



ہائیر ایجوکیشن کمیشن

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No. HEC/CD/NCRC/GEOLOGY/2025/**7167**

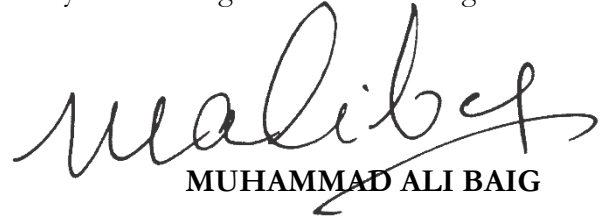
April 10, 2025

## **SUBJECT: REVISED CURRICULA FOR GEOLOGY DEGREE PROGRAMS**

The Higher Education Commission (HEC) of Pakistan, as mandated by its law, provides guidance to Higher Education Institutions (HEIs) on curricula for tertiary education levels in alignment with the National Qualifications Framework (NQF). To address evolving academic trends and market demands, HEC has revised the curricular standards for Geology degree programs at NQF levels 5, 6 and 7. These updated standards are intricately aligned with HEC's Undergraduate Education Policy V 1.1 (2023) and Graduate Education Policy (2023), ensuring coherence with national priorities and adherence to international benchmarks.

2. The revised curricula for Geology degree programs are hereby notified. Universities offering these programs are advised to align their Geology curricula with these updated standards as a minimum requirement. The respective departments must also develop course contents in accordance with the prescribed framework, ensuring that the programs address evolving scholarly, and industry needs to enhance employability potential of Geology graduates. Subsequently, the finalized course contents should be submitted electronically to this office at the earliest. An electronic copy of the revised curricula is available on HEC's official website.

3. With the support of universities in implementing these standards, HEC envisions a future where Pakistani graduates in Geology become leaders in geological research, mineral exploration, water resource management, disaster risk reduction, and energy sustainability—advancing scientific knowledge and supporting national and global development goals.

  
MUHAMMAD ALI BAIG

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**CURRICULUM FOR**  
**GEOLOGY DEGREE PROGRAMS**

**Associate Degree | Bachelor of Science | Master of Science**

**2025**

**Academics Division**  
**Higher Education Commission, Islamabad**  
**Government of Pakistan**

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## **PREFACE**

The curriculum serves as a comprehensive blueprint for the teaching-learning process that students must navigate to achieve specific academic objectives. This encompasses clearly defined prior learning requirements, program objectives, scheme of studies, and course learning outcomes. As knowledge rapidly evolves and new fields emerge, it is crucial to continually develop and revise curricula to ensure they remain current, relevant, and impactful.

As mandated by its law through Clause 10-1 (a), (l), (s), and (v), the Higher Education Commission (HEC) of Pakistan has been developing and periodically updating curricula through its National Curriculum Revision Committees (NCRCs). These committees are generally composed of subject matter experts, researchers, and representatives from accreditation bodies, professional councils, and industry stakeholders. In response to the evolving needs, HEC has undertaken the task to develop robust standards for the curricula of degree programs in Geology at levels 5, 6 and 7 of the National Qualifications Framework. These standards are meticulously structured in accordance with the HEC's Undergraduate Education Policy V 1.1 (2023) and Graduate Education Policy (2023), ensuring alignment with both national priorities and international educational standards.

The degree programs in Geology are designed to equip students with in-depth knowledge and practical skills in earth sciences, including the study of minerals, rocks, fossils, geologic processes, and natural resources. These programs aim to foster scientific inquiry, analytical thinking, and environmental awareness to address the complex challenges related to natural resource management, geohazards, and sustainable development. The curricular standards, developed by subject experts from across the country, are intended to enhance graduates' competencies, preparing them to contribute effectively to Pakistan's exploration, mining, environmental conservation, and geotechnical sectors.

With the support of universities in implementing these standards, HEC envisions a future where Pakistani graduates in Geology become leaders in geological research, mineral exploration, water resource management, disaster risk reduction, and energy sustainability—advancing scientific knowledge and supporting national and global development goals.

**Dr. Amjad Hussain**

Director General  
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## **GUIDING PRINCIPLES**

### **Minimum Standards**

The curricular standards and guidelines prescribed in this document are mandatory at minimum level. Universities or the departments concerned may, however, set higher standards provided that the standards prescribed herein are not reduced or compromised.

### **Course Sequence, Titles & Credits**

For Bachelor of Science and Master of Science in Geology, the sequence of courses prescribed in this document is logically arranged and is suggestive only. The department concerned may rearrange the sequence and alter the course titles and credit hours provided that the essence of the courses prescribed herein remains intact. The department concerned may also add more courses as and when required subject to the approval of the university's relevant statutory body.

### **Course Learning Outcomes**

Course learning outcomes (CLOs) are the bare minimum standards of learning that students must achieve upon completing a specific course. While these standards must not be compromised, departments are encouraged to enhance the rigor of the CLOs by incorporating additional learning outcomes, provided these do not alter the essence of the prescribed standards. In this document, CLOs are developed for core / major courses (for AD, BS & MS) and whereas for interdisciplinary and elective courses, the concerned departments are required to develop their CLOs considering the course's advanced nature and relevance to the program. For General Education courses as prescribed in the HEC Undergraduate Education Policy V 1.1 including the course of "Pakistan Studies", the departments may adopt the CLOs as prescribed in the HEC developed model courses.

### **Course Syllabus**

This document serves as a comprehensive guideline delineating the CLOs for each course as prescribed for the Bachelor of Science and Master of Science in Geology as minimum standards. The department concerned is required to prepare, modify, and tailor the syllabus of each course, ensuring alignment with the stipulated learning outcomes and industry demands. It is in this regard imperative that the department concerned utilizes instructional, reference, and reading materials that it deems appropriate to effectively meet the CLOs.

### **General Education**

For Bachelor of Science in Geology, the courses for General Education component including the course of "Pakistan Studies" must mandatorily be offered with the same titles and credit hours as prescribed in the HEC Undergraduate Education Policy V 1.1. The department concerned may adopt and follow the learning outcomes and study contents developed by HEC for these courses as available on its website. The requirement of General Education is not applicable to Master of Science in Geology.

### **Requirement of Internship**

Supervised internship of 3 credit hours in accordance with HEC Undergraduate Education Policy V.1.1. is a mandatory degree award requirement for Bachelor of Science. This requirement must be graded and supervised under a faculty member in collaboration with a supervisor in the field, protocols of which will be determined by the concerned department subject to approval of the same by the university's relevant statutory body. The concerned department may substitute this requirement with at least 2 "Geological Field Works", each of at least 2 credit hours, which must be graded and

supervised by a faculty member in accordance with the protocols as determined by the concerned university.

### Requirement of Capstone

It is a mandatory degree award requirement of 3 credit hours for Bachelor of Science in Geology. The capstone is a multifaceted body of work that serves as a culminating academic and intellectual experience for students. It must be supervised and graded by a faculty member as per the protocols prescribed by the department concerned. This requirement cannot be substituted with additional course work or internship.

### Associate Degree

The eligibility criteria and the first-four semesters of the Bachelor of Science in Geology as prescribed in this document guide the admission requirement and the structure of Associate Degree in Geology, respectively. Field experience / internship is not a mandatory requirement for the Associate Degree in Geology.

### Electives

- a) In accordance with the National Qualifications Framework, the department is required to offer at least 7 electives comprised of 21 credit hours i.e., minimum of 25% of the major i.e., Geology comprised of 84 credit hours, to meet the criteria of nomenclature with specialization. Where the department increases the range of major beyond 84, the number of electives will accordingly be adjusted.
- b) Where the electives are opted from the general pool of electives, the degree will be awarded as Bachelor of Science in Geology in its generic form and without any specialization. Example: **Bachelor of Science in Geology**.
- c) Where the electives are opted from within a single specialization domain, the degree will be offered as Bachelor of Science in Geology (with name of specialization) in accordance with the National Qualifications Framework (2015). Example: **Bachelor of Science in Geology (Marine Geology)**.
- d) Subject to approval of the relevant statutory body, the department may develop additional specializations other than those prescribed in this document. It should however be noted that offering of the degree program with specialization is prescribed in this document as an option only and not as a mandatory requirement or a binding on the offering department. In view of this, the department concerned may consider offering the degree program with specialization or not, in accordance with its available academic, human and infrastructural resources.

### Equivalence of Qualifications

- a) All the graduates having degrees of Bachelor of Science in Geology with or without specialization will be considered at par in terms of their knowledge, skills and abilities acquired through the course of the degree program, for the purpose of employment and further education. Therefore, all graduates having Bachelor of Science in Geology with any specialization are considered equivalent to Bachelor of Science in Geology. However, where specific specialization is required by employment agency such as Geology (Petroleum Geology), the same cannot be considered at par with any other specialization such as Geology (Economic Geology). The titles of degree given above are only examples for clarification.
- b) Graduates having NQF level 6 degrees in any of the fields of Geology seeking equivalence with Bachelor of Science in Geology will be required to have completed at least 60 credit hours of Geology by meeting the following conditions:
  - I) Completion of courses of at least 54 credits within the field of Geology including:

- 3 fundamental courses (9 credits) of Geology.
  - 4 interdisciplinary courses (12 credits) of Geology.
  - 7 electives (21 credits) of Geology.
  - A minor (minimum 12 credits) of Geology.
- II) Completion of a 3-credit internship in the field of Geology.
- III) Completion of a 3-credit capstone in the field of Geology.
- c) Upon meeting the above requirements, the graduates having NQF level 6 degrees in any of the fields of Geology such as BS Earth Sciences, BS Geophysics etc. will be granted equivalence to the BS Geology for employment and further education purposes.

**Note:** The references of BS Earth Sciences and BS Geophysics are given only as examples for clarification.

### Lab Requirements

Departments offering degree programs in the discipline of Geology are required to adhere to the industry driven lab requirements as minimum standards. Departments are expected to enhance the lab standards as and when required and maintain / upgrade the same to ensure quality education and research in the field of Geology.

### Entry & Exit Provisions at Undergraduate Level

#### Pathway for Graduates with Associate Degree

- a) Candidates who have completed Associate Degree in Geology are allowed admission in the fifth semester of the Bachelor of Science in Geology with or without any deficiency course up to a maximum of 18 credit hours as determined by the concerned university / department. In case where the deficiency courses are of more than 18 credit hours, the university concerned may decide not to offer admission in accordance with its screening, admission and merit calculation criteria approved by its statutory bodies.
- b) Students having completed Associate Degree in any discipline related to the field of Geology shall be required to complete deficiency courses up to a maximum 18 credit hours in a bridging semester as determined by the concerned university / department on case-to-case basis. Relevance of prior qualification in this regard may also be determined by the concerned university / department. In case where the deficiency courses are or more than 18 credit hours, the university concerned may decide not to offer admission in accordance with its screening, admission and merit calculation criteria approved by its statutory bodies.
- c) The minimum eligibility for admission in the fifth semester in the above cases is 2.00 / 4.00 CGPA in the prior qualification i.e., Associate Degree. The university concerned may, however, set higher eligibility and admission criteria for admission in the fifth semester of Bachelor of Science in Geology.

#### Pathway for Graduates with Conventional BSc / Equivalent Degree Programs

- a) Students having completed two-year conventional BSc / equivalent degree programs are allowed admission in the fifth semester of Bachelor of Science in Geology in which case, such students shall be required to complete deficiency courses up to a maximum of 21 credit hours through a bridging semester as determined by the concerned university. In case where the deficiency courses are of more than 21 credit hours, the concerned university may decide not offer admission, in accordance with its screening, admission and merit calculation criteria approved by its statutory bodies.

- b) The minimum eligibility for admission in the fifth semester in this case is 45% cumulative score in the prior qualification i.e., two-year conventional BSc / equivalent degree programs. The university concerned may, however, set higher eligibility and admission criteria for admission in the fifth semester of Bachelor of Science in Geology.

**Exiting from Bachelor of Science in Geology with the Associate Degree**

Students enrolled in Bachelor of Science in Geology are allowed to exit the program provided they have completed the requirements of the first-four semesters of the BS degree program as prescribed in this document.

## BACHELOR OF SCIENCE (BS)

### Program Description

The Bachelor of Science in Geology program is designed in accordance with the HEC Undergraduate Education Policy V 1.1 to provide students with a comprehensive understanding of Earth sciences, including mineralogy, petrology, geochemistry, geophysics, stratigraphy, hydrogeology, and geological mapping. The curriculum offers a balanced and robust educational experience through core geological courses, specialized subjects, and interdisciplinary studies related to environmental science, natural resource management, and geospatial technologies. The program emphasizes practical learning through field excursions, laboratory work, GIS and remote sensing applications, geological modeling, and industry collaborations, enabling students to bridge the gap between academic knowledge and real-world geological challenges. Students will develop critical thinking, scientific research skills, and problem-solving abilities to analyze Earth's processes and address issues related to natural hazards, resource exploration, environmental sustainability, and geotechnical engineering. Graduates of the BS Geology program will be well-prepared for careers in geological research, mineral and petroleum exploration, environmental consultancy, hydrology, geospatial analysis, and geotechnical engineering. They will also be equipped to pursue advanced studies in geology and related fields, both nationally and internationally.

### Standard Nomenclature

The scheme of study prescribed for the four-year undergraduate degree in Geology is based on a total of 7 electives. Where these courses are opted from the general pool of electives, the degree will be titled Bachelor of Science in Geology in its generic form and without any specialization. Whereas, if all the electives are opted from within a single specialization domain, the degree will be titled Bachelor of Science in Geology with name of specialization in parenthesis in accordance with the National Qualifications Framework (2015).

### Program Learning Outcomes

By the completion of Bachelor of Science in Geology, the graduates will be able to:

- a) Demonstrate a comprehensive understanding of key geological concepts, processes, and Earth systems, applying fundamental principles around the field of Geology.
- b) Apply theories, fieldwork techniques, and modern analytical tools to investigate earth resources, geological processes and geotechnical issues.
- c) Communicate geological knowledge to foster collaboration across academia and industry and to inform policy while making a contribution towards socio-economic development.

### Eligibility & Admission Criteria

Higher Secondary School Certificate (involving 12 years of schooling) or an IBCC equivalent qualification in any science group is the basic eligibility requirement for admission to the Bachelor of Science in Geology. Further, the university concerned may set minimum eligibility scores and may also conduct entry / admission test through its own testing body or an external testing services provider of repute as per the screening, admission and merit calculation criteria approved by its statutory bodies.

### Program Structure

The Bachelor of Science in Geology is structured in accordance with the provisions of the HEC Undergraduate Education Policy V 1.1. and comprises of minimum **138** credit hours spread over 8 regular semesters. Universities may offer courses up to a maximum of 148 credit hours provided that

the total number of credit hours are reasonably set to achieve the Program Learning Objectives (PLOs) without putting an undue burden on students.

<b>Minimum Credit Hours</b> (including all program related requirements)		138
<b>General Education</b>		34 credit hours (15 courses)
<b>Major</b>	<b>a) Compulsory</b>	60 credit hours (21 courses) Mandatory courses as reflected in the scheme of study, irrespective of the area of specialization (where applicable).
	<b>b) Mandatory Electives</b>	21 credit hours (7 courses) (to be opted from either general pool of electives or from a particular specialization)
	<b>Total Major Requirement</b>	81 credit hours (28 courses)
<b>Interdisciplinary Courses</b>		12 credit hours (4 courses)
<b>Supervised Geological Field Work</b>		8 credit hours
<b>Capstone Project</b>		3 credit hours
<b>Program Duration</b>		Minimum: 4 Years Maximum: 6 Years (further extendable to another year subject to approval of university's statutory body)
<b>Semester Duration</b>		16-18 weeks for regular semesters (1-2 weeks for examination)  8-9 weeks for summer semesters (1 week for examination)
<b>Course Load (per semester)</b>		15-18 credit hours for regular semesters  Up-to 8 credit hours for summer semesters (for remedial / deficiency / failure / repeat courses only)
<b>3 Credit Hours (Theory)</b>		3 classes (1 hour each) <b>OR</b> 2 classes (1.5 hour each) <b>OR</b> 1 class (3 hours) per week throughout the semester

The standard scheme of studies for the program of Bachelor of Science in Geology (irrespective of the area of specialization) is given as under:

<b>SEMESTER I</b>			
<b>S.N.</b>	<b>COURSE</b>	<b>CREDIT HOURS</b>	<b>CATEGORY</b>
1	Fundamentals of Geology	3 (2-1)	Major
2	Geomorphology	3 (2-1)	Major
3	Interdisciplinary Course – I *	3	Interdisciplinary
4	Quantitative Reasoning – I **	3 (3-0)	General Education
5	Functional English **	3 (3-0)	General Education
6	Applications of Information & Communication Technologies **	3 (2-1)	General Education
7	Understanding of Holy Quran – I **	1 (0-1)	General Education
<b>Total Credits Hours = 19</b>			

SEMESTER II			
S.N.	COURSE	CREDIT HOURS	CATEGORY
1	Mineralogy	3 (2-1)	Major
2	Stratigraphy	3 (3-0)	Major
3	Geological Field Work – I	2 (0-2)	Field Experience
4	Quantitative Reasoning – II **	3 (3-0)	General Education
5	Expository Writing **	3 (3-0)	General Education
6	Pakistan Studies **	2 (2-0)	General Education
7	Civics & Community Engagement **	2 (2-0)	General Education
8	Understanding of Quran – II **	1 (0-1)	General Education
<b>Total Credits Hours = 19</b>			

SEMESTER III			
S.N.	COURSE	CREDIT HOURS	CATEGORY
1	Paleontology	3 (2-1)	Major
2	Petrology	3 (2-1)	Major
3	Structural Geology	3 (2-1)	Major
4	Natural Science ***	3 (3-0)	General Education
5	Arts & Humanities ****	2 (2-0)	General Education
6	Islamic Studies ** (Religious Edu / Ethics for non-Muslim students)	2 (2-0)	General Education
7	Ideology & Constitution of Pakistan **	2 (2-0)	General Education
<b>Total Credit Hours = 18</b>			

SEMESTER IV			
S.N.	COURSE	CREDIT HOURS	CATEGORY
1	Geotectonic	3 (3-0)	Major
2	Economic Geology	3 (2-1)	Major
3	Engineering Geology	3 (2-1)	Major
4	Geology of Pakistan	3 (3-0)	Major
5	Geological Field Work – II	2 (0-2)	Field Experience
6	Social Science *****	2 (2-0)	General Education
7	Entrepreneurship **	2 (2-0)	General Education
<b>Total Credit Hours = 18</b>			

SEMESTER V			
S.N.	COURSE	CREDIT HOURS	CATEGORY
1	Petroleum Geology	3 (2-1)	Major
2	Geochemistry	3 (2-1)	Major
3	Sedimentology	3 (2-1)	Major
4	Hydrogeology	2 (2-0)	Major
5	Geophysics	2 (2-0)	Major
6	Interdisciplinary Course – II *	3	Interdisciplinary
<b>Total Credit Hours = 16</b>			

SEMESTER VI			
S.N.	COURSE	CREDIT HOURS	CATEGORY
1	GIS & Remote Sensing	2 (1-1)	Major
2	Mining Geology	3 (2-1)	Major

3	Elective – I *****	3	Major
4	Elective – II *****	3	Major
5	Geology Field Work – III	2 (0-2)	Field Experience
6	Interdisciplinary Course – III *	3	Interdisciplinary
<b>Total Credit Hours = 16</b>			

SEMESTER VII			
S.N.	COURSE	CREDIT HOURS	CATEGORY
1	Scientific Writing & Research Methods	3 (3-0)	Major
2	Sequence Stratigraphy	3 (2-1)	Major
3	Elective – III *****	3	Major
4	Elective – IV *****	3	Major
5	Geology Field Work – IV	2 (0-2)	Field Experience
6	Interdisciplinary Course – IV *	3	Interdisciplinary
<b>Total Credit Hours = 17</b>			

SEMESTER VIII			
S.N.	COURSE	CREDIT HOURS	CATEGORY
1	AI & Computational Geology	3 (1-2)	Major
2	Elective – V *****	3	Major
3	Elective – VI *****	3	Major
4	Elective – VII *****	3	Major
5	Capstone Project	3	Capstone
<b>Total Credit Hours = 15</b>			

- \* The university / concerned department may offer any 4 **interdisciplinary courses** from the recommended list provided in this document, or any other such course to enhance the interdisciplinary understanding of the students, keeping in view its available academic, human and infrastructural resources. **Credit combination** may be arranged in accordance with the nature of the course.
- \*\* HEC designed **model courses** for general education may be used by the university.
- \*\*\* The university / concerned department may offer any course in the broader category of **“Natural Sciences”** which should have relevance to the purpose of the degree program.
- \*\*\*\* The university / concerned department may offer any course in the broader category of **“Arts and Humanities”** including but not limited to a course of regional or international language such as Chinese, Arabic, French, Spanish etc. or any other course such as Philosophy, History etc.
- \*\*\*\*\* The university / concerned department may offer any course in the broader category of **“Social Sciences”** including but not limited to a course of Sociology, Social Work, Anthropology, Psychology, Education etc.
- \*\*\*\*\* Read in conjunction with guidance given on **“Standard Nomenclature”** in this document, the university / concerned department may offer any 7 advanced courses from either the general pool or from within one of the specializations as **electives** keeping in view its available academic, human and infrastructural resources. **Credit combination** may be arranged in accordance with the nature of the course.

### List of Interdisciplinary Courses

Students may opt interdisciplinary courses from the following list where required in the scheme of studies for Bachelor of Science in Geology, from other departments to complement their holistic

understanding of the major, provided that the same is allowed by the department concerned. The list provided here is a recommended one only and the department concerned may add more courses as and when needed.

- a) Introduction to Cultural Studies
- b) Introduction to Development Studies
- c) Introduction to Environmental Science
- d) Introduction to Geography
- e) Introduction to Media Studies
- f) Introduction to Philosophy
- g) Introduction to Psychology
- h) Introduction to Social Work
- i) Introduction to Sociology
- j) Principles of Management
- k) Project Management & Planning
- l) Public Policy & Administration
- m) Public Relations
- n) Sustainable Development
- o) Technology & Society

### Degree Award Requirements

The following minimum requirements are prescribed for the award of Bachelor of Science in Geology:

- a) All courses in the General Education category with titles and credit hours as prescribed in HEC Undergraduate Education Policy V 1.1. including the courses of “Pakistan Studies”, “Understanding of Holy Quran – I” and “Understanding of Holy Quran – II” must be completed.
- b) A minimum of **138** credit hours as prescribed in this document must be completed.
- c) Capstone / research project of 3 credit hours must be completed in accordance with HEC Undergraduate Education Policy V 1.1. This requirement cannot be substituted with additional coursework or internship.
- d) Read in conjunction with guiding principles on “**Requirement of Internship**”, the supervised internship of 3 credit hours must be completed in accordance with HEC Undergraduate Education Policy V 1.1. This requirement may be substituted with at least 2 “**Geological Field Works**”, each of at least 2 credit hours, which must be graded and supervised by a faculty member in accordance with the protocols as may be determined by the concerned department. The requirement of supervised internship or field work (as the case may be) cannot be substituted with additional coursework, capstone or project work.
- e) CGPA must not be below 2.00/4.00 at the time of completion of the degree program. The university may, however, set a higher standard in this regard.
- f) The minimum duration to complete the degree is 8 regular semesters spread over 4 years whereas the maximum duration is 12 regular semesters spread over 6 years. The maximum duration may further be extended to 2 more semesters (**OR**) 1 year, in extraordinary circumstances subject to approval of the university’s relevant statutory body. Summer semester is not considered as a regular semester.

## MAJOR SPECIALIZATIONS FOR BS

### Major Specializations for BS Geology

The following are a few example specialization streams in case the Bachelor of Science in Geology is offered with specialization. Subject to approval of the relevant statutory body, the department may develop additional specializations other than those prescribed below. The department concerned may consider offering the degree program with specialization or otherwise, keeping in view availability of its academic, human and infrastructural resources.

#### Specialization 1: Economic Geology

Below is the recommended list of courses within the given specialization. The department concerned may offer courses from the following list or any other course as elective(s) relevant to the given specialization, keeping in view its available academic, human and infrastructural resources:

- a) Artificial Intelligence in Mineral Exploration
- b) Environmental & Sustainable Mining Practices
- c) Exploration Drilling & Core Logging
- d) Geochemical Prospecting
- e) Geophysics in Mineral Exploration
- f) Hydrothermal Processes & Mineralization
- g) Industrial Minerals & Rocks
- h) Metallogeny & Ore Genesis
- i) Mineral Economics & Policy
- j) Mineral Resource Estimation
- k) Rare Earth Elements & Critical Minerals
- l) Remote Sensing for Mineral Exploration
- m) Techniques in Ore Microscopy

#### Specialization 2: Engineering Geology

Below is the recommended list of courses within the given specialization. The department concerned may offer courses from the following list or any other course as elective(s) relevant to the given specialization, keeping in view its available academic, human and infrastructural resources:

- a) Aggregate & Building Material in Pakistan
- b) AI & Data Analytics in Geotechnical Engineering
- c) Concrete & Asphalt Technology
- d) Dam & Reservoir Engineering Geology
- e) Geomechanics
- f) Geotechnical Engineering
- g) Geotechnical Site Investigation Techniques
- h) Landslide Hazard Analysis & Mitigation
- i) Methods in Soil & Rock Testing
- j) Rock Mass Classification & Slope Design
- k) Rock Mechanics & Geotechnical Engineering
- l) Slope Stability Analysis
- m) Soil Mechanics & Foundation Engineering
- n) Subsurface Excavation & Stability Modeling
- o) Tunnel Engineering & Underground Excavation

### Specialization 3: Geophysics

Below is the recommended list of courses within the given specialization. The department concerned may offer courses from the following list or any other course as elective(s) relevant to the given specialization, keeping in view its available academic, human and infrastructural resources:

- a) AI & Machine Learning in Exploration Geophysics
- b) Application of Remote Sensing in Geophysics
- c) Borehole Geophysics & Logging Techniques
- d) Geophysical Data Processing & Interpretation
- e) Geophysical Inversion Techniques
- f) Gravity & Magnetic Exploration Methods
- g) Hydro Geophysics
- h) Induced Seismicity & Reservoir Characterization
- i) Marine Geophysics & Oceanic Exploration
- j) Near Surface Geophysics
- k) Numerical Modeling in Geophysics
- l) Planetary Geophysics & Extraterrestrial Studies
- m) Rock Physics & Petrophysical Analysis
- n) Seismic Reflection Techniques
- o) Seismology & Earthquake Physics

### Specialization 4: Hydrogeology

Below is the recommended list of courses within the given specialization. The department concerned may offer courses from the following list or any other course as elective(s) relevant to the given specialization, keeping in view its available academic, human and infrastructural resources:

- a) Aquifer Characterization & Management
- b) Climate Change & Water Resources
- c) Environmental Tracers in Hydrogeology
- d) Field Techniques in Hydrogeology
- e) Groundwater Hydrology
- f) Groundwater Policy & Governance
- g) Hydraulic Fracturing & Water Resource Impacts
- h) Hydrogeochemistry & Isotope Hydrology
- i) Hydrogeophysical Methods in Groundwater Studies
- j) Hydroinformatics & AI Applications in Water Studies
- k) Hydrological Modeling & Simulation
- l) Managed Aquifer Recharge Techniques
- m) Surface Hydrological Systems
- n) Water Resource Engineering & Management
- o) Well Design & Pumping Tests

### Specialization 5: Marine Geology

Below is the recommended list of courses within the given specialization. The department concerned may offer courses from the following list or any other course as elective(s) relevant to the given specialization, keeping in view its available academic, human and infrastructural resources:

- a) Basin Analysis
- b) Biogeochemical Cycles in Marine Environments

- c) Coastal & Submarine Geohazards
- d) Coastal Geomorphology & Sediment Dynamics
- e) Deep-Sea Drilling & Core Analysis
- f) Deep-Sea Mineral Resources & Exploration
- g) Gas Hydrates & Deep-Sea Hydrocarbon Systems
- h) Marine Hydrothermal Systems & Geochemistry
- i) Marine Paleoecology & Fossil Records
- j) Marine Pollution & Sediment Contamination
- k) Marine Remote Sensing & GIS Applications
- l) Marine Resources
- m) Marine Sedimentology
- n) Ocean-Atmosphere Interactions & Climate Change
- o) Oceanography

### **Specialization 6: Mineralogy**

Below is the recommended list of courses within the given specialization. The department concerned may offer courses from the following list or any other course as elective(s) relevant to the given specialization, keeping in view its available academic, human and infrastructural resources:

- a) Analytical Techniques in Mineral Studies
- b) Clay Mineralogy & Soil Chemistry
- c) Computational Mineralogy & Machine Learning Applications
- d) Crystal Chemistry & Mineral Structures
- e) Gemology
- f) Igneous Petrology
- g) Industrial Mineralogy
- h) Metallogeny & Plate Tectonics
- i) Metamorphic Petrology
- j) Mineral Prospecting
- k) Nano Minerals & Advanced Material Science
- l) Planetary & Extraterrestrial Mineralogy
- m) Rare Earth & Platinum Group Elements
- n) Sedimentary Petrology
- o) Solid Solutions in Mineral Series

### **Specialization 7: Paleontology & Stratigraphy**

Below is the recommended list of courses within the given specialization. The department concerned may offer courses from the following list or any other course as elective(s) relevant to the given specialization, keeping in view its available academic, human and infrastructural resources:

- a) Biogeographic Distribution of Fossils
- b) Biostratigraphy
- c) Evolutionary Development of Early Life
- d) Ichnology & Trace Fossils in Sedimentary Systems
- e) Invertebrate Paleontology
- f) Isotope Geochemistry in Paleontology
- g) Micropaleontology
- h) Paleoenvironmental Reconstruction Techniques

- i) Palynology & Climate Reconstructions
- j) Quantitative Paleontology & Morphometric Analysis
- k) Quaternary Geology
- l) Stratigraphic Correlation & Basin Analysis
- m) Stratigraphy of Pakistan
- n) Tectono-stratigraphy
- o) Vertebrate Paleontology & Evolutionary Trends

### **Specialization 8: Petroleum Geology**

Below is the recommended list of courses within the given specialization. The department concerned may offer courses from the following list or any other course as elective(s) relevant to the given specialization, keeping in view its available academic, human and infrastructural resources:

- a) AI & Machine Learning in Hydrocarbon Exploration
- b) Basin Analysis
- c) CO<sub>2</sub> Sequestration & Carbon Capture in Petroleum Basins
- d) Geomechanics in Petroleum Systems
- e) Hydrocarbon Geochemistry
- f) Offshore Oil & Gas Exploration
- g) Oil Sands & Heavy Oil Recovery
- h) Petroleum Basin Tectonics & Structural Analysis
- i) Petroleum Economics & Risk Assessment
- j) Petroleum Engineering
- k) Petroleum System Modeling
- l) Reservoir Characterization & Rock Properties
- m) Sedimentary Basins of Pakistan
- n) Unconventional Hydrocarbon Resources
- o) Well Log Interpretation & Petrophysical Analysis

### **Specialization 9: Sedimentology**

Below is the recommended list of courses within the given specialization. The department concerned may offer courses from the following list or any other course as elective(s) relevant to the given specialization, keeping in view its available academic, human and infrastructural resources:

- a) AI & Machine Learning Techniques in Sedimentology
- b) Carbonate Diagenesis
- c) Carbonate Sedimentology
- d) Clastic Sedimentology
- e) Clay Mineralogy
- f) Facies Analysis
- g) Geochemistry of Sedimentary Rocks
- h) Ichnology & Trace Fossils in Sedimentary Systems
- i) Organic-Rich Deposits & Source Rock Evaluation
- j) Reservoir Sedimentology
- k) Sedimentary Depositional Systems
- l) Sedimentary Petrology & Geochemistry
- m) Sedimentary Record of Climate Change
- n) Sequence Stratigraphy & Basin Evolution

- o) Siliciclastic Sedimentology

**Specialization 10: Structural Geology & Tectonics**

Below is the recommended list of courses within the given specialization. The department concerned may offer courses from the following list or any other course as elective(s) relevant to the given specialization, keeping in view its available academic, human and infrastructural resources:

- a) AI & Machine Learning Techniques in Structural Geology
- b) Basin Analysis
- c) Applied Structural Techniques
- d) Global Tectonics
- e) Earthquake Hazard Assessment
- f) Orogeny & Mountain-Building Processes
- g) Paleoseismology
- h) Plate Tectonics & Lithospheric Dynamics
- i) Neo-tectonics & Active Fault Systems
- j) Structural Analysis of Deformed Terrains
- k) Geodynamics of Indian Plate
- l) Tectonic Control on Ore Deposits & Hydrocarbon Systems
- m) Tectonic Geomorphology & Landscape Evolution
- n) Quaternary Geology
- o) Micro Structures

## MASTER OF SCIENCE (MS)

### Program Description

The Master of Science in Geology program is designed in accordance with the HEC Graduate Education Policy 2023 to provide students with an advanced, interdisciplinary understanding of geological sciences. The program emphasizes in-depth knowledge of Earth processes, resource exploration, environmental geology, and geohazard assessment. Through a rigorous blend of theoretical foundations, fieldwork, and laboratory-based research, students develop critical analytical skills and technical expertise essential for solving complex geological challenges in both academic and industry settings. Spanning three semesters, the curriculum integrates core geological courses with specialized electives, ensuring a balanced approach to research and applied geosciences. Students engage in advanced research methodologies, including geological data analysis, geospatial techniques, and computational modeling, preparing them to conduct original studies that contribute to scientific advancements and sustainable resource management. With a strong foundation in applied and theoretical geology, graduates will be well-equipped to contribute to national and international scientific discourse, policy development, and industry advancements in geological sciences.

### Nomenclature

To ensure uniformity, the standard nomenclature for all NQF level 7 qualifications in the field of Geology will either be without name of the specialization as **“Master of Science in Geology”** or with name of the specialization such as the following:

- “Master of Science in Economic Geology”
- “Master of Science in Engineering Geology”
- “Master of Science in Marine Geology”
- “Master of Science in Petroleum Geology”

**Note:** The above specializations are given as examples only and the university concerned may offer NQF level 7 qualifications in Geology in any of the above or other specializations keeping in view its available academic, human and infrastructural resources and subject to provisions of the HEC Graduate Education Policy (2023).

### Program Learning Outcomes

By the completion of Master of Science in Geology with or without any specialization, the graduates will be able to:

- a) Demonstrate an advanced understanding of geological theories, principles, and methodologies, integrating interdisciplinary knowledge to analyze and interpret complex Earth processes, resources, and environmental challenges.
- b) Apply advanced research and analytical methods, geospatial technologies, and quantitative modeling to investigate geological phenomena, assess natural hazards, and contribute to sustainable resource management.
- c) Conduct independent and original research in geological sciences, critically synthesizing existing literature, employing rigorous field and laboratory techniques, and generating knowledge that informs industry practices, environmental policies, and scientific advancements.
- d) Communicate geological research findings, resource management strategies, and policy recommendations effectively through written, oral, and digital platforms, demonstrating

professional ethics, environmental responsibility, and global awareness in geoscience applications.

### Eligibility & Admission Criteria

- An undergraduate degree (involving 16 years of education) in Earth Science or any of its fields including but not limited to Geology, Geophysics, Geochemistry, Oceanography, Marine Science, Hydrology, Meteorology, Environmental Science, Paleontology, Seismology, Soil Science, Engineering Geology and Geotechnical Engineering is the basic eligibility requirement for admission to the Master of Science in Geology, including any of its specializations.
- The admitting department will require to assess deficiency on case-to-case basis and offer deficiency courses up-to 9 credit hours, to candidates having such deficiency in accordance with HEC Graduate Education Policy (2023).
- In addition to the basic eligibility, the university concerned is further required to conduct a rigorous admission test as an eligibility condition for admission to the program, with a passing score of 50% **(OR)** accept the GRE / HAT General / equivalent tests, with a passing score of 50%. The university concerned may also set minimum eligibility scores (above 50%) as per the screening, admission and merit calculation criteria approved by its statutory bodies.

### Program Structure

All NQF level 7 qualifications in Geology or any of its specializations must be structured with the following 5 mandatory components, provided that the minimum credit hours for the program must be 38.

- 2 core courses, each of 3 credit hours, as specified in this document.
- 6 elective courses, each of 3 credits hours, irrespective of the area of specialization, in case the degree is offered in its generic form with nomenclature of “Master of Science in Geology”, and specific to the area of specialization, in case the degree is offered in specialized area, such as “Master of Science in Marine Geology”.
- 2 courses on “Understanding of Holy Quran”, each of 1 credit hour.
- Field work of 6 credit hours.
- Research thesis of 6 credit hours.

Summary of the program including the model scheme of study is given below:

<b>Minimum Credit Hours</b>		38
<b>Course Work</b>	a) <b>Mandatory Subject Major</b>	6 credit hours (2 courses)
	b) <b>Subject Electives</b>	18 credit hours (6 courses)
	c) <b>Mandatory Quranic Courses</b>	2 credit hours (2 courses)
	<b>Total Coursework Requirement</b>	26 credit hours
<b>Geological Field Work</b>		6 credit hours
<b>Research Work / Thesis</b>		6 credit hours
<b>Program Duration</b>		Minimum: 1.5 Years (3 regular semesters) Maximum: 4 Years (8 regular semesters)  <b>Note:</b> In case a student is unable to secure an MS within the prescribed timeframe and claims for extension in duration,

	the university may constitute appropriate authority and determine the causes of delay. In the event of force majeure (i.e., delay on account of circumstance beyond the control of student), the university may grant an extension in the period of award of MS degree in accordance with the duration limiting factor(s) and shall also take corrective measures in case the delay is caused by process or administrative reasons.
Semester Duration	16-18 weeks for regular semesters (1-2 weeks for examination)  8-9 weeks for summer semesters (1 week for examination)
Course Load (per semester)	09-12 credit hours for regular semesters  Up-to 8 credit hours for summer semesters (for remedial / deficiency / failure / repetition courses only)
3 Credit Hours (Theory)	3 classes (1 hour each) <b>OR</b> 2 classes (1.5 hour each) <b>OR</b> 1 class (3 hours)

The standard scheme of studies for NQF level 7 qualification in Geology is given below:

SEMESTER I			
S.N.	COURSE	CREDIT HOURS	CATEGORY
1	Emerging Trends & Issues in Geology *	3 (3-0)	Common Core
2	Elective – I **	3	Elective
3	Elective – II **	3	Elective
4	Elective – III **	3	Elective
<b>Total Credit Hours = 12</b>			

SEMESTER II			
S.N.	COURSE	CREDIT HOURS	CATEGORY
1	Advanced Research Methods for Geological Sciences *	3 (3-0)	Common Core
2	Elective – IV **	3	Elective
3	Elective – V **	3	Elective
4	Elective – VI **	3	Elective
<b>Total Credit Hours = 12</b>			

SEMESTER III			
S.N.	COURSE	CREDIT HOURS	CATEGORY
1	Understanding of Holy Quran – I ***	1 (0-1)	General Education
2	Understanding of Holy Quran – II ***	1 (0-1)	General Education
3	Thesis ****	6	Research
<b>Total Credit Hours = 8</b>			

\* These are the **mandatory** courses for the program, irrespective of the area of specialization.

\*\* The university / concerned department may offer any advanced course in the field of Geology as an **elective**, where required as per its available academic, human and infrastructural resources. **Credit combination** (reflecting balance of theory and lab work) must be arranged in accordance with the nature of the course.

\*\*\* These are prescribed for all NQF level 4-8 qualifications as mandated vide HEC letter **No. 10-01/2022/Coord(Acad)/HEC/235** dated March 28, 2025.

\*\*\*\* **Research** work for thesis must be conducted by students individually in accordance with the university's policy as approved through its statutory bodies provided that the same is in accordance with the HEC Graduate Education Policy (2023).

### **Degree Award Requirements**

The following minimum requirements are prescribed for award of NQF level 7 qualification in Geology:

- a) A minimum of 26 credit hours of course work including 6 credit hours for core courses, 18 credit hours for electives and 2 credit hours for Quranic courses as prescribed in this document must be completed.
- b) Field work of 6 credit hours must be completed as per operational and assessment protocols to be determined by the department concerned.
- c) In addition to coursework and field work, a research thesis of 6 credit hours must also be completed individually as partial fulfilment of the degree program. Requirement of research thesis / project cannot be substituted with additional course work.
- d) CGPA must not be below 2.50 / 4.00 at the time of completion of the degree program. The university may, however, set a higher standard in this regard.
- e) The minimum duration required to complete the degree is 3 regular semesters which may be extended up to a maximum of 8 regular semesters. Summer semester is not considered as a regular semester.

## COURSE LEARNING OUTCOMES

AD, BS & MS

(Arranged in Alphabetical Order)

### Advanced Research Methods for Geological Sciences

By the end of this course, students will be able to:

- a) Apply advanced qualitative and quantitative research methods to investigate complex geological phenomena.
- b) Utilize field-based data collection, modern laboratory techniques, geospatial and related tools for geological research and analysis.
- c) Develop and communicate original research proposals, ensuring scientific rigor and ethical integrity in geological studies.

### AI & Computational Geology

By the end of this course, students will be able to:

- a) Understand the role and scope of artificial intelligence (AI) to analyze geological datasets.
- b) Explain computational models for simulating geological processes and predicting subsurface structures.
- c) Utilize programming and data visualization tools for geospatial and subsurface exploration.

### Economic Geology

By the end of this course, students will be able to:

- a) Identify and classify economically significant mineral deposits.
- b) Analyze the genesis and distribution of ore deposits.
- c) Evaluate the economic potential and environmental impacts of natural resource exploration.

### Emerging Trends & Issues in Geology

By the end of this course, students will be able to:

- a) Identify emerging trends and research gaps in the field of geology.
- b) Evaluate the nature and intensity of issues related to geology.
- c) Synthesize interdisciplinary approaches to address emerging challenges in geological sciences and propose innovative solutions.

### Engineering Geology

By the end of this course, students will be able to:

- a) Apply geotechnical principles to analyze soil and rock mechanics in construction projects.
- b) Analyze geotechnical properties of construction material, site suitability and geological hazards for infrastructure development.
- c) Explore engineering solutions to mitigate geological risks.

### Fundamentals of Geology

By the end of this course, students will be able to:

- a) Explain fundamental geological concepts and processes.
- b) Identify and classify minerals and rocks.
- c) Understand fundamentals of geological maps.

### Geochemistry

By the end of this course, students will be able to:

- a) Apply geochemical principles to study the composition and transformation of Earth materials.
- b) Use of elemental data to investigate geological processes and environment.
- c) Interpret geochemical data for mineral exploration, hydrocarbon systems, and environmental applications.

### **Geology of Pakistan**

By the end of this course, students will be able to:

- a) Understand the tectonic evolution and geological framework of Pakistan.
- b) Interpret the geological rock units, mineral resources, and basins of Pakistan.
- c) Develop the stratigraphic correlation of rocks in various basins.

### **Geomorphology**

By the end of this course, students will be able to:

- a) Understand the geomorphic processes shaping Earth's surface.
- b) Analyze landforms using topographic maps, satellite imagery, and field observations.
- c) Assess the impact of geomorphological processes on environmental sustainability.

### **Geophysics**

By the end of this course, students will be able to:

- a) Understand various geophysical principles and methods.
- b) Apply different geophysical techniques for subsurface investigation.
- c) Process and interpret geophysical data.

### **Mining Geology**

By the end of this course, students will be able to:

- a) Understand the significance of mining activities and evaluation of mineral reserves.
- b) Apply mining methods to exploit mineral deposits.
- c) Identify problems linked with mining activities and mitigation measures.

### **Geotectonics**

By the end of this course, students will be able to:

- a) Understand the mechanisms of plate tectonics and related processes.
- b) Interpret tectonic events using geological data.
- c) Assess the impact of tectonics on basin evolution.

### **GIS & Remote Sensing**

By the end of this course, students will be able to:

- a) Understand the role of GIS and Remote Sensing in Geology.
- b) Analyze geospatial data using GIS and Remote Sensing tools.
- c) Interpret satellite imagery for geological exploration, environmental monitoring, and disaster management.

### **Hydrogeology**

By the end of this course, students will be able to:

- a) Understand basic principles of hydrogeology and related processes.
- b) Explain groundwater flow, and aquifer properties.
- c) Apply hydrogeological techniques to assess groundwater prospecting.

### **Mineralogy**

By the end of this course, students will be able to:

- a) Recognize various rock-forming minerals.
- b) Identify minerals based on their physical and optical properties.
- c) Understand various crystal systems.

### **Paleontology**

By the end of this course, students will be able to:

- a) Understand the ancient life and processes of fossilization.
- b) Identify and classify fossils based on taxonomy.
- c) Interpret fossils to reconstruct paleo environments and geological record.

### **Petroleum Geology**

By the end of this course, students will be able to:

- a) Understand formation, migration and accumulation of hydrocarbons.
- b) Interpret and evaluate reservoir characteristics.
- c) Evaluate reservoir potential and risk factors in oil and gas exploration.

### **Petrology**

By the end of this course, students will be able to:

- a) Classify igneous, metamorphic, and sedimentary rocks based on mineralogical and textural properties.
- b) Analyze rock-forming processes using thin-section petrography and geochemical data.
- c) Interpret petrological data for applications in tectonic studies and resource exploration.

### **Sequence Stratigraphy**

By the end of this course, students will be able to:

- a) Understand the types of stratigraphic sequences.
- b) Establish relationship between sequences with sea-level fluctuation.
- c) Develop depositional models for petroleum systems.

### **Scientific Writing & Research Methods**

By the end of this course, students will be able to:

- a) Develop research proposals and design geological investigations.
- b) Analyze and interpret geological data using statistical and computational methods.
- c) Communicate scientific findings effectively through technical reports and publications.

### **Sedimentology**

By the end of this course, students will be able to:

- a) Describe sedimentary processes.
- b) Construct facies and interpret depositional and diagenetic environments.
- c) Apply sedimentological techniques in natural resources assessment.

### **Stratigraphy**

By the end of this course, students will be able to:

- a) Understand basic principles of stratigraphy and evolution of nomenclature.
- b) Correlate rock units and geological records.
- c) Recognize stratigraphy of selected geological sections.

### **Structural Geology**

By the end of this course, students will be able to:

- a) Understand the kinematics and dynamics of deformational structures.
- b) Prepare the geological maps and cross-sections.
- c) Assess the implications of structural geology in natural resources exploration and seismic hazard analysis.

## LABORATORY REQUIREMENTS

AD, BS & MS

Following is the list of mandatory equipment and apparatus required for Geology laboratories.

### Essential Equipment / Apparatus:

1. Analytical Balance
2. ASTM Sieve Set with Shaker
3. Brunton / Silva Compass
4. Casagrande Apparatus
5. Compression Machine
6. Core Cutter
7. Crystal Models
8. Fossil Samples
9. Furnace
10. Geological Hammer
11. GPS
12. Grinding Machine
13. Hand Lens
14. Hardness Scale
15. Hot Plates
16. Hydrometer
17. Lapping Machine
18. Laser Distance
19. Maps / Aerial Photographs
20. Mineral Samples
21. Oven
22. pH Meter
23. Point Counter
24. Polarizing Microscope
25. Polishing Machine
26. Pycnometer
27. Rock Samples
28. Satellite Imageries
29. Schmidt Hammer
30. Sieve set with shaker
31. Slide Cutter
32. Small Metal Container
33. Spectrophotometer
34. Stereo-net
35. Streak Plates
36. Structure Models
37. TDS Meter
38. Thermometer

39. Trim Saw
40. Water Absorption
41. Weight Balance
42. Workstation and related software

**Desirable Equipment / Apparatus:**

1. AAS
2. Cathodoluminescence Microscope
3. CBR Machine
4. Direct Shear Machine
5. GPR
6. Gravimeter
7. ICP-MS
8. Los angles Abrasion Machine
9. Magnetometer
10. Ore Microscope
11. Point load Apparatus
12. SEM
13. Slake durability
14. Soil triaxial
15. Stereoscopic Microscope
16. Tensile Strength Apparatus
17. Terrameter
18. UTM
19. XRD
20. XRF

## FOR FEEDBACK & QUERIES

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