



# Course Specification

Diploma

Course Title: Exploration Geophysics I

Course Code: APMQ1204

Program: Mining and Quarrying

Department: Diploma Department

College: The Applied College

Institution: Umm Al-Qura University

Version: 1

Last Revision Date: 20 February 2025



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## A. General information about the course:

### 1. Course Identification

1. Credit hours: ( 2 )

#### 2. Course type

A. ☐ University ☐ College ☒ Department ☐ Track ☐ Others  
B. ☒ Required ☐ Elective

3. Level/year at which this course is offered: ( 1 St. Level)

#### 4. Course General Description:

##### 1. Course Description

Exploration Geophysics course typically focuses on applying geophysical methods to explore subsurface structures and resources like minerals, oil, natural gas, water, and even environmental investigations. Geophysics is a critical tool in geoscience, where non-invasive techniques are used to study the Earth's subsurface.

Introduction, definition and branches of geophysics. Gravity field of the Earth. Geoid, GPS and isostasy. Magnetic and paleomagnetic methods. Electric and geothermal methods. Borehole geophysics. Practical work of some measured geophysical parameters.

#### 5. Pre-requirements for this course (if any):

None

#### 6. Co-requisites for this course (if any):

None

#### 7. Course Main Objective(s):

##### 1. Understand the Fundamentals of Geophysical Methods

- To introduce students to the principles and concepts behind the major geophysical techniques, such as seismic, magnetic, gravity, electrical, and electromagnetic methods.

##### 2. Develop Technical Skills in Data Acquisition

- Objective: To train students in the use of geophysical equipment and instruments for data collection.

##### 3. Learn Data Processing and Interpretation

- Objective: To develop skills in processing and analyzing raw geophysical data to extract meaningful information about subsurface structures.

##### 4. Apply Geophysical Methods to Real-World Exploration

- Objective: To provide practical applications for geophysical methods in various fields such as mineral exploration, oil and gas, groundwater detection, and environmental site assessments.



5. Develop Problem-Solving and Critical Thinking Skills

- Objective: To enhance students' ability to use geophysical methods for solving complex geological and geotechnical problems.

6. Gain Hands-On Experience with Geophysical Software

- Objective: To familiarize students with industry-standard software tools used for data analysis and visualization (e.g., Geosoft Oasis Montaj, MATLAB, Surfer, ArcGIS).

7. Understand the Integration of Multiple Geophysical Methods

- Objective: To explore how different geophysical methods can be combined to provide a more comprehensive understanding of subsurface conditions.

8. Address Environmental and Ethical Considerations in Geophysical Exploration

- Objective: To raise awareness of the environmental impact of geophysical exploration and the ethical considerations involved in resource extraction.

9. Conduct and Report on Field and Laboratory Work

- Objective: To provide experience in conducting field surveys, collecting geophysical data, and writing technical reports.

10. Foster Teamwork and Communication Skills

- Objective: To emphasize the importance of teamwork in geophysical surveys and the ability to communicate technical findings effectively.

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	30	100%
2	E-learning		
3	Hybrid <ul style="list-style-type: none"> <li>• Traditional classroom</li> <li>• E-learning</li> </ul>		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	Lectures	30
2.	Laboratory/Studio	
3.	Field	
4.	Tutorial	
5.	Others (specify)	

Total	45
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## B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

1.0	Knowledge and understanding			
1.1	understand how each method works, the physical principles behind them, and what types of geological features or resources they are best suited to explore.	K1	Lectures and Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes.
1.2	proficient in operating field instruments (e.g., seismographs, magnetometers, GPS systems) and understand how to design and conduct geophysical surveys in various environments.	K3	Lectures and Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes.
1.3	able to apply computational techniques to process data, identify anomalies, and interpret results in terms of geological features (e.g., faults, mineral deposits, groundwater).	K2	Lectures and Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes.
	understanding of best practices in minimizing environmental impacts during geophysical surveys, as well as the ethical issues surrounding the exploration and exploitation of natural resources.	K4	Lectures and Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes.
2.0	Skills			
2.1	able to assess when and how to apply different geophysical techniques based on the specific exploration target (e.g., minerals, hydrocarbons, water, or environmental hazards).	S1	Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes
2.2	capable of devising appropriate survey strategies, analyzing ambiguous or noisy data, and making sound recommendations based on the results.	S3	Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes
3.2	able to import, process, and visualize geophysical data effectively, and use these tools to create subsurface models and maps.	S4	Interactive Discussions	Written Exams (Mid-Term and Final Exams),
3.0	Values, autonomy, and responsibility			
3.1	work collaboratively on field projects, contribute to team-based decision-making, and present their findings clearly through written and oral communication.	V1	Individual and Group Presentations	Presentations

### C. Course Content

No	List of Topics	Contact Hours
1.	<b>Principles of Gravity method</b> <ul style="list-style-type: none"> <li>a. Gravitational forces and how density contrasts in the Earth's crust influence local gravity.</li> <li>b. Gravitational acceleration and its variation with latitude and altitude.</li> </ul>	2
2.	<b>Instruments and Equipment</b> <ul style="list-style-type: none"> <li>a. Gravimeters: Portable and absolute gravimeters.</li> <li>b. Field setup: Equipment calibration, data logging, and survey design.</li> </ul>	2
3.	<b>Data Processing and Corrections</b> <ul style="list-style-type: none"> <li>o Free-air corrections, Bouguer corrections, and terrain corrections.</li> <li>o Interpretation of gravity data: Identification of mass anomalies, such as subsurface cavities, mineral deposits, and tectonic structures.</li> </ul>	2
4.	<b>Applications</b> <ul style="list-style-type: none"> <li>o Mapping large-scale structures like sedimentary basins and fault zones.</li> <li>o Exploration for oil and gas, mineral deposits, and groundwater.</li> </ul>	2
5.	<b>Principles of Magnetic Method</b> <ul style="list-style-type: none"> <li>o Earth's magnetic field and the concept of magnetic anomalies.</li> <li>o Magnetic properties of rocks and minerals (ferromagnetic, paramagnetic, diamagnetic).</li> <li>o Understanding total magnetic intensity, inclination, declination, and susceptibility.</li> </ul>	2

6.	<b>Magnetic Survey Equipment</b> <ul style="list-style-type: none"> <li>○ Magnetometers: Proton precession magnetometers, Overhauser magnetometers, and fluxgate magnetometers.</li> <li>○ Field survey techniques: How to conduct magnetic surveys, handle instrumentation, and avoid interference.</li> </ul>	2
7.	<b>Data Processing and Interpretation</b> <ul style="list-style-type: none"> <li>○ Reduction of data: Diurnal and secular variation corrections.</li> <li>○ Magnetic anomaly types: Positive and negative anomalies, their relation to geological features.</li> </ul>	2
8.	<ul style="list-style-type: none"> <li>• <b>Applications</b></li> </ul>	2
9.	<ul style="list-style-type: none"> <li>○ Mineral exploration: Identifying magnetic minerals such as magnetite and pyrrhotite.</li> <li>○ Oil and gas exploration: Identifying features such as buried ridges or basins that may contain hydrocarbons.</li> <li>○ Archaeological and environmental surveys: Locating buried structures or pipelines.</li> </ul>	2
10.	<b>Electrical Resistivity Method</b> <ul style="list-style-type: none"> <li>• <b>Principles of Electrical Resistivity</b></li> </ul>	2
11.	<ul style="list-style-type: none"> <li>○ Concept of resistivity and its dependence on rock type, fluid content, and porosity.</li> <li>○ Electrical resistivity contrast: How differences in subsurface materials (e.g., clay, rock, water) affect resistivity.</li> <li>○ Relationship between resistivity, porosity, and water saturation in rocks.</li> </ul>	2
12.	<b>Survey Techniques</b> <ul style="list-style-type: none"> <li>○ <b>Wenner, Schlumberger, and Dipole-Dipole Arrays:</b> Different electrode configurations for measuring resistivity.</li> <li>○ <b>Electrode Placement:</b> Field setup for electrode spacing and depth of investigation.</li> </ul>	2
13.	<ul style="list-style-type: none"> <li>• <b>Data Processing and Interpretation</b></li> </ul>	2
14.	<ul style="list-style-type: none"> <li>○ <b>Apparent Resistivity:</b> Calculating resistivity from measurements taken at various electrode separations.</li> </ul>	2





	<ul style="list-style-type: none"> <li>○ <b>Inversion:</b> 1D, 2D, and 3D inversion techniques to generate subsurface resistivity models.</li> </ul>	
15.	<b>Applications</b> <ul style="list-style-type: none"> <li>○ Groundwater exploration: Mapping aquifers and identifying zones of high permeability or contamination.</li> <li>○ Mineral exploration: Identifying ore bodies or assessing the depth of mineral deposits.</li> <li>○ Environmental studies: Detecting contamination (e.g., oil spills, leachate) or mapping buried waste sites.</li> </ul>	2
<b>Total</b>		<b>30</b>

## D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Quizzes	5	10
2.	Mid-Term Exam	8	20
3.	Presentations	12	10
4.	Homework	All weeks	10
5.	Final Exam	16	50

\*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

## E. Learning Resources and Facilities

### 1. References and Learning Resources

<b>Essential References</b>	<p>"Introduction to Applied Geophysics" by Charles M. Kearey, Michael Brooks, and Ian Hill</p> <p>A very comprehensive book that covers the fundamental principles of exploration geophysics with practical examples. Great for beginners and intermediate students.</p> <p>"Environmental and Engineering Geophysics" by John M. Reynolds</p>
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	A textbook that emphasizes geophysical methods in environmental and engineering applications, including groundwater studies and site investigations.
<b>Supportive References</b>	<p>"The Solid Earth: An Introduction to Global Geophysics" by C.M.R. Fowler Offers a broader view of geophysics, covering global Earth structures and their relation to exploration techniques.</p> <p>"Practical Geophysics" by S. L. Uyeshima and D. P. L. S. G. S. T. R. Focused on practical, field-based applications and problem-solving. Excellent for those interested in field surveys and hands-on data collection.</p>
<b>Electronic Materials</b>	
<b>Other Learning Materials</b>	

## 2. Required Facilities and equipment

Items	Resources
<b>facilities</b> (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Classrooms
<b>Technology equipment</b> (projector, smart board, software)	Data show
<b>Other equipment</b> (depending on the nature of the specialty)	

## F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Faculty	Direct (project, HW, Quiz, midterm and final exam)
Effectiveness of Students assessment	Students	Indirect (Student Survey)
Quality of learning resources	Program Coordinator	Direct analysis
The extent to which CLOs have been achieved	Program Coordinator	Direct analysis
Other		

**Assessors** (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify))

**Assessment Methods** (Direct, Indirect)





## G. Specification Approval

COUNCIL /COMMITTEE	Umm Al-Qura University Council
REFERENCE NO.	851110214476/195605
DATE	18/2/1447

