ACADEMIC HANDBOOK 2022

PROGRAM MAGISTER
GEOLOGICAL ENGINEERING STUDY PROGRAM

DEPARTMENT OF GEOLOGICAL ENGINEERING
FACULTY OF ENGINEERING
GADJAH MADA UNIVERSITY

PREFACE

This 2022 Academic Guidebook (BPA) is intended for the entire academic community of the Masters Study Program, Department of Geological Engineering, Faculty of Engineering, Gadjah Mada University. For the realization of this book, we express our gratitude to the presence of God Almighty. Acknowledgements are conveyed to all Department Managers and lecturers of Geological Engineering FT UGM who have provided suggestions for the preparation of this BPA.

BPA 2022 is an academic guide for students to take the 2022 Curriculum at the DTGL FT UGM Masters Study Program. This curriculum is structured to realize the application of geological engineering to students in a comprehensive manner, are skilled in working in the field of applied geology, care about the interests of society, compete at the global level, are independent and ready to continue their studies at a higher level and are able to communicate and collaborate across disciplines with other disciplines. .

BPA 2022 needs to be carefully scrutinized by all students so that they can prepare effective learning strategies as early as possible up to the thesis stage. Learning strategies that are prepared early on will be the key to student success in studying at the Department of Geological Engineering, FT UGM. If there are matters that need further discussion, you are welcome to consult with the Academic Guardian Lecturer or the Manager of the Masters Study Program. Good luck achieving success in studies. Have a good study.

Yogyakarta, 12 August 2022
Head of Curriculum and Quality Assurance Unit

Ir. Salahuddin, S.T., M.Sc., Ph.D., IPM.

Acknowledged

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I. PRELIMINARY

A. Background

Geological Engineering Masters Study Program, FT UGM, was established in 1997 under the management of the Department of Geological Engineering, Faculty of Engineering, Gadjah Mada University. The permit to carry out this Study Program is based on the Decree of the Director General of Higher Education No. 473/DIKTI/Kep/1996 dated September 23, 1996. The Geological Engineering Masters Study Program, FT UGM, was designed as an advanced study program (postgraduate) in the field of Geological Engineering with the main target being those who have graduated from the bachelor's degree in Geological Engineering, Geophysics, Mining, Petroleum, Civil Engineering (Geotechnical), Geography (Physical) and those who have worked in industries/agencies related to geological or environmental resources/disasters.

In 2003, based on the Decree of the Chancellor of UGM No. 181/P/SK/HKTL/2003, Geological Engineering Masters Study Program, Faculty of Engineering, UGM opens interest in study as development of a regular program, namely Mining Geology Masters Study Interest (MGP). Furthermore, considering the increasing market demand for petroleum geologists with master degrees, a new study interest was formed in 2010, namely the Interest in Masters Studies*Petroleum Geoscience* (MPG), which was confirmed by Decree of the Dean of the Faculty of Engineering UGM No. 385/H1.17/OT/2010.

Thus, the Masters Study Program in Geological Engineering FT UGM consists of the Regular Program, Mining Geology Masters Study Interest (MGP) and Masters Study Interest*Petroleum Geoscience* (MPGs). To focus on the competency of its graduates, the Regular Program offers 3 study concentrations, namely: (i) Energy Resources Geology (SDE) study concentration, (ii) Mineral Resources Geology (SDM) study concentration, and (iii) Environmental Geology (GL) study concentration.

In 2017 the Geological Engineering Masters Study Program, FT UGM, made changes to the curriculum to address scientific developments and competency demands required by the community within the framework of providing human resources in accordance with the national development program. The Geological Engineering Masters Study Program removed the MGP and MPG Study Interests and changed the specializations to 8 (eight) new specializations (see explanation of the 2017 Curriculum).

The Geological Engineering Masters Study Program DTGL FT UGM has received recognition for the quality and quality of education nationally by obtaining an A accreditation score from the Indonesian National Accreditation Board for Higher Education (BAN-PT) for the 2021-2025 period based on Decree No. 5503/SK/BAN-PT/Ak-PPJ/M/IX/2020. International recognition has also been obtained through the appointment of Masters and Doctoral Study Programs in Geological Engineering FT UGM as *host institution* Geological Engineering higher education in Southeast Asia by the AUN/SEED-Net Program (*ASEAN University Network/Southeast Asia Engineering Education Development Network*) since 2003 and in 2021 the Geological Engineering Masters Study Program has won the trust to run the CUBE Program Grant (***C****ollaborative Education in Urban Geology*) in South East Asia.

All core activities of the Geological Engineering Masters Study Program, FT UGM, are carried out in the Geological Engineering Department building, which is equipped with adequate and modern facilities and infrastructure. In addition to face-to-face activities in class, research in the laboratory or literature studies in the library, academic activities are also carried out in the form of field research *field trip*, excursions and field data collection for thesis material.

Education in the Geological Engineering Masters Study Program, FT UGM, is supported by lecturers who are competent in their respective fields, both from the Geological Engineering Department, FT UGM and from other departments at UGM. In addition, to bridge technological developments and market needs, this study program also empowers lecturers from industry and related research institutions. The diversity of lecturer backgrounds is a valuable asset in giving lectures at the Geological Engineering Masters Study Program, FT UGM.

The number of Geological Engineering Masters Study Program students, FT UGM, is increasing from year to year in line with the interest of prospective students and promising job prospects in geology, with an average of around 30-40 new students per year. Until the end of the 2020/2021 academic year, the Geological Engineering Masters Study Program, FT UGM, had succeeded in graduating 502 students, 126 of whom were foreign students.

B. Vision and Mission of Study Program

As part of Gadjah Mada University which is a pioneer of superior and innovative world-class national universities, as well as part of the Faculty of Engineering which plays an active role in developing the application of science and engineering, the Geological Engineering Masters Study Program develops the vision and mission of its institution, which is derived from the Vision and the Mission of Gadjah Mada University and the Vision and Mission of the Faculty of Engineering, as follows:

1. Vision

   Gadjah Mada University Vision:
   Gadjah Mada University as a pioneer of world-class national universities that are superior and innovative, serving the interests of the nation and humanity imbued with the nation's cultural values based on Pancasila.

   Faculty of Engineering Vision:
   The Faculty of Engineering UGM is a technical higher education institution with a national and global network for strengthening new civilizations, strengthening national independence and sovereignty in the field of science and technology, and slowing down the increase in world entropy, in order to serve the interests of the nation and humanity imbued with national cultural values based on Pancasila .

   Vision of the Department of Geological Engineering:
   To become a center of excellence in the field of geological engineering, with international quality in the fields of education, research and community service, which is imbued with Pancasila.
   Vision of Geological Engineering Masters Study Program:
   To become a center of excellence in applied geology, with international quality in the fields of education, research and community service imbued with Pancasila.

2. Mission

   Gadjah Mada University Mission:
   Carrying out education, research, and community service as well as the preservation and development of knowledge that is superior and beneficial to society

Mission of the Faculty of Engineering:

1) Organizing education to produce graduates who are competent, have integrity and are able to become leaders of the nation.
2) Increasing research activities and community service in order to preserve, develop and produce science and technology that has an impact on the interests of the nation, humanity, civilization and slowing down world entropy.
3) Developing multidisciplinary collaboration networks with various domestic and foreign institutions in the context of developing higher education tridharma.
4) Improving organizational governance in a sustainable manner that is oriented to human interests in the context of Society 5.0.

Geological Engineering Department Mission:

Organizing international quality education and research as well as community service imbued with Pancasila, in the field of applied geology with an emphasis on harmony between geological processes and human life.

Mission of the Master of Geological Engineering Study Program, Faculty of Engineering, UGM:

Organizing postgraduate education at the Masters level and international quality research and community service imbued with Pancasila, in the field of applied geology with an emphasis on harmony between geological processes and human life.

II. 2022 CURRICULUM STRUCTURE

A. Graduate Profile Formulation

In the 2022 Curriculum, the formulation of the Graduate Profile that the Geological Engineering Masters Study Program wants to produce is based on the results of *tracer study*, input from*Advisory Board*, a comparison with the profile of graduates in the same study program at leading universities abroad and the need for professionals in the field of Geological Engineering in Indonesia. Based on this, the graduate profiles of the Geological Engineering Masters Study Program are determined as follows:

1. Practitioner (*professional geological engineer*) in the field of extraction geology (oil and gas, coal, geothermal, and minerals), geological disaster mitigation, engineering geology, hydrogeology, and conservation of natural resources and the environment,
2. Entrepreneurs and independent consultants in the fields of extraction geology (oil and gas, coal, geothermal and minerals), geological disaster mitigation, engineering geology, hydrogeology, and conservation of natural resources and the environment,
3. Government bureaucrats in the field of geological resource management and geological disaster mitigation,
4. Applied geological researcher in extraction geology (oil and gas, coal, geothermal, and mineral), geological disaster mitigation, engineering geology, hydrogeology, and conservation of natural resources and environment in research institutes,
5. Applied geology academics in extraction geology (oil and gas, coal, geothermal, and minerals), geological disaster mitigation, engineering geology, hydrogeology, and conservation of natural resources and the environment in educational institutions.

Based on Graduate Profile then*Program Educational Objectives* (PEO) of the Geological Engineering Masters Program are as follows:

1. Develop applied geology science and technology capabilities based on high scientific demands and comprehensive theoretical knowledge while upholding professionalism ethics.
2. Design, produce, manage and utilize geological resources and weigh impacts effectively and efficiently using the latest technology for various multi, inter and transdisciplinary interests in supporting the achievement of sustainable development goals.
3. Designing mitigation systems and managing the impact of geological disasters and the impact of utilization of geological resources on the environment effectively and efficiently using the latest technology for various multi, inter and transdisciplinary interests in supporting the achievement of sustainable development goals.

B. Formulation of Graduate Competency Standards (SKL) and Learning Outcomes (CPL)

To be able to achieve the graduate profile above, students must take learning that can be measured through achievement assessments. There are 5 (five) Learning Outcomes (*Learning Outcomes*) that must be mastered by students of the Geological Engineering Masters Study Program, namely:

1. Able to identify and analyze problems in engineering geology by applying knowledge of mathematics, science, and engineering.
2. Able to design and evaluate solutions to problems in the field of research-based engineering geology using modern engineering techniques and tools.

3. Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.
4. Able to weigh the impact of problem solutions in the field of engineering geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism.
5. Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Graduates of the DTGL FT UGM Geological Engineering Masters Study Program are expected to be able to have 5 (five) learning outcomes that are in accordance with the Minister of Education and Culture Regulation Number 3 of 2020 concerning National Higher Education Standards:

1. **Attitude Summary** (Permendikbud 3/2020)
    a. fear God Almighty and be able to show a religious attitude;
    b. uphold human values in carrying out duties based on religion, morals, and ethics;
    c. contribute to improving the quality of life in society, nation, state, and progress of civilization based on Pancasila;
    d. act as citizens who are proud and love their homeland, have nationalism and a sense of responsibility to the state and nation;
    e. appreciate the diversity of cultures, views, religions and beliefs, as well as the opinions or original findings of others;
    f. cooperate and have social sensitivity and concern for society and the environment;
    g. obey the law and discipline in the life of society and the state;
    h. internalize academic values, norms, and ethics;
    i. demonstrate a responsible attitude towards work in the field of expertise independently; and
    j. internalize the spirit of independence, struggle, and entrepreneurship.

2. **Formulation of General Skills** (Permendikbud 3/2020)
    a. able to develop logical, critical, systematic, and creative thinking through scientific research, creation of designs or works of art in the field of science and technology that takes into account and applies the values of the humanities in accordance with their areas of expertise, compiles scientific conceptions and results of studies based on rules, procedures, and scientific ethics in the form of a thesis or other equivalent form, and uploaded on the university's website, as well as papers that have been published in accredited scientific journals or accepted in international journals;
    b. able to carry out academic validation or studies according to their field of expertise in solving problems in relevant communities or industries through the development of their knowledge and expertise;
    c. relevant communities or industries through the development of their knowledge and expertise;
    d. able to identify scientific fields that are the object of his research and position them into a research map developed through an interdisciplinary or multidisciplinary approach;
    e. able to make decisions in the context of solving problems in the development of science and technology that takes into account and applies the values of the humanities based on analytical or experimental studies of information and data;

f. able to manage, develop and maintain networks with colleagues, peers within institutions and the wider research community;
g. able to increase learning capacity independently; and
h. able to document, store, secure, and rediscover research data in order to ensure validity and prevent plagiarism.

3. **Summary of Knowledge** (stipulated in DTGL FT UGM Academic Workshop March 23 2019)
   a. Able to identify and analyze problems in engineering geology by applying knowledge of mathematics, science, and engineering.
   b. Able to design and evaluate solutions to problems in the field of research-based engineering geology using modern engineering techniques and tools.

4. **Formulation of Special Skills**(stipulated in DTGL FT UGM Academic Workshop March 23 2019)
   a. Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.
   b. Able to weigh the impact of problem solutions in the field of engineering geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism.
   c. Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Curriculum development is aimed at achieving the vision and mission of the study program, which is marked by the synergy between curriculum development and the need for graduate competencies. The main goal in the educational process at the Geological Engineering Masters Study Program FT UGM is to produce graduates who have competence in developing knowledge and understanding, intellectual, practical and managerial related to the field of Geological Engineering in a quality manner (continuous quality improvement) and are able to compete at the national level as well as internationally.

In scientific developments that are increasingly complex, students are encouraged to have abilities hard *skills* and soft *skills* and at the same time are expected to be able to build readiness for post-graduation career development. There are five forms of career development that are expected of graduates of the Geological Engineering Masters Study Program, FT UGM, as reflected in the graduate profiles in Table 1.

Referring to UGM Rector Regulation No. 11 of 2016 article 47 paragraph 3, Curriculum 2022 Study Program Masters in Geological Engineering FT UGM consists of a number of courses aimed at developing general competencies, main competencies, and supporting competencies in achieving graduate qualifications according to the Indonesian national qualification framework.

1. General competence

UGM Rector Regulation No. 11 of 2016 article 48 paragraph 1 directs the general competency development of the Geological Engineering Masters Study Program, FT UGM with reference to UGM Chancellor's Regulation NO. 16 of 2016 article 3 paragraph 2 concerning the basic curriculum framework regarding the achievement of UGM graduate profiles, namely:

a. Graduates are able to master the scientific scope of Geological Engineering properly and are skilled in applying this knowledge;

b. Graduates are able to develop a professional attitude in doing work in the field of Geological Engineering; and
c. Graduates are able to develop personality traits that are tough, down-to-earth, caring, uphold ethics and integrity, cultivate a spirit of leadership and pioneering, and develop a spirit of socio-entrepreneurial.

2. Main competency

For the formulation of main competencies, UGM Rector Regulation No. 11 of 2016 article 48 paragraph 2 and article 49 paragraph 1 directs competency development through a number of courses and other scientific activities which are substantial material in the field of science in the Study Program, referring to the thesis level of the Indonesian national qualification framework, namely:

a. Graduates are able to analyze the development of science and technology in the field of Geological Engineering;
b. Graduates are able to solve problems in the discipline of Geological Engineering through research and engineering based on scientific principles; and
c. Graduates are able to develop performance in professional careers as indicated by the sharpness of comprehensive problem analysis.

3. Supporting competence

Supporting competencies are developed through a number of courses and other scientific activities to strengthen the development of the main competencies of Study Program graduates (GMU Rector Regulation No. 11 2016 article 48 paragraph 3), namely:

a. Graduates are able to understand the Earth as a dynamic system in space and time in the development of extraction, mitigation and conservation fields sustainable;
b. Graduates are able to process geological data using information technology as a basis for problem-solving analysis;
c. Graduates are able to compile scientific reports in a systematic and integrated manner, and are able to communicate them in various communication techniques; and
d. Graduates are able to work together and develop interdisciplinary networks.

The relationship between each CPL and the appropriate competence is clearly shown in Table 1 below:

Table 1. Relationship between CPL and KKNI/SN-DIKTI components

No.	**CPL/ *Learning Outcomes* (IT)**	**KKNI/SN-DIKTI components**
A	Able to identify and analyze problems in engineering geology by applying knowledge of mathematics, science, and engineering	General Competency/General Skill/Knowledge
B	Able to design and evaluate solutions to problems in the field of research-based engineering geology using modern engineering techniques and tools	Main Competencies/Special Skills
C	Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication	Supporting Competencies/General Skills

D	Able to weigh the impact of problem solutions in the field of engineering geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism.	Main Competencies/Special Skills/Attitudes/Values
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.	Supporting Competencies/Special Skills

With regard to the vision and mission of UGM, it is clear that the five CPLs above have fulfilled the ideals contained in the vision and mission of UGM, namely to be superior, innovative and beneficial to society based on Pancasila. In addition, this CPL also meets the needs of stakeholders in the field of Geological Engineering which requires graduates with *hard skills* and soft skills reliable according to the results of tracer *study*, which can be seen in the relationship between graduate competency standards (PEO) and the intended CPL (Table 2).

Table 2. Relationship between Graduate Competency Standards and CPL

	Graduate Learning Outcomes (CPL)				
Graduate competence standard	A	B	C	D	E
PEO 1	√	√	√	√	
PEO 2		√	√	√	√
PEO 3		√	√	√	√

C. Designation of Study Materials

To realize the achievement of Graduate Competency Standards (PEO) and CPL, it is necessary to determine the appropriate courses. The determination of this course must be based on the subject matter and current developments in applied geology. The 2022 curriculum proposes study material based on the mainstream of applying Geological Engineering in society, which is also formulated by the Association of Indonesian Geologists (IAGI) as a professional organization of graduates of the Geological Engineering Masters Study Program, namely:

1. *Geo-resources*: includes knowledge and skills in exploring natural resources and managing the exploitation of these natural resources.
2. *Geo-engineering*: includes knowledge and skills in assessing rock and soil conditions as well as the ability to make improvements and mitigation efforts for rock and soil conditions that do not support the development of an infrastructure.
3. *Geo-environment*: includes knowledge and skills in assessing environmental conditions needed by humans and the ability to make efforts to improve and mitigate environmental conditions that do not support human life and needs.
4. *Geo-hazard*: includes knowledge and skills in conducting assessments of environmental conditions that are hazardous to humans and the ability to make efforts to improve and mitigate these hazardous environmental conditions.

The four divisions are appropriate in that in engineering geology there are several subdisciplines that analyze various aspects of earth science and apply them to various engineering projects (Hutchinson, 2001).[1] It is realized that there is a slice of applied geological engineering science in the distribution of the study material above with other study programs, such as geotechnical engineering in civil engineering which intersects with *geo-engineering*, exploitation of geo-resources in mining engineering and petroleum engineering, geo-environment with environmental engineering. Currently, principally a geological engineer is responsible for planning, developing, and coordinating the site investigation and data acquisition program (including geophysical data) for all four study materials. Based on the study material above, courses in the Geological Engineering Masters study program must cover these four pillars, which are discussed in the following sub-chapters.

D. Determination of Courses

In accordance with the graduate competency standards (PEO) to be achieved, each course based on study material is designed to have Course Learning Outcomes (CPMK) as a form of its relation to Graduate Learning Outcomes (CPL), in addition to comparability with Bloom's Taxonomy level as well done, namely a: remember, b: understand, c: apply, d: analyze, e: evaluate, and f: create, in which case it is expected that master students have been able to reach a level after remembering and understanding. The courses set for both Lecture-Based and Research-Based Masters and their relationship with CPL (CPMK), PEO, and Bloom's Taxonomy in the 2022 Curriculum can be seen in Table 3.

Table 3. Subjects and their relationship with CPL, PEO, and Bloom's Taxonomy

No	Code	Course Name	SKS	Semester	Learning Outcomes of Course Graduates (CPMK)					SKL/(PEO)	taxonomy Bloom
					A	B	C	D	E		
Compulsory Courses											
1	TKFT22611	Philosophy of Science	1	I				√	√	PEO 2, PEO 3	c
2	TKG226102	Geology for Sustainable Development	3	I		√	√	√		PEO 2, PEO 3	e
3	TKG226103	Applied Geology I	4	I		√	√	√		PEO 2, PEO 3	e
4	TKG226151	Engineering and Geological Models	2	I		√	√	√		PEO 2, PEO 3	e
5	TKG226201	Geological Data Analysis	3	II	√	√				PEO 1	d
6	TKG226202	Research Methods, Ethics and Scientific Writing Techniques	3	II		√	√			PEO 1	c
7	TKG226203	Pre-thesis 1	4	II	√	√	√			PEO 1	e
8	TKG226204	Pre-thesis 2	6	II		√	√	√		PEO 2, PEO 3	e
9	TKG226205	Proposal Seminar	2	II	√	√	√			PEO 2, PEO 3	f
10	TKG226206	Applied Geology II	4	II		√	√	√		PEO2, PEO3	e
11	TKG227101	Internship / Practical Work / Field Work	4	III	√	√	√	√	√	PEO 2, PEO 3	e
12	TKG227201	Results Seminar 1	2	IV		√	√	√		PEO 1, PEO 2, PEO 3	f
13	TKG227202	Results Seminar 2	2	IV		√	√	√		PEO 1, PEO 2, PEO 3	f
14	TKG227203	Thesis	8	IV	√	√	√	√	√	PEO 1, PEO 2, PEO 3	f
15	TKG227204	Publication	8	IV			√	√	√	PEO 2, PEO 3	f
Elective Courses											
16	TKG226104	Applied Geophysics	2	I		√	√	√		PEO 2, PEO 3	d
17	TKG226105	Applied Geophysics Practicum	1	I			√	√		PEO 2, PEO 3	d
18	TKG226106	Numerical Method	2	I	√	√				PEO 1	d
19	TKG226107	Advanced Engineering Geology	2	I	√	√	√			PEO 1	f

[1] *Bulletin of Engineering Geology and the Environment* 2001 / 11 Vol. 60; Iss. 4.

No	Code	Course Name	SKS	Semester	Learning Outcomes of Course Graduates (CPMK)					SKL/(PEO)	taxonomy Bloom
					A	B	C	D	E		
20	TKG226108	Advanced Engineering Geology Seminar	1	I			√	√	√	PEO 2, PEO 3	f
21	TKG226109	Advanced Rock and Soil Mechanics	2	I	√	√				PEO 1	e
22	TKG226110	Advanced Rock and Soil Mechanics Practicum	1	I			√	√		PEO 2, PEO 3	d
23	TKG226210	Geotechnical Underground Construction	2	I	√	√				PEO 1	d
24	TKG226212	Construction Methods and Tunnel Design	2	I	√	√				PEO 1	e
25	TKG226113	Applied Hydrogeology	2	I	√	√		√		PEO 1	e
26	TKG226114	Groundwater Flow Modeling	2	I	√	√		√		PEO 1	e
27	TKG226115	Groundwater Geochemistry	2	I	√	√				PEO 1	e
28	TKG226116	Raw Water Treatment Engineering	2	I		√	√			PEO 1, PEO 2	d
29	TKG226117	Groundwater Exploration Engineering	2	I	√	√				PEO 1	d
30	TKG226118	Indonesian hydrogeology	2	I			√	√		PEO 2	e
31	TKG226119	Urban Geology	2	I		√	√	√		PEO 2	e
32	TKG226120	Geoheritage and Geopark	2	I				√	√	PEO 2, PEO 3	e
33	TKG226121	Medical Geology	2	I	√	√			√	PEO 1, PEO 2, PEO 3	e
34	TKG226122	Oil and Gas Geology and Hydrocarbon Geochemistry	2	I	√	√				PEO 1	e
35	TKG226123	Coal Geology	2	I	√	√				PEO 1	e
36	TKG226124	Unconventional Oil and Gas Geology	2	I	√	√				PEO 1	e
37	TKG226226	Reservoir Characterization	2	I	√	√				PEO 1	d
38	TKG226126	Basin Analysis	2	I	√	√			√	PEO 1, PEO 2	e
39	TKG226127	Advanced Geothermal Geology	2	I		√	√	√		PEO 2	e
40	TKG226128	Advanced Geothermal Geochemistry	2	I		√	√	√		PEO 2	e
41	TKG226129	Advanced Geothermal Geophysics	2	I		√	√	√		PEO 2	e
42	TKG226130	Geothermal Associated Products	2	I			√	√	√	PEO 2	e
43	TKG226131	Geothermal for Sustainable Development	2	I			√	√	√	PEO 2	e
44	TKG226132	Applied Petrology	2	I	√	√	√			PEO 1	d
45	TKG226133	Advanced Ore Deposit Geology	2	I	√	√	√			PEO 1	e
46	TKG226134	Advanced Industrial Mineral Geology	2	I	√	√		√		PEO 1	e
47	TKG226135	Special Topics for Mineral Deposits	2	I			√	√	√	PEO 2	e
48	TKG226136	Mineral Exploration Engineering	2	I		√	√		√	PEO 2	d
49	TKG226137	Metallogeny	2	I	√	√	√			PEO 1	d
50	TKG226138	Remote Sensing Geology and Information Systems	2	I	√	√	√			PEO 1	e
51	TKG226139	Geological Disaster Mitigation	2	I	√	√				PEO 1	e
52	TKG226140	Geological Disaster Risk Management	2	I			√	√		PEO 3	e
53	TKG226141	Geological Disaster Engineering Engineering	2	I		√		√		PEO 3	e
54	TKG226142	Earthquake Dynamics	2	I	√		√	√		PEO 1, PEO 3	d
55	TKG226143	Earthquake Hazard Mitigation	2	I	√		√	√		PEO 1, PEO 3	e
56	TKG226144	Volcano Monitoring Technology	2	I	√	√				PEO 1	e
57	TKG226145	Climate Change Reconstruction	2	I	√	√				PEO 1	e
58	TKG226146	Quaternary Geology and Climate Change	2	I		√		√		PEO 1	d
59	TKG226147	Marine Geology and Paleoclimatology	2	I	√	√		√		PEO 1	d
60	TKG226148	Quaternary stratigraphy	2	I			√		√	PEO 2	d
61	TKG226149	Vertebrate and Invertebrate Paleontology	2	I	√	√				PEO 1	d

No	Code	Course Name	SKS	Semester	Learning Outcomes of Course Graduates (CPMK)					SKL/(PEO)	taxonomy Bloom
					A	B	C	D	E		
62	TKG226150	Petrology and Diagenesis of Carbonate Rocks	2	I			√	√		PEO 1, PEO 2	d
63	TKG226207	Applied Geochemistry	2	II		√	√	√		PEO 2, PEO 3	d
64	TKG226208	Applied Geochemistry Practicum	1	II			√	√		PEO 2, PEO 3	d
65	TKG226209	Slope Stability	2	II	√	√				PEO 1	e
66	TKG226112	Construction Management	2	II	√	√				PEO 1	d
67	TKG226111	Dam Geotechnical	2	II	√	√				PEO 1	e
68	TKG226211	Finite Element Method	2	II	√	√				PEO 1	d
69	TKG226213	Safety, Health and Work Environment	2	II				√	√	PEO 2, PEO 3	d
70	TKG226214	Mining Geotechnical	2	II	√	√				PEO 1	e
71	TKG226215	Groundwater Pollution and Remediation Techniques	2	II	√	√				PEO 1	e
72	TKG226216	Groundwater Protection and Monitoring	2	II		√	√	√		PEO 2	e
73	TKG226217	Hydrogeology of Karst and Crystalline Rocks	2	II	√	√				PEO 1	d
74	TKG226218	Groundwater Exploitation	2	II	√	√		√		PEO 1, PEO 2	e
75	TKG226219	Urban Hydrogeology	2	II	√	√		√		PEO 1, PEO 2	d
76	TKG226220	Mass Transportation Modeling on Groundwater	2	II	√	√				PEO 1	e
77	TKG226221	Spatial Based Decision Making Analysis	2	II		√	√		√	PEO 1, PEO 2, PEO 3	e
78	TKG226222	Geology and Hazardous Waste Disposal	2	II	√	√		√		PEO 1, PEO 2	e
79	TKG226223	Erosion and Sedimentation	2	II	√	√				PEO 1	d
80	TKG226224	Soil Pollution and Remediation	2	II	√	√				PEO 1	d
81	TKG226225	Applied Stratigraphy	2	II	√	√				PEO 1	e
82	TKG226215	Formation Evaluation	2	II	√	√				PEO 1	e
83	TKG226227	Development of Oil and Gas Fields and EOR	2	II	√	√		√		PEO 1, PEO 2	e
84	TKG226228	Coal Technology	2	II		√	√	√		PEO 2	e
85	TKG226229	Environmental Geology for Oil and Gas Fields	2	II		√	√	√	√	PEO 2	e
86	TKG226230	Subsurface Geothermal Geothermal Systems	2	II	√	√	√			PEO 1	e
87	TKG226231	Geothermal Reservoir Engineering	2	II			√	√	√	PEO 2	e
88	TKG226232	Geothermal Environmental Management	2	II		√	√	√	√	PEO 2, PEO 3	e
89	TKG226233	Geothermal Direct Utilization	2	II		√	√	√	√	PEO 2	e
90	TKG226234	Geothermal Regulation and Business	2	II				√	√	PEO 2	d
91	TKG226235	Unconventional Mineral Resources	2	II		√	√	√		PEO 2	d
92	TKG226236	Advanced Mineral Characterization	2	II	√	√				PEO 1	e
93	TKG226237	Ore Deposit Geochemistry	2	II	√	√				PEO 1	e
94	TKG226238	Geological Materials for Industry	2	II	√	√		√		PEO 1	e
95	TKG226239	Regulation of Exploration and Extraction of Mineral Resources	2	II				√	√	PEO 2	d
96	TKG226240	Mineral Resource Modeling	2	II	√	√		√		PEO 1	e
97	TKG226241	Ore Microscopy	2	II	√	√				PEO 1	d
98	TKG226242	Geofluida	2	II	√	√				PEO 1	e
99	TKG226243	Geometallurgy	2	II	√			√	√	PEO 1, PEO 2	e
100	TKG226244	Economic Evaluation and Mineral Resources	2	II				√	√	PEO 2	e
101	TKG226245	Mining Environmental Management	2	II		√	√	√	√	PEO 2, PEO 3	e
102	TKG226246	Digital Image Analysis	2	II		√	√		√	PEO 1, PEO 2	e
103	TKG226247	Social Humanities related to Geological Disasters	2	II				√	√	PEO 3	d

No	Code	Course Name	SKS	Semester	Learning Outcomes of Course Graduates (CPMK)					SKL/(PEO)	taxonomy Bloom
					A	B	C	D	E		
104	TKG226248	Disaster Thematic Seminar	2	II			√			PEO 3	e
105	TKG226249	Geological Disaster and Environmental Impact	2	II	√			√		PEO 3	e
106	TKG226250	Volcano Geology	2	II	√	√				PEO 1	d
107	TKG226251	Volcano Numerical Modeling	2	II	√	√				PEO 1	e
108	TKG226252	Landslide Dynamics	2	II	√	√	√			PEO 1	e
109	TKG226253	Landslide Mitigation and Risk Assessment	2	II	√	√	√			PEO 1, PEO 3	e
110	TKG226254	Numerical Modeling of Landslide	2	II	√	√	√			PEO 1	e
111	TKG226255	Biostratigraphy, Paleoecology, and Paleogeography	2	II	√	√				PEO 1	d
112	TKG226256	Analytical Stratigraphy and Geochronology	2	II	√	√	√			PEO 1	e
113	TKG226257	Geoarchaeology and Paleoanthropology	2	II			√		√	PEO 2	d
114	TKG226258	Applied Micropaleontology	2	II	√	√		√		PEO 2	d
115	TKG226259	Quaternary Geological Excursion	2	II		√	√	√		PEO 2, PEO 3	e
116	TKG226260	Subsurface Geology	2	II		√	√	√		PEO 2, PEO 3	e

E. Course Organization

The course arrangement and curriculum structure are carried out based on the Vision and Mission of the Department of Geological Engineering, Graduate Profiles, and Graduate Competency Standards and Learning Achievements for Graduates of the Geological Engineering Masters Study Program which are efforts to improve the 2017 Curriculum and adapt it to the basis of study material.

In the 2022 curriculum, there are two types of learning offered, namely lecture-based (*by course*) and research-based (*by research*).

1. Lecture-Based Courses (*by course*)

Lecture-based learning has an open nature towards taking elective courses, in other words, lecture-based learning does not have a rigid structure, and students are free to take courses relevant to their research.

Broadly speaking, the 2022 Curriculum for the Geological Engineering Masters Study Program, FT UGM can be described as follows:

1. Minimum number of course credits is 40 credits.
2. Has a total of 9 (nine) study program compulsory subjects lectures including Philosophy of Science and Thesis.
3. Have elective courses with 8 (eight) interests/concentrations, namely:
   a. Engineering Geology and Tunnels – Dungeons
   b. Groundwater Technique
   c. Urban and Environmental Geology
   d. Geology of Oil and Gas and Coal
   e. Geothermal Geotechnology
   f. Geology of Mineral Resources
   g. Geodynamics and Geological Disasters
   h. Climate Change and Marine Geology

The composition of the courses in the 2022 Curriculum of the Geological Engineering Masters Study Program consists of compulsory courses and concentration elective courses. Compulsory courses are characteristics of the main competencies that have been formulated. Where compulsory courses are arranged so that (1) become the basis for achieving graduate competence, (2) Become a minimum standard reference, the quality of the implementation of study programs, (3) Are flexible and adaptive to very rapid changes in the future. While the elective concentration courses are courses developed by the Geological Engineering Masters Study Program, FT UGM, which contain substantive material that characterizes the chosen concentration.

The structure of the lecture-based master program curriculum can be seen in Table 4. In Table 4 it can be seen that the compulsory courses for lecture-based learning are:

1. Scientific Philosophy (1 Credit)
2. Geology for Sustainable Development (3 Credits)
3. Geological Data Analysis (3 Credits)
4. Research Methods and Ethics and Scientific Writing Techniques (2 Credits)
5. Proposal Seminar (1 Credit) can be taken in Odd and Even Semesters
6. Applied Geophysics (4 Credits)
7. Applied Geochemistry (4 Credits)
8. Engineering and Geological Modeling (2 Credits)
9. Thesis (8 credits) can be taken in Odd and Even Semesters

In the lecture-based master program, Implementation of Independent Campus Learning (MBKM) is outlined in apprenticeship courses (*internship*) with 4 credits conducted at institutions or industries related to research, which are recognized as elective courses. The list of specialization elective courses can be seen in Table 6.

Table 4. General Structure of the Geological Engineering Masters Study Program Curriculum FT UGM with a lecture-based learning scheme (by Course)

Course Name	Nature	SKS	Which.
Philosophy of Science	Compulsory Study Program	1	I
Geology for Sustainable Development	Compulsory Study Program	3	
Applied Geology I	Compulsory Study Program	4	
Engineering and Geological Models	Compulsory Study Program	2	
* a maximum of five (5) MK choices according to interest / cross-interest	Options	4 - 10	
Amount		**14-20**	
Geological Data Analysis	Compulsory Study Program	3	II
Research Methods and Ethics and Scientific Writing Techniques	Compulsory Study Program	2	
Seminar Proposal	Compulsory Study Program	1	
Applied Geology II	Compulsory Study Program	4	
* a maximum of five (5) MK choices according to interest / cross-interest	Options	4 - 10	
Amount		**14-20**	
* Internship / Practical Work /*Internship*	Options	4	**III**
Thesis	Compulsory Study Program	8	**IV**

Total SKS		**40-50**	

** List of specialization elective courses can be seen in Table 6.*

Determination of the number of credits for compulsory and elective courses refers to the Regulation of the Minister of Education and Culture No. 3/2020 Article 17 concerning National Higher Education Standards and UGM Rector Regulation No. 11 of 2016 where according to article 51 paragraph 2, namely 40-50 credits total credit.

Lecture-based learning students must take 28 credits of compulsory courses, and the remainder take elective courses in certain interests or in several relevant interests in accordance with the planned study and research materials, to meet the number of credits for graduation (see Table 6).

2. Research Based Courses (*by research*)

Research-based learning has a closed nature towards taking cross-interest courses, where students have indeed focused on the study materials and research interests they have chosen. In other words, this research-based learning has a rigid subject structure of expertise, because the main burden of learning is on research.

Prospective students for research-based learning are old graduates (*experienced graduate*) Undergraduate Study Program in a related scientific field and meet the requirements, including having a minimum of 2 years work experience and currently working in an institution/industry.

At present there are 8 research focuses provided for research-based learning in accordance with the interests offered in lecture-based learning, but do not cover interdisciplinary research focuses which are a combination of more than one interest/concentration.

The number of credits taken by research-based learning students refers to Rector Regulation No. 18 of 2019, namely 41 credits in the form of 10 credits for theory courses and 31 credits for research, thesis writing, publication writing and other activities supporting research. Compulsory courses for research-based learning are 6 credits taken in Semester I and consist of:

1. Scientific Philosophy (1 Credit)
2. Geology for Sustainable Development (3 Credits)
3. Research Methods and Ethics and Scientific Writing Techniques (2 Credits)

as well as elective courses of 4 credits chosen according to the research focus in interest/cross-interest (see Table 5 and Table 6).

Table 5. General Structure of the Geological Engineering Masters Study Program Curriculum FT UGM with a research-based learning scheme (by Research)

Subject	Nature	SKS	Semester
Scientific Philosophy	Compulsory Study Program	1	I
Geology & Sustainable Development	Compulsory Study Program	3	
Research Methods and Ethics and Scientific Writing Techniques	Compulsory Study Program	2	
* Minimum of two (2) MK of interest choices	Choice of Interest	4	

Amount		**10**	
Prethesis 1 (Excursion/Field Activities)	Compulsory Study Program	4	**II**
Prethesis 2 (Practical Work/Research)	Compulsory Study Program	6	
Seminar Proposal	Compulsory Study Program	1	
Amount		**11**	
Results Seminar 1	Compulsory Study Program	2	III/IV
Result Seminar 2 (Colloquium)	Compulsory Study Program	2	III/IV
Thesis	Compulsory Study Program	8	III/IV
Publication (1 Reputable International Journal or 2 Indexed International Proceedings)	Compulsory Study Program	8	III/IV
Amount		**20**	III (& IV)
Total SKS		**41**	

** List of specialization courses can be seen in Table 6.*

In Semester II, students are required to take Pre-thesis 1 (4 credits), Pre-thesis 2 (6 credits) and Proposal Seminar (1 credit) courses. In principle, this Pre-thesis course is a thesis preparation activity in the form of academic activities in the form of practical/field/research activities.

Pre-thesis 1 courses are field excursions/practice activities aimed at supporting students' competency development according to their interests. Pre-thesis 2 courses are practical work or research activities. This activity can be carried out in laboratories, workshops, studios or in combination with field activities as part of research to collect basic data. This activity can be carried out on campus or in other places, for example companies, research institutions, research centers, work institutions, etc. This Pre-thesis 2 course can be equated with the implementation of Independent Learning Campus Merdeka (MBKM) for research-based learning students.

In semester II, students are expected to have a research proposal to be tested. Furthermore, in Semesters III and IV, in principle, is the period of completion of this research-based master program. Students must write a thesis and carry out the 1st Results Seminar where students report their research results when they reach around 75% of the target as well as the 2nd Results Seminar (Colloquium) where students present their final research results before being submitted to the thesis exam. In addition, students must also write publications, namely at least 1 Reputable International Journal or 2 Indexed International Proceedings according to the requirements in Rector Regulation No. 18/2019.

The MbR assessment system for Proposal Seminars, Results Seminars and Thesis assessments is based on the following parameters:

1. processing (max. value 40),
2. grammar and language (max. grade 20),
3. mastery of the material (max. grade 30),
4. presentation and discussion skills (max. grade 10),

with a total value of 100 which is then converted to an alphabetic value according to the rules mentioned above.

Likewise for the Pre-thesis, the basis for the assessment is the same as above based on reports on the results of predetermined activities (field reports, assignments, academic papers, etc.) and student activity in carrying out activities.

Especially for the publication of assessments based on:

1. Substance (max. value 80)
2. problem/*state of the arts*
3. literature review/theoretical study/theoretical policy
4. research methods and or surveys
5. analysis and clarity of discussion
6. as well as conclusions and suggestions.
7. Write parameters (max. value 20)
8. grammar,
9. writing/writing systematics, and
10. literature.

Table 6. Distribution of 2022 Master Curriculum Subjects by Course Geological Engineering Masters Study Program

Whic h.	Types of Courses	Engineering Geology and Tunnels – Dungeons	SKS	Groundwater Technique	SKS	Urban and Environmental Geology	SKS	Geology of Oil and Gas and Coal	SKS	Geothermal Geotechnology	SKS	Geology of Mineral Resources	SKS	Geodynamics and Geological Disasters	SKS	Climate Change and Marine Geology	SKS
I	Study Program Compul sory Courses *Master by Course*	**Scientific Philosophy (1)**															
		Geology for Sustainable Development (3)															
		Applied Geology I (4)															
		Engineering and Geological Models (2)															
	Elective Courses *Master by Course*	**Applied Geophysics (2)**															
		Applied Geophysics Practicum (1)															
		Advanced Engineering Geology	2	Applied Hydrogeology	2	Urban Geology	2	Oil and Gas Geology and Hydrocarbon Geochemistry	2	Advanced Geothermal Geology	2	Applied Petrology	2	Remote Sensing Geology and Information Systems	2	Climate Change Reconstruction	2
		Advanced Engineering Geology Seminar	1	Groundwater Flow Modeling	2	Geoheritage and Geopark	2	Coal Geology	2	Advanced Geothermal Geochemistry	2	Advanced Ore Deposit Geology	2	Geological Disaster Mitigation	2	Quaternary Geology and Climate Change	2
		Advanced Rock and Soil Mechanics	2	Groundwater Geochemistry	2	Remote Sensing Geology and Information Systems	2	Unconventional Oil and Gas Geology	2	Advanced Geothermal Geophysics	2	Advanced Industrial Mineral Geology	2	Geological Disaster Risk Management	2	Marine Geology and Paleoclimatology	2
		Advanced Rock and Soil Mechanics Practicum	1	Raw Water Treatment Engineering	2	Medical Geology	2	Reservoir Characterization	2	Geothermal Associated Products	2	Remote Sensing Geology and Information Systems	2	Geological Disaster Engineering Engineering	2	Quaternary stratigraphy	2
		Construction Methods and Tunnel Design	2	Groundwater Exploration Engineering	2	Geological Disaster Mitigation	2	Basin Analysis	2	Geothermal for Sustainable Development	2	Special Topics for Mineral Deposits	2	Earthquake Dynamics	2	Vertebrate and Invertebrate Paleontology	2
		Geotechnical Underground Construction	2	Indonesian hydrogeology	2	Geoarchaeology and Paleoanthropolo gy	2					Mineral Exploration Engineering	2	Earthquake Hazard Mitigation	2	Petrology and Diagenesis of Carbonate Rocks	2
		Numerical Method	2									Metalogeny	2	Volcano Monitoring Technology	2	Geoheritage and Geopark	2
II	Study Program Compul	**Geological Data Analysis (3)**															
		Research Methods and Ethics and Scientific Writing Techniques (2)															
		Seminar Proposal (1)															

Whic h.	Types of Courses	Engineering Geology and Tunnels – Dungeons	SKS	Groundwater Technique	SKS	Urban and Environmental Geology	SKS	Geology of Oil and Gas and Coal	SKS	Geothermal Geotechnology	SKS	Geology of Mineral Resources	SKS	Geodynamics and Geological Disasters	SKS	Climate Change and Marine Geology	SKS
	sory Courses *Master by Course*	**Applied Geology II (4)**															
	Elective Courses *Master by Course*	**Applied Geochemistry (2)**															
		Applied Geochemistry Practicum (1)															
		Slope Stability	2	Groundwater Pollution and Remediation Techniques	2	Spatial Based Decision Making Analysis	2	Applied Stratigraphy	2	Subsurface Geothermal Geothermal Systems	2	Unconventional Mineral Resources	2	Digital Image Analysis	2	Biostratigraphy, Paleontology, and Paleogeography	2
		Construction Management	2	Groundwater Protection and Monitoring	2	Geology and Hazardous Waste Disposal	2	Formation Evaluation	2	Geothermal Reservoir Engineering	2	Advanced Mineral Characterization	2	Social Humanities related to Geological Disasters	2	Analytical Stratigraphy and Geochronology	2
		Finite Element Method	2	Hydrogeology of Karst and Crystalline Rocks	2	Erosion and Sedimentation	2	Development of Oil and Gas Fields and EOR	2	Geothermal Environmental Management	2	Ore Deposit Geochemistry	2	Disaster Thematic Seminar	2	Geoarchaeology and Paleoanthropolo gy	2
		Dam Geotechnical	2	Groundwater Exploitation	2	Groundwater Pollution and Remediation	2	Coal Technology	2	Geothermal Direct Utilization	2	Geological Materials for Industry	2	Geological Disaster and Environmental Impact	2	Applied Micropaleontolo gy	2
		Safety. Health and Work Environment	2	Urban Hydrogeology	2	Urban Hydrogeology	2	Environmental Geology for Oil and Gas Fields	2	Geothermal Regulation and Business	2	Regulation and Exploration and Extraction of Mineral Resources	2	Volcano Geology	2	Quaternary Geological Excursion	2
		Mining Geotechnical	2	Mass Transportation Modeling on Groundwater	2	Digital Image Analysis	2	Subsurface Geology				Mineral Resource Modeling	2	Volcano Numerical Modeling	2		
						Soil Pollution and Remediation	2					Ore Microscopy	2	Landslide Dynamics	2		
												Geofluida	2	Landslide Mitigation and Risk Assessment	2		
												Geometallurgy	2	Numerical Modeling of Landslide	2		

Whic h.	Types of Courses	Engineering Geology and Tunnels – Dungeons	SKS	Groundwater Technique	SKS	Urban and Environmental Geology	SKS	Geology of Oil and Gas and Coal	SKS	Geothermal Geotechnology	SKS	Geology of Mineral Resources	SKS	Geodynamics and Geological Disasters	SKS	Climate Change and Marine Geology	SKS
												Economic Evaluation and Mineral Resources	2				
												Mining Environmental Management	2				
III		**Thesis (8)**															
		Internship / Practical Work /*Internship* (4)															
IV		**Thesis (8)**															
		Internship / Practical Work /*Internship* (4)															

F. Flow / Prerequisites for Taking Courses

In taking Curriculum 2022 courses there are no prerequisite courses in the previous semester. Students can also take a certain number of cross-interest courses (not exceeding the number of credits of 50 credits), as long as they are still relevant to the interests they have chosen and support the research being conducted. Each course offered interest, both mandatory and elective, is expected to be attended by a minimum number of participants of 5 people, although if the minimum number is not reached the policy still applies for certain interests and courses that take into account future developments in scientific fields. For courses accompanied by practicum, the credit will be separated, making it easier for students to repeat the practicum without having to repeat the lecture.

The process of improving grades will be guided by the policy of the Study Program manager, in a situation where the course you want to repeat is not offered in that semester due to lack of interest, the Study Program manager can hold a remediation exam.

However, because in general the courses at the master's level are advanced (*advanced*), of course, a minimum provision of cognitive competencies is needed for those who are considered not eligible, especially for students with a non-linear undergraduate background (S1 non-Geological Engineering). For that, also designed deficiency **program** in 4 basic courses, namely:

1. Geomorphology
2. Petrology
3. Structural Geology
4. Field Geology Method

Students who follow deficiency will take regular lectures in special classes and must graduate by taking mid-term and end-term examinations. This course is not included in the Transcript so that information that the student has taken a deficiency will be provided in the Certificate of Accompaniment of the Diploma.

G. Assessment of learning outcomes

In assessing learning outcomes, the supporting lecturer will provide grading in the form of an alphabetic value on a scale of 0.00 – 4.00 which refers to UGM Rector Regulation No. 7 of 2022, concerning Gadjah Mada University Higher Education Standards. The procedure for assessing learning outcomes used in the 2022 Curriculum for the Geological Engineering Masters Study Program and its conversion from numerical values is in Table 7, as follows:

Table 7. Rules for Converting Numerical Values to Alphabetical Values

ALPHABETICAL VALUES	WEIGHT VALUE
A	4,00
A-	3,75
A/B	3,50
B+	3,25
B	3,00
B-	2,75
C	2,00
D	1,00
E	0,00

In addition, there is value **K** (less duties or other obligations, in 1 month if not fulfilled will be E (0,00)); and **T** (not attending UAS, in 1 month if not fulfilled will be E (0,00)).

Mechanisms and procedures for the assessment include the following stages: (1) Planning is carried out in accordance with the RPKPS/*Extended Syllabus* which has been socialized at the beginning of lectures, (2) giving quizzes, assignments or questions, (3) evaluating or observing the results of assignments or exam questions, (4) returning the results of observations, and (5) giving the final grade. Assignments or exam questions are adjusted to test the CPMK written on the RPPS. Evaluation of the achievement of CPL is carried out based on the achievement of the scores for each CPMK tested based on the average value and distribution of scores. If the average value of the CPMK tested is> 70, then the learning outcomes have been fully achieved and if the distribution of scores is a minimum of 70% with a score of ≥ 70 and a minimum of 90% with a score of ≥ 50, then the learning outcomes have been fully achieved. Value outside the rules above, the learning outcomes have not been fully achieved.

For Proposal Seminars, Results Seminars (Colloquium), and Thesis assessments are based on the following parameters:

1. processing (max. value 40),
2. grammar and language (max. grade 20),
3. mastery of the material (max. grade 30),
4. presentation and discussion skills (max. grade 10),

with a total value of 100 which is then converted to an alphabetic value according to the rules mentioned above.

Likewise for the Prethesis on the Program*Master by Research*, the basis for the assessment is the same as above based on reports on the results of predetermined activities (field reports, assignments, academic papers, etc.) as well as student activity in carrying out activities.

Especially for the publication of assessments based on:

1. Substance (max. value 80)
   a. problem/*state of the arts*
   b. literature review/theoretical study/theoretical policy
   c. research methods and or surveys
   d. analysis and clarity of discussion
   e. as well as conclusions and suggestions.
2. Write parameters (max. value 20)
   a. grammar,
   b. writing/writing systematics, and
   c. literature.

The evaluation of the educational study period for the Geological Engineering Masters Study Program, FT UGM, is regulated in 2 (two) stages, namely Early Stage Learning Evaluation and Final Stage Learning Evaluation which are detailed in Chapter IV of Academic Regulations point 4.e.

H. Graduation Requirements (Judicium)

In accordance with Rector Regulation No. 11 of 2016, concerning Postgraduate Education, students who have completed the number of credits in accordance with the Curriculum requirements of the Masters Program in Geological Engineering FT UGM are declared to have passed the Masters Program if:

1. Meets the following requirements:
   a. Minimum Grade Point Average of 3.00 (three point zero zero) for the Regular Program, while for the *Master by Research* Program is a minimum of 3.25 (three point two five)
   b. There are no D and/or E grades, while for the *Master by Research* Program no C grade
   c. Has passed the final thesis examination and completed the thesis revision which has been approved by the Chairperson and Examiner according to the deadline determined during the final thesis examination.
   d. Has submitted a thesis manuscript that has been approved by the Head of Department and Head of Study Program.
   e. Has had a scientific publication of at least 1 (one) article from the results of the thesis research that has been approved for publication (*accepted*) by the editor published (*published*) in national/international scientific journals or has been presented at national/international level seminars and does not violate the ethics of writing.

f. Approval of scientific publications can be in the form of correspondence via email and/or a statement letter from the editor attached with the manuscript.
g. For scientific publications that have been presented at national/international level seminars, it is mandatory to attach a certificate as a presenter at the seminar if the proceedings have not been published at the time of the graduation application.
h. Continuing point (g), students can include a statement approved by the supervisor (main or companion) that they will complete the intended publication/proceeding manuscript until it is approved/*accepted* by the organizing editor. In this case, the supervisor is also responsible for the completion of the publication manuscript.
i. For *Master by Research* Programs, the publication referred to in point (e) is 1 Reputable International Journals or 2 Indexed International Proceedings. For proceedings, the provisions follow points (g) and (h).

2. Has been declared passed in a judicial meeting held by the Faculty.

III. 2022 CURRICULUM COURSE SYLLABUS

Indonesia's geological conditions formed by the meeting of the Eurasian, Indo-Australian, Pacific, and other smaller plates have consequences in the form of diversity of earth resources, geological disasters, and geological characteristics that determine the environmental system. The saying "Unity in Diversity" is actually closely related to the geological conditions of the archipelago. Indonesia ("Archipelago") which is geologically in the form of a maritime continent has the consequence of being a meeting place and assimilation of various human races with all their different values and cultures. Pancasila as the basis of the state is very vital in maintaining the unity of the Indonesian nation which occupies an area with geological diversity. Thus the syllabus for the courses in the Masters Study Program, Department of Geological Engineering, FT UGM, is designed to provide students with the ability to manage the diversity of geological conditions for development that is Godly, humane, maintaining unity, people-oriented and just.
The future of humanity is determined by success in managing its life on planet earth, which has a limited carrying capacity. Therefore, this curriculum offers courses that provide an understanding of sustainable development, extraction and utilization of future-oriented resources such as clean and renewable energy, marine geology potential, and environmentally friendly resource exploration and extraction technologies. The success of resource management, disaster mitigation, environmental management and defense is determined by the accuracy and resolution of exploration. Therefore this curriculum also includes courses related to exploration technology which aim to reduce the risk of failure to understand geological conditions.

1. TKG226101 – Philosophy of Science (1 Credit) – Semester I

The Philosophy of Science course covers the study of formal objects of philosophy in general and the scientific mapping of philosophy, the position of philosophy of science in general philosophy, the history of science from ancient, Greek, medieval times to modern times, the nature of science (fundamentals of knowledge: ontology of science, epistemology science, and axiology of science), means of scientific thinking, and the scientific method.

Course Learning Outcomes (CPMK):

D	Able to weigh the impact of problem solutions in the field of engineering geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK D	CPMK E
Quiz 1	10%	√	
Task 1	10%	√	
Midterm exam	30%	√	
Quiz 2	10%		√
Task 2	10%		√
Final exams	30%		√

Reference:
Ewing, A.C. (2008). *Fundamental Problems of Philosophy* (Translation of The Fundamental Questions of Philosophy by Uzair Fauzan and Rika Iffati Farikha). Yogyakarta: Student library.
Kirkham, Richard L. (2013). *Critical and Comprehensive Introductory Truth Theories* (Translation from Theories of Truth: a Critical Introduction by M Khozim)
Muhadjir, Noeng. (2011).*Philosophy of Science: Ontology, Epistemology, First Order Axiology, Second Order & Third Order of Logics and Mixing Paradigms, Methodological Implementation*. Yogyakarta: Rake Sarasin.

2. TKG226102 - Geology for Sustainable Development (3 Credits) - Semester I

In this course students will study the role of Geology in sustainable development. Geological resources, in the form of minerals, hydrocarbons, water, soil, rocks, and others, are all scattered in the open system. The rapid development of the human population and global economic growth greatly affect the availability of resources and intervene in the geological processes at work. One of the uniqueness of Geology is to bring sustainability aspects into the concept of "*deep time*", where the geological history that records the development of the Earth over billions of years has reflected how all systems interact with each other and reflect dynamic changes. Earth's response to dynamic system changes in the geological time scale is now facing a new challenge: changes in the human time scale that cause impacts on the environment such as environmental impacts on mining exploitation, exploitation of geological data sources and provide examples of management to reduce these impacts.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate research-based solutions to problems in the field of Geology for Sustainable Development using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of Geology for Sustainable Development to various parties with good and responsible communication.
D	Able to consider the impact of problem solutions in the field of Geology for Sustainable Development on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	
Quiz 2	10%	√	√	
Task 2	10%			√
Final exams	30%	√	√	√

Reference:
Baker, S. (2015) *Sustainable Development*, 2nd ed., Routledge, 469 p.
Foley, D., McKenzie, G.D., Utgard, R.O. (2009) *Investigations in Environmental Geology*, Prentice Hall.
Montgomery, C.W. (2013) *Environmental Geology*, 10th ed., McGraw-Hill Education.
Mora, G. (2013)*The Need for Geologists in Sustainable Development*. GSA Today 23/12, 2 p.

3. TKG226103 – Applied Geology I (4 Credits) – Semester I

Applied Geology I is an interdisciplinary course in which the principles of various fields are related to geology and focus on the application of basic geological knowledge to address environmental, engineering, and geohazard problems. This course covers a wide range of topics including geodynamics, sedimentology and stratigraphy, volcanology, engineering geology, environmental geology, hydrogeology, geological hazards and mitigation, mineral resources, and energy resources (oil and gas, coal or geothermal). The application of these theories is aimed at improving the quality of human life, as well as ensuring that preventive and mitigating measures are taken to reduce geological hazards while monitoring the impact on the environment caused by the exploitation of natural resources.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate research-based problem solutions in the field of applied geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of applied geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of applied geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	
Quiz 2	10%	√		
Task 2	10%		√	√
Final exams	30%	√	√	√

Reference:
Anderson, R., and Ferriz, H., (2016), *Applied Geology in California*, AEG Special Publication Number 26, Star Publishing Company
De Maio , M. , & Tiwari , A. K. , (2020), *Applied Geology: Approaches to Future Resource Management 1st ed*., Springer.
Reddy, D.V., (2010), *Applied Geology*, 1st Ed, Vikas Publishing House PVT Ltd.

4. TKG226151 - Engineering and Geological Modeling (2 Credits) – Semester I

Engineering and geological modeling is a branch of engineering geology which is related to applied geology. As with Applied Geology I, this course is interdisciplinary in that the principles of various fields are related to geology and focus on the application of geological knowledge to address environmental, engineering, and geological hazard problems. In engineering and geological models,basic geological aspects, geological resources and geological hazards are applied to engineering exploration and exploitation of geological resources, geological disaster mitigation engineering, engineering engineering in the field of infrastructure such as the stage of determining the location, design, construction, construction implementation and maintenance of engineering work as well as geological model simulation to support resource predictions or future geological hazards.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate research-based problem solutions in the field of applied geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of applied geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of applied geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	
Quiz 2	10%	√		
Task 2	10%		√	√
Final exams	30%	√	√	√

<u>Reference</u>:

Turner, A.K., Kessler, H., and van der Meulen, M.J., (Ed.), (2021), *Applied Multidimensional Geological Modeling: Informing Sustainable Human Interactions with the Shallow Subsurface*, Wiley-Blackwell, 672p.

De Maio , M. , & Tiwari , A. K. , (2020),*Applied Geology: Approaches to Future Resource Management 1st ed.*, Springer.

Houlding, S.W., (1994), *3D Geoscience Modeling: Computer Techniques for Geological Characterization*, Springer, 311p.

5. TKG226201 – Geological Data Analysis (3 Credits) – Semester II

This course conveys various methods of quantitative analysis of geological data in various applied aspects. Quantitative analysis knowledge and skills enable the determination of interpretation boundaries. The presentation includes analysis of stratigraphic data, geological maps, and multivariable observations. Mastery of probability and statistics, including eigenvalue calculations, analysis of direction, line and plane data, maps and geostatistics, fractals and applications of machine *learning* for geology.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of geological data analysis by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in research-based geological data analysis using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Task 1	10%	√	
Midterm exam	30%	√	√
Task 2	10%		√
Final exams	30%	√	√

Reference:

Agterberg F. (2014)*Geomathematics: Theoretical Foundations, Applications and Future Developments (Quantitative Geology and Geostatistics)*, Springer, 553 p.

Buccianti, A.G. Mateu-Figueras, Dan V. Pawlowsky-Glahn (2006)*Compositional Data Analysis in the Geosciences: From Theory to Practice, Special Publication no 264*, Geological Society of London, 224 p.

Davis, J.C. (2003)*Statistics and Data Analysis in Geology*, 3rd ed. Wiley, 656 p.

Misra, S., Li, H., He, J. (2020) *Machine Learning for Subsurface Characterization*. Gulf Professional Publishing, Massassusets, 412p.

6. TKG226202 – Research Methods, Ethics, and Scientific Writing Techniques (3 Credits) – Semester II

This course will prepare students to start scientific research in the context of completing a thesis. How to prepare research will be conveyed, including exploring ideas, preparing resources, and considering ethical, social and cultural aspects that bind a research. Furthermore, how to determine variables and data collection techniques will be discussed, followed by a qualitative and quantitative method approach to a problem. Data processing by optimizing statistics in hypothesis testing. This course will also help students in completing their scientific work. It begins with a definition of scientific work and the ethical values that bind it. Then go into technical matters related to preparation of titles, preparation of abstracts, building introductions, presenting data and research methods carried out, writing up research results, outlining focused discussions, drawing conclusions, building constructive suggestions, composing thanks to the parties involved, and how to extract the literature used. In addition to the systematic matters above, this lecture will touch on how to design images, photographs and tables, which are easy for readers to understand. In the final section, it will be explained how to prepare presentation material and how to present it both orally and on posters.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate problem solutions in the field of research-based research methods and ethics using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of research methods and ethics to various parties with good and responsible communication through correct scientific writing techniques.

Learning methods:
1. Lectures are conducted on a hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%		√
Task 2	10%	√	
Final exams	30%	√	√

<u>Reference:</u>

Gastel, B., and R.A. Day (2016) *How to Write and Publish a Scientific Paper*, 8th ed. Greenwood, 326 p.

Hofmann, A. (2016) *Scientific Writing and Communication: Papers, Proposals, and Presentations*, 3rd ed. Oxford University Press, 768 p.

Jackson, S.L. (2015) *Research Methods and Statistics: A Critical Thinking Approach*, 5th ed. Wadsworth Publishing, 528 p.

7. TKG226203 – Pre-Thesis 1 (4 sks) – Semester II

This course is designed in the form of field lectures and/or excursions which are intended to provide a direct description of cases related to research. Supervisors will guide students to see examples of cases that occur carefully and carry out investigations of questions that arise from the phenomena encountered. It is hoped that this can provide broader insights, hone students' sensitivity to the problems to be studied, and master the application of expertise in dealing with problems in the field.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in engineering geology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in the field of research-based engineering geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of research methods and ethics to various parties with good and responsible communication through correct scientific writing techniques.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK C
Task 1	10%	√	√	√
Task 2	10%	√	√	√
Mid Semester Exams (Intermediate Report)	30%	√	√	√
Task 3	10%	√	√	√
Task 4	10%	√	√	√
Final exams (Final report)	30%	√	√	√

Reference:

Baird, B.N., and Mollen, D., (2019), *The Internship, Practicum, and Field Placement Handbok: A Guide for the Helping Professions*, 9th Edition, Routledge, Taylor and Francis Group, New York, USA.

Fajri, R.N., (2018),*Planning, Executing, Writing Apprenticeship Reports (Practical Guide to Students Who Will Embrace the World of Work Accompanied by Examples of Internship Reports)*, Deepublish.

Woodard, E., (2015), *The Ultimate Guide to Internships: 100 Steps to Get a Great Internship and Thrive in It*, Allworth Press, New York, USA.

8. TKG226204 – Pre-Thesis 2 (6 sks) – Semester II

This course is designed in the form of internships and/or practice in the field/studio/workshop where students deal directly with research-related cases by applying correct research methods. Supervisors will guide students to describe, collect data and analyze the cases they face carefully and write up the results of the analysis. It is hoped that this can provide basic data for students for writing materials related to the topic of thesis research.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based engineering geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of engineering geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Task 1	10%	√	√	√
Task 2	10%	√	√	√
Mid Semester Exams (Intermediate Report)	30%	√	√	√
Task 3	10%	√	√	√
Task 4	10%	√	√	√
Final exams (Final report)	30%	√	√	√

Reference:

Bairagi, V., and Munot, M.V., (2019)*Research Methodology: A Practical and Scientific Approach*, CRC Press, Taylor and Francis Group, New York, USA.

Creswell, J.W., and Clark, V.L.P., (2011), *Design and Conducting Mixed Research Methods*, 2nd Edition, SAGE.

Sugiyono, (2013),*Quantitative Research Methods, Qualitative and R&D*, Alphabet, Bandung.

9. TKG226205 – Proposal Seminar (2 sks) – Semester II

Proposal seminars are courses designed so that students can submit their thesis research plans in the seminar examination forum. Students are expected to be able to explain well about the background, objectives, theoretical basis, methodology and research hypotheses. Before carrying out research for a thesis, students are required to make a research proposal for a thesis (thesis proposal) which must be approved by the Thesis Advisory Team. Proposals are proof of a student's ability to design research and development of knowledge in one particular scientific field. Seminar on thesis research proposals is needed so that the implementation of thesis research can run smoothly based on the design stages and a clear schedule of activities, the progress of the implementation can be measured through monitoring procedures and focus on the objectives of achieving research results that can be equated with the thesis requirements to obtain a master's degree at Gadjah Mada University.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK E
Task 1	10%	√	√
Task 2	10%	√	√
Mid Semester Exams	30%	√	√
Quiz 2	10%	√	√
Task 2	10%	√	√
Final exams	30%	√	√

(Final report)			

Reference:
Alma, B., (2009),*Methods and Techniques for Developing Research Proposals*, Alphabet, Bandung.
Bui, Y.N., (2019), *How to Write a Master's Thesis*, 3rd Edition, SAGE Publications, USA
Dep , D. , Day , R. , Balas , V.E.*Engineering Research Methodology: A Practical Insight for Researchers*, Springer.
Emilia, E., (2009),*Writing Thesis and Dissertation*, Alphabet, Bandung.
Schimel, J., (2012),*Writing Science: How to write papers that get cited and proposals that get funded*, Oxford University Press.

10. TKG226106 – Applied Geology II (4 Credits) – Semester II

Applied Geology II is an advanced interdisciplinary course from Applied Geology I where the principles of various fields are related to geology and focus on the application of basic geological knowledge to address environmental, engineering, and geohazard problems. It covers a wide range of topics including geodynamics, sedimentology and stratigraphy, volcanology, engineering geology, environmental geology, hydrogeology, geological hazards and mitigation, mineral resources, and energy resources (oil and gas, coal or geothermal). The application of these theories is aimed at improving the quality of human life. It will also ensure that preventive and mitigating measures are taken to reduce geological hazards while monitoring the impact on the environment caused by the exploitation of natural resources.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate research-based problem solutions in the field of applied geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of applied geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of applied geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√	√	
Task 1	10%		√	√
Midterm exam	30%	√	√	√
Quiz 2	10%	√	√	
Task 2	10%	√	√	√
Final exams	30%	√	√	√

Reference:
Anderson, R., and Ferriz, H., (2016), *Applied Geology in California*, AEG Special Publication Number 26, Star Publishing Company

De Maio , M. , & Tiwari , A. K. , (2020), *Applied Geology: Approaches to Future Resource Management 1st ed*., Springer.
Reddy, D.V., (2010), *Applied Geology*, 1st Ed, Vikas Publishing House PVT Ltd.

11. TKG227101 – Internship / Practical Work / Field Work (4 Credits) – Semester III

This course is designed in the form of excursion/field activities or internships which are intended to provide a firsthand description of cases related to research. Supervisors will guide students to see examples of cases that occur carefully and carry out investigations of questions that arise from the phenomena encountered. It is hoped that this can provide broader insights, hone students' sensitivity to the problems to be studied, and master the application of expertise in dealing with problems in the field.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based engineering geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of engineering geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D	CPMK E
Task 1	10%	√	√		
Task 2	10%			√	√
Midterm exam (intermediate report)	30%	√	√	√	√
Task 3	10%	√	√		
Task 4	10%			√	√
Final exams (final report)	30%	√	√	√	√

<u>Reference</u>:

Baird, B.N., and Mollen, D., (2019), *The Internship, Practicum, and Field Placement Handbok: A Guide for the Helping Professions*, 9th Edition, Routledge, Taylor and Francis Group, New York, USA.
Fajri, R.N., (2018),*Planning, Executing, Writing Apprenticeship Reports (Practical Guide to Students Who Will Embrace the World of Work Accompanied by Examples of Internship Reports)*, Deepublish.
Woodard, E., (2015), *The Ultimate Guide to Internships: 100 Steps to Get a Great Internship and Thrive in It*, Allworth Press, New York, USA.

12. TKG227201 – Results Seminar 1 (2 SKS) – Semester IV

This course is designed in the form of delivering temporary research results or the results of writing a thesis in a seminar forum under the guidance of a supervisor. Students are expected to be able to explain the progress of the independent research concerned and be able to explain plans for follow-up activities to complete their research.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based engineering geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of engineering geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Center Learning andResearch based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D	CPMK E
Seminar Report	60%	√	√	√	√
Presentation tasks	40%	√	√	√	√

Reference:
Bui, Y.N. (2019) *How to Write a Master's Thesis*, 3rd ed., SAGE Publications, USA.
Carter, M. (2020) *Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters and More*, 2nd ed., Academic Press.
Dep , D. , Day , R. , Ballas , V.E. (2019)*Engineering Research Methodology: A Practical Insight for Researchers*, Springer.
Emilia, E. (2009)*Writing Thesis and Dissertation*, Alphabet, Bandung.

13. TKG227202 – Results Seminar 2/Colloquium (2 Credits) – Semester IV

This course is designed in the form of delivering the final research results before the awareness exam in a seminar forum under the guidance of a supervisor. Students are expected to be able to explain the results of their independent research and be able to explain the achievement of research objectives and thesis in accordance with the thesis standards for obtaining a master's degree at Gadjah Mada University.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based engineering geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of engineering geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Centered Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D	CPMK E
Seminar Report	60%	√	√	√	√
Presentation tasks	40%	√	√	√	√

Reference:

Bui, Y.N. (2019) *How to Write a Master's Thesis*, 3rd ed., SAGE Publications, USA.
Carter, M. (2020) *Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters and More*, 2nd ed., Academic Press.
Dep , D. , Day , R. , Ballas , V.E. (2019) *Engineering Research Methodology: A Practical Insight for Researchers*, Springer.
Emilia, E. (2009) *Writing Thesis and Dissertation*, Alphabet, Bandung.

14. TKG227203 – Thesis (8 SKS) – Semester III/IV

The thesis is a scientific written work resulting from independent research to fulfill the requirements for obtaining a master's degree in the Postgraduate Program at the Faculty of Engineering, Department of Geological Engineering, Gadjah Mada University. The main content of the thesis is a report on research results through study and synthesis of issues that are relevant to the Study Interest (Concentration) in which students are pursuing Masters education. The main aspects that are assessed in the thesis are the originality of the research, the content of the thesis in relation to the discussion in answering the objectives in relation to the basis of research methods that have been scientifically designed, the grammar and writing of the thesis, and the thesis presentation.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in engineering geology by applying knowledge of mathematics, science, and engineering.
B	Able to design and evaluate solutions to problems in the field of research-based engineering geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of engineering geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK C	CPMK D	CPMK E
Thesis Report	60%	√	√	√	√	√
Awareness Test	40%	√	√	√	√	√

Reference:
Bui, Y.N. (2019) *How to Write a Master's Thesis*, 3rd ed., SAGE Publications, USA.
Carter, M. (2020) *Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters and More*, 2nd ed., Academic Press.
Dep , D. , Day , R. , Ballas , V.E. (2019) *Engineering Research Methodology: A Practical Insight for Researchers*, Springer.
Eco, U. (2015) *How to Write a Thesis*, The MIT Press.
Emilia, E. (2009) *Writing Thesis and Dissertation*, Alphabet, Bandung.
Tang, H. (2021) *Engineering Research: Design, Methods and Publication*, John Wiley and Sons.

15. TKG227204 – Publication (8 SKS) – Semester III/IV

This course is basically writing scientific publications from the thesis research carried out. Students are required to submit their research results to international scientific forums either through international conferences with indexed proceedings or papers in reputable international journals.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of engineering geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK D	CPMK E
Publication 1	50%	√	√	√
Publication 2	50%	√	√	√

Reference:
Claudio, L. (2015) *How to Write and Publish Scientific Paper: The Step-By-Step Guide*, Write Now Publishing Company.
Dep , D. , Day , R. , Ballas , V.E. (2019) *Engineering Research Methodology: A Practical Insight for Researchers*, Springer.
Schimel, J. (2012)*Writing Science: How to papers that get cited and proposals that get funded*, Oxford University Press.
Tang, H. (2021)*Engineering Research: Design, Methods and Publication*, John Wiley and Sons.

16. TKG226104 - Applied Geophysics (2 Credits) – Semester I

This course describes the physical methods used in the exploration of subsurface geological resources (groundwater, hydrocarbons, minerals, and geothermal) and their application in the geotechnical field, including the study of gravity, magnetic, seismic, geoelectric, and radioactivity. All aspects related to these geophysical methods are studied, including theoretical background, data acquisition, data processing, and interpretation.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate problem solutions in the field of research-based applied geophysics using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of applied geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of applied geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√	√	
Task 1	10%		√	√
Midterm exam	30%	√	√	√
Quiz 2	10%			√
Task 2	10%	√	√	
Final exams	30%	√	√	√

Reference:

Burger, H.R., A.F. Sheehan, and C.H. Jones (2006) *Introduction to Applied Geophysics: Exploring the Shallow Subsurface*, W. W. Norton & Company, 600 p.

Dentith, M. and S.T. Mudge (2014) *Geophysics for the Mineral Exploration Geoscientist*, Cambridge University Press, 454 p.

Kearey, P., M. Brooks, and I. Hill (2002) *An Introduction to Geophysical Exploration*, 3rd ed., Wiley-Blackwell, 278 p.

Reynolds, J.M. (2011) *An Introduction to Applied and Environmental Geophysics*, 2nd ed., Wiley, 712, p.

17. TKG226105 – Applied Geophysics Practicum (1 Credit) – Semester I

This course describes the physical methods used in the exploration of subsurface geological resources (groundwater, hydrocarbons, minerals, and geothermal) and their application in the geotechnical field, including the study of gravity, magnetic, seismic, geoelectric, and radioactivity. All aspects related to these geophysical methods are studied, including theoretical background, data acquisition, data processing, and interpretation.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of applied geophysics to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of applied geophysics on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK D
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%		√
Task 2	10%	√	
Final exams	30%	√	√

Reference:

Burger, H.R., A.F. Sheehan, and C.H. Jones (2006) *Introduction to Applied Geophysics: Exploring the Shallow Subsurface*, W. W. Norton & Company, 600 p.

Dentith, M. and S.T. Mudge (2014) *Geophysics for the Mineral Exploration Geoscientist*, Cambridge University Press, 454 p.

Kearey, P., M. Brooks, and I. Hill (2002) *An Introduction to Geophysical Exploration*, 3rd ed., Wiley-Blackwell, 278 p.

Reynolds, J.M. (2011) *An Introduction to Applied and Environmental Geophysics*, 2nd ed., Wiley, 712, p.

18. TKG226106 – Numerical Method (2 SKS) – Semester I

This course discusses the basics of numerical analysis. Topics taught include error analysis, solving equations in one variable, curve fitting: least squares regression and interpolation; numerical differentiation and integration; initial-value problems for ordinary differential equations; solving equations with a linear system: direct and iteration methods; approximation theory; boundary value problems for ordinary differential equations; and numerical solutions to partial differential equations.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of numerical methods by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based numerical methods using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Task 1	15%	√	
Midterm exam	35%	√	√
Task 2	15%		√
Final exams	35%	√	√

Reference:

Burden, R.L. and Faires, J.D. (2011)*Numerical Analysis*. Thomson Brooks/Cole.

Chapra, S.C. and Canale, R.P. (2021) *Numerical Methods for Engineers.* 8th Edition. McGraw-Hill Education, New York, 988p.

Hutchinson, I.H. (2015) *A Student's Guide to Numerical Methods*, Cambridge University Press, 216 p.

Press, W.H., Teukolsky, S.A., Vetterling, W.T., and Flannery, B.P. (2007) *Numerical Recipes-The Art of Scientific Computing*. Cambridge University Press.

19. TKG226107 – Advanced Engineering Geology (2 Credits) – Semester I

This course discusses the application of geology in engineering work. Topics taught include consideration of engineering geological conditions in engineering work; engineering geological investigations in engineering work; and application of engineering geology in planning and construction construction. In addition to lecture activities in class, this course also contains field trip activities to improve understanding of geological conditions that need to be considered in planning and construction of construction in the field.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of engineering geology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based engineering geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK C
Quiz	20%	✔	✔	✔
Task	20%	✔	✔	✔
Written exam (UTS)	30%	✔	✔	✔
Written exam (UAS)	30%	✔	✔	✔

Reference:

Dearman, W.R. (2013)*Engineering Geological Mapping*, 2nd ed. Butterworth-Heinemann, 387 p.
Gattinoni, P., Pizzarotti, E.M., and Scesi, L. (2014)*Engineering Geology for Underground Works*. Springer.
Hencher, S. (2012) *Practical Engineering Geology*. Spon Press.
Price, D.G. (2009) *Engineering Geology - Principles and Practice*. Springer.

20. TKG226108 – Advanced Engineering Geology Seminar (1 Credit) – Semester I

This course examines various engineering geology investigations carried out in engineering work. Topics taught include investigation of general engineering geological conditions (geomorphology, rock and soil, geological structures, groundwater, and geodynamics) and geological hazards. Learning is done through reviewing publications, presentations, and discussions.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.

D	Able to weigh the impact of problem solutions in the field of engineering geology on the environment, society, socio-economic and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK D	CPMK E
Presentation & discussion	70%	✔	✔	✔
Written exam (UTS)	15%	✔	✔	
Written exam (UAS)	15%	✔	✔	

Reference:

Dearman, W.R. (2013)*Engineering Geological Mapping*, 2nd ed. Butterworth-Heinemann, 387 p.
Gattinoni, P., Pizzarotti, E.M., and Scesi, L. (2014)*Engineering Geology for Underground Works*. Springer.
Hencher, S. (2012) *Practical Engineering Geology*. Spon Press.
Price, D.G. (2009) *Engineering Geology - Principles and Practice*. Springer.

21. TKG226109 – Advanced Soil and Rock Mechanics (2 Credits) – Semester I

This course contains in-depth concepts of soil and rock mechanics used in engineering work. Topics taught include phases in soil and rock; concept of effective stress and *suction*; strength, permeability, and compressibility of water-saturated and unsaturated soils; rock strength and deformability; soil and rock in situ stresses; and design of construction foundations and retaining walls in soil and rock.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of soil and rock mechanics by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate problem solutions in the field of research-based soil and rock mechanics using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz	20%	✔	✔
Task	20%	✔	✔
Written exam (UTS)	30%	✔	✔
Written exam (UAS)	30%	✔	✔

Reference:

Budhu, M. (2010) *Soil Mechanics and Foundations*. John Wiley & Sons, Inc.

Fredlund, D.G. and Rahardjo, H. 1993. *Soil Mechanics for Unsaturated Soils*. John Wiley & Sons, Inc.
González de Vallejo, L. I. and Ferrer, M. (2011)*Geological Engineering*. Leiden, Netherlands: CRC Press/Balkema.
Push, R. 1995. *Rock Mechanics on a Geological Base*. Elsevier.

22. TKG226110 – Advanced Soil and Rock Mechanics Practicum (1 Credit) – Semester I

This practicum class contains an in-depth study of the concepts of soil and rock mechanics used in engineering work. Topics taught include phases in soil and rock; concept of effective stress and suction; strength, permeability, and compressibility of water-saturated and unsaturated soils; rock strength and deformability; soil and rock in situ stresses; and design of construction foundations and retaining walls in soil and rock.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate problem solutions in the field of research-based soil and rock mechanics using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of soil and rock mechanics to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C
Quiz	40%	✔	✔
Written exam (UTS)	30%	✔	✔
Written exam (UAS)	30%	✔	✔

<u>Reference</u>:

Budhu, M. (2010)*Soil Mechanics and Foundations*. John Wiley & Sons, Inc.
González de Vallejo, L. I. and Ferrer, M. (2011)*Geological Engineering*. Leiden, Netherlands: CRC Press/Balkema.
Lu, N. and W.J. Likos (2004)*Unsaturated Soil Mechanics*, Wiley, 584 p.

23. TKG226210 – Geotechnical Aspects of Underground Construction (2 Credits) – Semester I

This course discusses geotechnical applications in tunnel and underground construction. Topics taught include geotechnical aspects that need to be considered in planning cut-and-cover *tunnels*, *soft ground tunneling*, *rock tunneling,* and difficult *ground tunneling*; and geotechnical research in mixed *ground tunneling*.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the geotechnical field of underground construction by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate solutions to problems in the geotechnical field of research-based underground construction using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz	20%	√	√
Task	20%	√	√
Midterm exam	30%	√	√
Final exams	30%	√	√

Reference:
Campos e Matos, A., Ribeiro e Sousa, L., Kleberger, J., and Pinto, PL, 2006,*Geotechnical Risk in Rock Tunnels*, Taylor & Francis
Chapman, D., Metje, N., and Stärk, A., 2010,*Introduction to Tunnel Construction*, Spon Press.
Ng, C.W.W., Huang, H.W., Liu, G.B., 2009, *Geotechnical Aspects of Underground Construction in Soft Ground*, CRC Press.
The British Tunnelling Society and The Institution of Civil Engineers, 2004, *Tunnel Lining Design Guide*, Thomas Telford Ltd.

24. TKG226212 – Construction Method and Tunnel Design (2 Credits) – Semester I

This course discusses various methods used in the construction of tunnels and underground spaces, among others tunneling *using tunnel boring machines (TBM), drill and blast tunneling, Sequential Excavation Method/ New Austrian Tunnelling Method (NATM), cut-and-cover tunneling*. This course also discusses aspects that must be considered in the design of tunnel and underground space construction, including the design of excavation methods and tunnel support systems.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of construction and design methods by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based design and construction methods using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz	20%	√	√
Task	20%	√	√
Midterm exam	30%	√	√
Final exams	30%	√	√

Reference:
Beer, G., 2009, *Technology Innovation in Underground Construction*, CRC Press.

Guglielmetti, V., Grasso, P., Mahtab, A., and Xu, 2008,*Mechanized Tunnelling in Urban Areas: Design Methodology and Construction Control*, Taylor & Francis.
You, C-Y., 2006,*Deep Excavation: Theory and Practice*, Taylor & Francis.
Tatiya, R.R., 2013,*Surface and Underground Excavations: Methods, Techniques and Equipment*, CRC Press.
The British Tunnelling Society and The Institution of Civil Engineers, 2004, *Tunnel Lining Design Guide*, Thomas Telford Ltd.
U.S. Department of Transportation, 2009, *Technical Manual for Design and Construction of Road Tunnels– Civil Elements*. National Highway Institute.
Wood, A.M., 2000, *Tunneling: Management by Design*. E & FN Spon.

25. TKG226113 – Applied Hydrogeology (2 Credit Points)

This course focuses on the application of the existence, distribution, origin of groundwater resources, groundwater flow systems, aquifer systems, groundwater hydraulic properties and groundwater environment, groundwater recharge calculations, groundwater field investigations, construction and design of drilled wells, as well as discussing problems and engineering in groundwater applications such artificial *recharge* and the effects of climate change on groundwater resources.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of hydrogeology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in the field of research-based hydrogeology using modern engineering techniques and tools.
D	Able to weigh the impact of solutions to problems in the field of hydrogeology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	√
Midterm exam	30%	√	√	√
Quiz 2	10%		√	
Task 2	10%	√		√
Final exams	30%	√	√	√

Reference:
Fetter, C.W., (2014), *Applied Hydrogeology*, 4th ed., Pearson Inc. New Jersey
Healy, R.W., (2010), *Estimating Groundwater Recharge*, Cambridge University Press.
Weight, W.D., & Sonderegger, J.L., (2001), *Manual of Applied Field Hydrogeology*, McGraw Hill.

26. TKG226114 – Groundwater Flow Modeling (2 Credit Points) – Semester I

This course explains groundwater systems and flows, groundwater modeling which includes modeling objectives and classification, modeling stages, modeling parameters and assumptions, aquifer boundary conditions, preparation and optimization of modeling data, implementation of mathematics in modeling, groundwater modeling, model calibration as well as the application of groundwater flow models.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of groundwater modeling by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate solutions to problems in research-based groundwater modeling using modern engineering techniques and tools.
D	Able to weigh the impact of problem solutions in the field of groundwater modeling on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK D
Task 1	10%	√		√
Task 2	10%		√	√
Midterm exam	30%	√	√	√
Task 3	10%	√		√
Task 4	10%		√	
Final exams	30%	√	√	√

Reference:

Anderson, M.P., Woessner, W.W., & Hunt, R.J., (2015), *Applied Groundwater Modeling: Simulation of Flow and Transport Modeling*, 2nd ed, Academic Press.

Bear, J., & Cheng, A.H.D, (2010), *Modeling Groundwater Flow & Contaminant Transport (Theory and Applications of Transport in Porous Media)*, Springer.

Spitz, K., & Moreno, J., (1996), *A Practical Guide to Groundwater and Solute Transport Modeling*, Wiley-Interscience.

27. TKG226115 – Groundwater Geochemistry (2 Credits) – Semester I

This course will explain the chemical content of groundwater, chemical processes in groundwater such as dissolution, redox reactions and ion exchange, water-mineral/rock interactions, isotopes in groundwater, geochemical conceptual models, and geochemical applications to groundwater.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of groundwater geochemistry by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in the field of research-based groundwater geochemistry using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%		√
Task 2	10%	√	
Final exams	30%	√	√

Reference:
Clark, I., (2015), *Groundwater Chemistry and Isotopes*, CRC Press.
Eby, N., (2016),*Principles of Environmental Geochemistry*, Waveland Press, Inc.
Appelo, C.A.J., & Postma, D., (2005),*Geochemistry, Groundwater and Pollution*, 2nd ed, CRC Press.

28. TKG226116 – Raw Water Treatment Engineering (2 Credits) – Semester I

Raw water treatment techniques are focused on providing knowledge about methods of treating water from various kinds of contaminants, especially by utilizing geological materials. The topic given is water quality assessment, water treatment process, separation process; sedimentation and filtration, oxidation processes; biochemical and chemical oxidation, tertiary processing, examples of the use of geological materials for water treatment processes.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate problem solutions in the field of research-based raw water treatment techniques using modern engineering techniques and devices.
C	Able to convey ideas for problem solutions in the field of raw water treatment techniques to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%		√
Task 2	10%	√	
Final exams	30%	√	√

Reference:
Davis, M.L. (2010)*Water and Wastewater Engineering*, McGraw-Hill Company
Gray, N.F. (2010) *Water Technology; An Introduction for Environmental Scientists and Engineers*, 3rd ed., Butterworth-Heinemann

Pathak, H. (2013)*Assessment of Water Quality by Principal Component Analysis*, CreateSpace Independent Publishing Platform

29. TKG226117 – Groundwater Exploration Engineering (2 Credits) – Semester I

Detailed knowledge of groundwater resources enabling sustainable use with adapted management. Therefore, the groundwater exploration engineering course aims to understand the groundwater system as a whole, namely spatial distribution, hydraulic storage properties of source rock, interactions with aquifers below and above or surface water, and spatial and temporal variations of groundwater properties. . Groundwater recharge, natural flow rates, and extraction rates must also be known for sustainable management using a multidisciplinary methodological approach. In this course, surface exploration methods such as remote *sensing* and geophysics for exploration are given according to the type of aquifer, techniques for observing drilled wells and drilled holes including geophysical logging and hydraulic testing. Followed by groundwater piezometric pressure and surface measurement methods to investigate well discharge and groundwater hydraulic properties. Lastly, hydrochemical tests are not only used to determine the quality of groundwater, but with isotope investigation results can also provide information about the origin of groundwater.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of groundwater exploration engineering by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in the field of research-based groundwater exploration techniques using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%		√
Task 2	10%	√	
Final exams	30%	√	√

Reference:

Fetter, C.W., (2014), *Applied Hydrogeology*, 4th ed., Pearson Inc. New Jersey
Patra, H.P., Adhikari, S.H., and Kunar, S., (2016),*Groundwater Prospecting and Management*, Springer.
Kirsch, R., (Ed), (2009),*Groundwater Geophysics: A Tool for Hydrogeology*, 2nd ed., Springer.

30. TKG226118 – Hydrogeology of Indonesia (2 Credits) – Semester I

Indonesia's diverse geological conditions are the main controller for Indonesia's hydrogeological characteristics, including the presence of groundwater basins and productive aquifers in Indonesia. The topics discussed in this course are an overview of Indonesia's hydrogeological conditions from Sabang - Merauke, the distribution of groundwater basins in Indonesia along with the characteristics of the quantity and quality of groundwater and specific problems of groundwater resources in certain geological conditions in Indonesia.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of Indonesian hydrogeology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of Indonesian hydrogeology on the environment, society, socio-economic and culture, by upholding professionalism ethics

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK D
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%	√	
Task 2	10%		√
Final exams	30%	√	√

Reference:
Directorate of Environmental Geology (1988), Hydrogeological Map of Indonesia Scale 1:250000.
Directorate of Environmental Geology (1988), Hydrogeological Map of Indonesia Scale 1:100000.
Ministry of Energy and Mineral Resources of the Republic of Indonesia (2017), Minister of Energy and Mineral Resources Regulation No. 02 of 2017 concerning Indonesian groundwater basins.

31. TKG226119 – Urban Geology (2 SKS) – Semester I

An urban or urban area is a complex system that exists at the interface of the natural, built and social environment. Solutions to our urban challenges require interdisciplinary collaboration and an integrated approach. Geological and geotechnical information about the subsurface is of great importance and of high socio-economic value for urban development and maintenance of critical infrastructure (e.g. transport tunnels, supply lines and foundations). To achieve the resilient city vision, subsurface uses must be planned, integrated and managed as part of the aboveground agenda. Urban geology is a branch of geology which consists of all topics related to urban areas, such as hydrogeology, geochemistry, structural geology, engineering geology, geological hazards or geoheritage.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate research-based problem solutions in the field of urban geology using modern engineering techniques and tools.
C	Able to convey ideas for solutions to problems in the field of urban geology to various parties with good and responsible communication.
D	Able to weigh the impact of solutions to problems in the field of urban geology on the environment, society, socio-economic and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	√
Quiz 2	10%	√		
Task 2	10%		√	√
Final exams	30%	√	√	√

Reference:

Think Deep UK (2019). *Investing in urban underground space – Maximizing the social benefits*, Blue Paper. http://www.tduk.org/downloads

Bampton M. (1999) *Urban geology. In: Environmental Geology*. Encyclopedia of Earth Science. Springer, Dordrecht.

Leggett, R. F., (1973). *Cities and Geology*. New York: McGraw-Hill.

32. TKG226120 – *Geoheritage and Geopark* (2 SKS) – Semester I

Blue *book* Bappenas,*geopark* is a major national strategic program that needs to be accelerated. There are 180 plans geopark Inn Blue *book* Bappenas,*geopark* is a major national strategic program that needs to be accelerated. There are 180 plans geopark recorded in blue *book* Bappenas, but the realization has not been implemented. All constraints, submission requirements and also management geopark can be used as discussion and research material.

Course Learning Outcomes (CPMK):

D	Able to weigh the impact of problem solutions in the field of geoheritage and geopark on the environment, society, socio-economics and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK D	CPMK E
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%	√	
Task 2	10%		√
Final exams	30%	√	√

Reference:
Geological Agency, 2017,*Technical Guidelines for Assessment of Geological Heritage Resources*, Ministry of Energy and Mineral Resources.
Anonymous, On the Geosite Definition and the standards of Geopark Arrangement, Istanbul: Journal of Mineral Research and Exploration.
Anonymous, 2019, Regulation of the President of the Republic of Indonesia Number 9 of 2019.
Geological Agency, 2017,*Technical Standards for Inventory of Geological Diversity and Identification of Geological Heritage*, Ministry of Energy and Mineral Resources.
Dowling, R. K., 2010, *Geotourism's Global Growth*, Geoheritage (2013) 3, Australia, p 1-13.
Gray, Murray., 2003, *Geodiversity; valuing and conserving abiotic nature*, London: John Wiley & amp; Sons, Ltd.
Hermawan, H., 2017,*Conservation-Based Tourism Planning*, Bandung.
Kubalikova, L. (2013). Geomorphosite Assessment for Geotourism Purposes. *Czech Journal of Tourism*, Thing. 80-104.

33. TKG226121 – Medical Geology (2 Credits) – Semester I

Chemical elements can be classified as toxic or essential elements needed for the metabolism of humans and animals. Deficiency or excess in consumption of trace elements can cause health problems. Lectures in medical geology study the naturally occurring elements in water and soil in an area with certain geological conditions so that they can be consumed by humans. In addition, it also studies the effect of deficiency or excess in consuming trace elements and assesses the risk if it is affected by the consumption of trace elements and efforts to reduce these risks.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of medical geology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based medical geology using modern engineering techniques and devices.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK E
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	√
Quiz 2	10%	√	√	
Task 2	10%	√	√	√
Final exams	30%	√	√	√

Reference:
Olle Selinus, Brian Alloway, José A. Centeno, Robert B. Finkleman, Ron Fuge, Ulf Lindh, and Pauline Smedley (eds) (2005) *Essentials of Medical Geology Impacts of the Natural Environment on Public Health*. Elsevier Academic Press, 812 pp.

Olle Selinus, Robert B. Finkelman, Jose A. Centeno (Editor) 2011,*Medical Geology: A Regional Synthesis (International Year of Planet Earth) 2010th ed*.

34. TKG226122 – Oil and Gas Geology and Hydrocarbon Geochemistry (2 Credit Points) – Semester I

This course is intended to study the oil and gas system and play *concept* with case studies in Indonesia by integrating surface and subsurface data. This course discusses topics related to oil and gas geology, sedimentary rocks as reservoirs and source rocks, sedimentary facies, basin formation and filling. This course will also provide a detailed understanding of the composition, origin, controlling factors of genesis, generation and migration of oil and gas in conventional and unconventional oil and gas systems. The discussion includes techniques and evaluation criteria for source rock, oil and gas composition, analytical methods and reservoir geochemistry as well as applications for basin modeling. Participants are also expected to be able to interpret molecular data, chemical compounds and thermal maturity. In addition, the role of geochemistry in field development will also be discussed.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the fields of oil and gas geology and hydrocarbon geochemistry by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in research-based oil and gas geology and geochemistry of hydrocarbons using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	5%	√	
Task 1	20%	√	
Midterm exam	25%	√	√
Quiz 2	5%		√
Task 2	20%		√
Final exams	25%	√	√

<u>Reference:</u>

Dembicki, H. (2016) *Practical Petroleum Geochemistry for Exploration and Production*, Elsevier, 329 p.
Gluyas, J. and Swarbrick, R. (2004) *Petroleum Geoscience*, Blackwell Scientific Publications, 402 p.
Killops, S., Killops, V. (2005) *Introduction to Organic Geochemistry*, 2nd ed., Blackwell Publishing, Oxford, 393 p.
Peters, K.E., Walters, C.C., Moldowan, J.M. (2005) *The Biomarker Guide*, Cambridge University Press, Cambridge, 700 p.
Selley, R.C. and S.A. Sonnenberg (2014) *Elements of Petroleum Geology*, 3rd ed., Academic Press, 528 p.

35. TKG226123 – Coal Geology (2 Credits) – Semester I

This course discusses formation, depositional models, control, biochemical processes and dynamics that affect coal formation. Rank, coal quality in relation to proximate, ultimate and other analyses. Participants will be able to understand in more detail how coal is formed, especially in one what and the processes that followed. In addition, in this course the understanding of coal petrology and geochemistry is reviewed to find out its application in determining the process of coal formation and aspects of coal quality.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of coal geology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in the field of research-based coal geology using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%	√	
Midterm exam	30%	√	
Quiz 2	10%		√
Task 2	10%		√
Final exams	30%		√

Reference

Flowers, M., 2014.*Coal and Coalbed Gas: Fueling The Future*, Elsevier, San Diego, 697 p.

Speight, J.G. (2005) *Coal Analysis*, John Wiley & Sons, Chicester, 222p.

Suarez-Ruiz, I. and J.C. Crelling (2008) *Applied Coal Petrology: The Role of Petrology in Coal Utilization*, Academic Press, 708 p.

Thomas, L. (2020)*Coal Geology*, 3rd ed., Wiley-Blackwell, 536 p.

36. TKG226124 – Unconventional Oil and Gas Geology (2 Credit Points) – Semester I

This course will discuss unconventional oil and gas sources which include coal methane, shale hydrocarbons and methane hydrate. In addition, it will also discuss oil shale. An understanding of geology and geochemistry related to oil and gas genesis, generation, migration and alteration will be provided. In addition, the process of exploration and production of each of these unconventional oil and gas sources will also be discussed. It is hoped that participants will be able to integrate geological, geochemical and geophysical data to provide an assessment of the potential for unconventional oil and gas.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in non-conventional oil and gas geology by applying knowledge of mathematics, science, and engineering

B	Able to design and evaluate solutions to problems in research-based non-conventional oil and gas geology using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1/Exercise 1	10%	√	
Task 1	10%	√	
Midterm exam	30%	√	
Quiz 2/Exercise 2	10%		√
Task 2	10%		√
Final exams	30%		√

Reference

Flowers, M., 2014.*Coal and Coalbed Gas: Fueling The Future*, Elsevier, San Diego, 697 p.

Gandra, S., 2009.*Methane Production from Hydrate Bearing Formations*, Publishing Dr. Muller, Saarbrucken, 72 p.

Miller, F.P., Vandome A.F., McBrewster, J., 2009.*Oil Shale*, Alphascript Publishing, Berlin, 130 p.

Speight, J.G., 2013. *Shale gas Production*, Gulf Professional Publishing, Oxford, 162 p.

Surhone, L.M., Templedon, M.T., Marseken, S.F., 2010.*Oil Shale Geology*, Betascript Publishing, Berlin, 80 p.

37. TKG226226 – Characteristic Reservoir (2 SKS) – Semester I

This course provides an understanding of the integration of oil and gas reservoir data (rock facies, seismic, petrophysical and structural geology) to characterize the complexity and heterogeneity of oil and gas fields, especially within conventional and unconventional oil and gas frameworks. Basically, it will discuss the integration of well log, core, seismic and other data to create a realistic and predictive reservoir geology model. Focus will be on depositional geometry, diagenetic processes and reservoir compartmentalization.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of reservoir characteristics by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based reservoir characteristics using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	5%	√	
Task 1	20%	√	
Midterm exam	25%	√	√

Quiz 2	5%		√
Task 2	20%		√
Final exams	25%	√	√

Reference

Flowers, M. (2014)*Coal and Coalbed Gas: Fueling The Future*, Elsevier, San Diego, 697 p.

Lucia, F.J. (2007) *Carbonate Reservoir Characterization*. Springer Verlag, Berlin-Heidelberg, 336 p.

Nelson, R. A. (2001) *Geologic Analysis of Naturally Fractured Reservoirs*, Gulf Professional Publishing, Oxford, 332 p.

Slatt., R.M. (2006) *Stratigraphic Reservoir Characterization For Petroleum Geologists, Geophysicists, and Engineers*, Elsevier, Amsterdam, 478 p.

Rezaee, R. (2015) *Fundamentals of Gas Shale Reservoir*, John Wiley & Sons, New Jersey, 398 p.

38. TKG226126 – Basin Analysis (2 Credits) – Semester I

This course discusses the concept of the formation, development and modification of the structure of a sedimentary basin. Learning also includes increasing understanding of the formation of basins related to plate tectonics, the structure of the earth and its characteristics (physical, rheological and mechanical); basin classification; filling of hollows and their evolution; oil and gas system and valuation play. In addition, it discusses the evaluation of factors controlling the development of traps and reservoirs.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of basin analysis by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate problem solutions in the field of research-based basin analysis using modern engineering techniques and tools.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK E
Quiz 1	10%	√	√	
Task 1	10%		√	√
Midterm exam	30%	√	√	√
Quiz 2	10%	√	√	√
Task 2	10%	√	√	
Final exams	30%	√	√	√

Reference

Allen, P.A. and Allen, J.R. (2005) *Basin Analysis: Principles & Applications*, 2nd ed. Blackwell Scientific Publications, 549 p.

Leeder, M.R. (2011)*Sedimentology and Sedimentary Basins: From Turbulence to Tectonics*, 2nd ed., Wiley-Blackwell, 784 p.

Miall, A.D. (2000)*Principles of Sedimentary Basin Analysis*, 3rd ed., Springer, 637 p.

39. TKG226127 – Advanced Geothermal Geology (2 Credits) – Semester I

This course discusses the role of geology in the exploration, development and monitoring of geothermal fields. The discussion includes geological settings and geothermal manifestations and their implications in exploration strategies; understanding of the types of permeability and their implications for the hydrology of geothermal systems; rock fluid interaction processes, hydrothermal alteration and geothermal system characterization; age, activity duration and geothermal system dynamics.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based geothermal geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of geothermal geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of geothermal geology on the environment, society, socio-economic and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Task 1	15%	√		
Midterm exam	30%	√	√	
Task 2	15%			√
Final exams	40%	√	√	√

<u>Reference</u>

Boden, D.R. (2016) *Geologic Fundamentals of Geothermal Energy*, CRC Press, 425 p.

Gupta, H., and Sukanta, R. (2006)*Geothermal Energy: Alternative Resource for the 21st Century*, Elsevier Ltd.

Huenges , E. and P. Ledru (2011)*Geothermal Energy Systems: Exploration, Development, and Utilization*. Wiley-VCH, 486 p.

Mibei, G. (2013)*Geothermal Geology*, Lambert Academic Publishing, 100 p.

The Open University (2016) *Energy resources: Geothermal energy*, The Open University, 40 p.

40. TGL226128 – Advanced Geothermal Geochemistry (2 Credits) – Semester I

This course discusses the role of geochemistry in the exploration, production and monitoring of geothermal fields. The discussion covers the interpretation of water and gas isotope and chemical data, fluid-rock equilibrium, examples of the application of geochemistry in modeling geothermal systems, characterization of production fluids, and geothermal environmental monitoring. There is an emphasis on the importance of understanding the geological conditions of the geothermal area under study in designing geochemical research.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based geothermal geochemistry using modern engineering techniques and devices.
C	Able to convey ideas for problem solutions in the field of geothermal geochemistry to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of geothermal geochemistry on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Task 1	15%	√		
Midterm exam	30%	√	√	
Task 2	15%			√
Final exams	40%	√	√	√

Reference:

Boden, D.R. (2016) *Geologic Fundamentals of Geothermal Energy*, CRC Press, 425 p.

Gupta, H., and Sukanta, R. (2006)*Geothermal Energy: Alternative Resource for the 21st Century*, Elsevier Ltd.

Huenges , E. and P. Ledru (2011)*Geothermal Energy Systems: Exploration, Development, and Utilization*. Wiley-VCH, 486 p.

Mibei, G. (2013)*Geothermal Geology*, Lambert Academic Publishing, 100 p.

41. TKG226129 - Advanced Geothermal Geophysics (2 SKS) – Semester I

This course discusses the role of geophysics in the exploration, development and monitoring of geothermal fields. The discussion includes sources of geophysical anomalies in geothermal areas; methods for identifying the deposits and components of a geothermal system (type-resistance, magnetotelluric, gravitational, magnetic, temperature survey, geophysical drill hole *logging*), as well as methods for detecting fluid movement (micro-seismicity). There is an emphasis on the importance of understanding the geological conditions of the area under study on the selection of geophysical methods.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate problem solutions in research-based geothermal geophysics using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of geothermal geophysics to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of geothermal geophysics on the environment, society, socio-economics and culture, by upholding the ethics of professionalism.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Task 1	15%	√		
Midterm exam	30%	√	√	
Task 2	15%			√
Final exams	40%	√	√	√

Reference:

Gupta , H. , Sukanta , R. (2006).*Geothermal Energy: Alternative Resource for the 21st Century*, Elsevier Ltd.

Hochstein, M.P., and Bromley, C.J. (2005) Measurement of heat flux from steaming ground. *Geothermics*. 34. pp. 133–160.

Toth, A. and E. Bobok (2016) *Flow and Heat Transfer in Geothermal Systems: Basic Equations for Describing and Modeling Geothermal Phenomena and Technologies*, Elsevier, 379 p.

42. TKG226130 – Geothermal by-products (2 credits) – Semester I

This course discusses geothermal by-products in the form of gasses, liquids or solids which have been considered as waste and even pollutants. The discussion is focused on by-products from geothermal production with hydrothermal systems which are known to have the most by-products. The discussion includes the geological and geochemical characteristics of geothermal systems that have the potential to have by-products, examples of by-products, examples of utilization, and introduction of extraction technology. This course also provides an understanding of the necessity of using geothermal by-products as part of circular economic activities and environmental conservation.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of geothermal by-products to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of geothermal by-products on the environment, society, socio-economic and culture, by upholding the ethics of professionalism.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK D	CPMK E
Task 1	15%	√		
Midterm exam	30%	√	√	
Task 2	15%			√
Final exams	40%	√	√	√

Reference:

Behrens, H., Ghergut, J., Sauter, M., Wagner, B., and Wiegand, B. 2022. *Solute Co-Production from Small Geothermal Reservoirs – How Little Is Too Little?* PROCEEDINGS, 47th Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, California, February 7-9, 2022.

Climo, M., Carey, B., and Mroczek, E. 2022. *Update on Geothermal Mineral Extraction – the New Zealand journey*. Proceedings World Geothermal Congress 2020+1, Reykjavik, Iceland, April - October 2021.
DiPippo, R., 2016.*Geothermal Power Generation Development and Innovation*. Woodhead Publishing Series in Energi. 97. 822.
Dickson, M.H, and Fanelli, M., 2013. *Geothermal Energy: Utilization and Technology*. Routledge.
IRENA, 2019, *Global Energy Transformation 2019*.
Stringfellow, W.T., and Dobson, P.F. *Technology for the Recovery of Lithium from Geothermal Brines (2021)*. Energies. https://www.mdpi.com/journal/energies

43. TKG226131 – Geothermal for Sustainable Development (2 Credits) – Semester I

This course discusses geothermal energy as a natural resource that has the potential to be used as capital for sustainable development. The discussion includes: the character of geothermal resources which are controlled by geological conditions; superiority of geothermal energy and improvement of development technology that is more environmentally friendly; the role of geothermal energy in mitigating climate change and strengthening energy security and independence; the relevance of geothermal development to the global agenda*Sustainable Development Goals* (SDGs), and green recovery (*green recovery*).

Course Learning Outcomes (CPMK):

C	Able to convey ideas for solutions to problems in the geothermal field for sustainable development to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the geothermal field for sustainable development on the environment, society, socio-economic and culture, by upholding the ethics of professionalism.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	**Percentage**	**CPMK C**	**CPMK D**	**CPMK E**
Task 1	15%	√		
Midterm exam	30%	√	√	
Task 2	15%			√
Final exams	40%	√	√	√

Reference:

Brookes, A., 2021. *Challenges of Geothermal Developments in Small Islands Developing States*. Proceedings 43rd New Zealand Geothermal Workshop. 23-25 November 2021Wellington, New Zealand.
Dickson, M.H, and Fanelli, M., 2013. *Geothermal Energy: Utilization and Technology*. Routledge.
Soltani, M., Moradi Kashkooli, F., Souri, M., Rafiei, B., Jabarifar, M., Gharali, K., & Nathwani, J. S. (2021).*Environmental, economic, and social impacts of geothermal energy systems*. Renewable and Sustainable Energy Reviews, 140, 110750.
REN21:*Key Findings of the Renewables 2020*.
UNDP. 2022. *Sustainable Development Goals*. https://www.undp.org/sustainable-development-goals

Yasukawa, K., Kubota, H., Soma, N., & Noda, T. (2018).*Integration of natural and social environment in the implementation of geothermal projects*. Geothermics, 73, 111–123. https://doi.org/10.1016/j.geothermics.2017.09.011

44. TKG226132 – Applied Petrology (2 Credits) – Semester I

This course discusses the classification of igneous and metamorphic rocks based on aspects of texture, structure, and mineralogical and chemical composition. In addition, it also discusses the origins and processes of rock occurrence in the dimensions of space and time, in relation to the theory of plate tectonics and rock associations in various conditions of geological setting. This course also discusses the application of petrology of igneous and metamorphic rocks for the exploration of mineral deposits, as well as the engineering properties of rocks.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in applied petrology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based applied petrology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of applied petrology to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK C
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	√
Quiz 2	10%		√	
Task 2	10%			√
Final exams	30%	√	√	√

Reference:

Best, M.G. (2003) *Igneous and Metamorphic Petrology*, 2nd ed., Blackwell Publishing Co., 729 p.
Wilson, M. (2007) *Igneous Petrogenesis*, Springer-Verlag, Berlin, 466 p.
Winter, J.D. (2014) *Principles of Igneous and Metamorphic Petrology*, 2nd ed., Pearson Education Limited, Edinburgh, 737 p.

45. TKG226133 – Advanced Ore Sediment Geology (2 Credit Points) – Semester I

This course explains the definition of ore mineral deposits, classification of ore mineral deposits, hydrothermal alteration and ore texture, geology and characteristics of magmatic ore deposits such as chromite, nickel sulfide and PGM, geology and characteristics of hydrothermal ore deposits such as epithermal gold, porphyry copper-gold, copper-gold-base metal skarn, orogenic,*ore-mineralizing fluid*, geology of lateritic ore deposits (nickel, bauxite), geology of deposited gold deposits, several analytical techniques for ore deposit samples and an introduction to ore deposit exploration.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of ore deposit geology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate research-based problem solutions in the field of ore deposit geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of ore deposit geology to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√		
Task 1	10%	√		
Midterm exam	30%	√	√	
Quiz 2	10%		√	
Task 2	10%		√	
Final exams	30%		√	√

Reference:
Pohl, W.L., 2011,*Economic Geology: Principles and Practice*, Wiley-Blackwell, 663 p.
Robb, L. (2005),*Introduction to Ore-Forming Processes*, Blackwell Publishing, Carlton, Australia, 373 p.
Ridley, J., (2013), *Ore Deposit Geology*, Cambridge University Press, 398 p.

46. TGL226134 – Advanced Industrial Mineral Geology (2 Credits) – Semester I

This course discusses the definition of industrial minerals, the relationship between metal minerals and industrial minerals in the introductory session. In the following session, industrial mineral commodities were discussed, for example clay, especially kaolinite and bentonite, zeolite, phosphate, graphite, limestone, granite, pumice including their genesis, characteristics, availability and distribution mainly in Indonesia, method of identification, application in use, and simple processing processes.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of industrial mineral geology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in research-based industrial mineral geology using modern engineering techniques and tools.
D	Able to weigh the impact of problem solutions in the field of industrial mineral geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK D
Task 1	15%	√	√	
Midterm exam	35%	√	√	√
Task 2	15%		√	√
Final exams	35%	√	√	√

Reference:
Kogel , J.E. , Trivedi , N.C. , Barker , J.M. , Krukowski , S.T. (eds), 2006,*Industrial Minerals & Rocks: Commodities, Markets, and Uses*, 7th Ed., Society for Mining, Metallurgy, and Exploration, Inc., Colorado, 1548 p.

Murray, H.H., 2007, *Applied Clay Mineralogy, Development in Clay Science 2*, Elsevier, Amsterdam, 180 p.

Pohl, W.L., 2011,*Economic Geology: Principles and Practice*, Wiley-Blackwell, 663 p.

47. TKG226135 – Special Topic of Mineral Deposits (2 Credits) – Semester I

This course was made to anticipate and accommodate the emergence of interest in a new special topic related to a type of mineral resource, in accordance with the latest developments that have occurred in Indonesia and on a global scale. The types of mineral commodities and the scope of the topic of discussion will be adjusted according to developments that occur and the learning materials available at the time this course is offered. When this curriculum text is compiled in 2022, a special topic that is planned to be discussed in more depth is the topic of critical minerals (*critical raw metals*/minerals or CRM) which has become a global issue in recent years and is still being discussed as a strategic issue by the Indonesian government. In this case, this course discusses the definition, types/classification of critical minerals for the global and Indonesian context, as well as a discussion of the geological model of these critical mineral deposits and their exploration and extraction methods.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of special topics of mineral deposits to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of special technical techniques for mineral deposits on the environment, society, socio-economics and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK D	CPMK E
Quiz 1	10%	√		
Task 1	10%	√	√	
Midterm exam	30%	√	√	√
Quiz 2	10%		√	
Task 2	10%		√	√

Final exams	30%	√	√	√

Reference:

Gunn, G. (2014) *Critical Metals Handbook, American Geophysical Union*, 454 p.

National Research Council (2008), *Minerals, Critical Minerals, and the U.S. Economy, National Academies Press*, 263 p.

Pohl W.L. (2020)*Economic Geology, Principles and Practice: Metals, Minerals, Coal and Hydrocarbons – an Introduction to Formation and Sustainable Exploitation of Mineral Deposits*. 2nd ed. 755 p.

U.S. Department of Energy (2021) *Critical Minerals and Materials: U.S. Department of Energy's Strategy to Support Domestic Critical Mineral and Material Supply Chains* (FY 2021-FY 2031), 50 p.

48. TKG226136 – Mineral Exploration Engineering (2 Credits) – Semester I

This course will explain the notion of exploration, the mining industry cycle, geological criteria in exploration, exploration concepts, geophysical exploration methods, geochemical exploration methods (*stream sediment*/PALE,*soil and rock geochemical exploration*), sample and data analysis, geochemical data, estimation of resources & reserves with classical and geostatistical methods, Introduction to KCMI and feasibility studies of mining project.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based mineral exploration techniques using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of mineral exploration techniques to various parties with good and responsible communication.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMKB	CPMK C	CPMK E
Quiz 1	10%	√		
Task 1	10%	√		
Midterm exam	30%	√	√	
Quiz 2	10%		√	
Task 2	10%		√	
Final exams	30%		√	√

Reference:

Haldar, S.K., 2013,*Mineral Exploration: Principles and Applications*, Elsevier, Amsterdam, 334 p.

Marjoribanks, R., 2010, *Geological Methods, in Mineral Exploration and Mining*, 2nd Ed., Springer-Verlag, Heidelberg, 238 p.

Moon, J. C., Whateley, M.K.G., Evans, A.M., 2006, *Introduction to Mineral Exploration*, Blackwell Publishing, 481p.

KCMI IAGI-PERHAPI Joint Committee, 2017. Indonesian Mineral Reserves Committee Code (KCMI Code) 2017, 71 p.

49. TKG226137– Metallogeny (2 SKS) – Semester I

This course discusses the concept of metallogeny, namely the study of the genesis and existence/distribution of various types of mineral deposits both regionally and globally, which are related in space and time to the existence of rock types (lithology) and the conditions of a typical tectonic arrangement in various parts of the crust. earth. Specifically for the Indonesian archipelago, this course discusses current understanding of Indonesia's metallogenic provinces for various metal mineral commodities Cu-Au, Sn, Ni, and bauxite (Al). An understanding of the metallogenic conditions of an area is expected to provide us with knowledge about the typical geological conditions for the presence of certain types of mineral deposits, and can be applied by various stakeholders for regional development planning strategies, as well as regional selection strategies for successful exploration of similar mineral resources. in the future.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the metallogenic field by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate research-based problem solutions in the field of metallogeny using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of engineering geology to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK C
Quiz 1	10%	√		
Task 1	10%	√	√	
Midterm exam	30%	√	√	√
Quiz 2	10%		√	
Task 2	10%		√	√
Final exams	30%	√	√	√

Reference:

Arndt, N.T., Fontboté, L., Hedenquist, J.W., Kesler, S.E., Thompson, J.F.H., and Wood, D.G. (2017) *Future Global Mineral Resources*, Geochemical Perspectives, Vol. 6, – April 2017, p. 1-171, doi: 10.7185/geochempersp.6.1

Geological Agency (2013)*Peta Metalogeni Indonesia Skala 1: 5,000,000*

Pohl W.L. (2020)*Economic Geology, Principles and Practice: Metals, Minerals, Coal, and Hydrocarbons – an Introduction to Formation and Sustainable Exploitation of Mineral Deposits*. 2nd ed. 755 pp.

van Leeuwen, T. (2018)*25 More Years of Mineral Exploration and Discovery in Indonesia*, Special Publication Indonesian Geological Society, ISBN: 978-979-8126-34-5, 319 p.

50. TKG226138 – Geology of Remote Sensing and Information Systems (2 Credits) – Semester I

This course discusses the meaning of remote sensing geology, remote sensing imagery, remote sensing for geology, geological information obtained from remote sensing imagery, remote sensing systems, various types of remote sensing imagery, remote sensing imagery imaging, factors in image interpretation for geology, remote sensing image interpretation tools, image interpretation stages in geological mapping, photogrammetry for geology supported by Geographic Information Systems (GIS). This course provides advanced knowledge about the use of GIS and*Remote Sensing* for exploration, exploitation, analysis, evaluation of spatial data on geological resources and disasters. The topics given in GIS are data *storage, database modeling, spatial database management, data organization, spatial analysis, data quality and error* and understanding of remote sensing, remote sensing methods and use of remote sensing data processing software.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in remote sensing geology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate research-based solutions to problems in the field of remote sensing geology using modern engineering techniques and devices.
C	Able to convey ideas for problem solutions in the field of remote sensing geology to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK C
Task 1	10%	√		
Midterm exam	40%	√		
Task 2	10%	√	√	
Final exams	40%	√	√	√

Reference:
Keranen, K., and R. Kolvoord (2013).*Making Spatial Decisions Using GIS and Remote Sensing*. Esri Press.
Lillesand T., R.W. Kiefer, and J. Chipman (2007)*Remote Sensing and Image Interpretation*, 6th ed. Wiley, 804 pp.
Prost, G.L. (2013)*Remote Sensing for Geoscientists: Image Analysis and Integration*, 3rd ed. CRC Press, 702 pp.
Weng, Q. (2009)*Remote Sensing and GIS Integration: Theories, Methods, and Applications: Theory, Methods, and Applications*. McGraw-Hill Education, 416 pp.

51. TKG226139 – Mitigation of Geological Disasters (2 Credits) – Semester I

The topics discussed in this course include the introduction of sources of geological disasters as a result of geological processes. The discussion mainly focuses on processes that are common in Indonesia such as volcanoes, earthquakes, tsunamis, floods and landslides. The discussion of the material also emphasizes phenomena that have occurred, their predictions and mitigation. This course will also introduce several geological hazard assessment methods which include: heuristic, statistical, and probabilistic models as well as analysis of their reliability level.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of geological disaster mitigation by applying knowledge of mathematics, science, and engineering

B	Able to design and evaluate problem solutions in the field of research-based geological disaster mitigation using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz	10%	√	√
Task 1	10%		√
Midterm exam	30%	√	√
Task 2	10%	√	√
Final exams	30%	√	√

<u>Reference</u>:

Abbott, P. L. (2008) *Natural Disasters*. New York: McGraw-Hill.

Bell, F. G. (2003) *Geological Hazards: Their Assessment, Avoidance and Mitigation*. CRC Press.

Bolt, B. A., Horn, W. L., MacDonald, G. A., & Scott, R. F. (2013) *Geological Hazards: Earthquakes-Tsunamis-Volcanoes-Avalanches-Landslides-Floods*. Springer Science & Business Media.

Keller, E. A., and DeVecchio, D. E. (2016) *Natural hazards: Earth's Processes as Hazards, Disasters, and Catastrophes*. Routledge.

52. TKG226140 – Geological Hazard Risk Management (2 Credits) – Semester I

This subject is focused on geological disaster risk management to achieve community resilience in facing future geological disasters. The geological disaster risks discussed include volcanic eruptions, earthquakes, tsunamis, liquefaction, landslides, floods and droughts. In addition, at the beginning of the lecture, the definition of risk and the various parameters that influence it will be explained.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of geological disaster risk management to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of geological disaster risk management on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK D
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%	√	
Task 2	10%		√

Final exams	30%	√	√

Reference:

Twigg, J. (2015) *Disaster Risk Reduction, Humanitarian Policy Group Overseas Development Institute*, London, UK, 368p

Bell, F.G. (1999) *Geological Hazards-Their assessment, avoidance and mitigation*, CRC Press, 656p.

AND (2015)*Sendai Framework for Disaster Risk Reduction 2015-2030, 27p.*

Holmes, R.R, Jones, Jr., L.M., Eidenshink, J.C., Godt, J.W., Kirby, S.H., Love, J.J, Neal, C.A, Plant, N.G, Plunkett, M.L., Weaver, C.S., Wein, A., and Perry, S.C., (2013) *Natural Hazards Science Strategy— Promoting the Safety, Security, and Economic Well-Being of the Nation*, Circular 1383–F USGS

53. TKG226141 – Geological Disaster Engineering (2 SKS) – Semester I

This subject is focused on engineering geological disasters in dealing with and reducing the damage caused by these disasters. Geological disaster engineering discussed includes engineering and technical efforts related to volcanic eruptions, earthquakes, landslides and liquefaction, as well as flood disasters. In addition, at the beginning of the lecture, the definition of risks and impacts caused by the geological disaster and the various parameters that influence them will be explained. Engineering and engineering efforts discussed in this course also include the development of monitoring (*early warning system*), disaster management technology, and physical infrastructure in reducing the risk of geological disasters

Course Learning Outcomes (CPMK):

B	Able to design and evaluate problem solutions in the field of research-based geological disaster engineering engineering using modern engineering techniques and tools.
D	Able to weigh the impact of problem solutions in the engineering engineering field of geological disasters on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK D
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%	√	
Task 2	10%		√
Final exams	30%	√	√

Reference:

Abbott, P. L. (2008) *Natural Disasters*. New York: McGraw-Hill.

Abramson, L.W., Lee, T.S., Sharma, S., and Boyce, G.M., 2002, *Slope Stability and Stabilization Methods*, John Wiley & Sons, Inc.

Bell, F. G. (2003) *Geological Hazards: Their Assessment, Avoidance and Mitigation*. CRC Press.

Chopra, A.K., 2017.*Dynamics of structures. Theory and applications to Earthquake Engineering*, Pearson Education

54. TKG226142 – Earthquake Dynamics (2 credits) – Semester I

Topics that will be discussed in this lecture include the mechanism of earthquake occurrence in relation to the theory of plate tectonics which controls the distribution of earthquake centers, the relationship between earthquakes and faulting and its dynamics. The lecture will also provide an understanding of the definition and criteria for active faults and how to identify them. In addition, it also discusses the size of the earthquake (magnitude and intensity), the characteristics of the earthquake based on its source, the impacts caused by earthquakes, both direct and secondary impacts. Characteristics of seismic waves generated by earthquake events will also be discussed, including types of body and surface waves as well as earthquake monitoring systems. This lecture will also discuss the influence of local geological conditions on wave amplification and attenuation which will later affect the effects of the resulting shocks and their effects on*built infrastructure*.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of earthquake dynamics by applying knowledge of mathematics, science and engineering
C	Able to convey ideas for problem solutions in the field of earthquake dynamics to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of earthquake dynamics on the environment, society, socio-economic and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK C	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	√
Quiz 2	10%	√		
Task 2	10%			√
Final exams	30%	√	√	√

Reference:

Kearey, P., Klepeis, K.A. and Vine, F.J., 2013. *Global tectonics*. John Wiley & Sons.

Burbank, D. W., & Anderson, R. S. (2011). *Tectonic geomorphology*. John Wiley & Sons.

McCalpin, James P. "*Paleoseismology*." (2012): 311-312.

William , H.K.L. , Kanamori , H. , Jennings , P.C.*International Handbook of Earthquake and Engineering Seismology*, Part A, Academic Press, London,

Chopra, A.K., 2017.*Dynamics of structures. Theory and applications to Earthquake Engineering*, Pearson Education.

Stein, S. And Wysession, M., 2003. *An Introduction to Seismology, Earthquake, and Earth Structure*, Black Well Publishing.

55. TKG226143 - Earthquake Hazard Mitigation (2 Credit Points) – Semester I

The topic of discussion in this class includes an overview of the process by which earthquakes occur that affect human life, as well as efforts that can be made to reduce the impact of earthquake events.

By attending this course, students are expected to be able to understand comprehensively about geological processes and their relation to earthquake occurrences, including identifying the various types of impacts that may arise as a result of earthquake occurrences and mitigation strategies to minimize these impacts. This lecture will also discuss a series of general procedures in disaster and earthquake risk assessment and their use in determining the level of community vulnerability. There will also be an in-depth discussion of the relationship between the results of this assessment in disaster mitigation planning at various levels of society to the government.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of earthquake hazard mitigation by applying knowledge of mathematics, science and engineering
C	Able to convey ideas for problem solutions in the field of earthquake hazard mitigation to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of earthquake hazard mitigation on the environment, society, socio-economic and culture, by upholding the ethics of professionalism

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK C	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	√
Quiz 2	10%	√		
Task 2	10%			√
Final exams	30%	√	√	√

<u>Reference:</u>

Kearey, P., Klepeis, K.A. and Vine, F.J., 2013. *Global tectonics*. John Wiley & Sons.

William , H.K.L. , Kanamori , H. , Jennings , P.C.*International Handbook of Earthquake and Engineering Seismology*, Part A, Academic Press, London,

Chopra, A.K., 2017.*Dynamics of structures. Theory and applications to Earthquake Engineering*, Pearson Education.

Dilley, M. (2005). *Natural disaster hotspots: a global risk analysis (Vol. 5)*. World Bank Publications.

Center, A. D. R. (2011). *Natural Disaster Data Book*. 2009.(An Analytical Overview).

Abbott, P. L., & Samson, C. (2008). *Natural disasters* (p. 512). New York: McGraw-Hill.

56. TKG226144 – Volcano Monitoring Technology (2 Credits) – Semester I

This course delivers topics regarding volcano monitoring technology, both long-term and short-term monitoring. The monitoring technology that will be studied consists of geological, petrological, geochemical, and geophysical methods.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of volcano monitoring technology by applying knowledge of mathematics, science, and engineering

B	Able to design and evaluate problem solutions in the field of research-based volcano monitoring technology using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis , namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%	√	
Task 2	10%		√
Final exams	30%	√	√

Reference:
Sigurdsson, H., Houghton, B., McNutt, S.R., Rymer, H., Stix, J. (eds), 2015, *The Encyclopedia of Volcanoes*, 2 ed., Elsevier, Amsterdam, 1421 p.
Nishimura, T. and Iguchi, M., 2011,*Volcanic Earthquakes and Tremor in Japan*, Kyoto University Press, Japan.
Parfitt, L. and L. Wilson, 2008, *Fundamentals of Physical Volcanology*, Wiley-Blackwell, 252 p.
Wassermann, J., 2012,*Volcano Seismology - In Bormann P. (Ed)*, New Manual of Seismological Observatory Practice 2: Deutsches GeoForschungsZentrum GFZ, pp. 1-77.
Newhall, C. & Hoblitt, R., 2002, *Constructing event trees for volcanic crises. Bulletin of Volcanology*, Springer.

57. TKG226145 – Climate Change Reconstruction (2 Credits) – Semester I

Understand various proxies and methods used in climate change reconstruction. One of the methods to be discussed is the reconstruction of climate change using the Biogeochemistry method, namely Stable Oxygen Isotopes, besides that climate change reconstruction is also discussed using several types of fossils such as foraminifera, nannofossils, coral and pollen spores.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of climate change reconstruction by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in the field of research-based climate change reconstruction using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	5%	√	
Task 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%	√	
Task 3	10%		√
Final exams	30%	√	√

Reference:
Hillaire-Marcel, C. and A. de Vernal (eds) (2007) *Proxies in Late Cenozoic Paleoceanography*, Elsevier Science, 862 pp.
Ramkumar, M. (2015).*Chemostratigraphy: Concepts, techniques, and applications*. Elsevier
Ruddiman, W.F (2013) *Earth's Climate: Past and Future*, 3rd ed. W. H. Freeman, 464 pp.

58. TKG226146 – Quaternary Geology and Climate Change (2 Credits) – Semester I

This course introduces the topic of Quaternary Geology with an emphasis on important geological processes and events that occurred during the Quaternary era (2.6 million years ago), including glaciation processes, climate change and its consequences for sea level changes and other geological processes. happen. In addition, this course also introduces the methods used to study Quaternary Geology.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate research-based problem solutions in the fields of Quaternary geology and Climate Change using modern engineering techniques and tools.
D	Able to consider the impact of problem solutions in the field of quaternary geology and climate change on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK D
Quiz 1	10%	√	
Task 1	10%	√	
Midterm exam	30%	√	
Quiz 2	10%		√
Task 2	10%		√
Final exams	30%	√	√

Reference:
Bradley, R. S. (1999). *Paleoclimatology: reconstructing climates of the Quaternary*. Elsevier.

Gale, S., and Hoare, P. G. (2012). *Quaternary Sediments: Petrographic Methods for the Study of Unlithified Rocks*. Blackburn Press.
Walker, M., & Walker, M. J. C. (2005). *Quaternary Dating Methods*. John Wiley and Sons.

59. TKG226147 – MArine Geology and Palaeoclimate (2 SKS) – Semester I

Sediments of the sea and ocean floors provide valuable information about the dynamics of oceanic circulation and past climate change. This course will provide knowledge about ocean processes and mechanisms that produce the distribution of various types of seafloor sediments. Students will study how environmental and climate changes are recorded in the marine environment, as well as how the deposits and composition of marine sediments vary geographically. At the end of the course students will be able to:

- have knowledge state *of the art* about the sampling technique of seafloor sediments,
- interpret and understand the data (*proxy*) ancient climate
- critically evaluate and present the latest scientific literature related to the field of marine geology and paleoclimate.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of marine geology and paleoclimatology by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate research-based solutions to problems in the field of marine geology and paleoclimatology using modern engineering techniques and tools.
D	Able to weigh the impact of problem solutions in the field of marine geology and climatology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	
Quiz 2	10%			√
Task 2	10%			√
Final exams	30%	√		√

<u>Reference</u>

Ruddiman, W.F (2013) *Earth's Climate: Past and Future*, 3rd ed. W. H. Freeman, 464 pp.
Keith D. Alverson, K.D., R.S. Bradley , and T.F. Pedersen (eds) (2013)*Paleoclimate, Global Change and the Future*, Springer, 235 pp.
Hillaire-Marcel, C. and A. de Vernal (eds) (2007) *Proxies in Late Cenozoic Paleoceanography*, Elsevier Science, 862 pp.
Wicander, R. and J.S. Monroe (2010) *Historical Geology*, 8th ed., Brooks Cole, 448 pp.

60. TKG226148 – Quaternary Stratigraphy (2 Credits) – Semester I

Stratigraphy is the study of the sequence of formation of sedimentary rocks with various aspects of facies dynamics and changes in the depositional environment. Quaternary sedimentary rocks have unique and interesting advantages to study. Fossils, traces and evidence of human civilization from ancient to modern are stored in Quaternary rocks. Patterns, traces and dynamism of climate change to disasters as well as fossils of modern life make Quaternary rocks have important value in viewing history and predicting the future. Topics to be discussed include the characteristics of quaternary rocks, quaternary biostratigraphy, rocks that characterize climate change, the dynamics of life and quaternary disasters based on their stratigraphic records. Field trips will be carried out around the UGM campus to see aspects of quarterly stratigraphy, civilization and disaster.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of Quaternary stratigraphy to various parties with good and responsible communication.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK E
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%	√	
Task 2	10%	√	√
Final exams	30%	√	√

Reference:
Brookfield, M., 2004, *Principles of Stratigraphy*, Wiley-Blackwell, 340p.
Indonesian Stratigraphic Coding Commission, 1996,*Indonesian Stratigraphic Code*, IAGI, 36 p.
Lowe.J., and Walker, 1997, *Reconstructing Quaternary Environments*, Harlin, Longman Ltd. 568p.
Nichols, G., 2004, *Sedimentology and stratigraphy 2nd Ed.*, Wiley-Blackwell, 432p.
Walker, M., 2005, *Quaternary dating method*, John Wiley & Sons Ltd., 294p.

61. TKG226149 – Vertebrate and Invertebrate Palaeontology (2 Credit Points) – Semester I

One of the branches of paleontology is vertebrate and invertebrate fossils. This lecture will focus on discussing these two types of fossils. The distribution and evolution of vertebrate and invertebrate fossils is very wide and has a very significant meaning in the evolution of living things. In its evolution, organisms are very influential on climate change during their life. This lecture will thoroughly discuss the diversity of vertebrate and invertebrate fossils in relation to evolution and climate change.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of vertebrate and invertebrate paleontology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate research-based solutions to problems in the field of vertebrate and invertebrate paleontology using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%	√	
Midterm exam	30%	√	
Quiz 2	10%		√
Task 2	10%		√
Final exams	30%		√

Reference:

Benton, M. J. (2014). *Vertebrate paleontology*. John Wiley & Sons.

Kardong, K. V. (2019).*Vertebrates: comparative anatomy, function, evolution*. Heinle and Heinle Publishers.

Clarkson, E.N.K. 1998. *Invertebrate Palaeontology and Evolution*. 4th ed. Blackwell, NYC.

Foote, M. And Miller, A.I., 2007, *Principles of Paleontology*, 3rd ed., W.H. Freeman and Co., New York, 356p.

62. TKG226150 – Petrology and Diagenesis of Carbonate Rocks (2 Credits) – Semester I

Carbonate rocks have special characteristics that are different from siliciclastic rocks in general. Not only are carbonate rocks precipitated, but some are grown as a result of the activities of organisms, and are also formed as a result of chemical processes. This understanding is important, because not all carbonate rock textures can be used to describe the depositional environment and/or physical properties of the reservoir rock. Age changes in carbonate rocks towards younger rocks can be vertical, lateral or both. Uniquely all carbonate facies can turn into sati facies when they have undergone very advanced diagenesis. Therefore an understanding of carbonate rocks is very important.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of petrology and diagenesis of carbonate rocks to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of petrology and diagenesis of carbonate rocks on the environment, society, socio-economics and culture, by upholding professionalism ethics

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK D
Quiz 1	10%	√	
Task 1	10%	√	
Midterm exam	30%	√	
Quiz 2	10%		√
Task 2	10%		√
Final exams	30%		√

Reference:

Lucia, F.J., 2007, *Carbonate Reservoir Characterization an Integrated Approach,* Springer, 333p.
Plaice, P.A. and Scholle, D.S.U, 2003,*A Color Guide to the Petrography of Carbonate Rocks: Grains, textures, porosity, diagenesis*, AAPG Memoir 77, 470p.

63. TKG226107 – Applied Geochemistry (3 Credits) – Semester II

This course conveys the basic principles and techniques of modern geochemistry, starting with a review of the thermodynamics and kinetics aspects that work on Earth and its environment. This basic concept is then applied to the understanding of geochemical processes in aquatic systems and the behavior of elementary elements in magmatic systems. Subsequent reviews of isotope and radiogenic geochemistry and their applications in the determination of ancient geological and climate timing. The final section will cover organic geochemistry, covering the processes of hydrocarbon formation and carbon cycling in controlling Earth's climate, both in the past in the geological record and in the present in dramatic global climate change.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate problem solutions in research-based applied geochemistry using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of applied geochemistry to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of applied geochemistry on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√	√	
Task 1	10%		√	√
Midterm exam	30%	√	√	√
Quiz 2	10%	√	√	
Task 2	10%	√	√	√
Final exams	30%	√	√	√

Reference:
Eby, N. (2003)*Principles of Environmental Geochemistry*, Cengage Learning, 528 p.
Misra, K.C. (2012) *Introduction to Geochemistry: Principles and Applications*, Wiley-Blackwell, 452 p.
White, W.M. (2013) *Geochemistry*, Wiley-Blackwell, 668 p.

64. TKG226108 – Applied Geochemistry Practicum (1 Credit) – Semester II

This course conveys the basic principles and techniques of modern geochemistry, starting with a review of the thermodynamics and kinetics aspects that work on Earth and its environment. This basic concept is then applied to the understanding of geochemical processes in aquatic systems and the behavior of elementary elements in magmatic systems. Subsequent reviews of isotope and radiogenic geochemistry and their applications in the determination of ancient geological and climate timing. The final section will cover organic geochemistry, covering the processes of hydrocarbon formation and carbon cycling in controlling Earth's climate, both in the past in the geological record and in the present in dramatic global climate change.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of applied geochemistry to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of applied geochemistry on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK D
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%	√	√
Task 2	10%	√	√
Final exams	30%	√	√

Reference:
Eby, N. (2003)*Principles of Environmental Geochemistry*, Cengage Learning, 528 p.
Misra, K.C. (2012) *Introduction to Geochemistry: Principles and Applications*, Wiley-Blackwell, 452 p.
White, W.M. (2013) *Geochemistry*, Wiley-Blackwell, 668 p.

65. TKG226209 – Slope Stability (2 Credits) – Semester II

This course discusses the stability analysis of slopes composed of soil and rock. Topics taught include reviewing the principle of soil shear strength and analysis of effective and total stresses; soil slope stability analysis; soil slope stabilization method; instrumentation and monitoring of soil and rock slope stability; rock slope stability analysis; and rock slope stabilization methods.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of slope stability by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate research-based problem solutions in the field of slope stability using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz	20%	√	√
Task	20%	√	√
Midterm exam	30%	√	√
Final exams	30%	√	√

Reference:
Abramson, L.W., Lee, T.S., Sharma, S., and Boyce, G.M., 2002, *Slope Stability and Stabilization Methods*, John Wiley & Sons, Inc.
Duncan, J.M. and Wright, S.G., 2005, *Soil Strength and Slope Stability*, John Wiley & Sons, Inc.
Singh, B. and Goel, R.K., 2011, *Engineering Rock Mass Classification: Tunneling, Foundations, and Landslides*, Butterworth-Heinemann.
Wyllie, D.C. and Mah, C.W., 2004, *Rock Slope Engineering: Civil and Mining*, Spon Press.

66. TKG226112 – Construction Management (2 Credits) – Semester II

This course discusses management systems in surface and subsurface construction work. Topics taught include review of construction works, project procurement systems and construction management, construction management tools, building information modeling (BIM) in design and construction, contract documents, construction management, lean construction, and ISO certification in the construction industry.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of construction management by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate solutions to problems in the field of research-based construction management using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz	20%	✔	✔
Task	20%	✔	✔
Written exam (UTS)	30%	✔	✔
Written exam (UAS)	30%	✔	✔

Reference:
Goel, R.K., Singh, B., and Zhao, J., 2012, *Underground Infrastructures: Planning, Design, and Construction*, Buttenworth-Heinemann, Amstersdam, 336 pp.
Rumane, A.R., 2017,*Handbook of Construction Management: Scope, Schedule, and Cost Control*, CRC Press.
Eastman, C., Teicholz, P., Sacks, R., and Liston, K., 2011, *BIM Handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors*, 2nd ed., Wiley
Wood, A.M., 2000, *Tunneling: Management by Design*, E & FN Spon.

67. TKG226211 – Geotechnical Engineering of Dams (2 Credits) – Semester II

This course discusses geotechnical applications in the construction of fill dams. Topics taught include consideration of geological conditions in the construction of dams; field investigations; engineering properties of embankment and foundation materials; clay minerals and engineering properties of clay soil; division of zones and dam body construction materials; soil compaction; filter design; stability and deformation analysis; seismic considerations;*grouting*; as well as instrumentation and monitoring.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the geotechnical field of dams by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate solutions to problems in the geotechnical field of research-based dams using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

ComponentAssessment	Percentage	CPMK A	CPMK B
Quiz	20%	✔	✔
Task	20%	✔	✔
Written exam (UTS)	30%	✔	✔
Written exam (UAS)	30%	✔	✔

Reference:
Fell, R., MacGregor, P., Stapledon, D., Bell, G., and Foster, M., 2014, *Geotechnical Engineering of Dams*, CRC Press.
U.S. Army Corps of Engineers, 2004, *General Design and Construction Considerations for Earth and Rock-Fill Dams*.EM 1110-2-2300.
U.S. Bureau of Reclamation, 2011, *Design Standards No.13: Embankment Dams*, U.S. Department of the Interior.
Zhang, L., Peng, M., Chang, D., and Xu, Y., 2016, *Dam Failure Mechanisms and Risk Assessment*, John Wiley & Sons Singapore Pte. Ltd.

68. TKG226210 – Finite Element Method (2 Credits) – Semester II

This course discusses numerical modeling techniques in the design of surface and subsurface constructions using the finite element method. Topics taught include review of solid *mechanics*; elasticity theory; finite element method; and application of computer programs for slope stability analysis and tunnel and underground space construction design.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of finite element method by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based finite element methods using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	The CPM	CPMK B
Quiz	20%	√	√
Task	20%	√	√
Midterm exam	30%	√	√
Final exams	30%	√	√

Reference:
Beer, G., 2003, *Numerical Simulation in Tunnelling*, Springer-Verlag.
Lees, A., 2016, *Geotechnical Finite Element Analysis: A practical guide*, ICE Publishing.
Potts, D.M. and Zdravkovic, L., 1999, *Finite Element Analysis in Geotechnical Engineering: Theory*, Thomas Telford
Potts, D.M. and Zdravkovic, L., 2001, *Finite Element Analysis in Geotechnical Engineering: Application*, Thomas Telford.
Zhu, W. and Zhao, J., 2004,*Stability Analysis and Modelling of Underground Excavations in Fractured Rocks*, Elsevier Ltd.

69. TKG226212 – Safety, Health and Work Environment (2 Credits) – Semester II

This course provides knowledge about health and safety, especially in tunnel construction. The material that will be provided includes: basics of OHS (occupational health and safety), performance measurement and information recording, techniques in construction safety management, safety policies, risk assessment, control strategies for construction work, health and safety planning, construction and environment, construction hazards and solutions.

Course Learning Outcomes (CPMK):

D	Able to weigh the impact of problem solutions in the field safety*, health & environment* towards the environment, society, socio-economic and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK D	CPMK E
Task 1	15%	√	
Midterm exam	35%	√	√
Task 2	15%		√
Final exams	35%	√	√

Reference:
Brauer, R.L. (2005) *Safety and Health for Engineers*, 2nd ed. Wiley-Interscience, 758 pp.
Cahill, L.B. (2001) *Environmental Health and Safety Audits*, 8th ed. Government Institutes, 713 pp.
Mercurio, J., and J. Roughton, (2002) *Developing an Effective Safety Culture: A Leadership Approach*. Butterworth-Heinemann.
The Open University (2016) *Integrated safety, health and environmental management*. The Open University, 80 pp.

70. TKG226213 – Mining Geotechnical (2 Credit) – Semester II

This course discusses geotechnical applications in mining, especially open pit mining. Topics taught include an introduction to surface and subsurface mining methods; open pit mine slope design; subsurface mine stability; deformation monitoring; mining waste disposal; and acid mine water.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the mining geotechnical field by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in the field of research-based mining geotechnical engineering using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz	20%	√	√
Task	20%	√	√
Midterm exam	30%	√	√
Final exams	30%	√	√

Reference:
Blight, G., 2010, *Geotechnical Engineering for Mine Waste Storage Facilities*, CRC Press.
Hustrulid, W.A., McCarter, M.K., and Van Zyl, D.J.A., 2000, *Slope Stability in Surface Mining,* Society for Mining, Metallurgy, and Exploration, Inc.
Onargan, T., 2012,*Mining Methods*, InTech.
Read, J. and Stacey, P., 2009, *Guidelines for Open Pit Slope Design*, CSIRO.

71. TKG226215 – Pollution and Groundwater Remediation Techniques (2 Credit Points) – Semester II

The focus of this course material includes identification of natural groundwater quality, groundwater quality standards, concepts*Source-Media-Target*, sources and processes of groundwater contamination, pathogenic contaminants, organic-non-organic contaminants, pollutant transport processes in groundwater, and groundwater pollution mitigation.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of pollution and groundwater remediation techniques by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate problem solutions in the field of research-based pollution and groundwater remediation techniques using modern engineering techniques and devices.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%		√
Task 2	10%	√	
Final exams	30%	√	√

Reference:

Berkowitz, B., Dror, I., & Yaron, B. (2008) *Contaminant Geochemistry*, Springer-Verlag.

Fetter, C.W. (2008) *Contaminant Hydrogeology*, 2nd ed, Waveland Press, Inc.

Gray, W. (2019*) Groundwater Contamination: A practical approach to contamination assessment, remediation, and groundwater sampling*. Earth 2 Energy Educational Publishing, 426 p.

Weiner, E.R. (2012) *Applications of Environmental Aquatic Chemistry: A Practical Guide*, 3rd ed., CRC Press, 618 p.

72. TKG226216 – Groundwater Protection and Monitoring (2 SKS) – Semester II

This course focuses on the sustainability and sustainability of groundwater resources, both in quantity and quality. The material provided is the concept of sustainable groundwater management, integrated water resources management, groundwater protection, determination of groundwater protection zones, determination of groundwater vulnerability to pollution and groundwater pumping, monitoring concepts and determining locations for monitoring groundwater resources.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based groundwater protection and monitoring using modern engineering techniques and devices.
C	Able to convey ideas for problem solutions in the field of protection and supervision of groundwater to various parties with good and responsible communication.

D	Able to weigh the impact of problem solutions in the field of protection and supervision of groundwater on the environment, society, socio-economic and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	√
Quiz 2	10%	√		
Task 2	10%			√
Final exams	30%	√	√	√

Reference:

Gili, E., Mangan, C., & Mudry, J. (2012).*Hydrogeology: Objectives, Methods and Application*, CRC Press.

Johansson, P.-O, and Hirata, R. (2002) Rating of Groundwater Contaminant Sources, in Zaporosec, (ed), *Groundwater Contamination Inventory: A Methodological Guide*, IHP-VI, Series on Groundwater No.2, UNESCO, p.63 – 74.

Schmoll, O., Howard, G., Chilton, J., & Chorus, I. (2006) *Protecting Groundwater for Health*, World Health Organization, IWA Publishing.

73. TKG226217 – Hydrogeology of Karst and Crystalline Rocks (2 Credit Points) – Semester II

Hydrogeologically, it is known that more than half of the continent's surface area is covered with hard rock with low permeability and karst areas which have unique hydrological characteristics. In the first half, matters relating to karst hydrogeology are presented, namely the notion of karst, the laws of dissolution kinetics, chemical equilibrium and physical flows related to the karst environment, the classification system for cave systems and the influence of climate and climate change on karst hydrology. The second half discusses the hydrogeological aspects of fractures from various lithological groups, including crystalline rocks and volcanic rocks.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of hydrogeology of karst and crystalline rocks by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate problem solutions in the field of research-based karst hydrogeology and crystalline rocks using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%		√
Task 2	10%	√	
Final exams	30%	√	√

Reference:

Ford, D., & Williams, P. (2007) *Karst Hydrogeology and Geomorphology*, John Wiley & Sons Inc.

Krasny, J., & Sharp, J.M. (2003)*Groundwater in Fractured Rocks*, International Hydrogeologist Association (IAH), Taylor & Francis.

Singhal, B.B.S., & Gupta, R.P. (2010) *Applied Hydrogeology of Fractured Rocks*, 2nd ed, Springer.

74. TKG226218 – Groundwater Exploitation (2 Credits) – Semester II

This lecture focuses on the theory and practical application of groundwater utilization starting from understanding groundwater resource reserves, determining safe *yield* and sustainable *yield*, determination of the optimum discharge for pumping, treatment of groundwater exploitation wells, methods dewatering, the utilization of groundwater in various fields and regions, as well as the impact of groundwater utilization on the environment such as the problem of saltwater intrusion.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of groundwater exploitation by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate research-based solutions to problems in the field of groundwater exploitation using modern engineering techniques and tools.
D	Able to weigh the impact of problem solutions in the field of groundwater exploitation on the environment, society, socio-economic and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	√
Quiz 2	10%	√		
Task 2	10%			√
Final exams	30%	√	√	√

Reference:

Gili, E., Mangan, C., & Mudry, J. (2012).*Hydrogeology: Objectives, Methods and Application*, CRC Press.

LaMoreaux, P.E., Soliman, M.M., Memon, B.A., LaMoreaux, J.W., & Assaad, F.A. (2009) *Environmental Hydrogeology*, 2nd ed, CRC Press, Taylor Francis Group.

Smith, S.A. (1995) *Monitoring and Remediation Wells; Problem Prevention, Maintenance and Rehabilitation*, CRC Press.
Todd, D.K., & Mays, L.W. (2005) *Groundwater Hydrology*, 3rd ed, John Wiley & Sons.

75. TKG226219 – Urban Hydrogeology (2 SKS) – Semester II

Over the last three decades, urban groundwater has emerged as one of the world's most pressing problems. Explosive population growth, which is most common in cities, has placed excessive demands on groundwater supplies, driving concern for long-term sustainability at a time when the quality of the available resource i.e. groundwater is being increasingly degraded by anthropogenic activities. This course is focused on discussing groundwater problems in urban areas. The topics given are the understanding of urban hydrogeology, urban area hydrology, the concept of determining groundwater recharge and balance in urban areas, and urban hydrological problems.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of urban hydrogeology by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate solutions to problems in the field of research-based urban hydrogeology using modern engineering techniques and tools.
D	Able to weigh the impact of problem solutions in the field of urban hydrogeology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	√
Quiz 2	10%	√		
Task 2	10%			√
Final exams	30%	√	√	√

Reference:

Howard, K.W.F. (2006) *Urban Groundwater; Meeting the Challenge*, International Association of Hydrogeologist (IAH), CRC Press.
Morris, B.L., Lawrence, A.R., Chilton, P.J.C., Adams, B., Calow, R.C., and Klinck, B.A. (2003) *Groundwater and its susceptibility to degradation: A global assessment of the problem and options for management*. Early Warning and Assessment Report Series, RS.03-3. United Nations Environment Programme, Nairobi, Kenya.
Putra, D.P.E. (2007)*The Impact of Urbanization on Groundwater Quality; A Case Study in Yogyakarta City – Indonesia*, Communications on engineering geology and
Hydrogeology, Issue 96, 148 S, Chair of Engineering Geology and Hydrogeology Univ.-Prof.Dr. R. Azzam, RWTH Aachen University.

76. TKG226220 – Groundwater Mass Transportation Modeling (2 Credit Points) – Semester II

This course is a continuation of Groundwater Modeling I: Flow Modeling and is focused on numerical modeling of pollution/contaminants in groundwater. Topics discussed in this course are the mechanism of movement of contaminants/contaminants in groundwater, types of pollutant/contaminants and characteristics/processes in groundwater, boundary conditions of pollutant/contaminant transport models in groundwater, problems and discussion of pollutant/contaminant modeling with numerical models .

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of groundwater mass transportation modeling by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in the field of mass transportation modeling on research-based groundwater using modern engineering techniques and devices.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%		√
Task 2	10%	√	
Final exams	30%	√	√

Reference:

Anderson, M.P., Woessner, W,W., & Hunt, R,J. (2015) *Applied Groundwater Modeling: Simulation of Flow and Transport Modeling*, 2nd ed, Academic Press.
Batu, V. (2005)*Applied Flow and Solute Transport Modeling in Aquifers*, CRC Press.
Bear, J., & Cheng, A.H.D. (2010) *Modeling Groundwater Flow & Contaminant Transport*, Springer.

77. TKG226221 - Geospatial Based Decision Making Analysis (2 Credits) – Semester II

Sustainable development requires knowledge to make regional planning decisions based on spatial geological data. This subject is focused so that students have the provision to be able to make regional planning decisions based on these data. The topics discussed in this course are the basic principles of decision-making analysis based on multi-data criteria, methods of analysis and evaluation, and the application of GIS for regional decision-making.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate problem solutions in the field of research-based spatial decision-making using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of spatial decision making to various parties with good and responsible communication.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK E
Quiz 1	10%	√		
Task 1	10%		√	√
Midterm exam	30%	√	√	
Quiz 2	10%	√		
Task 2	10%		√	√
Final exams	30%	√	√	

Reference:
Albert, D.P. (2012)*Geospatial Technologies and Advancing Geographic Decision Making: Issues and Trends*, IGI Global.
Keranen, K., and Kolvoord, R. (2011).*Making Spatial Decisions Using GIS: A Workbook*, ESRI Press.
Malczewki, J. (2006)*GIS-based Multicriteria Decision Analysis; a Survey of Literature*, International Journal of Geographic Information System Vol.20, pp 703 - 726.

78. TKG226222 – Geology and Hazardous Waste Management (2 Credit Points) – Semester II

This course focuses on hydrogeological considerations for placing hazardous waste disposal sites, both solid waste and liquid waste. The topics discussed in this course are the definition of hazardous waste/waste and its types, methods for disposing of hazardous waste/waste, physical, geotechnical and geochemical characteristics as well as soil/rock hydraulics, soil/rock attenuation capability, and selection and determination of waste disposal sites. /hazardous waste.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in geology and hazardous waste management by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate research-based problem solutions in the field of geology and hazardous waste management using modern engineering techniques and devices.
D	Able to weigh the impact of problem solutions in the field of geology and hazardous waste management on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK D
Quiz 1	10%	√		
Task 1	10%		√	√
Midterm exam	30%	√	√	√
Quiz 2	10%			√
Task 2	10%	√	√	

Final exams	30%	√	√	√

Reference:
Hasan, S.E. (1996)*Geology and Hazardous Waste Management*, Prentice-Hall Inc.
LaMoreaux, P.E., Soliman, M.M., Memon, B.A., LaMoreaux, J.W., & Assaad, F.A. (2009) *Environmental Hydrogeology*, 2nd ed, CRC Press, Taylor Francis Group.
Head, S.M. (1993)*Geological Aspect of Hazardous Waste Management*, CRC-Press.

79. TKG226223 – Erosion and Sedimentation (2 Credits) – Semester II

This course focuses on processes, impacts and control of erosion and sedimentation processes. The topics discussed in this course are the definition of erosion and sedimentation, the types of erosion and their mechanisms, the calculation of erosion and sedimentation, the impact of erosion and sedimentation, and the control of erosion and sedimentation processes.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of erosion and sedimentation by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate research-based solutions to problems in the field of erosion and sedimentation using modern engineering techniques and devices.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research-based Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%		√
Task 2	10%	√	
Final exams	30%	√	√

Reference:
Julien, P.Y. (2012)*Erosion and Sedimentation*, 2nd edition, Cambridge University Press, 371p.
Department of Energy and Environment Watershed Protection Division Washington, DC (2017) *Erosion and Sediment Control Manual*, Center for Watershed Protection, Inc. 3290 North Ridge Road, Suite 290 Ellicott City, MD 21043, 342p.
Department of Environmental Protection, Bureau of Resource Protection Massachusetts (2003) *Erosion and Sediment Control Guidelines for Urban and Suburban Areas*, Department of Environmental Protection, Bureau of Resource Protection, One Winter Street 5th floor, Boston, MA 02108, 337p.

80. TKG2224 – Soil Pollution and Remediation (2 Credit Points) – Semester II

This course studies sources of soil pollution, consequences of soil pollution, types and types of soil pollution, mechanisms of soil contamination, sampling and monitoring procedures, and ways of managing polluted soil from both organic and non-organic pollutants such as remediation or decontamination methods.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of pollution and soil remediation by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate research-based problem solutions in the field of pollution and soil remediation using modern engineering techniques and devices.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Task	10%	√	
Midterm exam	40%	√	√
Task	10%		√
Final exams	40%	√	√

Reference:
Yong, R.N, (2001), Geoenvironmental Engineering: Contaminated Soils, Pollutant Fate, and Mitigation, CRC Press.
Reddi, L.N, Inyang, H.I., (2000), Geoenvironmental engineering: Principles and Applications, CRC Press.
Hillel, D., (2003), Introduction to Environmental Soil Physics, Elsevier.
Sparks, D.L., (2003), Environmental Soil Chemistry, Academic Press.

81. TKG226225 – Applied Stratigraphy (2 Credits) – Semester II

This course discusses sedimentology, petrography and stratigraphy methods used to analyze and interpret siliciclastic and carbonate sedimentary rocks and sedimentary sequences. This course summarizes how knowledge of sedimentology and stratigraphy is very important in oil and gas exploration and development activities and is very decisive for making model predictions. In addition, the discussion also includes parameters and processes that control sedimentation, stratigraphic patterns, sedimentation cycles, depositional sequences and parasequences, sequence boundaries, biostratigraphy and their applications for prospecting of hydrocarbons. It is hoped that participants will be able to interpret the physical processes and depositional environment of the facies and facies models and know the evolution of the sedimentary basins.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in applied sedimentology and stratigraphy by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based applied sedimentology and stratigraphy using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	5%	√	
Task 1	20%	√	
Midterm exam	25%	√	√
Quiz 2	5%		√
Task 2	20%		√
Final exams	25%	√	√

Reference
Boggs, S., Jr. (2006) *Principles of Sedimentology and Stratigraphy*, 4th ed. Pearson Prentice Hall, New Jersey, 662 p.
Catuneanu, O. (2006)*Principles of Sequence Stratigraphy*, Elsevier Science, 388 p.
Miall, A.D. (2010)*The Geology of Stratigraphic Sequences*, 2nd ed., Springer-Verlag, Berlin-Heidelberg, 522 p.

82. TKG226125 – Formation Evaluation (2 Credits) – Semester II

In this course, you will learn about methods for determining the potential of hydrocarbons in reservoirs from oil and gas drilling well data. Topics covered include; 1). drilling principle,*coring* and logging, 2). Description of lithology, interpretation of facies associations and depositional environments and their correlations, 3). Determination of petrophysical parameters (*volume shale*, porosity and saturation) and related input data, 4). Determination*Net Reservoir*, *Pay Reservoir* and fluid contact, 5). Reservoar content test, 6). Potency of subsurface *hazards*.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of formation evaluation by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based formation evaluation using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%		√
Task 2	10%	√	
Final exams	30%	√	√

Reference:
Asquith, G.B., 1983, *Log Evaluation of Shaly Sandstone: A Practical Guide, Course Note Series#31*, AAPG, Oklahoma, 59 p.

Asquith, G.B., 1985, *Handbook of Log Evaluation Techniques for Carbonate Reservoirs, Methods in Exploration Series No#5*, AAPG, Oklahoma, 47 p.
Dewan , J.T. , 1983 .*Essentials of Modern Open Hole Log Interpretation*, Penwell Publishing Co., Oklahoma, 361 p.
Harsono, A., 1997,*Formation Evaluation and Application Logs*, Schlumberger, Jakarta, 316 p.
Hilchie, D., W., 1989,*Advanced Well Log Interpretation*, DWH Inc. , Colorado , 392 p.

83. TKG226227 – Oil and Gas Field Development and EOR (2 Credit Points) – Semester II

This course explains the stages in the development of oil and gas fields as an advanced part of the exploration process. This course will explain in more detail about the petroleum system, which includes source rock, reservoir rock, cover rock, traps, migration, and accumulation. The petroleum play concept is given later to provide an understanding of how oil and gas can be trapped in economical amounts below the surface. Calculation of reserves and determination of exploration risk form the basis for preparing the field development process. A more detailed analysis related to lithofacies studies, reservoir properties to static modeling is the core of the oil and gas field development plan. As part of the field development process, one of the alternative activities introduced is Enhance Oil Recovery, the procedure and implementation of which can be presented at the end of this lecture.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of oil and gas field development and EOR by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate solutions to problems in the field of research-based oil and gas field development and EOR using modern engineering techniques and tools.
D	Able to weigh the impact of problem solutions in the field of oil and gas field development and EOR on the environment, society, socio-economic and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK D
Quiz 1	5%	√		
Task 1	20%	√	√	
Midterm exam	35%	√	√	√
Quiz 2	5%		√	
Task 2	20%		√	√
Final exams	25%	√	√	√

<u>Reference</u>

Allen Allen, P.A, and J.R. Allen (2005) *Basin Analysis*: *Principles and Applications*, 2nd ed. Blacwell Publishing, Malden, 549 hal.
Head, R & Simmons, M., 2021, *Exploration Handbook*, Halliburton, Abingdon, 202p
Jahn, F., Cook, M, and Graham, M, 2008. *Hydrocarbon Exploration and Production*, 2nd ed., Elseiver, Singapore, 444p
Selley, R.C., 1998, *Elements of petroleum geology*, 2nd, Academic Press, San Diego, 470p.

Welte, D.H., Horsfield, B & Baker, D.R., 1997, *Petroleum and basin evolution*, Springer, Madras, 535p.

84. TKG226228 – Coal Technology (2 Credits) – Semester II

This course will explain the engineering of coal and peat technology, especially as an environmentally friendly energy resource. The use of coal at this time is still widely considered to be unfriendly to the environment because of the impurities produced by burning coal. For this reason, technological engineering is needed so that coal can be used efficiently and cleanly. Knowledge of technologies such as desulphurisation, carbonation, coal liquefaction, etc. is needed to make this happen. In addition, knowledge regarding the formation, geochemistry and analysis of coal will also be given to understand the characteristics of coal. Participants are expected to have an understanding of the characteristics of coal and the concept of coal utilization technology.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based coal technology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of coal technology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of coal technology on the environment, society, socio-economic and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1/Exercise 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	
Quiz 2/Exercise 2	10%		√	
Task 2	10%			√
Final exams	30%		√	√

Reference

Schobert, H., 2013.*Chemistry of Fossil Fuels and Biofuels*, Cambridge University Press, New York, 480 p.
Speight, J.G., 2005. *Handbook of Coal Analysis*, John Wiley & Sons, Chicester, 222 p.
Suarez-Ruiz, I., Diez, M.A., Rubiera, F., 2019.*New Trends in Coal Conversion*, Elsevier, Duxford, 511 p.
Sukandarrumidi, 2006.*Coal and Its Use*, Gadjah Mada University Press, Yogyakarta 247p.

85. TKG226229 – Environmental Geology for Oil and Gas Fields (2 Credit Points) – Semester II

This course contains an introduction to the activities of the petroleum industry from the exploration stage to exploitation and their effects on the environment; waste generated as a result of oil and gas exploration and exploitation; the effects on the environment (water, soil and groundwater), as well as the management and remediation of the resulting environmental pollution.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based exploration and exploitation of oil and gas environmental management using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of environmental management of oil and gas exploration and exploitation to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of environmental management of oil and gas exploration and exploitation on the environment, society, socio-economic and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D	CPMK E
Quiz 1	10%	√	√		
Task 1	10%			√	√
Midterm exam	30%	√	√	√	
Quiz 2	10%	√	√		
Task 2	10%			√	√
Final exams	30%	√	√	√	

Reference:

Reiss, J.C, *Environmental Control in Petroleum Engineering*, 1996, Gulf Professional Publishing, 400 p.

Patin, S.,*Environmental Impact of the Offshore Oil and Gas Industry*, 1999, Ecomonitor Publising, 448 p.

J. O. Robertson, *G. V. Chilingar, Environmental Aspects of Oil and Gas Production*, 2017, Scrivener Publishing, 416 p.

86. TKG226230 – Subsurface Geology of Geothermal Systems (2 Credits) – Semester II

This course discusses subsurface geological conditions in several models of geothermal system arrangements*(geothermal system play)*. The discussion includes: understanding of the geological setting; heat source; permeability and fluid flow; fluid-rock interactions; ways of obtaining and understanding subsurface data; modeling principles and techniques; and the implications of subsurface knowledge for field development strategies.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the subsurface geology of geothermal systems by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in the field of research-based subsurface geology of geothermal systems using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the subsurface geology of geothermal systems to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK C
Quiz 1	10%	√		
Task 1	10%		√	√
Midterm exam	30%	√	√	
Quiz 2	10%	√		
Task 2	10%		√	√
Final exams	30%	√	√	

Reference:

Burnell, J., Clearwater, E., Croucher, A., Kissling, W., O'Sullivan, J., O'Sullivan, M., and Yeh, A. 2012. Future Directions in Geothermal Modeling. *New Zealand Geothermal Workshop 2012 Proceedings*, Auckland.

Harvey, C., Beardsmore, G., Moeck, I., and Rüter, H., 2016. Geothermal Exploration Global Strategies and Applications. IGA Academy, Bochum.

Peacock, J.R., Glen, J., Ritzinger, B., Earney, T., Schermerhorn, W., Siler, D., Anderson, M. 2018. Geophysical Imaging of Geothermal Systems Spanning Various Geologic Settings. *GRC Transactions*, Vol. 42.

Siler, D.L., Faulds, J.E., Hinz, N.H., Dering, G.M., Edwards, J.H., and Mayhew, B. 2019. Three-dimensional geologic mapping to assess geothermal potential: examples from Nevada and Oregon. *Geothermal Energy*. 7:2. https://doi.org/10.1186/s40517-018-0117-0

87. TKG226231 – Geothermal Reservoir Engineering (2 Credits) – Semester II

This course discusses the basics of geothermal reservoir modeling for field development purposes. There is an emphasis on the importance of geological data in estimating permeability, patterns of heat and fluid flow, and emphasizing the principles of heat and fluid flow in fractured media and porous media. This course introduces some of the latest software used for *natural-state* modeling and reservoir simulation.

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of geothermal reservoir engineering to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of geothermal reservoir engineering on the environment, society, socio-economics and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK D	CPMK E
Quiz 1	10%	√		

Task 1	10%		√	√
Midterm exam	30%	√	√	
Quiz 2	10%	√		√
Task 2	10%		√	√
Final exams	30%	√	√	

Reference:

Grant, M.A., Donaldson, I.G., Bixley, P.F. (2011) *Geothermal Reservoir Engineering*, Academic Press.

Horne, R. (2005) *Modern Well Test Analysis: A Computer-Aided Approach*. 2nd ed. Petroway, 257 pp.

O'Sullivan, M.J., Pruess, K., and Lippmann, M.J. (2001) State of the art of geothermal reservoir simulation: *Geothermics*, v. 30, p. 395–429.

88. TKG226232 – Geothermal Environmental Management (2 Credits) – Semester II

This course discusses the application of environmental geology in managing geothermal fields. The discussion includes monitoring changes in geothermal manifestations; identification of geohazard potential and mitigation in geothermal areas; recommendations for structuring the geothermal environment; as well as examples of environmentally sound use of geothermal energy.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based geothermal environmental management using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of geothermal environmental management to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of geothermal environmental management on the environment, society, socio-economic and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D	CPMK E
Quiz 1	10%	√	√		
Task 1	10%			√	√
Midterm exam	30%	√	√	√	
Quiz 2	10%		√	√	√
Task 2	10%	√	√	√	√
Final exams	30%	√	√	√	

Reference

Browne, P.R.L., and Lawless, J.V. (2001) Characteristics of hydrothermal eruptions, with examples from New Zea-land and elsewhere. *Earth Science Reviews*. 52. pp. 299 – 331.

Hochstein, M.P., and Browne, P.R.L. (2000) Surface manifestations of geothermal systems with volcanic heat sources, in Sigurdsson, H. (ed): *Encyclopedia of Volcanoes*: San Diego, Haraldur Sigurdsson, p. 835 – 855.

DiPippo, R. (2008)*Geothermal Power Plant: Principles, Applications, Case Studies and Environmental Impact*, Elsevier Ltd.

89. TKG226233 – Direct Utilization of Geothermal Energy (2 Credit Points) – Semester II

This course discusses the direct use of geothermal energy based on the geoscientific character of the resource and its environment. The discussion in this course includes: an introduction to various direct use schemes such as agro- and mina-industry, tourism, health, and so on with examples from within and outside the country; positive impact on environmental conservation; strategies for sustainable use and mitigation of hazards to the environment that may arise with an approach from a geological/geoscience perspective.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based direct utilization of geothermal energy using modern engineering techniques and devices.
C	Able to convey ideas for problem solutions in the field of geothermal direct utilization to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the direct utilization of geothermal energy on the environment, society, socio-economics and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D	CPMK E
Quiz 1	10%	√	√		
Task 1	10%			√	√
Midterm exam	30%	√	√	√	
Quiz 2	10%		√	√	√
Task 2	10%	√	√	√	√
Final exams	30%	√	√	√	

Reference:
DiPippo, R., 2016. Geothermal Power Generation Development and Innovation. *Woodhead Publishing Series in Energ*i. 97. 822.
Harvey, C., Beardsmore, G., Moeck, I., and Rüter, H. (2016) Geothermal Exploration – Global Strategies and Applications. *IGA Academy Books*, 196 p.
Rubio-Maya, C., Diaz, V.M.A., Martinez, E.P., Belman-Flores, J.M., 2015. Cascade utilization of low and medium enthalpy geothermal resources – A review. *Renewable and Sustainable Energi Reviews*. 52. 689 – 716.

90. TKG226234 – Geothermal Regulation and Business (2 Credits) – Semester II

This course describes the legal aspects of geothermal development and utilization in Indonesia and introduces the differences with several other geothermal developing countries; identification of risks in the exploration and development of geothermal fields; an integrated approach in preparing geothermal exploration and development strategies from upstream and downstream sides. This lecture also discusses the economic problems of geothermal energy, especially regarding the economic feasibility criteria of geothermal energy, several geothermal financing/investment schemes, and calculating the price of geothermal energy.

Course Learning Outcomes (CPMK):

D	Able to weigh the impact of problem solutions in the field of geothermal regulation and business on the environment, society, socio-economics and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK D	CPMK E
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	√
Quiz 2	10%	√	
Task 2	10%		√
Final exams	30%	√	√

Reference:
Harvey, C., Beardsmore, G., Moeck, I., and Rüter, H. (2016) Geothermal Exploration – Global Strategies and Applications. *IGA Academy Books*, 196 p. International
Geothermal Association (2014) Best Practices Guide for Geothermal Exploration*, IGA Service GmbH*, 196 p.
President of the Republic of Indonesia (2014)*Law No. 21 of 2014 about Global Warming*, 62 p.
Yusgiantoro, P and Yusgiantoro L (2018)*Energy Economics Theory and Applications*. Purnomo Yusgiantoro Foundation, Jakarta.

91. TKG226235 – Unconventional Mineral Resources (2 Credits) – Semester II

This course discusses various types of mineral resources that have not been extensively studied, explored or optimally extracted, both in Indonesia and throughout the world. An understanding of these new or unconventional natural resources is felt to be very important in becoming a solution to the scarcity of various mineral resources which are not evenly distributed in all places on earth. As an illustration, Indonesia has the largest wealth of nickel metal resources in the world and is the basic capital for the development of the electric car battery industry in the country. However, Indonesia does not yet have the resources for several other metals important to this industry, such as lithium and rare earth metals. These two metal resources are categorized as critical and unconventional for Indonesia, where we need to immediately find sources that can be processed economically in the Indonesian archipelago. The potential for other unconventional mineral resources can be obtained by applying the principles of conservation and optimizing the production processes of the mining, energy and other industries which have so far produced side products or waste that have not been utilized optimally. For example, the mining and processing of tin in Indonesia can be further developed to become a source of other associated metals such as titanium and rare earth metals. The results of the processing of bauxite (Al) and nickel (Ni) laterite ores also have the potential to extract other associated metals such as scandium (Sc) and cobalt (Co).

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based unconventional mineral resources using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of unconventional mineral resources to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of unconventional mineral resources on the environment, society, socio-economic and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√		
Task 1	10%	√	√	
Midterm exam	30%	√	√	√
Quiz 2	10%		√	
Task 2	10%		√	√
Final exams	30%	√	√	√

<u>Reference</u>:

Kesler, S.E. and Simon, A.C. (2015) *Mineral Resources, Economics and the Environment,* Cambridge University Press, 434 p.

Craig, J.R., Vaughan, D.J., Skinner, B.J. (2014) *Earth Resources and the Environment,* Pearson Education Limited, 544 p.

Pohl W.L. (2020)*Economic Geology, Principles and Practice: Metals, Minerals, Coal and Hydrocarbons – an Introduction to Formation and Sustainable Exploitation of Mineral Deposits*. 2nd ed. 755 p.

U.S. Department of Energy (2021) *Critical Minerals and Materials: U.S. Department of Energy's Strategy to Support Domestic Critical Mineral and Material Supply Chains* (FY 2021-FY 2031), 50 p.

92. TKG226236 – Advanced Mineral Characterization (2 Credits) – Semester II

This course will explain the various methods and benefits of characterizing rock, ore and mineral samples. Characterization in general consists of mineralogical and textural characterization, rock and ore geochemical characterization, mineral chemical characterization and hydrothermal fluid characterization.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of mineral characterization by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based mineral characterization using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%	√	
Midterm exam	30%	√	√
Quiz 2	10%		√
Task 2	10%		√
Final exams	30%	√	√

Reference:
Flewitt, P.E.J., Wild, R.K. (2017) *Physical Methods for Materials Characterization*. 3rd Ed., CRC Press, Taylor & Francis Group, Boca Raton, 723p.
Hűbschen, G., Altpeter, I., Tschuncky, R., Herrmann, H.-G. (eds) (2016) *Materials Characterization Using Nondestructive Evaluation (NDE) Methods*. Woodhead Publishing. Amsterdam, 303p.
Kafle, B.P. (2020)*Chemical Analysis and Material Characterization by Spectrophotometry*. Elsevier, Amsterdam, 302p.
Li , B. , Li , J. , Ikhmayies , S. , Zhang , M. , Kalay , Y.E. , Carpenter , J.S. , Hwang , J.-Y. , Spena , P.R. , Goswami , R. (eds) (2019).*Characterization of Minerals, Metals, and Materials 2019*. The Minerals, Metals & Materials Society, Switzerland, 804p.

93. TKG226237 – Ore Sediment Geochemistry (2 Credits) – Semester II

This course will explain geochemical principles in mineral exploration, rock geochemistry, hydrothermal system geochemistry, magma geochemistry and the formation of hydrothermal systems, metal mineral solubility and impurities, stable isotope geochemistry and its applications, thermodynamics and chemical equilibrium, silicate mineral stability diagrams and sulfide mineral stability diagram.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of ore deposit geochemistry by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based ore deposit geochemistry using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Task 1	15%	√	
Midterm exam	35%	√	√
Task 2	15%		√
Final exams	35%	√	√

Reference:
Robb, L. (2005),*Introduction to Ore-Forming Processes*, Blackwell Publishing, Carlton, Australia, 373 p.
Rollinson, H., Pease, V. (2021) *Using Geochemical Data to Understand Geological Processes*. Cambridge University Press. Cambridge, ePub format.
Scott, S.D. (ed) (2014) *Geochemistry of Mineral Deposits, in Holland*, H.D. & Turekian, K.K. (eds), Treatise on Geochemistry vol. 13, 2nd Ed., Elsevier, Amsterdam.
Shikazono, N. (2003) *Geochemical and Tectonic Evolution of Arc-Backarc Hydrothermal Systems*, Elsevier, Amsterdam, 463 p.

94. TKG226238 – Geological Materials for Industry (2 Credits) – Semester II

This course provides an overview of various types of industrial mineral deposits and metallic mineral deposits which are used as raw materials for the benefit of the industrial sector. The main material presented in this course begins with an explanation of the various types of industrial mineral deposits followed by various types of metal mineral deposits, along with the application of each of these mineral deposits in the industrial field.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of geological materials for industry by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in the field of geological materials for research-based industries using modern engineering techniques and tools.
D	Able to weigh the impact of problem solutions in the field of geological materials for industry on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK D
Task 1	15%	√		
Midterm exam	35%	√	√	√
Task 2	15%		√	
Final exams	35%	√	√	√

Reference:
Chatterjee, K.K., 2007, *Uses of Metals and Metallic Minerals, New Age International Ltd*., New Delhi, 314 p.
Chatterjee, K.K., 2009, *Uses of Industrial Minerals, Rocks and Freshwater*, Nova Science Publishers, Inc. , New York , 584 p.
Laznicka, P., 2006, *Giant Metallic Deposits: Future Sources of Industrial Metals*, Springer-Verlag, Heidelberg, 732 p.
Murray, H.H., 2007, *Applied Clay Mineralogy, Development in Clay Science 2*, Elsevier, Amsterdam, 180 p.

95. TKG226239 - Regulation, Exploration and Extraction of Mineral Resources (2 Credit Points) – Semester II

Provides an understanding of mining law and law, which is a sub-system of energy law, agrarian law or natural resources, the scope of which is earth, space water, and the natural wealth in it. Mining control rights, along with energy, agrarian or natural resource control rights, include national rights, state control rights, customary law community customary rights, and individual/individual rights. Mining Law is within the domain of the public legal system and private law. The complexity of the problem of carrying out exploration and extraction of mineral resources is closely related to, among others, Minerba Law, Oil and Gas Law, Law on Agrarian Administration or Natural Resources, Law on Spatial Planning, Law on Land Procurement, Law on the Recognition and Respect of Communities' Ulayat Rights, Customary Law, Forestry Law.

Course Learning Outcomes (CPMK):

D	Able to weigh the impact of problem solutions in the field of regulation and exploration and extraction of mineral resources on the environment, society, socio-economic and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK D	CPMK E
Task 1	10%	√	
Midterm exam	35%	√	√
Task 2	10%		√
Final exams	45%	√	√

Reference:
Lilford , E. , Guj , P. (2021)*Mining Taxation: Reconciling the Interests of Government and Industry*. Springer Nature Switzerland AG, Switzerland, 232p.
Roeder, R.W. (2016) *Foreign Mining Investment Law: The Cases of Australia, South Africa and Colombia*. Springer International Publishing, Switzerland, 200p.
Sornarajah, M. (2010)*The International Law on Foreign Investment*. 3rd Edition. Cambridge University Press, Cambridge, 524p.
Sullivan, B., Purwono, C.T. & Partners (2013)*Mining Law & Regulatory Practice in Indonesia: A Primary Reference Source*, John Wiley & Sons Singapore Pte. Ltd., 509p.

96. TKG226240 – Mineral Resources Modeling (2 Credits) – Semester II

This course will explain the processing of mineral exploration data, including geochemical, geophysical, and geological data combined with remote sensing image data. Sampling and drilling methods, QA/QC and data validation are also provided. Method *pre-processing* data is also given at the beginning of this lecture followed by data processing using the geostatistical method. 2D and 3D data visualization with GIS software and*Micromine* given at the end of this course.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of mineral resource modeling by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based mineral resource modeling using modern engineering techniques and tools.
D	Able to weigh the impact of problem solutions in the field of mineral resource modeling on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK D
Task 1	15%	√	√	
Midterm exam	35%	√	√	√
Task 2	15%		√	√
Final exams	35%	√	√	√

Reference:

Brimicombe, A. (2010) GIS, 2010 .*Environmental Modeling and Engineering*, 2nd Ed., CRC Press, Taylor & Francis Group, Boca Raton, 361p.

Hengl, T. (2009) *A Practical Guide to Geostatistical Mapping*. UvA Publishing, Amsterdam, 270p.

Růžičková, K., Inspector, T. (eds) (2015)*Surface Models for Geosciences*. Springer International Publishing, Switzerland, 308p.

Talapatra, A.K. (2020)*Geochemical Exploration and Modelling of Concealed Mineral Deposits*. Springer – Capital Publishing Company, New Delhi, 201p.

Turner, A.K., Kessler, H., van der Meulen, M.J. (eds) (2021)*Applied Multidimensional Geological Modeling: Informing Sustainable Human Interactions with the Shallow Subsurface*. John Wiley & Sons Ltd, New Jersey, 644p.

97. TKG226241 – Ore Microscopy (2 Credits) – Semester II

This course will explain the meaning of ore, classification of ore mineral deposits, genesis of ore mineral deposits, structure and texture of veins and ore, ore preparation and microscopy techniques, identification of ore minerals, optical properties of ore minerals, sequences of ore paragenesis and ore petrology applications in mining industry.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of ore microscopy by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based ore microscopy using modern engineering techniques and devices.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B

Task 1	15%	√	
Midterm exam	35%	√	√
Task 2	15%		√
Final exams	35%	√	√

Reference:

Marshall, D., Anglin, L., Mumin, H. (2004) *Ore Mineral Atlas*, Geological Association of Canada, Newfoundland, 112 p.

Petruk, W. (2000)*Applied mineralogy in the mining industry*, Elsevier Science, Otawa, 288p.

Pracejus, B. (2008)*The ore minerals under the microscope; An optical guide*, Elsevier, Oxford, 1118p.

98. TKG226242 – Geofluids (2 SKS) – Semester II

In this Geofluid course, the focus will be on studying the physical characteristics (microthermometric) and chemical composition of two types of hydrothermal fluids, namely modern hydrothermal fluids and paleo-hydrothermal fluids, especially those related to hydrothermal fluids that form ore deposits such as epithermal gold deposits (LS & HS epithermal), porphyry copper-gold, copper-gold skarns, VMS, SEDEX, MVT and orogenic (mesothermal) gold deposits. An introduction to modern hydrothermal fluids is given for the purpose of serving as an analogy for understanding paleo-fluids. In this course, knowledge will also be given on how to form magmatic fluids, meteoric water (*meteoric water*) and metamorphic *fluid*, as well as hydrothermal alteration caused by rock and fluid interactions. The analytical approach that will be discussed includes the chemical-physical direct measurement method geothermal *fluids*, fluid inclusion microthermometry analysis,*Raman spectrometry* and conventional stable isotope analysis which includes H, O, C and S isotopes. This course will also discuss the interpretation of the analysis data above to determine chemical characteristics, fluid physics, fluid sources (*fluid source*), as well as a comparison between modern hydrothermal fluids and paleo-hydrothermal fluids, so understanding paleo-fluids can be analogous to modern fluids.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of geofluids by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate research-based problem solutions in the field of geofluids using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Task 1	15%	√	
Midterm exam	35%	√	√
Task 2	15%		√
Final exams	35%	√	√

Reference

Birkle , P. , Torres-Alvarado , I.S. (eds.), 2010,*Water-Rock Interaction*, CRC Press, 978 hal.

Hurai, V., Huraiova, M., Slobodnik, M., Thomas, R., 2015,*Geofluids: Developments in Microthermometry, Spectroscopy, Thermodynamics, and Stable Isotopes*, Elsevier, Amsterdam, 489 p.
Nicholson, K., 2011, *Geothermal Fluids – Chemistry and Exploration Techniques*, Springer, 263 hal.
Robb, L., 2004,*Introduction to Ore-Forming Processes*, Blackwell Science, 373 hal.
Yardley, B., Manning, C., Garven, G., 2011, *Frontiers in Geofluids*, Wiley-Blackwell, Oxford, 318 p.

98. TKG226243 – Geometallurgy (2 SKS) – Semester II

This course will focus on understanding and comprehensive study of the geology of ore deposits, process mineralogy/ore characterization and texture, mineral processing and metallurgy. Comprehensiveness between aspects of geology, mineral processing and metallurgy in the geometallurgy course is aimed at being able to spatially model the planning and process management of a mineral ore so that optimum processing conditions can be obtained while taking into account sustainability and socio-economic aspects. The geological aspect of the ore deposits will be focused on the types of ore deposits, both native metals, oxides and sulfides that are most commonly formed in Indonesia, such as copper-gold porphyry, LS & HS epithermal gold and copper-gold skarn, tin placer, nickel laterite and bauxite. Process mineralogy includes mineralogy and chemical characterization of ores and metallurgical products such as using optical microscopy, XRD, SEM EDS, EPMA, SIMS (*Secondary Ion Mass Spectroscopy*), Qemscan MLA (*Mineral Liberation Analyser*). Aspects of mineral processing (*mineral processing*) covers basic principles for unit operation, equipment selection, linkage to process mineralogy as well test *work* processing of these minerals. Metallurgical aspects include the basic principles for metal production, product properties (*product properties*) as well as quality and user requirements (*customer*). The final material is in the form of geometallurgical modeling including the application of geostatistics, modeling of mineral processing and metallurgy as well particle-based *material balancing*.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of geometallurgy by applying knowledge of mathematics, science and engineering
D	Able to weigh the impact of problem solutions in the field of geometallurgy on the environment, society, socio-economic and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK D	CPMK E
Task 1	10%	√		
Midterm exam	35%	√	√	
Task 2	10%		√	
Final exams	45%		√	√

<u>Reference</u>:

Ridley, J., 2013, *Ore Deposit Geology*, Cambridge University Press, 398 hal.
Rosencrantz, J., Lamberg, P., 2015,*Advances in Geometallurgy*, Minerals, MDPI Publishing

Russel, J., Cohn, R., 2016, *Geometallurgy*, Bookvika Publishing, 152 hal.
Taylor, R., 2009, *Ore textures, Recognition and Interpretation*, Springer, Berlin-Heidelberg, 288 hal.

99. TKG226244 – Economic Evaluation of Mineral Resources (2 SKS)

This course will provide an introduction to economic evaluation, such as metal prices, calculations net *smelter return* (NSR) a mine, calculation net *present value* (NVP) and internal rate *of return* (IRR), quantitative evaluation methods in mineral exploration, calculation of mineral reserves and estimation of mine life. This course will also be given on management concepts in exploration, introduction to mining strategy, organizational design, and introduction to OSH in exploration and mining.

Course Learning Outcomes (CPMK):

D	Able to weigh the impact of problem solutions in the field of evaluation of mineral resources on the environment, society, socio-economics and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	**Percentage**	**CPMK D**	**CPMK E**
Task 1	15%	√	
Midterm exam	35%	√	√
Task 2	15%		√
Final exams	35%	√	√

Reference:
Aswathanarayana, U., 2003,*Mineral Resources Management and the Environment*, A.A. Balkema, Smooth, 294 p.
Camus, J.P., 2002,*Management of Mineral Resources: Creating Value in the Mining Business*, Society of Mining, Metallurgy, and Exploration, Inc., Colorado, 101 p.
Chatterjee, K.K., 2015, *Macro-Economics of Mineral and Water Resources*, Springer-Verlag, 305 p.
Rossi, M.E., German, C.V., 2014,*Mineral Resource Estimation*, Springer-Verlag, Berlin, 332 p.
Wellmer, F.-W., Dalheimer, M., Wagner, M., 2008,*Economic Evaluations in Exploration*, 2nd Ed., Springer-Verlag, Berlin, 250 p.

100. TKG226245 – Mining Environment Management (2 Credits)

This course contains an introduction to mining industry activities from the exploration, mining (exploitation) stages and their effects on the environment, both for metallic and non-metallic minerals, processing and refining of mining materials to post-mining environmental management; mining environmental management regulations; impacts of mining activities; management of environmental impacts from mining activities; mining environmental audit; and post-mining closure and reclamation.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based mining environmental management using modern engineering techniques and tools.
C	Able to convey ideas for solutions to problems in the field of mining environmental management to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of mining environmental management on the environment, society, socio-economic and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D	CPMK E
Quiz 1	10%	√	√		
Task 1	10%			√	√
Midterm exam	30%	√	√	√	
Quiz 2	10%	√	√	√	
Task 2	10%		√	√	√
Final exams	30%	√	√	√	

Reference:
Spitz, K. Krudinger, J., 2019. *Mining and the Environment*.
From Ore to Metal, 2nd Edition, CRC Press, 812 p.
Ripley, E.A and Redmann, R.E, *Environmental Effects of Mining*, 1995, CRC Press, 368 p.
Lottermoser, B., *Mine Wastes: Characterization, Treatment and Environmental Impacts*, 2010, Springer, 909 p.

101. TKG226246 – Digital Image Analysis (2 Credits) – Semester II

This course introduces image analysis methods and digital data for geological analysis. By applying the basic concepts of mathematics that are applied to image processing and algorithms for image processing. The basic concepts of mathematics discussed include, namely transformation fourier, transformation wavelet and morphological *mathematics*. Image processing techniques include enhancement, restoration, segmentation and compression of images, creation and transformation of digital data into derivative data, merging and processing multitemporal and multiresolution data, recognition of geological features in digital data.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate problem solutions in the field of research-based digital image analysis using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of digital image analysis to various parties with good and responsible communication.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK E
Task 1	10%	√		
Midterm exam	40%	√		
Task 2	10%		√	
Final exams	40%		√	√

Reference:

Lillesand, T. M. and Kiefer, R. W., 2015, *Remote Sensing and Image Interpretation, 7th Edition*, John Wiley and Sons Inc., New York.

Linder, W, 2003, *Digital Photogrammetry: Theory and Applications*, Springer Berlin Heidelberg

Linder, W, 2006. *Digital Photogrammetry*, Second Edition, Springer

Paine, D.P. and, Kiser, J. D., 2012*, Aerial Photography and Image Interpretation, Third Edition*, John Wiley & Sons, Inc., Canada

Prost, G.L., 2013,*Remote Sensing for Geoscientists: Image Analysis and Integration*, Third Edition, CRC Press, New York

Sabins, F. F. Jr., 1996.*Remote Sensing, Principles and Interpretation*, the Third Edition, W. H. Freeman and Co., New York

102. TKG226247 – Social Humanities related to Geological Disasters (2 Credits) – Semester II

Humans in disaster management have two roles, namely: as objects affected by disasters and also as actors in disaster risk reduction efforts. Therefore reducing the risk of volcanic disasters apart from understanding the geological process of volcanoes and their eruptions also requires an understanding of the impacts and efforts that can be carried out by people who live in areas around volcanoes. This course will discuss social humanities issues related to reducing the risk of volcanic disasters.

Course Learning Outcomes (CPMK):

D	Able to weigh the impact of problem solutions in the field of social humanities related to geological disasters on the environment, society, socio-economics and culture, by upholding the ethics of professionalism
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK D	CPMK E
Quiz 1	10%	√	
Task 1	10%	√	
Midterm exam	30%	√	√
Quiz 2	10%	√	
Task 2	10%	√	√
Final exams	30%	√	√

Reference:
Papale, Paul, 2015,*Volcanic Hazards, Risks, and Disasters*.
Haraldur Sigurdsson (Editor), Bruce Houghton (Editor), Steve McNutt (Editor), Hazel Rymer (Editor), John Stix (Editor), *The Encyclopedia of Volcanoes 2nd Edition*, 2015.

103. TKG226248 – Disaster Thematic Seminar (2 Credits)

This course is designed to:
- Opening opportunities for students to be exposed to comprehensive research topics regarding volcanic disasters, earthquakes, landslides, and other natural disasters
- Familiarize students with the development of disaster research themes
- Prepare student skills in preparing and assessing scientific seminars
- Participate in discussions with colleagues

Course Learning Outcomes (CPMK):

C	Able to convey ideas for solutions to problems in the field of geological disaster to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C1	CPMK C2
Task	10%	√	
Midterm exam	30%	√	√
Presentation	10%		√
Final exams	30%	√	√

Reference:
Recent publications in the Bulletin of Volcanology, Springer
Recent publication in the Journal of Volcanology and Geothermal Research, Elsevier
Recent publications on Landslides, Springer
Recent publications on Advances in Volcanology, Springer

104. TKG226249 – Geological Disasters and Environmental Impacts (2 Credits) – Semester II

This subject is focused on the mechanism of geological disaster events and their impacts. The geological disasters discussed include volcanic eruptions, earthquakes, tsunamis, liquefaction, landslides, floods and droughts. Environmental impacts include environmental damage and direct impacts on human life.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of geological disasters and environmental impacts by applying knowledge of mathematics, science and engineering
D	Able to weigh the impact of problem solutions in the field of geological disasters and environmental impacts on society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK D
Quiz 1	10%	√	
Task 1	10%	√	
Midterm exam	30%	√	√
Quiz 2	10%	√	
Task 2	10%	√	√
Final exams	30%	√	√

Reference:
Bell, F.G. (1999) *Geological Hazards-Their assessment, avoidance and mitigation*, CRC Press, 656p.
The World Bank and The United Nations (2010) *Natural Hazards, UnNatural Disasters*, Washington DC, 239p.
Holmes, R.R, Jones, Jr., L.M., Eidenshink, J.C., Godt, J.W., Kirby, S.H., Love, J.J, Neal, C.A, Plant, N.G, Plunkett, M.L., Weaver, C.S., Wein, A., and Perry, S.C., (2013) *Natural Hazards Science Strategy— Promoting the Safety, Security, and Economic Well-Being of the Nation*, Circular 1383–F USGS.

105. TKG226250 – Volcano Geology (2 Credits) – Semester II

A volcano is a place where magma or gas is erupted onto the earth's surface. The body of a volcano is generally composed of piles of material resulting from single or repeated eruptions. The eruptive material keeps records of the eruption process which includes the type of eruption, transport and deposition of material. This course teaches students to record geological data in the field, map the distribution of volcanic rocks, and interpret and understand the processes, types and sequences of eruptions. Learning topics include eruptive rocks, characteristics of volcanic bodies, mechanisms for transporting and depositing eruptive materials, processes and types of eruptions.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of volcanic geology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate research-based solutions to problems in the field of volcanic geology using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%	√	
Midterm exam	30%	√	√
Quiz 2	10%	√	

Task 2	10%	√	√
Final exams	30%	√	√

Reference:

Decker, R., and B. Decker (2005) *Volcanoes*, 4th ed., W. H. Freeman, 320 p.
Lockwood, J.P., and R.W. Hazlett (2010) *Volcanoes: Global Perspectives*, Wiley-Blackwell, 550 p.
Parfitt, L., and L. Wilson (2008) *Fundamentals of Physical Volcanology*, Wiley-Blackwell, 252 p.
Schmincke, H-U (2003)*Volcanism*, Springer, 334 p.

106. TKG226251 – Volcano Numerical Modeling (2 Credits)

This course focuses on numerical modeling of processes that occur in magma in volcanoes. The topics discussed in this course are the mechanism of magma formation in the mantle, the process of magma differentiation in the earth's crust, the distribution of flow deposits and pyroclastic falls, and determining the type and scale of eruptions.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of volcanic numerical modeling by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based volcanic numerical modeling using modern engineering techniques and tools.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%	√	
Midterm exam	30%	√	√
Quiz 2	10%	√	
Task 2	10%	√	√
Final exams	30%	√	√

Reference:

Bonadonna, C & Costa, A. (2013)*Plume height, volume, and classification of explosive volcanic eruptions based on the Weibull function*, Bulletin of Volcanology, Springer.
Daggitt, M. L., Mather, T. A., Pyle, D. M., & Page, S. (2014). *AshCalc–a new tool for the comparison of the exponential, power-law and Weibull models of tephra deposition*. Journal of Applied Volcanology, 3(1), 7.
Faure, G. & Mensing, T. M. (2009) *Isotopes: Principles and Applications*, John Wiley & Sons, 897 pages.
Winter, J.D. (2013) *Principles of Igneous and Metamorphic Petrology*. Pearson Education, 744 pages https://vhub.org/resources/tools.

107. TKG226252 – Landslide Dynamics (2 Credits) – Semester II

This course discusses the processes and mechanisms of movement, principles of mobility,*expansion* and runout *analysis* of landslide material, including its controlling factors. The material taught includes the mechanism of initiating slope collapse into landslides, the increase in pore water pressure in the slope,*shear strength reduction in progress of shear displacement*, mobility of scrap materials, and conditions of residual*/steady state* landslide material. In addition, it also discusses the characteristics and dynamics of rock material landslides (*rockfall* and rockslide), *velocities and trajectory phases*, coefficient of restitution, energy change and its impact.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of landslide dynamics by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate solutions to problems in the field of research-based landslide dynamics using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of landslide dynamics to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK C
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	
Quiz 2	10%	√		√
Task 2	10%		√	√
Final exams	30%	√	√	

Reference:

Sassa, K., Tiwari, B., Liu, K-F., McSaveney, M., Strom, A., Setiawan, H. (2018)*Landslide Dynamics: ISDR-ICL Landslide Interactive Teaching Tools, Vol.2: Testing, Risk Management and Country Practices*, 836 p, Springer International Publishing AG 2018.

Sassa, K., Fukuoka, H., Wang, F., Wang, G. (2007)*Progress in Landslide Science*, 378p, Springer.

Wyllie, D.C. (2015) *Rock Fall Engineering*, 1st ed, 270p, CRC Press.

Wyllie, D.C., and Mah, C.W. (2004) *Rock Slope Engineering: Civil and Mining*, 431p, Spon Press

108. TKG226253 – Landslide Mitigation and Risk Assessment (2 Credit Points) – Semester II

This course discusses landslide disaster mitigation and risk assessment from a review of the relationship between hazard, *vulnerability* and risks from landslides. The material provided includes mitigation based people-centered (UN-ISDR) risk *knowledge*, *monitoring and warning device*, *dissemination and communication*, and response *capability*, as well as structural-based mitigation, then evaluation and assessment methods related to landslide hazard and risk which are conceptual and semi-quantitative in nature.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of landslide mitigation and risk assessment by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate problem solutions in the field of landslide mitigation and research-based risk assessment using modern engineering techniques and tools.

C	Able to convey ideas for problem solutions in the field of landslide mitigation and risk assessment to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK C
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	
Quiz 2	10%	√		√
Task 2	10%		√	√
Final exams	30%	√	√	

Reference:

Anderson, M.G., and Holcombe, E. (2013) *Community-Based Landslide Risk Reduction: Managing Disasters in Small Steps*, 404p, The World Bank.

Glade, T., Anderson, M., Crozier, M.J. (2005) *Landslide Hazard and Risk*, 810p, John Wiley & Sons Ltd.

Hungr, O., Fell, R., Couture, R., Eberhardt E. (2005) *Landslide Risk Management*, 751p, A.A. Balkema Publishers, Taylor & Francis Group.

Mandal, S., and Maiti, R. (2015) *Semi-quantitative Approaches for Landslide Assessment and Prediction*, 292p, Springer (2015)*Sendai Framework for Disaster Risk Reduction 2015-2030, 27p.*

109. TKG226254 – Numerical Modeling of Landslide (2 Credits) – Semester II

This course is focused on introducing several numerical modeling of landslides based on the basic equations of limit *equilibrium*, *shear resistance*, *solid friction*, and fluid *friction* applied to slope stability (*slope stability*) and landslide movement (*mobility analysis*). An understanding of landslide modeling is also based on several influential factors such as input rain data,*digital elevation model*, geotechnical parameters of slope material, geological and engineering geological conditions, or seismic data.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of numerical modeling of landslides by applying knowledge of mathematics, science and engineering
B	Able to design and evaluate problem solutions in the field of research-based landslide numerical modeling using modern engineering techniques and tools.
C	Able to convey problem solution ideas in the field of landslide numerical modeling to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK C
Quiz 1	10%	√		

Task 1	10%		√	
Midterm exam	30%	√	√	
Quiz 2	10%	√		√
Task 2	10%		√	√
Final exams	30%	√	√	

<u>Reference</u>:

Clague, J.J., and Stead, D. (2012) Landslides Types, Mechanisms and Modeling, 420p, Cambridge University Press.

Geostudio (2018) Stability Modeling with Geostudio, 244p, Geo-Slope International, Ltd.

Sassa, K., Tiwari, B., Liu, K-F., McSaveney, M., Strom, A., Setiawan, H. (2018)*Landslide Dynamics: ISDR-ICL Landslide Interactive Teaching Tools, Vol.2: Testing, Risk Management and Country Practices*, 836 p, Springer International Publishing AG 2018.

Tiwari, B., Sassa, K., Bobrowsky, P., Takara, K. (2021)*Understanding and Reducing Landslide Disaster Risk, Volume 4: Testing, Modeling and Risk Assessment*, 504p, Springer.

110. TKG226255 – Biostratigraphy, Paleoecology, and Paleogeography (2 Credits) – Semester II

This course discusses the division of sedimentary rocks based on fossil content, understanding how to determine age based on determining biodatum and index fossil biomarkers. Understanding the role of biostratigraphic zone biomarkers in high *resolution correlation*. Understand bio-chronostratigraphy, determining age accuracy by calibrating it with the magnetostratigraphic method and radiometric *dating*. Application of biostratigraphy in determining unconformity zones, calculating sedimentation velocity. Discusses the application of microfossils in relation to paleogeography, paleogeography and depositional environments.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the fields of biostratigraphy, paleogeography and paleogeography by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate research-based problem solutions in the fields of biostratigraphy, paleoecology and paleogeography using modern engineering techniques and devices.

Learning methods:

1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B
Quiz 1	10%	√	
Task 1	10%		√
Midterm exam	30%	√	
Quiz 2	10%	√	
Task 2	10%		√
Final exams	30%		√

<u>Reference</u>:

McGowran, B. (2005*) Biostratigraphy: Microfossils and Geological Time*. Cambridge University Press, New York, 459 p.

Ogg, J.G., G.M. Ogg, and F.M. Gradstein (2016) *A Concise Geologic Time Scale*, Elsevier, 216 p.

Hemleben, C., Kaminski, M. A., Kuhnt, W., & Scott, D. B. (Eds.). (2012). *Paleoecology, biostratigraphy, paleoceanography and taxonomy of agglutinated foraminifera* (Vol. 327). Springer Science & Business Media.

111. TKG226256 – Analytical Stratigraphy and Geochronology (2 Credits)

This course discusses the application of stratigraphy in solving problems in geology and stratigraphy, besides that it also discusses the concept of chronostratigraphy in relation to methods and interpretation of geological age data both absolute and relative. This course also explains the method of dating rock age which is suitable to be applied to various materials, the age range of rock and the material whose age will be determined. The advantages and disadvantages of each age dating method will also be discussed. In addition, sampling methods will also be introduced for age dating and risk of contamination. The material discussed also includes methods of analyzing and combining age data obtained from various measurement methods and how to interpret them to determine geological history, petrogenesis, tectonic conditions, and natural resource potential.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of analytic stratigraphy and geochronology by applying knowledge of mathematics, science, and engineering
B	Able to design and evaluate problem solutions in the field of research-based analytical stratigraphy and geochronology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of analytic stratigraphy and geochronology to various parties with good and responsible communication.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK C
Quiz 1	10%	√		
Task 1	10%		√	
Midterm exam	30%	√	√	
Quiz 2	10%	√		√
Task 2	10%		√	√
Final exams	30%	√	√	

Reference:
Koutsoukos, E. A. (Ed.). (2005).*Applied stratigraphy (Vol. 23)*. Springer Science & Business Media.
McGowran, B. (2005) *Biostratigraphy: Microfossils and Geological Time*. Cambridge University Press, New York, 459 p.
Boggs, S. (2012). *Principles of sedimentology and stratigraphy*.
Vance, D., Muller, W., Villa, I.M., 2003, *Geochronology: Linking the Isotope Record with Petrology and Textures*. Geological Society, London, Special Publications.

112. TKG226257 – Geoarchaeology and Paleoanthropology (2 Credits)

The results of archaeological and paleoanthropological studies so far confirm that environmental aspects influence the selection of residential locations, the existence and dynamics of life, to the process of forming patterns of archaeological data (taphonomic processes) after life in a place ends. To explain this, an approach is needed that is able to explain how environmental aspects, especially those related to earthly phenomena, interact with human life and the traces they leave behind, both on a micro (site level) and macro (regional or regional level) scale. The variety of natural processes and resources that influence life and the formation of archaeological data also has an impact on the diversity of site features and the methods of analysis that must be carried out. Through this course students are expected to be able to understand the role of the earth sciences in site estimation, contextual analysis, stratigraphy, and formation of archaeological data, as well as archaeological interpretation for scientific and practical purposes

Course Learning Outcomes (CPMK):

C	Able to convey ideas for problem solutions in the field of geoarchaeology and paleoanthropology to various parties with good and responsible communication.
E	Able to work together in cross-disciplinary and cross-cultural teams, develop and maintain networks and increase learning capacity independently.

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK C	CPMK E
Quiz 1	10%	√	
Task 1	10%	√	√
Midterm exam	30%	√	
Quiz 2	10%	√	√
Task 2	10%	√	√
Final exams	30%	√	

Reference:

Bridge, J. and R. Demicco, 2008, Earth surface processes, landforms and sediment deposits, Cambridge University Press, Cambridge.

Brown, A.G., 1997, Alluvial geoarchaeology: Floodplain archaeology and environmental change, Cambridge University Press, Cambridge

Butzer, K. W., 1990, Archaeology as Human Ecology: Method and Theory For A Contextual Approach, Cambridge University Press, Cambridge.

French, C., 2003, Geoarchaeology in Action: Studies in Soil Morphology and Landscape Evolution, Routledge, London.

113. TKG226258 – Applied Micropaleontology (2 Credits) – Semester II

Micropaleontology focuses on the discussion of microfossils, where microfossils are fossils that can be well preserved compared to other types of fossils. Several types of microfossils that will be discussed, namely foraminifera, nannoplankton, pollen-spores, radiolaria, diatoms and other microfossils that have important meaning in the history of geological time. The discussion covers basic biology and taxonomy, morphology and its application in solving geological and stratigraphic problems.

Course Learning Outcomes (CPMK):

A	Able to identify and analyze problems in the field of applied micropaleontology by applying knowledge of mathematics, science, and engineering

B	Able to design and evaluate problem solutions in research-based applied micropaleontology using modern engineering techniques and tools.
D	Able to weigh the impact of problem solutions in the field of applied micropaleontology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK A	CPMK B	CPMK D
Quiz 1	5%	√		
Task 1	10%		√	
Task 2	10%	√		
Midterm exam	30%	√	√	
Quiz 2	5%		√	√
Task 3	10%	√		
Final exams	30%	√		√

Reference
Armstrong, H., & Brasier, M. (2005). *Microfossils* (p. 296)
Haq, B. U., & Boersma, A. (Eds.). (1998).*Introduction to marine micropaleontology*. Elsevier.
Saraswati, P. K., & Srinivasan, M. S. (2015).*Micropaleontology: Principles and applications*. Springer.

114. TKG226259 – Quaternary Geology Excursion (2 Credits) – Semester II

The geological environment in which humans lived today and in the past can be studied through the Quaternary rocks, sediments, and landscapes that determined human land use. The development of human civilization began with the discovery of many hominid fossils from this period. The Quaternary period was also marked by recent tectonic movements and drastic sea level changes that occurred on a global scale. Quaternary deposit studies also provide an opportunity to refine methods of correlation between each of these events. Accurate geological deposit correlations that reflect recent geological events are urgently needed to make predictions about changes in the environment where humans live.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate solutions to problems in the field of research-based quaternary geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of quaternary geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of Quaternary geology on the environment, society, socio-economics and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√	√	
Task 1	10%		√	√
Midterm exam	30%	√	√	√
Quiz 2	10%	√	√	
Task 2	10%		√	√
Final exams	30%	√	√	√

Reference:

Mulyaningsih, S., Sampurno, Y. Zaim, D.J. Puradimaja, S. Bronto, and D.A. Siregar, 2006, Geological Developments in the Early Quarter to Historical Period in the Yogyakarta Plain,*Journal of Indonesian Geology*, 1/2, pp. 103-113.

Haryono, E., and M. Day, 2004, "*Landform Differentiation within The Gunung Kidul Kegel Karst, Java, Indonesia*", in*Journal of Cave and Karst Studies, vol.66, no.2*, p.62-69.

Watanabe, Naotune dan Darwin Kadar (ed.), 1985, "Quaternary geology of the hominid fossils bearing formations in Java", *Report of the Indonesia – Japan Joint Research Project CTA-41, 1976 – 1979*, Geological Research and Development Center, Bandung.

Yuwono, JSE, 2009, "Late Pleistocene to Mid-holocene Coastal and Inland Interaction in the Gunung Sewu Karst, Yogyakarta", *Bulletin of the Indo-Pacific Prehistory Association (IPPA Bulletin) vol.*29 (2009), p. 33-44.

115. TKG226260 – Subsurface Geology (2 Credits) – Semester II

This course is aimed at studying subsurface data interpretation and integration techniques which include seismic, corestone and log data to create a subsurface model, especially for oil and gas exploration and development. In general, participants are expected to be able to make*lead & prospects,* calculating reserves and determining drilling points. In addition, it is hoped that participants will also be able to develop a subsurface geological model from related data.

Course Learning Outcomes (CPMK):

B	Able to design and evaluate research-based problem solutions in subsurface geology using modern engineering techniques and tools.
C	Able to convey ideas for problem solutions in the field of subsurface geology to various parties with good and responsible communication.
D	Able to weigh the impact of problem solutions in the field of subsurface geology on the environment, society, socio-economic and culture, by upholding the ethics of professionalism

Learning methods:
1. Lectures are conducted on a regular hybrid basis, namely in person classes and online.
2. The method used is Student Centered Learning and Research based Center Learning.

Assessment Method and Linkages to CPMK:

Assessment Component	Percentage	CPMK B	CPMK C	CPMK D
Quiz 1	10%	√	√	
Task 1	10%		√	√
Midterm exam	30%	√	√	√
Quiz 2	10%	√	√	

Task 2	10%		√	√
Final exams	30%	√	√	√

Reference:

Evenick, J.C. (2019) *Introduction to Well Logs and Subsurface Maps*, 2nd ed., Pennwell Corp, 314 p.

Groshong, R.G., Jr. (2006) *3-D Structural Geology, A Practical Guide to Quantitative Surface dan Subsurface Map Interpretation*, Springer Berlin-Heidelberg, 400 p.

Tearpock, D.J. and R.E. Bischke (2002) *Applied Subsurface Geological Mapping: With Structural Methods*, 2nd ed., Prentice Hall, 822 p.

IV. ACADEMIC RULES

To properly support the achievement of learning objectives in the Geological Engineering Masters Study Program, FT UGM, binding academic regulations are needed. Regulations are drawn up in order to obtain equal rights and obligations for each student so that the quality of academic administration services can be achieved. Regulations in the Geological Engineering Masters Study Program, FT UGM can be broadly divided into two types, namely: regulations related to academic conduct and academic ethics.

A. Academic Implementation

The implementation of academic activities in the Geological Engineering Masters Study Program FT UGM which are regulated in the academic regulations in this guidebook include:

1. Academic Advisor (DPA)
2. Completion of Study Plan Card (KRS)
3. Semester Credit System (SKS)
4. Evaluation of Learning Outcomes and Study Period
5. Teaching and learning process
6. Academic Permit
7. Academic Leave
8. Implementation of Semester Tests (UTS and UAS)
9. Semester Examination Rules (UTS and UAS)
10. Proposal Thesis
11. Implementation of Colloquium
12. Implementation of Thesis Test
13. Implementation of the Judiciary
14. Plagiarism Prevention

1. Academic Advisor (DPA)

a. The Study Program determines **Academic Advisor** (DPA) for each student, where one of his duties is to guide his guardianship students in planning their studies and completing KRS.

b. Every consulting and mentoring meeting with DPA, students should also fill in logbook consulting inhttps://simaster.ugm.ac.id/.

c. Students are required to meet the DPA when: (i) filling out **Study Plan Card** (KRS), (ii) KRS revision, (iii) KRS cancellation, (iv) UTS card signing, (v) UAS Card signing, and (vi) graduation arrangements. Apart from these activities, students are encouraged to continue interacting frequently with DPA in order to obtain effective mentoring and in the future be able to develop warm collegial/collegiate relationships.

d. Students are prohibited from contacting DPA outside working days and hours. Workday schedule Monday to Thursday, 07.15 – 16.15 and Friday, 7.15 – 15.15.

e. If due to some special circumstances, students cannot consult directly with their guardian lecturers, then filling in/revising/canceling KRS can be represented by other fellow students, bringing a stamped power of attorney and a letter of introduction explaining the reasons for the need to be represented for filling in the KRS. Likewise for the DPA consultation process for judicial management.

f. If the DPA is not in place, the student guardian can consult with the Masters Study Program Management, provided that there is a report/information from the absent DPA to the Masters Study Program Management.

2. Completion of Study Plan Card (KRS)

a. KRS filling is done online by students at the time frame at the beginning of the semester determined by the Study Program in the academic calendar, with the approval of the DPA.

1) Students fill out the KRS online form through https://simaster.ugm.ac.id/ with a list of courses that have been planned to be taken. Before completing the KRS, students must first consult with the DPA, including the limit on the maximum number of credits that may be taken in that semester.
2) KRS *online* form which has been filled through master approval can be requested from the DPA during the KRS filling period.
3) Before giving KRS approval, DPA can check the **Study Result Card** (KHS) of the previous semester which contains a list of grades and **Semester Achievement Index** (IPS) on Simaster.
4) If it has been approved by the DPA, then the KRS filling process is complete.

b. Program Student (change) or Program Student (cross out) the courses taken are permitted within a predetermined time frame at the beginning of the semester as stated in the academic calendar. The revision period lasts for 1 week after the KRS filling period, while the cancellation period lasts for 1 week after the KRS revision period.

c. Revision of KRS is the replacement of a course with another subject within the credit limit permitted by the system. KRS cancellation is the termination of a course and not replaced with another course.

3. Semester Credit System (SKS)

a. Learning activities in the Geological Engineering Masters Study Program FT UGM are carried out using **semester credit system** (SKS).

b. For **students**, 1 (one) credit means every week in a certain semester participating in scheduled 50-minute face-to-face activities, 60 minutes of structured academic activities and 60 minutes of independent study activities.

c. For **lecturers**, 1 credit means that every week in one semester has an obligation to teach 50 minutes face-to-face, 60 minutes for planning and evaluating structured academic activities, and 60 minutes for developing course material through research and community service activities.

d. For **laboratory practice**, 1 credit is equivalent to 3 hours of activity per week in one semester. For the **field practice**, 1 credit is equivalent to 4 to 5 hours work per week for one semester.

e. For **thesis** 1 credit is 64-80 hours of activity in one semester.

f. The span of learning activities in one semester is 16 weeks, including midterm and final semester exams.

g. **All courses taken by students are still taken into account in calculating the cumulative GPA**, even though the total number of credits has exceeded the number of credits required for students to take as a graduation requirement.

4. Evaluation of Learning Outcomes and Study Period

a. The evaluation system used is characteristic **class relative assessmen**t, where the student's ability assessment is compared to the abilities of other students in the class. Thus, the achievements of all students in a class are used as the basis for assessment, so that there must be students whose abilities are very good, good, sufficient, lacking and bad.

b. The student's ability is graded with letters **A, A-, A/B, B+, B, B-, B/C, C+, C, C-, D, E, T** and **K**, with the conversion and weighting rules set out in Table 7.

1) Score **K** = empty (no value), the value data is incomplete or absent because the student has legally withdrawn from educational activities. If a student withdraws illegally, a point is given **E**.
2) Score **T** = incomplete, the value data is incomplete because not all assignments have been completed on time with the permission of the lecturer concerned. The assignment must be completed no later than two weeks after the exam scores are announced, and if it is not fulfilled the T grade is changed to **E**.

c. The final study results in each semester will be reported by SIA automatically in the form of KHS, each student should download and print it as a requirement for KRS consultation with DPA. KHS contains information on the Semester Achievement Index (IPS).
d. The GPA, both for one semester (IPS) and cumulative for several semesters (GPA), is calculated using the following formula:
   IP = the number of times the value of the course weight to the number of credits each divided by the total number of credits

$$IP = \frac{\sum[weight\ value\ .\ large\ number\ of\ credits]}{number\ of\ credits}$$

e. The evaluation of the educational study period for the Geological Engineering Masters Study Program, FT UGM, is regulated in 2 (two) stages, namely the Early Stage Learning Evaluation and the Final Study Evaluation.
   1) The Early Stage Study Evaluation for Masters Program Students is carried out with the following conditions:
      a) Students who until the end of semester 2 (two) do not achieve a total of 15 (fifteen) credits and with a minimum grade point average of 3.00 (three point zero zero) for the Regular Program and 3.25 (three point two five) for the*Master by Research* not allowed to take the thesis until the deadline set by the Faculty.
      b) In the event that the deadline for 1 (one) additional semester a student cannot achieve the study progress referred to in the point above, the student concerned is not allowed to continue his studies and is declared to have resigned or drop-out.
   2) The Final Stage Study Evaluation for Masters Program Students is carried out with the following provisions:
      a) Students who until the end of semester 3 (three) have not completed all learning activities with a minimum grade point average of 3.00 (three point zero zero) for the Regular Program and 3.25 (three point two five) for the*Master by Research*, was given a First Warning Letter.
      b) Students who until the end of semester 4 (four) have not completed all learning activities with a minimum achievement index of 3.00 (three point zero zero) for the Regular Program and 3.25 (three point two five) for the*Master by Research* given a Second Letter of Warning.
      c) Regular program students who until the end of semester 5 (five) have not completed all learning activities with a minimum grade point average of 3.00 (three point zero zero), are given a Third Warning Letter and are given the opportunity to complete their studies for a maximum of 1 (one) semester.
      d) *Master by Research* Program Student who until the end of semester 5 (five) have not completed the total number of credits minus thesis credits and publication credits with a grade point average of at least 3.25 (three point two five), and have not submitted publications, are given a Third Warning Letter and are given the opportunity to complete the study no later than 1 (one) semester.
      e) In the event that a student cannot complete the study as referred to in the third point above, the student concerned is not allowed to continue his studies and is declared to have resigned or dropped out.
f. Students who have declared **resigned** from the Faculty of Engineering UGM, and wishing to continue their studies at other tertiary institutions, the Department of Geological Engineering FT UGM with the knowledge of the Faculty of Engineering UGM will provide **Letter of Statement** and of **Academic Transcript**.
g. The graduation predicates for the Masters Program are as follows:
   1) Graduates get predicate *Cumlaude* (graduation title with honors), if the person concerned has a Grade Point Average (GPA) of more than 3.75 (three point seven five) and completes studies in less than or equal to 5 (five) semesters.

2) Graduates receive the title of Very Satisfactory (high graduation predicate), if the person concerned has a Grade Point Average (GPA) of more than 3.51 (three point five one) and less than or equal to 3.75 (three point seven five), or who concerned has a Grade Point Average (GPA) of more than 3.75 (three point seven five) and completes studies in more than 5 (five) semesters.
3) Graduates receive the title of Satisfactory (medium graduation predicate), if the person concerned has a Grade Point Average (GPA) of more than or equal to 3.00 (three point zero zero) and less than completing studies in less than 3.51 (three point five one).

5. Teaching and learning process

a. Students are required to fill out the available lecture attendance list in an orderly manner, and are not allowed to sign on the lecture attendance list represented by another friend. The number of student attendance in class is at **least 75%** in one semester, if the number of attendance is less then it will be considered a failure in the course and get a score **E**.
b. Interactive teaching and *Blended Learning* learning process in accordance with the Decree of the Chancellor of UGM No. 463/UN1.P/KPT/HUKOR/2019, concerning Amendments to the UGM Chancellor's Decree No. 825/UN1/SK/HUKOR/2018, concerning the Use of Methods *Blended Learning* in Learning at the Gadjah Mada University Environment, can be carried out face-to-face online at a maximum of 40% (forty percent) of the number of meetings planned in the RPKPS.
c. For students who **repeat/retake** a course, the value taken in the GPA calculation is the **best score** (Circular Letter of the Dean of FT UGM No.4070/H1.17/PS/2013 dated 23 July 2013). It is expected that students repeat seriously and earnestly diligently in improving their achievements.
d. For students who **canceled** a course, it is expected to immediately cancel or **revise** his **KRS** , in order to prevent his name from being continuously listed as one of the course participants until the final exam which results in getting **Score E**.
e. In the 2021 curriculum, students are given the freedom to choose **interest**, according to the student's interest in planning the thesis to be taken.
f. Change the course schedule whenever possible avoided and course lecturers who are forced to change their schedule are required to report/propose a change in schedule to the Teaching. Proposed changes to the schedule can be rejected in the event of a conflict with another class schedule.
g. Learning evaluation exams are held twice in each semester, covering the **Mid Semester Exam** (UTS) and **Final Exam** (UAS). The two tests are summative, namely evaluating several topics of discussion in an integrated manner, so that both have the same position with the same assessment weight component for the final grade of learning outcomes (Decisions of the Internal Academic Workshop August 1 2018).
   - Because the nature of the evaluation is **summative**, then students must take both exams (UTS and UAS). Absence in any of the exams will cause the student to be considered to **resign** or **fall-off**, and will score **E** (Decision of Internal Academic Workshop August 1 2018).
h. The final grade is given by the lecturers in charge of the course in the form of a relative score, based on the assessment **assignments**, **UTS**, and **UAS**.
i. If within 2 (two) weeks after the UAS has taken place the final grade has not been issued, then the student may use a B grade for that course (stipulated by the UGM Chancellor's Decree no. 237/P/SK/HT/2004), provided that there is no special policy related to the final assessment deadline issued by the Faculty or University in a particular semester.
j. Especially for non-class courses for *Master by Research* Program students, then the assessment is carried out by the course lecturer or supervisor by taking into account the results of the activities that have been determined (reports, assignments, academic papers,

etc.) as well as the activeness of students in carrying out activities. Grades will be issued after students have completed their obligations according to the time determined by the study program manager at the end of the semester based on the consideration of the course supervisor or supervisor. The value for publication is determined based on the reputation and quality of the indexed journal/proceedings.

6. **Academic Permit**
   a. One of the conditions to be able to follow **UTS** and **UAS** is class attendance **more than 75% face to face**.
   b. **Amount permitted absences is 25%**, including **absenteeism with a permit** (RKJ results dated 27 April 2012).
   c. Application for a permit known **by the management of the Masters Study Program Only** to uphold academic ethics,**not a guarantee** can exceed the 25% limit.
   d. As for justifiable **reasons according** to academic regulations (those who get a dispensation outside the 25% quota) are:
      1) Sick, with proof of a doctor's letter
      2) Parents died
      3) The residence was hit by a natural disaster
      4) Carry out the task of representing the interests of Study Program/Department/Faculty/University, **does not include representing student organizations**.
   e. Submission mechanism license is **addressed** to the Head **of the Masters Study Program** through the secretariat, by attaching proof **of reason** recognized by academic regulations. Furthermore, the Head of Study Program will make a letter **of notification** for lecturers of the subject in question.
   f. The license that is processed is when it is submitted no **later than a week after**:
      1) The related student is confirmed **healthy** or completing bed-rest (referring to the doctor's letter),
      2) the date of the death of the parents (referring to the environmental leader's certificate or RT/RW/Kades/Kadus/Lurah),
      3) the date of the natural disaster and the evacuation process (referring to the environmental leader's certificate or RT/RW/Kades/Kadus/Lurah),
      4) the activity date on which students are sent by the Study Program/Department/Faculty/University (referring to the permit from Study Program/Department/Faculty/University).
   g. Permit letter is made by students and must be immediately **submitted** to the respective lecturer without **going through the secretariat of the Study Program**, and will be considered invalid.
   h. For those who have exceeded 25% absence are still **subject to sanctions** in the course, and will get a grade **E**.

7. **Academic Leave**
   a. Academic leave is only allowed when students have **written permit** from the **Dean**.
   b. Academic vacation time is **not taken into account** as an active period in relation to the study deadline.
   c. During the student's academic leave **no need to pay UKT/Tuition Fee.**
   d. Students who wish to return to active college after taking academic leave must carry out the following steps:
      1) Submit an active **college application letter** to the **Dean** (for those who previously received leave permission from the Dean) or to the Chancellor (for those who previously received

leave permission from the Rector). This application letter must have been submitted **at least 1 month** prior to the semester's activities.
2) Perform re-registration by showing active **college permit** and Student Cards at the UGM Registration Office and make UKT payments.

7. Students who **do not register** and did **not take the Study Plan Card** (KRS) **<u>without applying academic leave</u>** will be considered absent **from college**.

8. Implementation of Semester Tests (UTS and UAS)

a. Semester exams are carried out according to the **academic calendar** Department of Geological Engineering FT UGM (see **Appendix 3** in this Academic Handbook).
b. During the semester exams, lectures and other academic activities (practicum,*field trip*, dll.) **eliminated**.
c. Lecturers in the subject being tested are **encouraged to attend** at the time of the exam.
d. Test scores are announced in ranges **14 working days** after the implementation of the semester exam (according to point E.9).
e. students who do not take part in the semester exams according to the schedule can submit an application for **follow-up test** or special assignments in lieu of exams, under the condition of these following reasons :
   1) students who are sick or admitted to the hospital (accompanied by a doctor's certificate),
   2) biological parents/in-laws passed away (referring to the environmental leader's certificate or RT/RW/Kades/Kadus/Lurah),
   3) the place of residence affected by a natural disaster, (referring to the environmental leader's certificate or RT/RW/Kades/Kadus/Lurah),
   4) assignments that are very important to represent the interests of the Study Program/Department/University/Faculty (referring to the permit of Study Program/Department/Faculty/University), not including student activities (HMTG).
f. Submission mechanism license is addressed to the Head **of the Masters Program** through the secretariat, by attaching **proof of reason** recognized by academic regulations. Furthermore, the Head of Study Program will make a **letter of notification** for lecturers of the subject in question.
g. Giving Follow-up **tests** or special assignments in lieu of exams, completely authority **lecturer** course tutor.
h. Requests for submission of follow-up exams/substitute exam assignments can be made by students to the Teaching Section starting from H-7 to H+14 of the predetermined exam schedule.
i. student who didn't **take the exam whether** intentional or unintentional, or is stated not **eligible to take the exam** (because the number of lecture attendance is less than 75% face to face), or fail **the test** (because it is known to cheat during the exam), will considered **to resign** of the course, and get grades **E**.

9. Semester Examination Rules (UTS and UAS)

a. Students who are entitled to take the exam are students who have fulfilled the academic and administrative requirements, including:
   1) have filled in the KRS of the subject being tested
   2) have paid UKT for the semester,
   3) meet the attendance requirement of ≥ 75 %.
b. Students print **examinee cards** from Simaster independently one week before the exam. Examination card **must be signed/authorized** by the **Academic Advisor** (DPA).
c. Students must present 10 minutes before the exam takes place by bringing the required exam equipment and exam card that has been completed with a recent photograph.
d. Students sit in the room and exam chairs that have been determined by the Study Program.

e. The **tolerance time** is **10 (ten) minutes** prior to the exa**m**. Students who are more than 10 minutes late are **not allowed to take the exam**.
f. The implementation of the exam will be marked with a bell which is carried out by the exam supervisor coordinator appointed by the Department:
   1) bell ringing 1 time: signal for the start of the exam
   2) twice the bell sign: the 10 (ten) minute mark of the exam
g. During the execution of the test is not allowed:
   1) carrying and activating communication tools in any form
   2) commit fraud in any way
   3) discuss with friends
   4) Borrow stationery from friends
   5) in and out of the test room
   6) disturbing order
h. All actions that violate the above provisions will be carried out:
   1) recorded in the Minutes of Examination, to be subject to sanctions of disqualification (can be given an E value) by the Lecturer
   2) removed from the examination room by the Picket Lecturer / Supporting Lecturer
i. The implementation of the exam is supervised by picket lecturers and exam supervisors consisting of the supervisor coordinator and several members of the exam supervisor.
   1) Picket Lecturer on duty:
      a) monitor the implementation of the exam on that day
      b) record and take firm action against students taking exams who commit violations or cheating
   2) The Exam Supervisory Officer Coordinator is in charge of:
      a) Be the supervisor as well as coordinating the implementation of the exam in the exam room that has been determined according to the schedule
      b) record every incident that took place during the exam on the minutes
      c) convey the results of the exam to the officer distributing the results of the exam
      d) in charge of ringing the bell to mark the execution of the test
   3) Members of the Examination Supervisor are in charge of:
      a) help distribute exam questions and answer sheets
      b) Assist in distributing exam attendance lists
      c) help check and sign the exam participant card
      d) Help collect and check test results

10. Proposal thesis

a. Submitting a Thesis Proposal
   1) Students determine the desired thesis theme and determine the prospective thesis supervisor lecturer.
   2) Students discuss with prospective supervisors the theme of the thesis to be taken.
   3) Students compile proposals in a format determined by the Study Program and available in the Academic Guidebook (**Appendix 4**).
   4) Students fill out the thesis proposal test application form on the linkhttp://ugm.id/FormulirPermohonanProposalTesisMagisterDTGL, accompanied by a draft proposal that has been signed by the thesis supervisor candidate and the thesis advisor candidate.
   5) The Study Program determines the composition of the team of lecturers examining the thesis proposal exam, with the following criteria:
      a) Chief Examiner (selected from lecturers who have scientific competence in accordance with the topic of the thesis proposal in question),

   b) Companion Examiners (DPA or other lecturers whose scientific competence is different from the topic of the thesis proposal),
   c) Moderator (prospective supervisor), as well as concurrently as a note taker,
   d) Examiner Members (associate supervisors if any).
6) Scheduling the implementation of the thesis proposal examination (contacting the examiner, finding a time and room) as well as making invitations for the implementation of the proposal examination by the Teaching Department.
7) In special conditions where one of the examiners resigns after the exam schedule has been circulated, then:
   a) If resignation is submitted to the study program management no later than 3 working days before the exam day, then the administrator can determine a replacement examiner, and the exam will continue on a predetermined schedule,
   b) If the withdrawal occurs within less than 3 working days prior to implementation, the exam will still take place on the set schedule and the examiner who resigns is asked to make **written evaluation** on the draft thesis proposal being tested.
8) Preparation for the implementation of the thesis proposal examination, namely:
   a) Preparation of agenda forms, attendance lists, and evaluation sheets by the Teaching Section,
   b) Preparation of note book by the Teaching Section,
   c) Consumption orders by the Finance Department,
   d) Preparation of test facilities and infrastructure, in the form of rooms and viewers by the Department of Infrastructure.
9) Implementation of the thesis proposal exam, students who take the proposal exam are expected to:
   a) Be present in the exam room 10 minutes before the exam starts to prepare for the presentation,
   b) Dress neatly, with a light-colored top and dark-colored bottoms, non-woven trousers jeans,
   c) Bring a laptop and equipment for presentations
   d) Bring one copy proposal draft,
   e) Bring proof of student card identity.
10) Procedure for carrying out the thesis proposal examination:
   a) The chairman of the assembly opened the event, conveyed the outline of the thesis proposal agenda to all examiners,
   b) The chairman of the assembly invites the examiners to provide general input before the thesis proposal examination is carried out (if any),
   c) The head of the assembly calls and invites students to present,
   d) Maximum student presentations are 20 minutes long,
   e) The discussion and question and answer are guided by a moderator (prospective main thesis supervisor) with a maximum allocation of 20 minutes for each examiner,
   f) When the discussion is over, the moderator asks the students to leave the room for an evaluation.
   g) The moderator asked the chairperson to read the evaluation results and sign the exam results,
   h) Students are asked to return to the courtroom.
   i) The chairman of the assembly read out the results of the exam in front of the students,
   j) The chairperson closed the event.

b. <u>Evaluation of the thesis proposal exam</u>
1) The evaluation aspects of the thesis proposal are as follows:
   a) Without improvement the proposal and research can be approved, or

b) Improvements to proposals and research can be approved, or
c) Proposal improvement with re-examination, or
d) Rejected
2) The proposal assembly must also determine the length of time for proposal revision.
3) Students carry out revisions or re-examination of thesis proposals according to the results of the proposal examination.
4) Students submitting revised thesis proposals must be accompanied by tabulations of improvements in accordance with the directions or suggestions from the Examining Team lecturers.
5) The draft revision of the proposal approved by the supervising lecturer must get the signature of the approval of the other examiners.
6) The department issues a Decision Letter (SK) for Thesis Guidance if students have submitted a revised draft of the proposal that has been signed by the examiner team.

c. Validity SK Pembimbangan
   a. Thesis Guidance Decree has an effective validity period until the end of the current semester.
   b. The maximum extension of the Thesis Guidance Decree is 1 (one) time which is valid for 1 (one) semester.

11. Implementation of Thesis Colloquium (Thesis Results Seminar)

a. Students fill out the thesis colloquium application form via the link http://ugm.id/FormulirPermohonanKolokiumMagisterDTGL
b. Submit back the colloquium thesis application form to the Teaching Department along with the completeness of the requirements, namely:
   1) The thesis draft that has been signed by the main supervisor and assistant supervisor,
   2) Register to attend the thesis colloquium (minimum 10x),
   3) *Copy* Study Plan Card (KRS) filled with thesis taking.
c. Scheduling the implementation of the thesis colloquium (contacting the supervisor, finding a time and room) as well as making invitations to carry out the thesis colloquium by the Teaching Department.
d. Preparation for the implementation of the colloquium thesis, namely:
   1) Preparation of agenda forms, attendance lists, note books and evaluation sheets by the Teaching Department.
   2) Preparation of colloquium facilities and infrastructure, in the form of rooms, and*viewer* by the Department of Infrastructure.
e. Implementation of a thesis colloquium, student concerned. expected:
   1) Be present in the exam room 10 minutes before the colloquium starts to prepare for the presentation,
   2) Dress neatly, with a light-colored top and dark-colored bottoms, non-woven trousers jeans,
   3) Bring*laptop* and equipment for presentations,
   4) Prepare at least 2 copies of thesis draft/*file* presentation and abstract a number of 10*copy* which was distributed to the colloquium participants,
   5) Ensuring that the number of participants in the colloquium is at least 10 students.
f. Thesis colloquium implementation procedure:
   1) The moderator (supervisor/counselor) opens the colloquium,
   2) Students present for a maximum of 20 minutes,
   3) The discussion is led by a moderator for a maximum of 90 minutes.
g. Evaluation of the thesis colloquium by the supervisor:
   1) The acceptance aspect of the thesis draft is as follows:
      a) No repairs, or

b) With minor repairs, or
c) With major repairs
2) Determination of the length of time for thesis revision.

h. Students make revisions according to the results of the thesis colloquium.
i. The colloquium evaluation sheet is a mandatory requirement for the thesis examination.
j. For *Master by Research* Student only, seminars on thesis results were conducted 2 times, namely Seminar on Thesis Results 1 (research progress seminar after completion of +-75%) and Colloquium/Seminar on Thesis Results 2 (final progress seminar).

12. Implementation of Thesis Test

a. Students fill out the thesis test application form on the linkhttp://ugm.id/FormulirPermohonanUjianPendadaranMagisterDTGL, along with the completeness of the exam submission requirements, namely:
   1) The thesis draft that has been signed by the main supervisor and assistant supervisor,
   2) Final assignment consulting card (*logbook*) which has been signed by the supervising lecturer and the Head of Study Program,
   3) Grade Transcripts that have been checked by the Teaching Department and approved by the department secretary,
   4) Current semester Study Plan Card (KRS),
   5) Decree of thesis guidance that is still valid,
   6) List of attending thesis colloquia (minimum 10 times, can be S-1, S-2 colloquiums, or other scientific presentations conducted by postgraduate students),
   7) Letter or notification of the absence of a supervisor/examiner from outside the Master Study Program (if any)
b. The Study Program Manager determines a team of lecturers examining the thesis examination with the following criteria for the examining team:
   1) Chief Examiner (selected from lecturers who have scientific competence in accordance with the topic of the thesis in question),
   2) Companion Examiner (academic supervisor or other lecturer whose scientific competence is different from the thesis topic),
   3) Moderator (lecturer supervisor),
   4) Examiner Members (associate supervisors if any)
c. Scheduling the implementation of the thesis examination (contacting the examiner, finding a time and room) as well as making invitations to carry out the examination by the Teaching Department.
d. In special conditions where one of the examiners resigns after the exam schedule has been circulated, then:
   1) If resignation is submitted to the management of the Masters Study Program within a maximum period of 3 working days before the exam day, the administrator can determine a replacement examiner, and the exam will continue on a predetermined schedule.
   2) If the withdrawal occurs within less than 3 working days, the exam will still take place at the set schedule and the withdrawing examiner is asked to make a **written evaluation** on the draft thesis being tested.
e. Preparation for the implementation of the thesis examination, namely:
   1) Preparation of agenda forms, attendance lists, and assessment sheets by the Teaching Section,
   2) Preparation of note books by the Teaching Section and note takers appointed by the Head of Study Program,
   3) Preparation of test facilities and infrastructure, in the form of rooms, and*viewer* by the Department of Infrastructure.

f. Implementation of the thesis exam, students who take the exam are expected to:
   1) Be present in the exam room 10 minutes before the exam starts to prepare for the presentation,
   2) Dress neatly and politely, with a light-colored top and dark-colored bottoms, men wear a dark tie and are prohibited from wearing pants made of jeans, for women to adapt,
   3) Bring a laptop and equipment for presentations
   4) Bring one copy thesis draft,
   5) Bring proof of identity in the form of a valid student card.
g. Procedure for carrying out the thesis examination:
   1) The Chairman opened the event,
   2) The Chairman invites the examiners to provide general input before the exam is carried out,
   3) The Head of the Session calls and invites students to present,
   4) Maximum student presentations are 20 minutes long,
   5) The Chairperson of the Session hands over the moderation of the discussion to the Moderator,
   6) Discussions and questions and answers are guided by the Moderator with a maximum allocation of 20 minutes for each examiner.
   7) When the discussion is over, the Moderator asks the students to leave the room for an assessment.
   8) The Moderator invites the Chairman of the Session to read out the results of the assessment and sign the results of the exam,
   9) Students are asked to return to the courtroom.
   10) The chairman of the assembly read out the results of the exam in front of the students,
   11) The chairperson closed the exam.
h. The assessment of the thesis examination includes the following parameters with their weights:
   1) Thesis draft material : 0 – 40,0
   2) Writing and language : 0 – 20,0
   3) Material mastery : 0 – 25,0
   4) Presentation and discussion techniques : 0 – 15,0

13. Implementation of the Judiciary

a. The Judiciary is carried out by the Faculty based on a **Graduate Letter** (SKL) from the Head of the Geological Engineering Department. To get an SKL, students must complete all academic and administrative requirements.
b. Requirements for Submitting a Graduate Letter (SKL):
   1) Students fill out the Judicium Application Form at the link:http://ugm.id/FormulirPermohonanYudisiumMagisterDTGL
   2) Valid student card
   3) A recent 3 X 4 color passport photo with a dark base color, upright body position facing forward, body position must not be tilted, especially for men are required to wear complete civilian clothing (jacket with a tie) women adjust, both earlobes must be visible for those who are not wearing a headscarf and don't wear sunglasses
   4) Photocopy of S-1 diploma
   5) Photocopy of birth certificate/passport
   6) Complete/Final Thesis Documents
   7) Proof of Publication
   8) TOEFL and TPA certificates
   9) Transcripts
   10) Final Assignment Guidance Consultation Card (*Logbook*)

11) Certificate of free borrowing of the services of the Geological Engineering Department
12) Proof of Submission of thesis via Independent Upload (*upload*), on the page https://unggah.etd.ugm.ac.id
13) Fill out the Satisfaction Questionnairehttp://ugm.id/KuesionerKepuasanDTGL

c. Judicial Special Meeting:
    1) The Graduate Letter is signed by the Head of the Department before a special faculty level judiciary meeting.
    2) A Graduate Letter is given to students to take care of the needs of the Faculty Judiciary.
    3) A Special Judicial Meeting at the Faculty level is held jointly at the Faculty level before each graduation period.
    4) The Special Judicial Meeting at the Faculty level was attended by the Masters Study Program Management from each Department.
    5) The meeting evaluates all the requirements that have been submitted by students as well as the student's track record while studying at the Geological Engineering Masters Study Program, FT UGM.

14. Plagiarism Prevention

(referring to the Regulation of the Minister of National Education of the Republic of Indonesia no. 17 of 2010)

a. **Plagiarism** is an act intentionally or unintentionally in obtaining or trying to obtain credit or value of a scientific work, by quoting part or all of its **work** and/or **scientific work** from other parties who are recognized as scientific work, without mentioning the source properly and adequately.
b. **Scientific work** is the academic work of students/lecturers/researchers/educational staff in tertiary institutions, which is made in written form, both printed and electronic, which is published and/or presented.
c. **Work** is the result of academic or non-academic works by individuals, groups, or bodies outside the higher education environment, whether published, presented, or made in written form.
d. Action **plagiarism** includes:
    1) refers to or quotes terms, words, sentences, data, maps, and information from a source without mentioning the source in the quotation notes or without adequately stating the source;
    2) referring to or quoting random terms, words, sentences, data, maps, and information from a source without mentioning the source in the citation notes or without adequately stating the source;
    3) use a source of ideas, opinions, views, formulas or theories without adequately stating the source;
    4) formulate in your own words or sentences from sources, words or sentences, ideas, opinions, views, or theories without adequately stating the source;
    5) submit a scientific work that has been produced or has been published by another party as a scientific work without adequately stating the source.
e. **Source** of scientific works or works **referred to or quoted** in an act of plagiarism can come from material that has been published, presented, or published, with the following details:
    1) published as:
        1) printed books and distributed by publishers or universities;
        2) articles published in scientific periodicals, magazines or newspapers;
        3) working papers or professional papers from certain organizations;
        4) content of electronic pages;
    2) represented as:
        1) presentations in front of a general or limited audience;

2) presentation via multimedia (radio/television/video/compact disc/digital video disc)
3) published in written form in the form of printed or electronic.

f. As **Preventive measures** is that in every scientific work produced in a tertiary institution, a statement signed by the compiler must be attached that:
    1) the scientific work is free of plagiarism;
    2) if at a later date it is proven that there is plagiarism in the scientific work; then the drafter is willing to accept sanctions in accordance with statutory provisions.
g. As **countermeasures** in the event that plagiarism is suspected by students, the Masters Study Program will take the following steps:
    1) The head of the Master's Study Program makes a comparison between the student's scientific work and a work or scientific works that are suspected to be a source not specified by the student.
    2) The Head of the Masters Study Program asks a lecturer with relevant competence to provide written testimony about the truth of the plagiarism that the student allegedly committed.
    3) Students who are suspected of committing plagiarism are given the opportunity to defend themselves before the Head of the Masters Study Program.
    4) If based on comparison and testimony it has been proven that plagiarism has occurred, then the Head of the Master's Study Program imposes sanctions on the student as a **plagiarist**.
h. **Penalty** for students who are proven to have committed plagiarism, sequentially from the lightest to the heaviest, consisting of:
    1) warning;
    2) written warning;
    3) postponement of granting some student rights;
    4) cancellation of the value of one or several courses obtained by students;
    5) honorable discharge from student status;
    6) dishonorable dismissal from status as a student; or
    7) withdrawal of a degree when a student has graduated from a program.

B. Academic Ethics

Academic ethics is a set of rules and written agreements drawn up by the Department of Geological Engineering FT UGM as one of the characteristics of the academic atmosphere on campus. Some of the academic ethics that have been agreed upon are:

1. During at **campus environment** Department of Geological Engineering FT UGM and student academic needs **prohibited**:
    a. wearing a t-shirt or polo shirt (except for field practice purposes).
    b. Wearing knee-length or torn pants/jeans,
    c. Wearing slippers/ sandals / hiking sandals.
    d. Have more than shoulder length hair (for men).
    e. Wearing earrings for men.
    f. Dying hair with a non original color (for Indonesian students the normal hair color is black).
    g. Littering,
    h. Do drugs and alcohol.
    i. Smoking around the campus area during academic activities (lectures and practicum) or while attending *field trips*, both along the trail and around the outcrops.

2. In addition to some of the above restrictions on students **urged** for :
    a. Always maintain the neatness, discipline and cleanliness of the campus environment.

b. All students are required to pay attention to any academic information provided by the Teaching Department, in all social media provided.
c. Always maintain the cleanliness and tidiness of laboratory equipment before and after use.
d. Contacting lecturers and education staff for academic needs during working hours,
e. Park the vehicles in the assigned parking lots, especially during office hours (06.30-16.30 WIB).
f. Do not create a rowdy atmosphere that disrupts the teaching and learning process.

3. Academic Ethics during online learning
    a. Pay close attention to the schedule.
    b. Study the material when it is available.
    c. Setting up devices (computers/cell phones) and headsets ahead of time.
    d. *Login* with full and clear identity accordingly,
    e. Wear neat and polite clothes.
    f. Turn on the video unless the lecturer does not instruct otherwise.
    g. turn off the microphone and click the hand symbol to interrupt or ask a question.
    h. Request via permission chat when you have to leave an online class.
    i. Use existing facilities/features responsibly.

Department management, lecturers, laboratory assistants, and staff/teaching staff, **has the right and obligation to refuse to provide academic and administrative services** for students who violate the academic ethics mentioned above.