



# Course Specification

Diploma

Course Title: Soil and Rock Mechanics

Course Code: APMQ2207

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: ( 3 )

#### 2. Course type

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

3. Level/year at which this course is offered: ( 2 )  
(2nd. Level)

#### 4. Course General Description:

##### 1. Course Description

Description and classification of soils and rock. Physical properties of soils: composition of soils, classification tests, ascertaining of soil properties. Water in soil: groundwater flow, hydraulic permeability, buoyancy, hydraulic thrust, hydraulic base failure. Stress in soils: Initial conditions and stress paths: total stress, effective stress, pore water pressure. Stress strain behavior of soils. Laboratory and field tests for stress strain haracte and shear strength parameters of soils: compression test, triaxial test, shear test, stiffness modulus, shear strength parameters. Consolidation: time-settlement-curve, consolidation ratio, consolidation theory. Settlements: floppy and stiff loading. Active and passive earth pressure: earth-pressure theory, arithmetical and graphical ascertaining of earth pressure, sliding surfaces, earth pressure at rest. Proof of bearing capacity: Tilt over, sliding, base failure, slope failure. Securing obstacle jumps. Structural important rock and rock mass properties: Properties of joint faces, strength properties and stress strain behavior of rock. Relations rock – rock mass. Failure of rock. Initial conditions and tensions around a underground space. Objective (expected results of study and acquired competences) Basic knowledge of soil- and rock mechanics and design of structures in the field of foundation engineering. Ability of independent solution to simple problems in soil- and rock mechanics.

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

General Geology

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

None

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

1. Understand the origin and classification of soils and rocks, including the basic geological processes involved in their formation.





2. Determine and interpret physical properties of soils and rocks through standard laboratory and field testing procedures (e.g., grain size analysis, Atterberg limits, compaction, permeability).
3. Analyze seepage and flow through soils, using concepts of permeability, Darcy's law, and flow nets.
4. Apply the effective stress principle to understand stress conditions in saturated and unsaturated soils.
5. Evaluate stress distribution beneath loaded areas using classical elastic theories (Boussinesq, Westergaard).
6. Analyze and calculate settlement and consolidation characteristics of soil layers under loading, using Terzaghi's one-dimensional consolidation theory.
7. Determine shear strength parameters of soils and rocks using laboratory and empirical methods, and apply them to stability problems.
8. Apply earth pressure theories to the design and analysis of retaining structures, considering different wall and soil conditions.
9. Perform slope stability analysis for both natural and engineered slopes, and recommend appropriate stabilization techniques.
10. Classify and assess rock masses, using systems such as RMR and Q-system, and understand their influence on engineering behavior.
11. Evaluate mechanical properties of rocks, and assess their behavior under different loading and stress conditions.
12. Understand failure mechanisms in rock slopes, and use kinematic and limit equilibrium methods for stability assessment.
13. Apply knowledge to real-world geotechnical problems, including foundation design, excavation support, and tunneling.
14. Interpret and synthesize lab and field data to make informed engineering decisions and design recommendations.

## 2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	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	30
3.	Field	
4.	Tutorial	
5.	Others (specify)	
Total		45

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

1.0	Knowledge and understanding			
1.1	Understand the origin and classification of soils and rocks, including the basic geological processes involved in their formation.	K1	Lectures and Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes.
1.2	Determine and interpret physical properties of soils and rocks through standard laboratory and field testing procedures (e.g., grain size analysis, Atterberg limits, compaction, permeability).	K3	Lectures and Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes.
1.3	Analyze seepage and flow through soils, using concepts of permeability, Darcy's law, and flow nets. Apply the effective stress principle to understand stress conditions in saturated and unsaturated soils.	K2	Lectures and Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes.
1.4	Evaluate stress distribution beneath loaded areas using classical elastic theories (Boussinesq, Westergaard).	K4	Lectures and Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes.
2.0	Skills			
2.1	Analyze and calculate settlement and consolidation characteristics of soil layers under loading, using Terzaghi's one-dimensional consolidation theory.	S1	Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes
2.2	Determine shear strength parameters of soils and rocks using laboratory and empirical methods, and apply them to stability problems. Apply earth pressure theories to the design and analysis of retaining structures, considering different wall and soil conditions.	S3	Interactive Discussions	Written Exams (Mid-Term and Final Exams), Quizzes





3.2	Classify and assess rock masses, using systems such as RMR and Q-system, and understand their influence on engineering behavior. Evaluate mechanical properties of rocks, and assess their behavior under different loading and stress conditions.	S4	Interactive Discussions	Written Exams (Mid-Term and Final Exams),
3.0	Values, autonomy, and responsibility			
3.1	Understand failure mechanisms in rock slopes, and use kinematic and limit equilibrium methods for stability assessment. Apply knowledge to real-world geotechnical problems, including foundation design, excavation support, and tunneling.	V1	Individual and Group Presentations	Presentations

### C. Course Content

No	List of Topics	Contact Hours
1.	<b>Introduction to Soil and Rock Mechanics</b> <ul style="list-style-type: none"> <li>Importance in Civil Engineering</li> <li>Historical development</li> <li>Scope and applications</li> </ul>	2
2.	<b>Soil Origin and Classification</b> <ul style="list-style-type: none"> <li>Soil formation processes</li> <li>Soil structure and fabric</li> <li>Particle size classification (USCS, AASHTO)</li> <li>Consistency limits (Atterberg Limits)</li> <li>Soil compaction and field density</li> </ul>	2
3.	<b>3. Permeability and Seepage</b> <ul style="list-style-type: none"> <li>Darcy's law</li> <li>Laboratory and field determination of permeability</li> <li>Seepage analysis: flow nets, uplift pressure, piping</li> </ul>	2
4.	<b>Effective Stress and Pore Water Pressure</b> <ul style="list-style-type: none"> <li>Total stress, effective stress, and pore pressure concepts</li> <li>Capillarity and seepage forces</li> </ul>	2
5.	<b>Stress Distribution in Soils</b>	2





	<ul style="list-style-type: none"> <li>Boussinesq and Westergaard theories</li> <li>Stress distribution under various loadings</li> <li>Understanding total magnetic intensity, inclination, declination, and susceptibility.</li> </ul>	
6.	<b>Consolidation and Settlement</b> <ul style="list-style-type: none"> <li>One-dimensional consolidation (Terzaghi's theory)</li> <li>Time rate of consolidation</li> <li>Immediate and secondary settlement</li> </ul>	2
7.	<b>Shear Strength of Soils</b> <ul style="list-style-type: none"> <li>Mohr-Coulomb failure criterion</li> <li>Laboratory testing: direct shear, triaxial, unconfined compression</li> <li>Factors affecting shear strength</li> </ul>	2
8.	<b>Earth Pressure Theories</b>	2
9.	<b>9. Slope Stability</b> <ul style="list-style-type: none"> <li>Rankine and Coulomb earth pressure theories</li> <li>Active, passive, and at-rest pressure</li> <li>Earth pressure on retaining structures</li> <li>Types of slope failures</li> <li>Infinite and finite slopes</li> <li>Stability analysis methods: Swedish Circle, Bishop's Method</li> </ul>	2
10.	<b>Introduction to Rock Mechanics</b>	2
11.	<ul style="list-style-type: none"> <li>Rock vs. soil behavior</li> <li>Applications in tunneling, foundations, slopes</li> </ul> <b>11. Classification of Rocks</b> <ul style="list-style-type: none"> <li>Geological and engineering classification</li> <li>Rock mass rating systems (RMR, Q-system)</li> </ul>	2
12.	<b>Physical and Mechanical Properties of Rocks</b> <ul style="list-style-type: none"> <li>Porosity, density, permeability</li> <li>Compressive strength, tensile strength, modulus of elasticity</li> </ul>	2
13.	<b>Rock Mass Behavior</b>	2
14.	<ul style="list-style-type: none"> <li>Discontinuities: joints, faults, bedding planes</li> <li>In-situ stress conditions</li> </ul> <b>Laboratory and In-Situ Testing of Rocks</b> <ul style="list-style-type: none"> <li>Point load test, triaxial test, Brazilian test</li> <li>Plate load test, borehole jack test</li> </ul>	2
15.	<b>Rock Slope Stability</b> <ul style="list-style-type: none"> <li>Modes of failure (plane, wedge, toppling)</li> </ul>	2





	<ul style="list-style-type: none"> <li>Kinematic analysis</li> <li>Remedial measures (bolting, anchors, shotcrete)</li> </ul>	
<b>Total</b>		<b>30</b>

## C.2 Experimental Content

No	List of Topics	Contact Hours
1.	Index Properties of Soil	2
2.	<ul style="list-style-type: none"> <li>Moisture Content Determination (Oven drying method – IS 2720 Part 2)</li> <li>Specific Gravity of Soil Solids (Pycnometer method – IS 2720 Part 3)</li> <li>Grain Size Distribution                             <ul style="list-style-type: none"> <li>Sieve Analysis (IS 2720 Part 4)</li> <li>Hydrometer Analysis (for fine-grained soils)</li> </ul> </li> <li>Atterberg Limits                             <ul style="list-style-type: none"> <li>Liquid Limit (Casagrande device)</li> <li>Plastic Limit</li> <li>Shrinkage Limit</li> </ul> </li> </ul>	2
3.	Soil Classification	2
4.	<ul style="list-style-type: none"> <li>Based on grain size distribution and Atterberg limits using IS classification system (IS 1498)</li> </ul> <p>Compaction Test</p> <ul style="list-style-type: none"> <li>Standard Proctor Test (IS 2720 Part 7)</li> <li>Modified Proctor Test (IS 2720 Part 8)</li> </ul>	2
5.	Permeability Test	2
6.	<ul style="list-style-type: none"> <li>Constant Head Method (for coarse-grained soils)</li> <li>Falling Head Method (for fine-grained soils)</li> </ul>	2
7.	Consolidation Test	2
8.	One-Dimensional Consolidation Test (Oedometer) – IS 2720 Part 15	2
9.	Physical Properties of Rocks	2
10.	<ul style="list-style-type: none"> <li>Specific Gravity and Water Absorption</li> <li>Porosity and Density</li> </ul>	2
11.	Strength Tests on Rocks	2
12.	<ul style="list-style-type: none"> <li>Uniaxial Compressive Strength (UCS) Test</li> <li>Brazilian Tensile Strength (Indirect Tension Test)</li> <li>Point Load Strength Index Test</li> <li>Triaxial Compression Test on Rock Cores</li> </ul>	2
13.		2
14.		2
<b>Total</b>		<b>28</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

Essential References	<p>"Introduction to Applied Geophysics" by Charles M. Kearey, Michael Brooks, and Ian Hill</p> <p><b>Braja M. Das</b> – <i>Principles of Geotechnical Engineering</i></p> <ul style="list-style-type: none"> <li>Widely used for undergraduate and graduate studies in soil mechanics.</li> </ul> <p><b>T.W. Lambe &amp; R.V. Whitman</b> – <i>Soil Mechanics</i></p> <ul style="list-style-type: none"> <li>A classic book for understanding theoretical soil behavior.</li> </ul> <p><b>Karl Terzaghi, Ralph B. Peck, and Gholamreza Mesri</b> – <i>Soil Mechanics in Engineering Practice</i></p> <ul style="list-style-type: none"> <li>Authored by the "father of soil mechanics," this is essential for understanding fundamental principles.</li> </ul>
Supportive References	<p><b>Bieniawski, Z.T.</b> – <i>Rock Mechanics Design in Mining and Tunneling</i></p> <ul style="list-style-type: none"> <li>Well-known for the Rock Mass Rating (RMR) system.</li> </ul> <p><b>E. Hoek and J. Bray</b> – <i>Rock Slope Engineering</i></p> <ul style="list-style-type: none"> <li>Standard text for understanding rock slope stability.</li> </ul> <p><b>J.C. Jaeger, N.G.W. Cook, and R.W. Zimmerman</b> – <i>Fundamentals of Rock Mechanics</i></p> <ul style="list-style-type: none"> <li>Highly detailed and technical; excellent for advanced study.</li> </ul>
Electronic Materials	
Other Learning Materials	

### 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

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

