orbis Books, 2005. Konsorsium Sosialisasi Ajaran Sosial Gereja, Sosialisasi Ajaran Sosial Gereja, Yogyakarta, Kanisius, 2002.
12. KWI. Iman Katolik, Yogyakarta, Kanisius-Obor, 1966.
13. Rukiyanto, B.A. dan Esti Sumarah, Ignatia (ed.), Semakin Menjadi Manusiawai: Teologi Moral Masa Kini, Yogyakarta, Universitas Sanata Dharma, 2014.
14. Tisera Guido, SVD, Firman Telah Menjadi Manusia: Memahami Injil Yohanes, Yogyakarta, Kanisius, 1992.
15. Wijngaards John, Yesus Sang Pembebas, Yogyakarta, Kanisius, 1994.

9. Christian Religion Education

UNU 1002 Christian Religious Education (2 SKS MKW Sem: 1)

Prerequisite: -

Objective and Competency:

Delivering students as intellectual capital to carry out lifelong learning processes in becoming scientists with mature personalities who uphold humanity and life and students can demonstrate the development of aspects of spirituality of mature personalities (what regardless of the choice of spirituality-religious belief/denomination)

Syllabus:

- Religion and Religious Dimensionality
- The nature of religion and religion, viewed in the context of Indonesia, academic studies of religious/theological studies, and the United Nations Universal Declaration of Human Rights,
- Contradictory Realities in Religious Human Life,
- Sacred Texts (Bible): Texts and Context of Interpretation, as well as Aids for Its Understanding.
- Personality, Faith, Religion, and Development of Faith / Forms of Religious Appreciation and Behavior,
- Faith and Science,
- Diversity of Religious Life and Peace (Understanding and Appreciating Religious Differences, Overcoming Prejudice between Religious People, and Seeing the Meeting Points of Noble Humanity Values among Religions)

References:

a. Alkitab/ Kitab Suci: Perjanjian Lama dan Perjanjian Baru, Bogor: Lembaga Alkitab Indonesia, Bogor, 1974 (or edition/translation in another language)(mandatory for Kristen - Protestan) can also use the Bible through the website of the Lembaga Alkitab Indonesia atau Yayasan Sabda.
b. Basic theological-dogmatic reference book (not mandatory):

1. Hadiwijono, Harun. 1985. Iman Kristen, Jakarta: BPK Gunung Mulia.
2.1986. Inilah Sahadatku, Jakarta: BPK Gunung Mulia.
3. Soedarmo. 1991. Ikhtisar Dogmatika, Jakarta: BPK Gunung Mulia.

c. Material basic reference book consideration: Buku Ajar MKWU Pendidikan Agama Kristen, Dirjen Belmawa, Kemenristekdikti R.I., 2016 (Ebook)
d. Complementary/enrichment readings:
   1. Brownlee, Malcolm. 1986. Pengambilan Keputusan Etis, dan faktor faktor di dalamnya, Jakarta: BPK Gunung Mulia.
   2. Crapps, Robert W.1993. Dialog Psikologi dan Agama, Yogyakarta: Kanisius.
   3. . ……1994. Perkembangan Kepribadian dan Keagamaan,.....,
   4. Caputo, John D. 2001, Agama Cinta, Agama Masa Depan, Bandung: Mizan.
   5. Cremers, Agus. 1995. Tahap-tahap Perkembangan Kepercayaan, Yogyakarta: Kanisius.
   6. Darmaputera, Eka. 1992. Pancasila, Identitas dan Modernitas, Jakarta: BPK Gunung Mulia.
   7.2002. Beragama dengan Akal Sehat, Yogyakarta: Gloria Cyber M.
   8. Dister, Nico Syukur. 1988. Pengalaman dan Motivasi Beragama, Yogyakarta: Kanisius.
   9. Juergensmeyer, Mark. 2003. Terorisme Para Pembela Agama, Yogyakarta: Tarawang Press.
   10. Kelsay, John & Twiss, Summer B. 2007. Agama dan Hak-hak Asasi Manusia, Yogyakarta: Dian/ Interfidei, cetakan II.
   11. Keene, Michael. 2006. Agama-agama Dunia: Yogyakarta: Kanisius.
   12. Lane, Tony. 1989. Runtut Pijar, Sejarah Pemikiran Kristen, Jakarta: BPK Gunung Mulia, 1989 7
   13. Peters, Ted & Bennet, Gaymont. 2005. Menjembatani Sains dan Agama, Jakarta: BPK Gunung Mulia & The Center for Theology and Natural Sciences, Berkeley.
   14. Shenk, David W. 2001. Ilah-ilah Global: Menggali Peran Agama Agama dalam Masyarakat Modern, Jakarta: BPK Gunung Mulia.
   15. Smith, Huston. 2008. Agama-agama Manusia, Jakarta: Yayasan Obor, Jakarta.
   16. Sumarthana, Th. Dkk. 2005. Pluralisme, Konflik & Pendidikan Agama di Indonesia, Yogyakarta: DIAN/ Interfidei.
   17. Sutrisno, Mudji. 1996. Agama: Wajah Cerah & Wajah Pecah, Jakarta: Obor.
   18. Thompson, Norman H. 1988. Religious Pluralism and Religious Education, Birmingham: Religious Education Press.
   19. Wahid, Abdurrahman (dkk.). 1993., Dialog: Kritik & Identitas Agama, Yogyakarta: Dian/ Interfidei & Pustaka Pelajar.

10. Hindu Religion Education

UNU 1003 Hindu Religious Education (2 SKS MKW Sem: 1)

Prerequisite: -

Objective and Competency:

After attending this course, students are expected to have competence in:

1. Fostering, nurturing and developing students to become graduates who are virtuous based on Dharma teachings, have Sradha and Bhakti, spiritual morality and broad views based on Satyam Sivam and Sundharam (truth, purity and harmony) in carrying out life.
2. Have broad insight in responding to various changes in society. And able to interpret with essential values.
3. Students are intellectual in science, but graceful in morality and uphold religious values.

4. Able to communicate, have an attitude of tolerance in carrying out life in society
5. Upholding the value of humanism based on a sense of ahimsa

Syllabus:

Brahma Widya (Hindu Theology), The Role of Vedic Studies, Hinduism Concepts In Building Student Personality, Hindu Susila Teachings in Building Student Morality, The Role of Religious Art in shaping an aesthetic personality, Building Harmony according to Hindu teachings, Scope of Hindu Teachings, Catur Marga Yoga , Law and Human Rights in upholding justice

References:

1. Cassirer, E, 1987, Manusia dan Kebudayaan: Sebuah Esei Tentang Manusia, terjemahan Alois A. Nugroho, Gremedia, Jakarta.
2. Dillistone, F.W, 2003, Daya Kekuata Simbol, The Power of Symbols, terjemahan A. Widyatmartaya, Kanisius , Yogyakarta
3. Kajeng, Nyoman DKK, 1999, Sarasamuscaya Dengan Teks Bahasa Sansekerta dan Jawa Kuna, Paramita, Surabaya
4. Kamajaya Gede, 2000, Yoga Kundalini, Carauntuk mencapai Sidhi dan Mokas, Paramita, Surabaya.
5. Mantara, IB,1983/1984, Tata Susila Hindu Dharma, Parisadha Indoneisa Pusat, Jakarta.
6. Pendit, Nyoman S, 1979, Bhagawad Gita, Departemen Agama RI, Jakarta
7. Pudja, Gde, dan Sudarta Rai, 1976/1977, Menawa Dharmasastra, Manu Dharmasastra Weda Smrti Compedium Hukum Hindu, CV. Junasco, Jakarta
8. Pudja, Gde, 1984, Sraddha, Mayasari, Jakarta
9. Pudja, Gede, 1992, Theologi Hindu (Brahma Widya), Dharma Saratih, Jakarta
10. Sura Gede, 2001, Pengendalian Diri dan Etika dalam ajaran agama Hindu, Hanoman Sakti, Jakarta
11. Team, 2001, Modul Keluarga Bahagia Sejahtra, Menurut Pandangan Hindu, Departemen Agama Pusat, Yakarta
12. Titib, I Made, 2003, Teologi dan Simbol-simbol Dalam Agama Hindu, Paramita , Surabaya
13. Team, 2004, Graha Jagadhita, Paramita, Surabaya
14. Wardhana, Ida Bagus Rai, 1963, Sosiologi Hindu Dharma, Departemen Agama Hindu dan Budha, Jakarta
15. Wiana Ketut, 1993, Bagaimana Umat Hindu menghayati Tuhan, Manikgeni Denpasar
16. Tim Penyusun,2014, Mata kuliah Wajib Umum (MKWU) Pendidikan Agama Hindu, Kementerian Pendidikan dan Kebudayaan Republik Indonesia.

11. Buddhism Religion Education

UNU 1004 Buddhism Religious Education (2 SKS MKW Sem: 1)

Prerequisite: -

Objective and Competency:

After taking this course, students are expected to have the competence to:

1. Understanding the contents of the Tripitaka Buddhist holy book as a guide to life.

2. Understanding Buddhism and its philosophy as the basis for thinking and behaving in everyday life in the diverse Indonesian society.
3. Implement a tolerant and peaceful attitude in accordance with universal law Buddha.
4. Understanding Buddhist culture and politics in response to advances in science, technology and art.
5. Compile written works and conduct seminars in the context of implementing Buddhism in their respective fields of study
6. More active in religious rituals and other Buddhist activities.

Syllabus:

The Tripitaka Holy Book, Religion and Purpose of Life for Buddhists, God Almighty and Divinity, Moral Ethics, Buddha (Sila), Science and Technology and Arts, Harmony Between People, Buddhist Society, Buddhist Culture in Indonesia, Buddhism and Politics, Buddhist Universal Law , Bhavana, Papers related to the field of study and Seminars

References:

1. Arifin, H.M., 1990, Menguak Misteri Ajaran Agama-Agama Besar, Jakarta : Golden Trayon Press.Departemen Agama RI, 1991, Pengkajian dan Pengembangan Kerukunan Hidup Beragama di Indonesia, Jakarta : Balitbang Departemen Agama RI
2. Dewaraja, L.S., 2000, Kedudukan Wanita dalam Agama Buddha, Jakarta : FPM Sekolah Tri Ratna
3. Ekayana, 1995, Sains dan Buddha Dharma, Jakarta : Karaniya
4. Geertz, C., 1992, Kebudayaan dan Agama, Jogjakarta : Kanisius
5. Hartoko, D., 1984, Manusia dan Seni, Jogjakarta : Kanisius.
6. Harold, C., 1989, Pluralisme Tantangan bagi Agama-Agama, terj., Jogjakarta : Kanisius.
7. Houston, S., 1985, Agama Agama Manusia, terj., Jakarta : Yayasan Obor Indonesia.
8. Jinarakkhita, A., 1992, Meditasi untuk Pendidikan Tinggi Agama Buddha, Jakarta : Vajra Dharma Nusantara.
9. Kirthisinghe, B.P., 1995, Agama Buddha dan Ilmu Pengetahuan, terj., Jakarta: Aryasuryacandra
10. Krishnanda, W.M., 2003, Wacana Buddha Dharma, Jakarta: Yayasan Dharma Pembangunan
11. Mahavirothavaro, 1991, Samma Samadhi, terj., Bandung : Yayasan Succino Indonesia.
12. Narada, 1992, Sang Buddha dan Ajaran-Ajaran-Nya, jilid 1 dan 2, Jakarta: Dharmadipa Arama.
13. Paravahera, V., 1987, Buddhist Meditation in theory and practice, Kuala Lumpur : Buddhist Missionary Society.
14. Piyasilo, 1988, Buddhist Culture, Selangor : The friends of Buddhism
15. Rashid, T., 1997, Sila dan Vinaya, Jakarta : Buddhist Bodhi
16. Saccako, 2005, Ketuhanan dalam Agama Buddha, Medan: Dian Dharma
17. Tanumihardja, E. 2016, Buddhadhamma untuk Universitas. Yogyakarta: UNY Press
18. Wowor, C., 1997, Pandangan Sosial Agama Buddha, Jakarta: Aryasurcandra.
19. Wowor, C., 1995, Ketuhanan dalam Agama Buddha, Jakarta : STAB Nalanda.

12. Confucianism Religion Education

UNU 1005 Confucianism Religious Education (2 SKS MKW Sem: 1)

Prerequisite: -

Syllabus:

The legal foundations of religious life and the main points of Confucianism. The history of its emergence and development, faith and the basics of moral ethics. Various knowledge of Confucianism scriptures, and various matters concerning the practice and meaning of worship and ceremonies.

References:

SU SI, Kitab suci Agama Khonghucu, Matakin.

13. Physical Mathematics I

MFF1020 Physical Mathematics I (3 SKS MKW Sem: 1)

Prerequisite: -

Syllabus:

Complex numbers and hyperbolic functions (complex number concepts, complex number algebra, complex conjugates, polar representations, de Moivre's theorem, complex roots, polynomial equations, logarithms and powers of complex numbers, hyperbolic functions: Definition, hyperbolic trigonometry function, hyperbolic identity, hyperbolic equation, inverse hyperbolic functions, calculus of hyperbolic functions), Series, Partial Derivatives (multivariate functions, definition of partial derivatives, total derivatives and total differentials, exact and inexact differentials, important theorems, chain rules, variable changes, series Taylor, extreme values), Analytical Geometry (curves and surfaces, parametric equations, implicit equations, and explicit equations, conic sections (parabola, hyperbola, ellipse), three-dimensional shapes (parabola, hyperbola, ellipsoid, spheroid), Vector Algebra (scalars and vectors), vector addition and subtraction, multiplication with scalars, base vectors and vector components,magnitude of a vector, dot product, cross product, equation of line, plane equation, spherical surface, determine distance with vector, vector inverse), Vector calculus (vector derivative with respect to a parameter, integration of vector with respect to a parameter, curves and surfaces in space, field vectors and scalar fields, isoscalar surfaces, vector operators:gradient, divergence, rotation, important formulas, cylindrical and spherical coordinates, curved coordinate system, line and surface integrals, the connection of a region, Green's theorem on a plane, potential and sustainable fields, volume integrals, gradient integral forms, divergences, and rotation, Stokes and Gauss theorems).

References:

1. K. F. Riley, M.P. Hobsonand S.J. Bence, 2006, Mathematical methods for physics and engineering, edisi ketiga, Cambridge University Press, Cambridge.
2. Tom M. Apostol, Calculus, jilid I, edisi kedua, John Wiley & Sons,1967.
3. Tom M. Apostol, Calculus, jilid II, edisi kedua, John Wiley & Sons,1967.

14. Basic Geology

MFG 1104 Basic GeologyI (2 SKS MKW Sem: 2)

Prerequisite: -

Objective and Competency:

Basic Geology course aim is to introduce what geology is and its role as supporting geophysics. In addition, the Basic Geology course also introduces reasoning, conception and general geology materials (geology in general/fundamental). After attending the course, students are expected to be able to understand the basics of geosciences to support the next geology and geophysics course in the next semester.

Syllabus:

Rocks and minerals. Exogenous processes: rock weathering, geological processes by wind, surface and groundwater flows, ice and snow, ocean, lake and marsh, and humans. Diagenesis. Endogenous processes including igneous intrusive activities and igneous effusive activities, earth plate movement, earthquake, epeirogenic movements, folding, faulting, rupturing, metamorphism. Introduction to petrology, morphology, geological structure and stratigraphy: igneous rock, sedimentary rock, metamorphic rock. Rock layers, fold, joints and faults. Intrusion and extrusion. Topography: land and sea, mountain and mountain range, highlands and lowlands, lakes, rivers and swamp, shelf, trench and ocean floor. Fossils, stratigraphy, historical geological time scales. Introduction to Physical Geology: weathering and erosion; water and groundwater cycles. Wind, dust and desert. Sedimentation and sedimentary rock, volcano, igneous rock and geothermal, plutonism, metamorphism, and mineral resources. Earth crust deformation and implication. Earthquake and tsunami, etc. Basic mapping, topography map, geology map and geologic cross sections. Complementary descriptions: Exploration Geology, Engineering Geology, Marine Geology and Environmental Geology.

References:

1. Gilluly, et al., 1968, Principles of Geology, W.H. Freeman and Company
2. Porter, S.C., 1989, Physical Geology, John Wiley &Sons
3. Strahler, A.N., 1981, Physical Geology, Harper & Row, Publishers, NewYork.
4. Harles C. Plummer et al., 2005, Physical Geology, 10th ed., McGrawHill.

15. Geology Lab work

MFG 1105 Geology Lab work (1 SKS MKW Sem: 2)

Prerequisite: -

Objective and Competency:

Geology Lab work aim is to support, complete and liven up Basic Geology lectures, by visually introducing general geology materials, introducing and practicing equipment, observation techniques, measurement techniques and geological reporting techniques.Geology Lab work course is to introducing visually to students with geology structure, equipments, observation technique, surface and subsurface geology structure data collecting and interpretation. After attending this course, students are expected to create, read and interpret surface and subsurface geology structure maps.

Syllabus:

Practice mineralogy, petrology, structure, topography maps, geology maps and geological incision plus 3 different geological field trips in a day. Practice create/use: cross-section structure, box diagram, stereonet, analysis of structural data and subsurface structural maps.

References:

1. Buku Petunjuk Praktikum Geologi Dasar, Teknik Geologi FT-UGM
2. Rowland, S.M., Deubendorfer, E.M., Schiefelbein, L.M., 2007. Structural Analysis & Synthesis: A Laboratory course in structural geology (3rd Ed.). Blackwell Publication.
3. Buku Petunjuk Praktikum Geologi Struktur, Teknik Geologi FT-UGM.

16. Basic Physics II

MFF 1012 Basic Physics II (3 SKS MKW Sem: 2)

Prerequisite: -

Syllabus:

Electrostatics (Electric Charge and Coulomb'sLaw, Electric Fields, Gauss's Law, Work and Force, Capacitor and Capacitance), Dynamic electricity (Electric current, Electric power, Electronic measuring instrument, RC circuits), Static magnetism (Magnetic fields, magnetic force, Laws of Ampere, Induction and inductance, Electromagnetic vibration and alternating current, magnetic materials), Maxwell's equation (Gauss's Law for magnetic fields, Induction of magnetic fields, Shifting current, Magnetization, Maxwell's equations in materials), Electromagnetic wave (Energy transport and Poynting Vector, Radiation pressure, Polarization, Principles of geometric optic, Reflection and refraction, perfect reflection, Polarization by reflection), Geometric optics (formation of images by reflection, formation of images by refraction, Optical instruments), Physical Optics (Lights as a wave, light interference, Relativity (Galileo's relativity, Einstein's postulates), Quantum theory, Structure of matter (History of concepts atomic, Atomic physics), Astrophysics and cosmology (Physics of stars, Concepts of the universe), Physics of solids (electrical properties of solids, semiconductors, diodes and transistors).

References:

1. Halliday, D., Resnick, R and Walker, J., 2014, Fundamental of Physics, Fundamental of Physics Extended, tenth edition, John Wiley & Sons, Inc, USA.
2. Tipler, P.A., 2008, Physics for Scientists and Engineers, sixth edition, W. H. Freeman and Company, New York, USA.
3. Raymond A. Serway, dan John Jewett, 2014, Physics for Scientists and Engineers, Brooks/Cole Cengage Learning, Singapore.

17. Basic Physics Lab work II

MFF 1014 Basic Physics Lab work II (3 SKS MKW Sem: 2)

Prerequisite: -

Syllabus:

Thermometer calibration, underground temperature measurement, hygrometer, barometer, equivalence of heat and mechanical energy, lens and mirror, Newton Ring, measurement of wavelength and frequency of light, DC and AC electric current, R, L, and C circuit, Wheatstone bridge

References:

1. Staf LFD , 2011, Buku Panduan Praktikum Fisika Dasar II (Sem.II).
2. Prestone D. W., Kane & M. Sternheim 1983, Experiments in Physics : A Lab Manual, John Wiley & Sons.

18. Wave

MFF 1405 Wave (2 SKS MKW Sem: 2)

Prerequisite: Basic Physics II

Syllabus:

Oscillation, Wave Movement, Mechanical Wave, Sound Wave in solids, liquid and gas, Wave reflection and Standing Wave, Spherical and Cylindrical Waves, Wave in Non-uniform Media and Multidimensional Waves, Soundwave and Shockwave DopplerEffects, Electromagnetic wave, Electromagnetic Wave Radiation, Fourier Method, Interference and Diffraction.

References:

1. Hirose, A., dan K.E. Longren, 1985: Introduction to wave phenomena, John Wiley & Sons.
2. Pain., H.J., 2005: The physics of vibrations and waves, J. Wiley&Sons.
3. Zahara M., 1994: Gelombang dan optika, Proyek Pembinaan Tenaga Kependidikan PT, Ditjen DIKTI, Depdikbud.

19. Wave Lab work

MFF 1405 Wave Lab work (1 SKS MKW Sem: 2)

Prerequisite: Wave

Syllabus:

Coupled vibrations, Superposition of vibrations and waves, mechanical wave in solids and liquid, diffraction, dispersion, stationary waves, EM waves, Fraunhofer slit/lattice diffraction, Fresnel Diffraction.

References:

1. Crawford Jr., F.S., 1968, Waves, Berkeley Physics Course, Vol. 3, McGraw-Hill Book Co., New York.
2. Pain., H.J., 1989: The physics of vibrations and waves, John Wiley &Sons.

20. Mechanics I

MFF 1401 Mechanics I (3 SKS MKW Sem: 2)

Prerequisite: Basic Physics I, Calculus I

Objective and Competency:

After attending this course, students are expected to be able to solve conceptual and practice problems about mechanics which include A.1 Kinematics, Dynamics, Gravity, Swing, Vibration, Waves and Sound.

Syllabus:

Basic physics concept, vector algebra and its implementation in kinematics, fundamentals of Newtonian mechanics, friction, work and energy, linear and impulse momentum, torque and angular momentum, Dynamics in a moving frame of reference, relativistic motion, motion in a rotating frame. Simple harmonic swing, muffled and forced. Rigid body mechanics. Keppler's gravitational field and motion. Hooke's law, stress, strain, moduli of elasticity. Vibration, waves and sound. Examples of cases of physics and geophysics.

References:

1. Halliday, D., Resnick, R. and Walker, J., 1997: Fundamental of Physics Extended, fifth edition, John Wiley & Sons, Inc., USA

21. Mathematics for Physics II

MFF 1021 Mathematics for Physics II (3 SKS MKW Sem: 2)

Prerequisite: Calculus I, Mathematics for Physics I

Syllabus:

Matrix, determinants and Vector spaces (vector spaces, vector subspaces, linear and linear independent relations, bases, linear operators and their properties,linear and matrix operators, matrix addition, matrix multiplication by scalars, matrix multiplication, transpose, complex conjugates and conjugates Hermite, trace of a matrix, determinants and its properties, matrix inverse, degrees of matrix, special matrices, Eigenvalue Eigenvector, change of basis, diagonal of matrix, linear equation system), Fourier series and transformation (Dirichlet conditions, Fourier coefficients, equilaterals, discontinuous functions, non periodic functions, complex Fourier series, Parseval's theorem, Fourier transform and its properties, uncertainty principle, Dirac delta, odd and even function, convolution and deconvolution, Fourier transform for high dimensions). Laplace transform (Laplace transform for derivatives and integrals, properties of Laplace transform), ordinary differential equations (equations of degree one: general answer forms, equations with separate variables, exact equations, inexact equation, homogeneous equations, equations of degree two: linear equations with fixed coefficients, linear equations with variable coefficients, answer with series: ordinary and singular points, series around and ordinary points, series around singular points, Legendre equation, Hermite equation, Bessel equation, etc). Introduction to partial differential equations (boundary conditions, variable separation, Fourier analysis, diffusion and heat propagation equation, wave equations, integral equations.

References:

1. K.F. Riley, M.P. Hobson and S.J. Bence, 2006, Mathematical methods for physics and engineering, third edition, Cambridge University Press, Cambridge.
2. Tom M. Apostol, Calculus, jilid I, edisi kedua, John Wiley & Sons,1967
3. Tom M. Apostol, Calculus, jilid II, edisi kedua, John Wiley & Sons,1967

22. Calculus II

MMM 1102 Calculus II (3 SKS MKW Sem: 2)

Prerequisite: Basic Physics I, Calculus I

Objective and Competency:

1. Students are expected to be able to solve problems related to indefinite integrals.
2. Students can understand the meaning of certain integrals and their properties. Students can understand the meaning of improper integral.
3. Students are expected to be able and proficient in using integral in various applications, such as calculating the area of a plane, the volume of a rotating object, the length of a curve, the area of a rotating area, the center of gravity, and the moment of inertia.

Syllabus:

1. Indefinite integral: definition, properties, integration techniques
2. Certain integrals: understanding, properties, Fundamental Theorem of Calculus, changing variables Improper integrals.
3. Some examples of certain integral applications: area of a plane, volume of a rotating object, arc length, rotating area, center of mass/center of gravity, Pappus-Guldin theorem, moment of inertia, parallel axis theorem.

References:

1. Abe Mizrahi and Michael Sullivan, 1990. Calculus and Analytic Geometry, Wadsworth.
2. James Stewart, 1999, Calculus, 4th edition, Brooks/Cole Pub.Comp.
3. Robert A. Adam and Cristhoper Essex, 2010. Calculus, A complex Course, Pearson.
4. Tim Pengajar Kalkulus, Diktat Kuliah Kalkulus II, FMIPA, UGM.

23. Pancasila

UNU 1010 Pancasila (2 SKS MKW Sem: 2)

Prerequisite: -

Objective and Competency:

Developing Pancasilaist human character in thoughts, attitudes, and actions.

Syllabus:

Pancasila and UGM's; History of Pancasila Thought: Past, Present and Future; Pancasila as the State Foundation; Pancasila as Ideology and Way of Life; Pancasila as a Philosophical System; Pancasila as the Ethical System Pancasila as the Basis and Orientation for the Development of Science and Pancasila Cases

References:

1. Soekarno, 1945, Pidato Lahirnya Pancasila, di Sidang BPUPK, dokumen.
2. _, 2018, Pancasila Dasar Negara, kumpulan pidato, PSP UGM, Yogyakarta.
3. Notonagoro, 1951, Pancasila Dasar Falsafah Negara, UGM, dokumen Pidato Penganugerah Gelar Doktor Honoris Causa pada Ir. Soekarno.
4. _, 1971, Pancasila Secara Ilmiah Populer, Pancuran Tujuh, Jakarta.
5. Pranarka, 1989, Sejarah Perumusan Pancasila, Jakarta.
6. Kaelan, 2002, Filsafat Pancasila, Paradigma, Yogyakarta.

7. Kusuma, A.B. 2004, Lahirnya Undang-Undang Dasar 1945: Menurut Salinan Dokumen Oetentik Badan Oentoek Menjelidiki Oesaha2 Persiapan Kemerdekaan, Badan Penerbit Fakultas Hukum UI, Jakarta.
8. Latif, Yudi, 2011, Negara Paripurna: Historisitas, Rasionalitas, dan Aktualitas Pancasila, Gramedia Pustaka Utama, Jakarta.
9. _, 2014, Mata Air Keteladanan: Pancasila dalam Perbuatan, Mizan, Bandung.
10. Tim MKWU Pendidikan Pancasila Dikti, 2016, Buku Mata Kuliah Wajib Pendidikan Tinggi Pendidikan Pancasila, e-book, Kemenristek Dikti..

24. Structural Geology

MFG 1106 Structural Geology (2 SKS MKW Sem: 3)
Prerequisite: Basic Geology
Objective and Competency:
The aim of the Structural Geology course is to impart the basics of structural geology, and introduce them to structural geology topics, especially those relevant to geophysics. After attending this course, students are expected to be able to choose the location and direction of the survey stretch, and interpret geological structures based on geophysical data.
Syllabus:
Background, definition, scope, method and benefits of structural geology, especially for geophysics; development history and geological trends of the structure for the next 5 or 10 years. Introduction to the principles of rock deformation and the occurrence of structures: Stress, strain and rock deformation; sources of stress; faulting and folding processes; igneous rock intrusion emplacement; role/gravity control. Various structures resulting from deformation in sedimentary, igneous and metamorphic rocks: folds, joints, faults, foliation, and linearization. Benefits and disadvantages of having structures: structural traps, stable zones, unstable zones, etc. Introduction to regional structures: Semangko fault, Sorong fault, the 90E ridge, the Alpine Himalayan belt, San Andreas fault, Opak fault etc.

References:
1. Billings, M.P., 1982, Structural Geology, 3rd.ed., Prentice Hall, Privare Ltd. NewDelhi
2. Ragan, D.M.,1985, Structural Geology. An Introduction to Geometrical Technique, John Wiley & Sons
3. Fossen, H., 2010. Structural Geology, Cambridge University

25. Geodetically Mapping

MFG 2102 Geodetically Mapping (2 SKS MKW Sem: 3)
Prerequisite: Mathematic
Objective and Competency:

After attending this course and Lab work, students are expected to be able to collect and process data and make topographic maps, perform analysis and interpretation of topographic maps for geophysical purposes, know the types of maps and how it is made.

Syllabus:

Coordinate system, types of maps and projection: Cone projection, azimuthal projection, cilindrical projection, equidistant projection, conformal projection. Basic mapping and measuring: angle measurement, flatness: techniques, accuracy and flatness methods, distance measurement, azimuth measurement. Methods of collecting and processing topographic map data, various topographic maps, their analysis and interpretation. Photogrammetry Techniques. Various land measuring instruments. Case examples for geophysics.

References:

1. Ir. Suyono Sosrodarsono dan Mayayoshi Takasaki (ed.), Pengukuran Topografi dan Teknik Pemetaan, PT Pradnya Paramita, Jakarta,1983.
2. Sutomo Wongsotjitro, Ilmu Proyeksi Peta, Yayasan Kanisius, Yogyakarta 1982.
3. Ir Sumaryo Joyokusumo, Survei Topografi Dalam Industri Perminyakan, Jur. Teknik Geodesi, Fak. Teknik Universitas Gadjah Mada, Yogyakarta, 1993.
4. Ir. Heinz Frick, Ilmu dan Alat Ukur Tanah, Kanisius, Yogyakarta, 1979.

26. Geodetic Mapping Lab work

MFG 2103 Geodetic Mapping Lab work (1 SKS MKW Sem: 3)

Prerequisite: Mathematic

Objective and Competency:

After attending this Lab work, students are expected to be able to read, analyze, and interpret topographic maps. Students are expected to be able to make maps using field practice materials, terrestrial map-making and introduction of GPS devices.

27. Electromagnetics

MFG 2105 Electromagnetics (2 SKS MKW Sem: 3)

Prerequisite: Basic Physics II

Syllabus:

Electrostatics in a vacuum: Coulomb's law. Electric field and Gauss's law. Potential and electric potential energy. A conductor in an electrostatic field. Capacitance. Electrostatic energy. Multipole expansion of electric potential. Electric poles, moments and energy. The boundary conditions for electric fields and electric potential. Electrostatics in matter: Polarization. Electric shift. Homogeneous isotropic linear dielectric. Electric Current: Current and electric current density, Equation of continuity. Electrical conductivity and Ohm's law Power dissipation. Magnetostatics in a vacuum: Ampere's Law. Biot-Savart Law. Lorentz style. Ampere's law of circuits (integral form of Ampere's law). Magnetic flux. Vector potential. Vector potential

multipole expansion. Magnetic dipole field, moment and energy. Electromagnetic induction: Faraday's law of induction. Lenz's Law. Induction electric field. inductance. Magnetic energy. Magnetism in matter: Magnetization. Magnetizing current density. Magnetic field. Homogeneous isotropic linear magnetic material. Specialized Methods in electrostatistics (Laplace's Equation, Poisson's, method of reflection, method of separation of variables, etc.). Maxwell's equations, vector and scalar potential, electromagnetic energy and momentum.

References:

1. Ronald K. Wangness, 1986, Electromagnetic fields, 2nd Edition, Penerbit: John Wiley&Sons.
2. D. J Griffiths, 1989, Introduction to Electrodynamics, 2nd Edition, Penerbit: Prentice Hall.
3. Reitz, J. R., F. J. Milford, and R. W. Christy, 1992: Foundations of ElectromagneticTheory, edisi 3, Addison-Wesley.

28. Geophysical Analysis Method

MFG 2106 Geophysical Analysis Method (3 SKS MKW Sem: 3)

Prerequisite: Wave, Mechanics I, Calculus II, Physical Mathematics II

Objective and Competency:

After attending this course, students are expected to have basic knowledge and skill in processing geophysical data in the time and frequency domain, analysis and modeling of continuous and discrete time systems, characteristics of continuous and discrete time systems, Laplace transforms and their inverses, continuous and inverse time Fourier transforms, continuous to discrete time conversions, Z transformations and their inverses, discrete time Fourier transforms and their inverses and design digital filters especially FIR and IIR filters.

Syllabus:

Continuous-time signals and systems, analysis and modeling of continuous-time signals and systems, fourier transformations of continuous and inverse time, laplace and inverse transforms, conversion of continuous to discrete-time signals, discrete-time signals and systems, analysis and modeling of discrete-time signals and systems, transformations Z, discrete fourier transform and its inverse and inverse, types of continuous and discrete time filters, IIR filter design, FIR filter design.

References:

1. Michael D. Adams, Continuous-Time Signals and Systems, University of Victoria, Canada
2. Luis F. Chaparro Signals and Systems Using MATLAB, Elsevier, 2011
3. Ingle, V.K. and Proakis, 2012, J.G., Digital Signal Processing using Matlab, Cengage Learning
4. John G. Proakis and Dimitris G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, 4th Edition. Prentice Hall. 2007.
5. Oppenheim, A.V., Schafer, R.W, 1999, "Discrete-Time Signal Processing", Second Edition, Prentice-Hall, New Jersey, ISBN 0-13-083443-2.

6. Frank Scherbaum, of Pole and Zero, Kluwer academic Press, 1998

29. Geophysical Analysis Method Lab work

MFG 2107 Geophysical Analysis Method Lab work (1 SKS MKW Sem: 3)
Prerequisite: Geophysical Analysis Method
Objective and Competency:
After attending this course, students are expected to be have skill in processing Geophysical data in time and frequency domains, analyzing and modeling continuous and discrete time systems, transforming data from time to frequency domains or vice versa, convoluting data, designing continuous time and discrete filters for both FIR and IIR types
Syllabus:
Python programming for data processing, signal generation, system modeling, convolution, fourier transform and inverse fourier transform, notch filter design, IIR filter design for lowpass, bandpass and highpass filters, FIR filter design for lowpass, bandpass and highpass

References:
1. Michael D. Adams, Continuous-Time Signals and Systems, University of Victoria, Canada
2. Luis F. Chaparro Signals and Systems Using MATLAB, Elsevier, 2011

30. Physical Mathematics III

MFF 2024 Physical Mathematics III (3 SKS MKW Sem: 3)
Prerequisite: Calculus I, Physical Mathematics I and II
Syllabus:
1. Ordinary differential equations: equations of degree one: general answer forms, equations with separate variables, exact equations, inexact equations, homogeneous equations (Riley, Ch. 14), equations of degree two: linear equations with fixed coefficients, linear equations with coefficients indeterminate, answers with sequences: ordinary and singular points, series around ordinary points, series around singular points, (Riley, Ch.15).
2. Fourier series: Dirichlet conditions, Fourier coefficients, equivalence, discontinuous functions, non-periodic functions, complex Fourier series, Parseval theorem, (Riley, Ch. 12) Fourier transform: Fourier transform and its properties, uncertainty principle, Dirac delta , odd and even functions, convolution and deconvolution, Fourier variance for high dimensions (Riley, Ch. 13).
3. Laplace transform: Laplace transform for derivative and integral, properties of laplace transform (Riley, Ch. 13)
4. Typical functions: gamma function, beta function, (Riley, Ch.18). (2weeks) (Boas, Ch.11) Introduction to partial differential equations: boundary conditions, separation of variables, Fourier analysis, diffusion and heat propagation equations, wave equations (Riley, Ch. 20).

31. Computation Method

MFG 1102 Computation Method (2 SKS MKW Sem: 3)
Prerequisite: Programming
Objective and Competency:
After finishing this course, students are expected to be able to create simple application programs to solve physics and geophysics problems, and be able to process and analyze geophysical data using computer programs.
Syllabus:
Introduction to computers and programming, General structure of programs, basic elements of programs and program algorithms, Functions and modules in programs, Conditional operations and loop operations, Arrays and pointers (one-dimensional and multi-dimensional), I/O operations and displays, Applications computing and programming in Physics and Geophysics. Data processing: Characteristics of geophysical data (field data and synthetic data generation), Analysis of statistical properties of geophysical data (Mean, Mode, Median, Distribution and Variance, Standard deviation), Analysis of data in the space-frequency area, Screening (low pass filter) , top pass, ribbon pass and ribbon stop filter), Contour Making.

References:

1. Sudarmaji, Buku Panduan Kuliah Metode Komputasi, Diktat Kuliah FMIPA-UGM
2. Jamsa, K., Klander, L., 1998, C/C++ Programmer's Bible, Jamsa Press, Las Vegas, USA.
3. Part-Enander, E., Sjoberg A., Melin, B., Isaksson, P., 1996, The Matlab handbook, Addison-Wesley, Essex, UK.
4. Pranata, A., 2000, Algoritma dan Pemrograman, J&j Learning, Yogyakarta.
5. Munir, R., 2000, Algoritma dan Pemrograman dalam Bahasa Pascal dan C, Penerbit Informatika, Bandung.
6. Software: C/C++ 5, Matlab, Petrel, Surfer, Excel

32. Computation Method Lab work

MFG 1102 Computation Method Lab work (1 SKS MKW Sem: 3)
Prerequisite: *)
Objective and Competency:
After finishing this course, students are expected to be able to create simple application programs to solve physics and geophysics problems, and be able to process and analyze geophysical data using computer programs.
Syllabus:
Making simple programs in C/C++, Creating functions and program modulation, Creating conditional operations in programs, Creating loop operations in programs, Arrays and pointers in programs, input/output in programs, introduction to geophysical data acquisition, statistical

processing of geophysical data, data filtering geophysics, visualization and contouring of geophysical data.

References:

1. Sudarmaji, Buku Panduan Kuliah Metode Komputasi, Diktat Kuliah FMIPA-UGM
2. Jamsa, K., Klander, L., 1998, C/C++ Programmer's Bible, Jamsa Press, Las Vegas, USA.
3. Part-Enander, E., Sjoberg A., Melin, B., Isaksson, P., 1996, The Matlab handbook, Addison-Wesley, Essex, UK.
4. Pranata, A., 2000, Algoritma dan Pemrograman, J&j Learning, Yogyakarta.
5. Munir, R., 2000, Algoritma dan Pemrograman dalam Bahasa Pascal dan C, Penerbit Informatika, Bandung.

33. Civic

UNU 3000 Civic (2 SKS MKW Sem: 3)

Prerequisite: -

Objective and Competency:

After attending this course, students are expected to be able to: understand the study material, have awareness and responsibility as good citizens, be able to think critically in dealing with problems in society, provide creative solutions for solving national problems and act as evidence of defending the country.

Syllabus:

Introduction to RPKPS (Semester Learning Activities Program Plan), Function of PKN/Civic for scholars and professionals, Function of National Identity for nation building and community character, the importance of National Integration, Function of Values and Norms, Project Citizen I, Rights and Obligations of the State and Citizens of the State, Dynamics of Democratic Practices in Indonesia, The Dynamics of Law Enforcement in Indonesia, The Urgency of Archipelago Insights as the Collective Insight of the Nation, Challenges of National Resilience and the Importance of Defending the State and Project Citizen II.

References:

RISTEKDIKTI,2016,Pendidikan Kewarganegaraan,.

Material development can be done by reading related references.

34. Indonesian Language

UNU222005 Indonesian Language (2 SKS MKWK Sem: 4)

Prerequisite: -

Objective and Competency:

Students are able to express thoughts orally and in writing with good and correct Indonesian language rules, making Indonesian language a source of knowledge and a unifying tool for the nation

Syllabus:

1. The nature of the Indonesian language as the national language;
2. Exploring texts in academic life (inculcating the values and nature of the Indonesian language as a source of knowledge);
3. Exploring the world of libraries;
4. Design research proposals and activity proposals;
5. Reporting research results and activity results;
6. actualize themselves in scientific articles.

References:

35. Geological Field Work

MFG 2101 Geological Field Work (2 SKS MKW Sem: 4)

Prerequisite: Basic Geology, Structural Geology

Objective and Competency:

After finishing this course, students are expected to be able to understand, appreciate, and carry out geological field work.

Syllabus:

Refresher lecture and initial tests on basic geology and structural geology, and provision of knowledge of geological field work (e.g. the use of maps, compasses and geological hammers). Geological observation exercises under the guidance of instructors a.l. introduction to rocks, geological structures, stratigraphy, geomorphology (landscapes), geological history, etc. In its original place in nature. Furthermore, the results of these observations must be able to be given standard signs or symbols on the map. With systematic and intensive guidance from lecturers and assistants, this ten-day learning process in the field will further strengthen the mastery of Basic Geology (MFS 131) and Structural Geology (MFS 231) courses along with their internship in the laboratory.

References:

1. Nukman, M., Husein, S., 2014. Buku Panduan Kuliah Lapangan Geologi untuk Geofisika, Prodi Geofisika-FMIPA, UGM

36. Electronics

MFF 2108 Electronics (2 SKS MKW Sem: 4)

Prerequisite: Basic Physics II

Syllabus:

Basic Concepts of Electrical Circuits, Basic Laws of Electrical Circuits, Series-parallel Resistive Circuits, DC circuit analysis methods, Network Theorems, Capacitors and Inductors, AC Circuit

Fundamentals, AC circuit analysis methods, RLC and resonant circuits, Diodes and transistors, Operational amplifiers , Logic gate.

References:

1. Wang, M., 2010, Understandable Electric Circuits, The Institution of Engineering and Technology, London, United Kingdom
2. Sadiku, M.N.O., dan Alexander, C.K., 2013, Fundamentals of Electric Circuits, 5th edition, The McGraw-Hill Companies, Inc.
3. Maini, A.K, 2007, Digital Electronics:Principles, Devices and Applications, John Wiley & Sons, Ltd.
4. Modul mata kuliah.

37. Electronics Lab work

MFG 2109 Electronics Lab work (1 SKS MKW Sem: 4)

Prerequisite: *)

Objective and Competency:

Geophysics students are able to do a good soldering process, assemble simple circuits, and know the character of several electronic instruments.

Syllabus:

Good and correct soldering exercise, making a simple power supply circuit, analyzing the Thevenin circuit, Active Filter, Passive filter, analog to digital converter.

References:

1. Hartantyo dan Rakhman, 2015. Buku Panduan Praktikum Elektronika. Lab Geofisika FMIPA, UGM.
2. Sutrisno, 1986: Elektronika, teori dan penerapannya, Jilid I, Penerbit ITB, Bandung.
3. Brophy, 1969: Basic electronics for scientists and engineers, J. Willey.
4. Milmann, J. & Grabel, A. 1988: Microelectronics, McGraw-Hill.
5. Bunker, C.A., - UNILAB-Notes for use – Unilab Limited Clarendon RoadBlackburn.

38. Geoelectricity and EM Methods

MFG 2120 Geoelectricity and EM Methods (3 SKS MKW Sem: 4)

Prerequisite: Electromagnetics, Geophysical Analysis Method

Objective and Competency:

After completing this course, students are expected to understand geoelectricity and electromagnetic theories, and can solve conceptual problems related to geoelectricity and electromagnetism, design surveys, conduct surveys, data processing and interpretation of subsurface geology.

Syllabus:

Basic theory (Ohm's law), electrical properties of rock, potential in a homogeneous medium, measurement of rock resistivity (sample), single current source in medium, surface current source, two point current electrodes (point source), electrode arrangement, current distribution , the effect

of inhomogeneity of the medium, the effect of the boundary field on the current line, the effect of the boundary field on the potential, the potential at the surface to the horizontal layered medium, the distribution of the potential at the surface the effect of a buried conductor sphere, the anisotropic effect of the medium, the topographic effect, Geoelectricity survey tools , survey methods “mapping” and “sounding”, physical model (in the laboratory), field survey method, resistivity method, Induced Polarization method, Mise A la Masse method, Self Potential method, Magnetotelluric method., rapid interpretation, use of program packages, case examples. Electromagnetic basic theory, magnetic vector potential, Maxwell's law, description of electromagnetic fields, amplitude and phase, mutual inductance, elliptic polarization, electromagnetic survey methods, surveying tools, physical modeling, intensity measurement, elliptic polarization measurement, "dip angle" measurement, phase measurement, various measurement methods in the field, “airborne EM”, HLEM, Transient EM, Audio MagnetoTelluric (AMT), CSAMT, interpretation, use of programs (packages), field cases.

References:

1. Telford, WM., 1976, Applied Geophysics, Cambridge University Press.
2. Keller, GV. and Frischknecht, FC., 1966, Electrical Methods in Geophysical Prospecting, London Pergamon Press. Nabighian MN (editor), 1991, Electromagnetic Methods in Applied Geophysics, SEG

39. Seismic Method

MFG 2117 Seismic Method (3 SKS MKW Sem: 4)

Prerequisite: Wave,Geophysic Analysis Method

Objective and Competency:

After completing this course, students are expected to be able to explain the basic concepts of reflected seismic waves for exploration, calculate seismic wave parameters, design data acquisition, process data using standard processing, and interpret simple seismic data qualitatively and quantitatively. .

Syllabus:

Elasticity theory, stress-strain, relationship between elasticity constants, scalar and vector wave equations. Seismic waves, body waves, surface waves, medium anisotropy, effects of the medium on wave propagation, diffraction. Seismic survey tools, positioning, energy sources, detectors, recording. Data acquisition parameters. Geophone group, design geophone array, calculate array response. Damping, quality factor, wave character due to the properties of the medium. Wavelets, Ricker's wavelets. Identify waves, flat reflectors, oblique reflectors, flat reflectors and oblique refractors. Vertical separation, horizontal separation, sampling in space and time. Shallow refractive wave seismic, geophone span, interpretation of delay time method (delay time), HagiwaraMasuda method, General Reciprocal Method (GRM). Seismic data routine processing, demultiplexing, labeling, gathering, gain recovery, static correction (elevation, weathered layer), dynamic correction (NMO, residual). Velocity: velocity analysis, velocity estimation, checkshot. Fourier transform, convolution, correlation. Synthetic seismogram. Frequency filter, inversion

filter, F-K filter. Wiener filter, spike deconvolution and predictive filter. Migration method F-K (Stolt). An introduction to modeling with ray trail methods, wave theory, and finite difference. Identify the change in amplitude. Identify the structure. The basics of the interpretation stage. Introduction to Stratigraphy. Basic introduction to 3D seismic survey design. VSP basics and their uses. The basic principle of AVO. Introduction to Tomography. Seismic attributes.

References:

1. Sherif, R.E, dan Geldart, L.P., 1995, Exploration Seismology, 2nd edition, Cambridge University Press.
2. Sismanto, 1996, Sismanto, 1996, Pengantar Survei dengan Menggunakan Gelombang Seismik. Gerbang Media Aksara, Yogyakarta. ISBN 978-602-6248-07-7.

40. Seismic Method Lab work

MFG 2118 Seismic Method Lab work (1 SKS MKW Sem: 4)

Prerequisite: *)

Objective and Competency:

Geophysics students are expected to understand, acquire, process and analyze the seismic bias method.

Syllabus:

Introduction, Introduction to the types of wavelets recorded in shallow seismic, Picking first Break, Flat Layer Analysis, Sloping Layer Analysis, Analysis using the abc method, Analysis using the Hagiwara Masuda method, Introduction to instruments, Synthetic Data Exercise, Field Data Exercise, Data Measurement in field

References:

1. Panduan Praktikum Metode Seismik 1, Lab Geofisika, 2004

41. Mechanics of Continuous Medium

MFG 2111 Mechanics of Continuous Medium (2 SKS MKW Sem: 4)

Prerequisite: Mechanics I

Objective and Competency:

After completion of this course, students are expected to understand the relationship between strain in a deformed object, geodynamic processes related to strain and recognize mechanical waves that propagate in the earth. The relationship between the strain tensor and the stress tensor (Hooke's Law), modulus of resilience. Bending in elastic bodies and deformation in geodynamic processes. Equation of motion and elastic medium (Navier's equation), equation of elastic wave and the propagation of longitudinal and transverse waves in elastic medium.

References:

1. A.B Bathia dan R.N. Singh, 1978, Mechanics of Deformable Media.
2. Turcotte and Schubert, 1982, Geodynamics; Application of Continuum Physics to Geological Problems; John Wiley &Sons.
3. George E. Mase, 1970, Schaum’s Outline of Continuum Mechanics

42. Indonesian Tectonic

MFG 3115 Indonesian Tectonic (2 SKS MKW Sem:5)
Prerequisite: *)
Objective and Competency:
The main objective of this course is to understand the tectonic conditions of Indonesia and its surroundings as an indispensable basic provision for studying the geodynamics of the Indonesian region. In addition, Indonesia's tectonic conditions should be understood by Indonesian geophysicists. After taking this course, students are expected to be able to explain properly and correctly the ins and outs of Indonesian tectonics.
Syllabus:
An overview of the theory of plate tectonics; Special tectonic features; Indonesian regional tectonics; Indonesian local tectonics: the western Sunda arc, the eastern Sunda arc, the Banda arc, Sulawesi, the Maluku Sea and its surroundings, Irian/Papua New Guinea; Case studies: Sumba Island, Banggai-Sula Islands, etc.
References:
1. Hamilton W. (1979). Tectonics of the Indonesian Region,U.S.Geol.Surv.Prof.Paper, 1078.
2. Katili J.A. (1980). Geotectonics of Indonesia: a modern view, Department of Geology, Bandung Institute of Technology.

43. Physical Volcanology

MFG 3111 Physical Volcanology (2 SKS MKW Sem:5)
Prerequisite: Non Seismic Method Lab work
Objective and Competency:
The main objective of this course is to understand basic understanding of volcanoes, types of volcanic eruptions, the concept of monitoring volcanic activity, and analyze geophysical data for both monitoring and mapping purposes.
Syllabus:
Understanding the basics of Physical Volcanology both in static aspects (structure) and dynamic aspects (mechanisms), Understanding volcano monitoring; Use of potential methods for volcanoes, such as: gravity, geomagnetic, magnetotelluric, and geoelectric methods, heat methods, deformation methods, seismic methods for volcanoes, data analysis of volcano physics in time, space, and frequency domain.
References:
1. Bulletin of Volcanology, Journal of Volcanology and Geothermal Research

44. Seismology

MFG 3109 Seismology (2 SKS MKW Sem:5)
Prerequisite: Mechanics of Continuous Medium
Objective and Competency:

The main objective of this course is to introduce students to the basics of seismology (earthquakes), to recognize the terminology and understand the theoretical and practical foundations that are absolutely necessary if students want to work in the field of earthquakes. After attending this course, students are expected to be able to explain properly and correctly about earthquake, earthquake magnitude, earthquake intensity, earthquake locations and actions to reduce risk in the event of an earthquake.

Syllabus:

History and insights of seismology: development of the theory of elasticity and seismology, early knowledge of the interior of the earth; Seismological instrumentation: seismometers and seismographs, period problems, seismometer calibration; Seismic waves: type and speed of seismic waves, Snell's law, head waves, body waves from long-range/near/moderate earthquakes, surface/mantle/channel waves, microseismic waves; Source parameters and their determination: epicenter, hypocenter, magnitude and energy, earthquake intensity; Earthquake source mechanism: fault plane completion and earthquake source mechanism parameters.

References:

1. Markus Bath (1979). Introduction to Seismology, BirkhauserVerlag.
2. Waluyo (1998). Materi kuliah Seismologi, Program Studi Geofisika, FMIPA-UGM.

45. Seismology Lab work

MFG 3110 Seismology Lab work (1 SKS MKW Sem:5)

Prerequisite: *)

Syllabus:

Calculating Distances and Azimuth, Introduction to Seismology Reading Seismograms at Intermediate Distance, Determining the Hypocentral parameters from the seismograms of a single station, Identification of Body Wave for a Deep-Focus Earthquake, Identification of Body Wave for A Distant Earthquake, Determination of Hypocentral coordinates from P times, Determination of Hypocentral coordinates by Richther's method, Determination of Mb, and Ms of an Earthquake, Determination ofGroup velocity of rayleigh wave, Focal mechanism determination from first mention of P wave.

References:

1. Wiwit Suryanto dkk, Modul Praktikum Seismologi, Program Studi Geofisika, 2021

46. Gravity and Magnetic Methods

MFG 3113 Gravity and Magnetic Methods (3 SKS MKW Sem:5)

Prerequisite: Physical Mathematics III

Objective and Competency:

After attending lectures and passing the exams for this course, students are expected to be able to understand the basic principles of gravitational and magnetic exploration surveys, solve

conceptual and practical problems regarding the source of the earth's gravitational and magnetic fields and their properties.

Syllabus:

1. Gravity Method: Rock properties detectable by gravity, gravitational potential field theory (e.g. Newton's law of gravitation, scalar potential, Laplace equation, Poisson equation, equivalent layer, upward and downward continuation of potential field, potential differentiation, expansion multipole field), the use of potential field theory (e.g. calculating excess mass, determining the position of the center of mass), collecting gravity data (e.g. gravity meter, calibration, tidal effects, working procedures in the field).Reduction of gravity data (e.g. latitude effects, elevation effects, Bouguer effects, topographic effects, transfer of data from topographical surfaces to horizontal planes, creation of gravity anomaly contour maps), processing of gravity data (i.e. separation of regional and residual effects, derivation, upward and downwards, use of density log data), interpretation (e.g. the principle of ambiguity of interpretation results as a consequence of solving the inversion problem, direct interpretation with downward continuation, direct interpretation with multipole expansion, indirect interpretation using characteristic curves, and modeling).
2. Magnetic Method: Earth's main magnetic field, corrections to geomagnetic data, reduction to the horizontal plane, Magnetic anomaly, Stratum equivalent principle, Pseudo gravity, Magnetic field continuity, Demagnetization, Reduction of magnetic field to poles, Separation of regional-residual anomalies, Characteristic curves, Numerical calculation of anomaly profiles, depth estimation from aeromagnetic surveys, magnetic minerals, various types of rock magnetization. Case examples in geophysics.

References:

1. Grant, F.S., dan G.F. West, 1965, Interpretation Theory in Applied Geophysics, McGraw-Hill.
2. Komite Gayaberat Nasional, 1992, Buku Petunjuk untuk Operator Gravimeter LaCoste & Romberg, Bakosurtanal.
3. Makalah-makalah tentang gravitasi di Jurnal-jurnal (a.l. JGR, Geophysics, Geophysical Prospecting), Prosiding (a.l. PIT HAGI), dan Skripsi-skripsi.
4. Telford, W.M., 1983., Applied Geophysics. Cambridge University Press.
5. Parkinson, W.D., 1983. Introduction to Geomagnetism, Scottish Academic Press.

47. Non Seismic Method Lab work

MFG 3114 Non Seismic Method Lab work (1 SKS MKW Sem:5)

Prerequisite: *)

Objective and Competency:

After taking this course, students are expected to be able to carry out the data processing, data acquisition, processing and interpretation of data by several non-seismic methods, including: geomagnetic, gravity, geoelectric, VLF, MT, and Self Potential.

Syllabus:
Survey preparation, acquisition, processing, and interpretation of geophysical, gravity, geoelectric, VLF, MT and Self Potential geophysical methods.

48. Laboratory Work

MFG 4943 Laboratory Work (1 SKS MKW Sem:7)
Prerequisite: Minimum 90 SKS
Objective and Competency:
Geophysics students are able to work as Lab work assistants for Basic Physics I and Basic Physics II courses organized by Basic Physics Laboratory, Physics Department, Faculty of Mathematics and Natural Science UGM (FMIPA UGM).
Syllabus:
Laboratory Lab work
References:
Similar to course references

49. Scientific Writing and Presentation

MFG 3101 Scientific Writing and Presentation (2 SKS MKW Sem:5)
Prerequisite: Minimum 45 SKS
Objective and Competency:
Students are expected to be able to make scientific writings according to standard language rules and are able to make interesting and clear scientific presentations.
Syllabus:
This course equips students with: a) scientific writing formats (proposals, theses, scientific articles); b) Detailed format of scientific writing structure; c) Formal written communication; d) ethics in scientific writing; e) practice writing scientific papers; f) type and format of scientific writing; g) techniques and ethics in scientific presentations; h) Practice making and conducting clear scientific presentations.

50. Workshop on Geophysics

MFG 3121 Workshop on Geophysics (2 SKS MKW Sem:6)
Prerequisite: Minimum 100 SKS
Objective and Competency:
After attending this course, students are expected to be able to apply and integrate all geophysics and geology methods on geophysics exploration work.
Syllabus:
Survey planning, data collection, data processing and interpretation of all geophysical methods, making daily reports, presentations, and writing papers for each method, and integrated analysis of several geophysical methods.

References:
Buku Panduan Lokakarya Geofisika Lapangan

51. Internship

MFG 3122 Internship (2 SKS MKW Sem:6)
Prerequisite: Minimum 80 SKS
Objective and Competency:
After attending this course, students are expected to be able to know real job opportunities for geophysicist
Syllabus:
Field work practice in companies or institutions that are closely related to geophysics for approximately 1-2 months in a row.

52. Student Service Learning (KKN PPM)

UNU 2220001 Student Service Learning (3 SKS MKW Sem:6)
Prerequisite: Has taken 100 credits without an E and is not currently taking any courses.
Objective and Competency:
Universitas Gadjah Mada Student Service Learning (KKN PPM) is a compulsory subject for Universitas Gadjah Mada students to live with the community by carrying out community empowerment activities in an interdisciplinary manner. KKN PPM is part of the educational process at Universitas Gadjah Mada which has the aim of increasing student empathy and concern, implementing science, technology, teamwork, and interdisciplinary applications, instilling personality values, increasing national competitiveness, and instilling researcher's soul. KKN-PPM must be carried out by every student who has taken lectures and practicums of at least 100 (one hundred) semester credit units (SKS) without an E grade for diploma four or applied undergraduate programs , undergraduate programs, and professional programs with a weight of 4 (four) credits. KKN-PPM is carried out within a period of 2 (two) months with the number of effective working hours for each student at least 288 (two hundred and eighty eight) hours
Syllabus:
General debriefing, special debriefing, Campus Service, consolidation, general test, Observation and Preparation of activity plans for Observation, Implementation of KKN programs and Activity implementation reports and Discussion of activity accountability
References:
DPKM UGM. 2020. Buku Pedoman Kuliah Kerja Nyata Pembelajaran Pemberdayaan Masyarakat (KKN-PPM) Universitas Gadjah Mada. Yogyakarta

53. KKN: Community Communication (KM)

UNU 222002 Community Communication (KM) (2 SKS MKW Sem:6)
Prerequisite: Has taken 100 credits without an E and is not currently taking any courses.

Objective and Competency:
Community Communication Lecture (KM) is a compulsory elective course containing material related to students' ability to communicate directly with the public when carrying out KKN and collaborating with various other stakeholders. In this course students become agents of change in solving real problems and development in society with an orientation towards Sustainable Development Goals (SDGs).
Syllabus:
Provision of communication ethics and outreach, Observation, Implementation, Reporting and evaluation
References:

DPKM UGM. 2020. Buku Pedoman Kuliah Kerja Nyata Pembelajaran Pemberdayaan Masyarakat (KKN-PPM) Universitas Gadjah Mada. Yogyakarta

54. KKN : Application of appropriate technology

UNU 222003 KKN (4 SKS MKW Sem:6)
Prerequisite: Has taken 100 credits without an E and is not currently taking any courses.
Objective and Competency:
Lectures on Application of Appropriate Technology are mandatory elective courses that are carried out in conjunction with KKN PPM course which contain an interdisciplinary approach in learning community empowerment with the application of knowledge that is owned by either applying appropriate technology or knowledge management according to local wisdom and resources which encourages a process of mutual learning between students and the community for sustainable development.
Syllabus:
Provision regarding the application of science and technology, observation, implementation, reporting and evaluation
References:

DPKM UGM. 2020. Buku Pedoman Kuliah Kerja Nyata Pembelajaran Pemberdayaan Masyarakat (KKN-PPM) Universitas Gadjah Mada. Yogyakarta

55. Bachelor Thesis

MFG 4101 Bachelor Thesis (6 SKS MKW Sem: 8)
Prerequisite: Minimum 130 SKS
Objective and Competency:
Students are expected to be able to conduct scientific geophysical research reported in the form of a thesis. Able to describe research results in scientific publications that can be understood by the geoscience community and uploaded on university websites. Able to make appropriate decisions in the context of solving problems in their field of expertise based on the results of information and data analysis. Able to maintain and develop a network with supervisors, colleagues both inside and outside the institution.
Syllabus:

In accordance with the topic of the thesis

References:

In accordance with the topic of the thesis

II. Elective Courses

56. Thermodynamics

MFF 1051 Thermodynamics (3 SKS MKW Sem: Even)

Prerequisite: Physical Mathematics I, Basic Physics I

Syllabus:

System, phase and state magnitude. Temperature, Thermodynamic Equilibrium and Zeroth Law of Thermodynamics, Gas Thermometers and Absolute Temperature. Ideal Gas Equations of State and Van der Walls. Thermodynamic Work, Kinetic Theory of Gases, Heat and Heat Capacity, and First Law of Thermodynamics. Internal Energy and Enthalpy,

References:

1. Sears, F. W. and G. L. Salinger, 1982: Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Addison-Wesley, Reading, Massachusetts.
2. Greiner, W., dkk., 1997: Thermodynamics and Statistical Mechanics, Springer, New York.

57. Physical Volcanology Lab work

MFG 3112 Physical Volcanology Lab work (1 SKS MKW Sem: Even)

Prerequisite: *)

Objective and Competency:

After attending this Lab work, students are expected to be able to measure, process, analyze, and interpret physical volcanology data.

Syllabus:

Acquisition and analyzing volcano seismic data in space, time and frequency domain. The heat method for research on volcanic physics, statistical analysis of seismic signals, experiments on physical models of volcanic eruptions, visits to volcanic monitoring stations, field Lab work with various geophysical methods.

References:

Reports, physical volcanology research article on Geophysics Laboratory FMIPA-UGM and BPPTKG office, Yogyakarta

58. General Biology

MFG 4701 General Biology (2 SKS MKW Sem: Even)

Prerequisite: *)

Syllabus:

Biology of cells and their organelles (membranes, mitochondria, DNA, RNA etc. and their protein structure), cell abnormalities, cancer, micro transport systems (in cells: diffusion, osmosis and others) and macro (blood transport, lymphatic circulation system for the immune system, immune system, etc.) respiratory system, muscle movement/active and skeleton/passive and nervous system, homeostasis (/bioenergetics).

References:

1. Basic histology, Junqueira,
2. Cell Biology,
3. Fisiologi kedokteran, GanongGuyton

59. Petrology

MFG 4703 Petrology (2 SKS MKW Sem: Even)

Prerequisite: *)

Objective and Competency:

This course provides basic knowledge about rocks (occurrence, physical properties and their distribution), which are the object of geophysical measurements. After taking this course, students are expected to have an understanding in lithology interpretation from the results of geophysical measurements.

Syllabus:

Rocks and minerals = igneous rocks: magma and its composition, Bowen's Reaction series, fractionation of magma, lava, intrusion extrusion dike-vine, how volcano formed, magma chamber structure, texture and composition of acidic - intermediate - basic igneous rocks, pyroclastic rocks, introduction and description of igneous rocks samples. Sedimentary Rocks: rock cycles,weathering,sedimentation processes, sedimentation environment, grain size scale, lithification and diagenesis, clastic and non clastic sediment, carbonate rocks, sedimentary structure, as well as introduction and description of sedimentary rocks samples. Metamorphic rocks: Metamorphosis, metamorphic rock classification,metamorphic mineral, rock texture, contact metamorphism and regional metamorphism, as well as introduction and description of examples of metamorphic rocks. In the middle of the semester, several field trips will be held.

References:

1. Blatt, H. & Ehlers, E.G., 1982, Petrology Igneous, Sedimentary, and Metamorphic, W.H. Freeman & Co.
2. Huang, W.T., 1962, Petrology, Mc Graw Hill Book Co., NewYork.
3. Hydman,D.W.,1972, Petrology of Igneous and Metamorphic Rock, McGraw Hill Book Co., New York.
4. Jackson, K.C., 1970, Text Book of Lithology, Mc Graw Hill Inc., NewYork.
5. Pettijohn, F.J., 1962, Sedimentary Rocks, 2nd, Oxford & IBH Pub. Co, New Delhi.

60. Petrology Lab work

MFG 4704 Petrology Lab work (1 SKS MKW Sem: Even)

Prerequisite: *)

Objective and Competency:

To support, complete and liven up Petrology lectures by visually introducing examples of igneous, sedimentary, and metamorphic rocks

Syllabus:

Description and classification of igneous, sedimentary, and metamorphic rocks in the laboratory, plus 1 trip.

References:

Buku Petunjuk Praktikum Petrologi, Teknik Geologi FT-UGM

61. Physical Education and HSE

MFG 4705 Physical Education and HSE (1 SKS MKW Sem: Even)

Prerequisite: *)

Objective and Competency:

After attending this course, students are expected to be able to understand concepts and essence from physical education, sport, and HSE, and be able to apply it in everyday life, especially when working in the field of geophysics.

Syllabus:

This course equips students with an understanding of motion, physical activity, sports and HSE (health, safety, and the environment).

References:

Freeman, William., 2000. Physical Education and Sport in Changing Society. Minneapolis, MN. Burgess

62. Geochemistry

MFG 4707 Geochemistry (2 SKS MKW Sem: Even)

Prerequisite: Basic Chemistry I

Objective and Competency:

After attending this course, students are expected to be able to explain the earth's chemical composition system and can determine the reactions of the earth's elements that occur, and calculate the age of earth's rocks using chemical methods in an integrated and comprehensive manner.

Syllabus:

Earth chemistry and its relation to the universe, Earth's chemical structure and composition, magma and igneous rocks, sedimentation and sedimentary rocks, metamorphism and metamorphic rocks, geochemical cycles, geothermometry, isotope geochemistry, radioactivity, dating.

References:

1. Manson, B., and Moore, C.B., 1982, Principles of Geochemistry. Edisi 4., John Wiley and Sons, NewYork.

2. Turcote, and Scubert, 1982, Geodynamics and Application of Continuum Physics to Geological Problems. John Wiley and Sons, NewYork
3. Rybach, L. and Muffler, L.P.J., 1981, Geothermal System; Principles and case Histories. John Wiley and Sons, New York.

63. Global Positioning System

MFG 4709 Global Positioning System (2 SKS MKW Sem: Even)

Prerequisite: Basic Physics I

Objective and Competency:

After attending this course, students are expected to be able to understand the basic concept of GPS and principle of positioning with GPS satellites observations. Coordinate system, orbit and ephemeris of GPS satellites, GPS signal propagation, Concept of equations and positioning with GPS. Type of surveys with GPS, absolute and relative positioning with GPS, quality control bias and error in determination with GPS. Coordinate transformation, UTM projection system, DOP, various GPS instruments.

Syllabus:

Coordinate system, GPS satellite orbit and ephemeris, GPS signal propagation, The concept of equations and positioning with GPS. Types of surveys with GPS, absolute and relative positioning, bias and error in determinations with GPS, Quality control. Coordinate transformation, UTM projection system, DOP, various GP tools

References:

1. Leick, A. 1990, GPS Satellite Surveying, John Wiley & Sons,Maine
2. Aris Sunantyo, T., 1999, Pengantar Survei GPS Satelit, Teknik Geodesi, Fak. Teknik Universitas Gadjah Mada, Yogyakarta
3. Teunissen, P.J.G. and A. Kleusberg (ed), 1998 GPS for Geodesy, Springer,Berlin.
4. Triemble, 1998, GP Survey Software Manual, Trimble.

64. Geostatistics

MFG 4711 Geostatistics (3 SKS MKW Sem: Even)

Prerequisite: Calculus II

Objective and Competency:

After attending this course, students are expected to be able to understand the basic concept of statistics and its application in geophysics, solve the problems and apply its applications especially in the case of geophysics.

Syllabus:

Statistics in general and Geostatistics; Regionalized variables, distributions, probability density functions, normal distributions, and their characteristics: Spatial correlations: variogram, character variogram, theoretical variogram, vertical and lateral variogram, geometric anisotropy; Automatic kriging and contouring, types of kriging, and kriging and mapping, Stochastic simulation: general simulation, deterministic approach, stochastic approach, conditional simulation, Monte Carlo and

Gaussian sequential indicator simulation, Boolean stochastic simulation, fractal geostatistics, and Annealing; Bayes's rule, Bayes' theorem and its applications in geology.

References:

1. Munadi, S, 2005, Pengantar Geostastika, Program Pasca Sarjana Fisika Kekhususan Geofisika Reservoir, Universitas Indonesia.
2. Waluyo, 2013, Buku Ajar Geostatistika, Program Studi Geofisika, FMIPA, Universitas Gadjah Mada.
3. McKillup, S., & Dyar, M., 2010, Geostatistics Explained: An Introductory Guide for Earth Scientists. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511807558
4. Sarma, D.D., 2009, Geostatistics with Applications in Earth Sciences., Copublished by Springer, P.O. Box 17, 3300 AA Dordrecht, The Netherlands with Capital Publishing Company, New Delhi, India.
5. Pyrcz, MJ., and Deutsch, C.V., 2014, Geostatistical reservoir modeling, Oxford University Press, 198 Madison Avenue, New York, NY 10016

65. Project Management

MFG 4713 Project Management (2 SKS MKW Sem: Even)

Prerequisite: Minimum 60 SKS

Objective and Competency:

After attending this course, students are expected to be able to lead and carry out projects, starting from planning, budgeting, operational stages, monitoring, evaluation and finishing.

Syllabus:

Introduction to project administration and bureaucracy, techniques for winning a project (participating in auctions/tenders, etc.), Management of planning, implementing, and leading a project, Introduction to project financial management, management of people and materials/equipment, techniques for making progress reports and final reports, Simulation plans a comprehensive geophysical survey project.

References:

1. Priyana, 1997. Tatalaksana Proyek, Publikasi Internal.
2. Verheijen, P.J.T, Project Management Reading, Lab. GeofisikaUGM.

66. Rock Mechanics

MFG 4715 Rock Mechanics (2 SKS MKW Sem: Even)

Prerequisite: Mechanics of Continuous Medium

Objective and Competency:

After attending this course, students are expected to be able to explain concept and solve basic problems of rock mechanics in an integrated and comprehensive manner

Syllabus:

Rocks and rock mechanics; Definition of rock, rock composition, definition of rock mechanics, rock properties, some features of rock mechanics, some problems in rock mechanics, scope of

rock mechanics, stress and strain analysis; Stress analysis in planes, Mohr circle of stress, strain analysis. Physical and mechanical properties of rock; Determination of physical and mechanical properties of rock in the laboratory, Determination of mechanical properties in situ.Rock Behavior; Elastic, elastoplastic, rock creep, rock relaxation, stress and strain relationship for linear and isotropic elastic behavior. Rock "Failure" criteria; Mohr theory, Mohr-Coulomb criterion, maximum tensile stress criterion, maximum shear stress criterion. Measurement of in situ stress in the rock mass; Rosette deformation method, Flat jack method, over coring method, Hydraulic fracturing. Technical classification of rock masses; Important factors in rock classification, rock mass properties, rock mass classification.

References:

1. Rai, M.A., 1988, Mekanika Batuan, Laboratorium Geoteknik, PAU-Ilmu Rekayasa, ITB Bandung.
2. Atkinson, B.K., 1987., Structure mechanics of rocks, academic press.

67. Fluid Mechanics

MFG 4717 Fluid Mechanics (2 SKS MKW Sem: Even)

Prerequisite: Physical Mathematics III

Objective and Competency:

The main objective of this course is to learn the basics of fluid mechanics and its application in geophysical problems. After attending this course and passing the exam, students are expected to be able to solve conceptual and practical problems about fluid mechanics and its application in geophysics.

Syllabus:

Brief study of vector calculus and static fluids, basic equations of fluid mechanics, non-viscous fluids, laminar and turbulent flows, viscous fluid flows, double-phase fluid flows. viscous fluid flow and phase/double component in a porous medium, rheology, fluid mechanics in geophysics a.l. hydrological cycle, water-ground, water currents in rivers & seas, wind currents, groundwater flows, oil, water and gas/steam flows in oil and gas reservoirs and geothermal reservoirs: secondary recovery, enhancement oil recovery, magma flow.

References:

1. James A. Liggett 1994, "Fluid Mechanics", McGraw-Hill, Inc.
2. Journals: a.l. Journal Geophysical Research, Geophysics, Geophysical Prospecting, andGeophysical research Letters.
3. Relevant article from various references

68. Geophysical Instrumentation

MFG 4719 Geophysical Instrumentation (2 SKS MKW Sem: Even)

Prerequisite: Electronics

Objective and Competency:

After attending this course, students are expected to be able to understand how geophysical tools work, calibration methods, use of tools correctly and safely, minor repairs, and routine maintenance of geophysical tools and their auxiliary tools.

Syllabus:

History of the development of Geophysical instruments and measurements in the laboratory and in the field, sensors of physical quantities and their characteristics, basic principles of measurement, system characteristics, Geophysical instrument systems, analog and digital systems, data transmission, telemetry systems, special understanding of Geophysical tools , Geophysical data collection (special emphasis on instrumentation, errors in measurement, calibration, fault finding on tools and maintenance of tools.

References:

1. Wolf, E.A. and Mercanti, E.P. 1973, GeoscienceInstru-mentation-JohnWilley&Sons
2. Geophysical instrument manual books

69. Geophysical Instrumentation Lab work

MFG 4720 Geophysical Instrumentation Lab work (1 SKS MKW Sem: Even)

Prerequisite: *)

Objective and Competency:

After attending this course, students are expected to be able to understand how to use geophysics instruments in the correct and safe manner, tool calibration, minor repairs and maintenance. Practical materials for making simple electronic systems, investigating the nature of tools and sensors, measuring physical quantities in the laboratory, finding faults and calibration.

Syllabus:

The practice of making simple electronic systems, investigating the nature of tools and sensors, measuring physical quantities in the laboratory, finding error and calibration.

References:

Geophysical instrument manual books

70. Environmental Geophysics

MFG 4721 Environmental Geophysics (2 SKS MKW Sem: Even)

Prerequisite: All Geophysics Methods courses

Objective and Competency:

After attending this course, students are expected to be able to explain the importance of maintaining environmental quality, able to explain environmental geophysical techniques, especially those related to monitoring and mitigating physical environmental pollution and natural disasters.

Syllabus:

The importance of maintaining environmental quality, various kinds of physical environmental pollution and natural disaster and their mitigation, Environmental geophysical techniques related to monitoring and mitigation of physical environmental pollution, such as dust, smoke, chemical,

groundwater, seawater, noise, vibration, radioactive, heat, electromagnetic wave, environmental geophysical techniques related to monitoring and mitigation of natural disaster, such as earthquake, volcanic eruption, tsunami, lahar, floods, landslide, etc.

References:

1. Ward, S.H., Editor 1990, Geotechnical and Environmental Geophysics,SEG.
2. Davis, M.L. and Cornwell, D.A., 1991, Introduction to Environmental Engineering, McGraw Hill, Inc.

71. Geophysical Computer Programming

MFG 4723 Geophysical Computer Programming (2 SKS MKW Sem: Even)

Prerequisite: Geophysic Analysis Method

Objective and Competency:

After attending this course, students are expected to be able to understand advanced programming in various operating systems, especially UNIX/Linux based with an emphasis on applications in the field of physics/geophysics. Contains material on the basics of commands in Unix, shell programming in Unix, plotting, making maps / graphics, compiling programming languages, super computing, and 3D visualization.

Syllabus:

introduction to UNIX operating system, shell scripting in UNIX, cshell, Generic Mapping Tools, Fortran90, Supercomputing, Povray

References:

1. Suryanto, W. 2011. Diktat kuliah komputasi paralel, Lab. Geofisika FMIPA UGM

72. Digital Transformation

UNU 163200 Digital transformation (2 SKS MKP Sem: Even)

Prerequisite: -

Objective and Competency:

Syllabus:

73. Ethics and Communication in Geoscience

MFG 4725 Ethics and communication in Geosciences (2 SKS MKP Sem: Even)

Prerequisite: Scientific writing and presentation

Objective and Competency:

Students are expected to understand and apply how to explain geoscience phenomena on natural disasters in a scientific way, based on data, and educative.

74. Geothermal Exploration

MFG 4727 Geothermal Exploration (2 SKS MKP Sem: Even)

Prerequisite: Minimum 100 SKS

Objective and Competency:

Students are expected to be able to explain the hydrothermal system and be able to determine the boundaries of the prospect area for geothermal energy sources, dimensions, and conditions using integrated geophysical methods.

Syllabus:

Benefits of geothermal energy, geothermal systems, geothermal geology, geothermal rock alteration, geothermal geochemistry, geothermometry, physical phenomena of geothermal sources, the role of geophysics for exploration of geothermal resources (using gravity, magnetic, active and passive geoelectrical, thermal, electromagnetic, seismic methods) active or passive).

References:

1. Rybach, L. and Muffler, L.P.J., 1981, Geothermal System; Principles and case Histories. John Wiley andSons.
2. Colin Harvey, Graeme Beardsmore. Inga Moeck and Horst Rüter, 2016, Geothermal Exploration – Global Strategies and Applications, IGA Academy Books
3. Hochstein, M.P., 1982, Introduction to Geothermal Prospecting. Geothermal Institute, University ofAuckland.
4. Nicholson, K., 1993, Geothermal Fluids-Chemistry and Exploration Techniques. Springer, Verlag, Berlin, Heidelberg.

75. Geothermal Exploration Lab work

MFG 4728 Geothermal exploration Lab work (1 SKS MKP Sem: Even)

Prerequisite: *)

Objective and Competency:

Students are expected to make a planning, acquisition, processing, and interpret geophysical data (geoelectric VES, Dipole-dipole, MT, AMT, CSAMT, Gravity, Geomagnetic, Geochemical) for geothermal exploration.

Syllabus:

Application of geothermal energy, geothermal systems, geothermal geology, geothermal rock alteration, geothermal geochemistry, geothermometry, physical phenomena of geothermal sources, the role of geophysics for exploration of geothermal resources (using gravity, magnetic, active and passive geoelectrical, thermal, electromagnetic, seismic methods) active or passive.

76. Philosophy of Physics

MFF1015 Philosophy of Physics (2 SKS MKW Sem: Odd)

Prerequisite:

Objective and Competency:

Syllabus:

Logic: knowledge, skill, scientific method, deductive logic, syllogism. Scientific method: inductive and inductivism, inductivism problems. Physic theory dynamics: falsificationism,

revolution on physics and rationality. Physics development (Aristoteles to Galileo): Aristoteles theories.

References:

1. J Ladyman, 2002, Understanding Philosophy of Science, Routledge,London.
2. G Holton dan S G Brush, 2005, Physics, The Human Adventure, Rutgers Univ Press, USA.
3. A Hermanto, 2012, Bahan Ajar Filsafat Fisika,FMIPA-UGM

77. Entrepreneurship and Management

MFG 3103 Entrepreneurship and Management (2 SKS MKW Sem: Odd)

Prerequisite: Minimum 45 SKS

Objective and Competency:

Students are expected to think creatively, and have basic knowledge to be an entrepreneur as well as business planning, financial management, and business financing, marketing, business ethics.

Syllabus:

Innovation thinking, leadership, starting a new business, risk management, management of business financial.

References:

1. Modul Kewirausahaan untuk Program Strata 1, 2010, Rhenald Khasali, A.H. Nasution,
2. B.R. Purnomo, A. Ciptarahayu, Dwi Larso, I.R. Mirzanti, S. Rustiadi, H.K. Daryanto, A. Mulyana. PT. Mizan Publika, Jakarta.
3. Management and Entrepreneurship, 2009, Veerabhadrappa Havinal, New Age International Limited Publisher, India

78. Energy

MFG 4601 Energy (2 SKS MKP Sem: Odd)

Prerequisite: Basic physics 1

Objective and Competency:

Students are expected to have knowledge and understanding in energy, sources of all energy sources on planet earth, diversity of energy sources and the process of their formation, understanding of non-renewable energy sources, new and renewable energy sources.

Syllabus:

energy sources formation on earth, non-renewable energy sources or fossil energy sources, oil and gas, coal, exploration and exploitation of fossil energy sources, management and fossil energy sources processing, potential sources of fossil energy, fossil energy sources potency, renewable energy sources, solar energy sources, wind energy sources, water energy sources, tidal energy sources, OTEC, wave energy sources, biomass energy sources, biogas energy,
Biofuel energy, renewable energy in nuclear form, magnetic energy, and hydrogen energy.

References:

1. Michael Wesley, 2007, 'Energy Security in Asia', Routledge Publishing, London

79. Rock Physics

MFG 4603 Rock Physics (2 SKS MKP Sem: Odd)
Prerequisite: Basic physics 2
Objective and Competency:
Students are expected to explain the concept and solve basic questions of physical rock characteristics comprehensively.
Syllabus:
Minerals and Rocks, Igneous rock, Sedimentary rock. porous media; Porosity, porosity evolution, Surface adsorption, Surface roughness. Heterogeneous media; Micro, mini, macro scale, calculation of effective properties, Percolation, Percolation through fracture. Mechanical behavior of dry rock; stress-strain, deformation, elastic behavior, fracture, plasticity. fluid flow; Darcy's law and permeability, permeability model. Mechanical behavior of fluid-saturated rock; Linear poroelastic, fracture, plasticity. Acoustic properties; Elastic wave velocity, attenuation, anisotropic velocity, Electrical conductivity. Dielectric properties. Thermal Conductivity, Magnetic Properties.
References:
1. Gueguen,Y. and Palciauskas, V.,1994, Introduction to the Physics of Rocks. Princenton University Press, NewJersey.

80. Meteorology

MFG 4605 Meteorology (2 SKS MKP Sem: Odd)
Prerequisite: Thermodynamics
Objective and Competency:
Students are expected to explain the fundamentals of climatology, earth's atmosphere dynamic, surface, cloud, rain, as well as the weather forecast.
Syllabus:
Introduce the system and weather's modeling, terrestrial ecosystem, structure and composition of earth's atmosphere, atmosphere dynamic and thermodynamic, hydrostatic equilibrium, cloud and rain, chemical and atmosphere radioactive, movement classification and atmosphere waves, ocean circulations, land surface.
References:
1. Bigg, G.R., 1996. The Oceans and Climate, Cambridge UniversityPress.
2. Trinberth, K.E., 1992. Climate System Modeling, Cambridge UniversityPress.

81. Inversion Method

MFG 4607 Inversion Method(2 SKS MKP Sem: Odd)
Prerequisite: Physical Mathematics 2
Objective and Competency:
Geophysical inversion course explains the fundamental inversion method that is applied to geophysical fields.

Syllabus:
INTRODUCTION: Inverse Theory, Useful Definitions, Possible Goals of an Inverse Analysis, Nomenclature, REVIEW OF LINEAR ALGEBRA AND STATISTICS: Introduction, Probabilistic and Statistics, INVERSE METHODS BASED ON LENGTH, Introduction, Data Error and Model Parameter Vectors, Measures of Length, Minimizing the Misfit: Least Squares, Derivation of the General Least Squares Solution,Two Examples of Least Squares Problems, Four-Parameter Tomography Problem, Determinacy of Least Squares Problems, Minimum Length Solution, Weighted Measures of Length, A Prior Information and Constraints, Variance of the Model Parameters, LINEARIZATION OF NONLINEAR PROBLEMS: Introduction, Linearization of Nonlinear Problems, General Procedure for Nonlinear Problems, Three Examples, Creeping vs Jumping (Shaw and Orcutt, 1985), THE EIGENVALUE PROBLEM: Introduction, The Eigenvalue Problem for Square (M× M) Matrix A, Geometrical Interpretation of the Eigenvalue Problem for Symmetric, Decomposition Theorem for Square, Eigenvector, Structure of mLS
References:

82. Spectral Analysis of Digital Signal

MFG 4609 Spectral Analysis of Digital Signal (2 SKS MKP Sem: Odd)
Prerequisite: Physical Mathematics 3
Objective and Competency:
Students are expected to do an analysis of geophysics exploration of digital spectrum signals in the time and space domain.
Syllabus:
Introductions: digital system, digital signal in time domain, DFT (discrete-time Fourier transform). DRT (discrete-time random processes): random variable, random process, ARMA process, AR and MA process, harmonic process, power spectrum. Non stationary processes, Signal modeling: least square method, finite data record, stochastic model (ARMA model, AR and MA model), power spectrum estimation. Spectrum estimation: peak spectrum accuracy identification, non parametric method, variance spectrum minimum estimation, maximum entropy method, parametric method (AR, MA, and ARMA spectrum estimations), frequency estimation, principal components spectrum estimations. Spectral density: narrow & broadband process, cross spectral density, coherency spectral density. Statistics of narrow band processes. Wavelet transform, wavelet transform coherence.
References:
1. Newland D.E., 1994, An introduction to random vibrations, spectral & wavelet analysis, Logman Scientific & Technical Publising.
2. Hayes M.H., 1996," Statistical digital signal processing & modeling", John Willey and SonsInc.

83. Spectral Analysis of Digital Signal Lab work

MFG 4610 SADS Lab work (1 SKS MKP Sem: Odd)

Prerequisite: *)

Objectives & Competency:

Students are expected to make code related to spectrum processing of digital time series data signals using Fortran, C++ or Matlab programming languages. Students are also capable to process time-series data using existing software (eg: Geopsy, Pitsa, etc.)

Syllabus:

Digital system, digital signal in time domain, DTFT (discrete-time Fourier transform). DRT (discrete-time random processes): random variables, random processes, ARMA processes, AR and MA processes, harmonic processes, power spectrum. Non-stationary processes. Signal modeling: least squares method, finite data record, stochastic model (ARMA model, AR & MA models), estimated power spectrum. Spectrum estimation: Spectrum peak determination accuracy, non-parametric method, minimum varince spectrum estimation, maximum entropy method, parametric method (AR, MA, & ARMA spectrum estimations), frequency estimation, principal components spectrum estimations. Spectral density: narrow & broad band process, cross spectral density, coherency spectral density. Statistics of narrow band processes. Wavelet transorm, coherence of wavelet transform.

84. Numerical Solution

MFG 4611 Numerical solution (2 SKS MKP Sem: Odd)

Prerequisite: Physical Mathematics 3

Objectives & Competency:

Students are expected to solve numerical computation problems using mathematical calculation in geophysical cases.

Syllabus:

Introduction to computation: error, accuracy, stability, precision. Solution of nonlinear equations an root mean, solutions of linear equations,

Pengantar komputasi: erorr, ketelitian, stabilitas, presisi. Penyelesaian persamaan non-linear dan mencari akar, Penyelesaian persamaan linier, least square curve matching, interpolation and extrapolation, polynomial interpolation and extrapolation, cubic spline interpolation, 2D interpolation. Integration: classic method (trapesium method, simpson method), romberg integral, Gaussian quadrature, double integral. Solution of nonlinear root. Numerical differensiation, solution of simple differential and partial differential.

References:

1. Chapra, C.S. and Canale, R.P, 2015, 'Numerical Methods for Engineers', 7th Edition, Mc Graw Hill Education, New York, USA

2. Kiusalaas, 2013,' Numerical Methods in Engineering with Python 3', cambridgeuniversitypress, New York, USA

3. Madhumangal Pal, 2007, 'Numerical Analysis for Scientists and Engineers: Theory and C Programs, Alpha Science Intl Ltd.

85. Numerical Solution Lab work

MFG 4612 Numerical solution Lab work (1 SKS MKP Sem: Odd)

Prerequisite: *)

Objectives & Competency:

Students are expected to solve numerical computation in geophysical problems using computers.

Syllabus:

Error and accuracy on computation. Solution of non-linear equation and root mean. Solution of linear equation, least square curve matching, interpolation and extrapolation, integration, numerical differential, solution of simple differential equation and partial differential equation.

References:

1. Chapra, C.S. and Canale, R.P, 2015, 'Numerical Methods for Engineers', 7th Edition, Mc Graw Hill Education, New York, USA

2. Kiusalaas, 2013,' Numerical Methods in Engineering with Python 3', cambridgeuniversitypress, New York, USA

3. Madhumangal Pal, 2007, 'Numerical Analysis for Scientists and Engineers: Theory and C Programs, Alpha Science Intl Ltd.

86. Stratigraphy

MFG 4613 Stratigraphy (2 SKS MKP Sem: Odd)

Prerequisite: Geological Field Work

Objectives & Competency:

Students are expected to understand the objective and complete description of rocks components, both vertical and horizontal, as well as understand the types and kinds of relationships between the components of the rock body and the reconstruction of the formation process.

Syllabus:

Fundamental concept of stratigraphy, sediments facies, sediments environment and basin formation, stratigraphic process in relation with depositional environment, sediment geometry, stratigraphic relations, geologic time and correlation, paleogeography, sequence basis and stratigraphic analysis, and stratigraphic code recognition.

References:

1. Boggs,S., 1983. Principle of Sedimentology and Stratigraphy, Merrill Publishing Co., A Bell & Howell Co., Ohio.

2. Friedman, G.M. & Sanders, J.E., 1978. Principle of Sedimentology, John Willey and Sons, New York.

3. Mathew,R.K., 1974.DinamicStratigraphy,PrenticeHallInc.,Englewood.NewJersey.

4. Serra,O.,-,SedimentaryEnvironmentsfromWirelinelogs,Schlumberger,SecondEd.

5. Reading, H.B., 1978. Sedimentary Environment and Facies, Elsevier Scientific Publ. Co., Amsterdam.
6. Sandi Stratigrafi Indonesia, 1973. Ikatan Ahli Geologi Indonesia
7. Selly, R.C., 1975. Ancient Sedimentary Environment, Chapman and Hall Ltd., London.
Walker,R.G.,1979.FaciesModels,GeologicalAssociationofCanada,Ontario

87. Geodynamics

MFG 4615 Geodynamics (2 SKS MKP Sem: Odd)
Prerequisite: Indonesian Tectonic
Objectives & Competency:
Introduce the fundamentals of earth science that is necessary to understand the concepts and discuss problems related to mechanisms and surface features of the earth. As a basis for understanding deeper and broader geophysical method courses. Students are expected to solve simple geodynamics problems and have adequate knowledge to understand geophysical expertise courses in the following semesters.
Syllabus:
Introduction: Definition, scope, method, and benefit of geodynamics; The development history and geodynamics trend 5 to 10 years ahead. Geodynamics phenomenon in geology and geophysics: Earth evolution; geographic and continent and ocean physiography; crust, mantel, and earth core; earthquake center; gravity anomaly distribution; phenomena of the absolute calendar and geothermal, continental drift and seafloor spreading. Deformation mechanisms: stress, strain, and rocks rheology; plasticity and plastic materials; viscosity and viscous fluid; maxwell fluid and kelvin; fracture. Geodynamics effect: earth precession, tidal, and phase; polar wandering and convection flow.Orogenesis: the theory of plate movement and other theories of orogenesis. Geo-tectonics: Theories about fault, fold, and petrofabrics, earthquake source, boundary effect. Local hues: boudinage, piercement, volcanic effect, impact, ejecta, gravitational crater, contemporary movement. Global tectonic: Earth structure, sea floor spreading, and continental drift, ocean ridge, transform fault and transcurrent faults, subduction zone and mountain ranges.
References:
1. Scheidegger, A.E., 1982, Principles of Geodynamics,Springer-Verlag
2. Kearey, P. and F.J. Vine, 1990, Global Tectonics, Blackwell Sci.Publ.
3. Turcotte, 1982, Geodynamics. Appli. of Continuum Physics to Geological Problems, John Wiley &Sons.

88. Petroleum Geology

MFG 4617 Petroleum Geology (2 SKS MKP Sem: Odd)
Prerequisite: Seismic Method 2
Objectives & Competency:

Students are expected to know the history of the formation, trapping, and evaluation of oil and gas reservoir formations, as well as understand and implement its role comprehensively in oil and gas exploration.

Syllabus:

The origin of petroleum, the presence of petroleum which includes: source rock, reservoir, cap rock, trap structure, migration, accumulation, and maturation of oil and gas. Familiar with the properties of oil and gas, petroleum exploration and development, petroleum basins in Indonesia, drilling, well logging, geological prospecting for oil and gas. In the middle of the semester, a field trip will be held.

References:

1. Chapman, R.E., 1976, Petroleum Geology, Second Reprint, Elsevier Scr. Publishing Co., NewYork.
2. Lowell, J.D., 1985, Structural Styles in Petroleum Geology, Oil and Gas Consultant International Inc, Pebul., Tulsa,Oklahoma.
3. Mopdy, G.B., 1961, Handbook of Petroleum Geology, Mc Graw Hill Book Co., New York.
4. Pirson, S.J., 1963, Handbook of Well Log Analysis and Oil and Gas Gas Formation Evaluation, Prentice Hall Inc., Engle wood Clifts, NewYork.

89. Petroleum Geology Lab work

MFG 4618 Petroleum geology Lab work (1 SKS MKP Sem: Odd)

Prerequisite: *)

Objectives & Competency:

Support and complement the Petroleum Geology course by introduce and practice the material that has been given in the Petroleum Geology class.

Syllabus:

Petroleum and gas characteristics, petroleum exploration and development, petroleum basin in Indonesia, well logging, geological field trip.

References:

Petroleum Geology Lab work Manual, Geological Engineering FT-UGM.

90. Stratigraphic Seismic

MFG 4619 Stratigraphic Seismic (2 SKS MKP Sem: 6)

Prerequisite: Seismic Method 2

Objectives & Competency:

Students are capable to explain the background of seismic stratigraphy and using seismic stratigraphy data to interpret geological mechanisms for exploration.

Syllabus:

Stratigraphic seismic definition, biostratigraphy, chronostratigraphy, lithostratigraphy, and sequence stratigraphy. Seismic waves propagation, relation of rock physical characteristics and seismic waves. Isostasy (Airy, Pratt, Thermal dan Flexure plate). Changes in sea level, Eustacy,

Basin subsidence, Accommodation, Deposition, Track system. Seismic facies, Seismic attributes, and Case study

References:

1. Levy, M., 1991, Sequence Stratigraphy : Term and concept. Chevron Oil Field Research Company.
2. Payton, C.E., 1977, Seismic stratigraphy application to hydrocarbon exploration. American Association on Petroleum Geologist, Tulsa,USA.

91. Assistance of Course

MFG 4621 Assistance of Course (1 SKS MKP Sem: Odd or Even)

Prerequisite: Min 100 SKS

Objectives & Competency:

Geophysics students are capable to work as a compulsory and elective course assistant that is held by a geophysical study program.

Syllabus:

Tutorial, Correction, and Assistance.

References:

Based on course references

92. Heat Mass Transfer

MFG 4623 Heat Mass Transfer (2 SKS MKP Sem: Odd)

Prerequisite: Minimum 100 SKS

Objectives & Competency:

Students are expected to solve the heat mass transfer problem in geophysics.

Syllabus:

Introduction: Heat transfer, Relation of heat transfer and thermodynamics, heat transfer concept. Continuity equation, movement, energy and mass diffusion. Heat transfer by conduction: heat flux, heat conduction differential equation, boundary conditions, non dimensional parameter in heat conduction, heat conduction equation in homogen and heterogen. Heat conduction problem solving: variable separation method, integral transformation, laplace transformation, analytic approach, numeric. Heat transfer by convection: laminar and turbulence boundary, natural convections, boiling, condensation, heat radiation.

References:

1. Louis C., 1982, ‘Convective Heat transfer’, John Wiley andSons.
2. John H.L.,1981, ‘A Heat Transfer Textbook’, Prentice-Hall,Inc.
3. Necati M., 1980,’ Heat conduction’. John Wiley andSons.
4. Michael E.O., 1989‘Viscous and compressible fluid dynamics’, Ellis HorwoodLimited

93. Marine Geophysics

MFG 4625 Marine Geophysics (2 SKS MKP Sem: Odd)

Prerequisite: Minimum 100 SKS

Objectives & Competency:

Students are capable to explain geophysical marine exploration methods and describe the earth character based on marine geophysics observation.

Syllabus:

Fundamental marine sensing using Sonar and Lidar, Marine seismic exploration, Marine seismic data acquisition, Marine potential field, Marine potential magnetic, Heat flow, Seabed observation using geoelectrical method, Subduction zone study, Geophysical observations in offshore boreholes, and Oceanography

References:

1. Jones, E.J.W., 1999, Marine Geophysics, Wiley.

94. Capita Selecta

MFG 4627 Capita Selecta (2 SKS MKP Sem: Odd)

Prerequisite: Minimum 100 SKS

Objectives & Competency:

Geophysics students are expected to update their own competency of the latest science and technology through exploring various special topics and current interesting issues by organizing special lectures, guest lectures, field camps, special Lab works, etc.

Syllabus:

Materials are selected and agreed upon by the lecturers and students, and are in accordance with the latest interesting topics or issues.

References:

Conform the course materials

95. Aero and Satellite Geophysics

MFG 4629 Aero dan Satellite Geophysics (2 SKS MKP Sem: Odd)

Prerequisite: Minimum 100 SKS

Objectives & Competency:

Students are capable to apply operationally the measurement and data acquisition, satellite data processing for mitigation, and interpretation of satellite data, either taken by plane, UAV (drone), or satellite.

Syllabus:

Sensors that are placed on plane/UAV and satellite, leveling and orientation, recording and data transferring, study cases, analysis of surface transformation caused by earthquake, landslides and volcanic explosion, flood mapping based on satellite .

References:

1. Moreira dkk (2013). A Tutorial on Synthetic Aperture Radar. IEEE

96. Geographic Information System

MGF 4631 Geographical Information System (2 SKS MKP Sem: Odd)

Prerequisite: -

Objectives & Competency:

After taking this course, Students can visualize geophysical surveys, analyze spatially, create an informative and comprehensive map, and know spatial data for policy determination.

Syllabus:

Geographical information mapping introduction, types of spatial data, raster data analysis, geophysics and geographics integrations, spatial data visualization in 2D and 3D.

References:

1. Campbell, J. (2011) Essentials of Geographic Information Systems.

97. Geographic Information System Lab work

MGF 4632 GIS Lab work (1 SKS MKP Sem: Odd)

Prerequisite: -

Objectives & Competency:

Students are capable to analyze the spatial data, create a map, integrating geophysical data to the spatial data, analyze the topography data, topography transformation due to deformation, landslides, erosion, and analyze the raster data and vector.

Syllabus:

Map digitization, vector data creation, geophysical data and spatial data integration, visualizations data on comprehensive maps.

References:

Manual and tutorial book of arcGIS dan QGIS

98. Volcano Seismology

MFG 4633 Volcano Seismology (2 SKS MKP Sem: Odd)

Prerequisite: FGA (Physical Volcanology)

Objectives & Competency:

Volcano seismology is one of the main instruments in monitoring processes and forecasting the volcanic eruptions. In its development, volcano seismology is more directed to the science of observation and cumulative experiments. The aim of this course is to provide a comprehensive overview of volcano seismic signals, types of sources, and signal characteristics, as well as spatial and temporal distribution at different levels of volcanic activity. In addition, the Volcano Seismology course is also proposed to introduce analysis using the concept of volcanic earthquakes and the process of volcanic eruptions associated with seismic signals. Various examples of cases around the world will also be discussed along with the basic theories and examples of solving problems in real challenges.

After taking this course, students are expected to be able to understand and apply the basic concepts of volcano seismology concerning monitoring and understanding the process of volcanic eruptions and their relation to mitigation.

Syllabus:

1. Section 1: Volcanic seismology introduction: Volcano seismology history and scope, discussion about developed theoretical and experimental models to learn the volcanic earthquake.
2. Section 2: Fundamental theory about Volcanic-Tectonic (VT) earthquake and swarms: case study VT activity that is associated with a diverse volcanic eruption environment (basaltic, andesitic, dacitic).
3. Section 3: General understanding of VT swarms: character on the eruption process, the source characteristic, and the VT risks.
4. Section 4: Earthquake eruption description. The fundamental theory of earthquake eruption, volcanic tremor, correlation of the seismic signals and pyroclastic flow, rockfalls, volcanic mudflow, explosion, LP and VLP, microEQ swarms, acoustic event, and the correlation of the eruption process.
5. Section 5: Earthquake mitigation (tentative). A short discussion about the methodology of earthquake observations and eruption forecasting using seismic signals.

References:

1. Vyacheslay M. Zobin, 2012, Introduction to Volcanic Seismology, 2nd edition, Elsevier B.VISBN:978-0-444-56375-0
2. Joachim Wassermann, 2002, Manual of Seismological Observatory Practice CHAPTER 13: Volcano Seismology,IASPEI
3. Bahan bacaan tambahan: Journal articles and book sections will be assigned during lectures.

99. MIPA Frountier

MFG 3101 MIPA FROUNTIER

100. Seismic Attribute

MFG 4645 Seismic Attribute (2 SKS MKP Sem: Odd)

Prerequisite: Minimum 60 SKS

Objectives & Competency:

After taking this course, students are expected to have the competency to; analyze the seismic attribute 2D/3D post-stack and pre-stack using seismic attribute for geophysical hydrocarbon (oil and gas) exploration and exploitation.

Syllabus:

General description about seismic attribute, Post-stack 2D/3D seismic attribute: Post-stack 2D/3D seismic inversion, geometrics attributes, spectral decomposition; Pre-stack 2D/3D seismic attribute: Pre-stack 2D/3D seismic inversion, AVO, AVO inversion; multi attribute analysis.

References:

1. Satinder Chopra, Kurt J. Marfurt, 2007, Seismic Attributes for

2. Prospect Identification and Reservoir Characterization, Society of Exploration Geophysicists
03. Rob Simm, CMike Bacon, 2014, Seismic Amplitude: An Interpreter's Handbook, Cambridge University Press.
4. S. P. Maurya•N. P. Singh•K. H. Singh, 2019, Seismic Inversion Methods: A Practical Approach, Springer GeophysicsISBN 978-3-030-45661-0.

101. Methane Hydrate Exploration

MFG 4647 Methane Hydrate Exploration (2 SKS MKP Sem: Odd)
Prerequisite: Minimum 60 SKS
Objectives & Competency:
After taking this course, students are expected to understand: the use of gas hydrate or methane hydrate as a clean energy source, exploration of gas hydrates, appy operationally seismic and geophysical methods for gas hydrates exploration, and calculating the volume of gas hydrates.
Syllabus:
Introduction to clean energy needs; gas hydrate; stability conditions of gas hydrate, geological indication of gas hydrate, geophysical indication of gas hydrate, geophysical survey and analytical data, identification for gas hydrate quantification, geophysical method development to explore gas hydrate.
References:
1. Eleanor C. Willoughby, and Satinder Chopra Edited by: Michael Riedel, 2010, Geophysical Characterization of Gas Hydrates , Society of Exploration Geophysicists
2. Sanjeev Rajput, Naresh Kumar Thakur, 2011, Exploration of Gas Hydrates: Geophysical Techniques, Springer-Verlag Berlin Heidelberg
3. Ayhan Demirbas , 2010, Methane Gas Hydrate , Springer-Verlag London

102. Artificial Intelligence for Geoscience

MFG 4649 Artificial Intelligence for Geoscience (2 SKS MKP Sem: Odd)
Prerequisite: Computation Method (MFG-1102)
Objective & Competency:
After taking this course, students are expected to be able to understand and use data science, especially in the field of geosciences. In this course, students will be given material on the basic methodology of data science along with exercises using the Python programming language. Then students are also invited to work on small data science projects to answer geoscience problems. In the end, students are expected to be able to understand the basic methodology of data science, and design the right methodology and analytics task to answer their respective problems that are still related to the earth sciences.
Syllabus:
History and definition of data science and artificial intelligence; the use of the Python programming language in data science applications; review the data visually and statistically; data preparation for machine learning (data cleaning, feature transformation); methods of

classification, regression, and clustering; artificial neural network (ANN) and deep learning methods; and machine learning model evaluation techniques

References:

1. Aggarwal, C. C. (2021). An Introduction to Artificial Intelligence. In Artificial Intelligence (pp. 1-34). Springer, Cham.
2. Bishop, C. M. (2006). Pattern recognition. Machine learning, 128(9).
3. Duda, R. O., & Hart, P. E. (2006). Pattern classification. John Wiley & Sons.
4. Friedman, J. H. (2017). The elements of statistical learning: Data mining, inference, and prediction. springer open.
5. VanderPlas, J. (2016). Python data science handbook: Essential tools for working with data. " O'Reilly Media, Inc.".
6. Zheng, A., & Casari, A. (2018). Feature engineering for machine learning: principles and techniques for data scientists. " O'Reilly Media, Inc.".