Ministry of Higher Education and Scientific Research

University of Mosul

College of Petroleum and Mining Engineering

Courses Description

Mining Engineering Department

Level Three / Semester Two / Bologna Process

2025-2026

MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	Soil Mechanics			**Module Delivery**	
Module Type	C			☒ Theory ☐ Lecture ☒ Lab ☒ Tutorial ☐ Practical ☒ Seminar	
Module Code	DME321				
ECTS Credits	6				
SWL (hr/sem)	150				
Module Level	UGIII		**Semester of Delivery**	6	
Administering Department	Mining Engineering		**College**	Petroleum and Mining Engineering	
Module Leader	Nihad Saoud Najim Aljuboori		**e-mail**	nihadsaoud@uomosul.edu.iq	
Module Leader's Acad. Title	Lecturer		**Module Leader's Qualification**	Ph.D.	
Module Tutor	Sarah Mwafaq Adulazeez		**e-mail**	sarahtaie87@uomosul.edu.iq	
Peer Reviewer Name	Hudhaifa Raad Hamzah		**e-mail**	hudhaifahamzah@uomosul.edu.iq	
Scientific Committee Approval Date	15/9/2025		**Version Number**	1	

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module	None	**Semester**	
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Objectives أهداف المادة الدراسية	1. Understand soil properties: Students should develop an understanding of the physical and mechanical properties of soils, including grain size distribution, consistency, compaction, permeability, shear strength, and compressibility. 2. Soil classification: Students should be able to classify soils based on their particle size distribution and other relevant properties using established soil classification systems such as the Unified Soil Classification System (USCS) or the AASHTO classification system. 3. Soil-water interaction: Students should learn about the behavior of soils in response to water, including concepts such as effective stress, pore water pressure, capillarity, seepage, and consolidation. 4. Shear strength of soils: Students should understand the factors influencing the shear strength of soils, including cohesion, friction angle, and effective stress. They should be able to apply different shear strength theories (e.g., Mohr-Coulomb theory) to analyze stability and failure of soil slopes or foundations. 5. Settlement analysis: Students should be able to analyze and predict soil settlement behavior, including immediate settlement and consolidation settlement, using methods such as Terzaghi's one-dimensional consolidation theory. 6. Ground improvement techniques: Students should become familiar with various ground improvement methods to enhance soil properties, including compaction, stabilization, and reinforcement techniques. 7. Geotechnical laboratory testing: Students should gain practical experience in conducting laboratory tests on soil samples to determine their engineering properties, including tests for grain size analysis, compaction, permeability, and shear strength. 8. Geotechnical report writing: Students should develop skills in preparing geotechnical reports that summarize the findings of site investigations, laboratory testing, and analysis. They should be able to communicate the results effectively and provide recommendations for geotechnical design
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	Important: Write at least 6 Learning Outcomes, better to be equal to the number of study weeks. 1. Knowledge of soil composition and formation: Understand the components of soil, including minerals, organic matter, air, and water. Comprehend the processes involved in soil formation, such as weathering, erosion, and deposition. 2. Knowledge of soil properties: Understand the physical and mechanical properties of soils, including grain size distribution, consistency, compaction, permeability, shear strength, and compressibility.

	3. Soil classification: Classify soils based on their particle size distribution and other relevant properties using established soil classification systems such as the Unified Soil Classification System (USCS) or the AASHTO classification system. 4. Understanding soil-water interaction: Comprehend the behavior of soils in response to water, including concepts such as effective stress, pore water pressure, capillarity, seepage, and consolidation. 5. Ability to analyze stress in soil: Analyze the stress distribution in soil masses due to external loads, applying concepts of stress, strain, and elasticity. This may involve stress paths, stress-strain relationships, and Mohr's circle. 6. Analysis of shear strength: Determine the factors influencing the shear strength of soils, including cohesion, friction angle, and effective stress. Apply shear strength theories (e.g., Mohr-Coulomb theory) to analyze stability and failure of soil slopes or foundations. 7. Design of retaining structures: Design and analyze various retaining structures, such as retaining walls and sheet piles, based on principles of earth pressure and stability analysis. 8. Settlement analysis: Analyze and predict soil settlement behavior, including immediate settlement and consolidation settlement, using methods such as Terzaghi's one-dimensional consolidation theory. 9. Familiarity with ground improvement techniques: Understand various ground improvement methods to enhance soil properties, including compaction, stabilization, and reinforcement techniques. 10. Proficiency in geotechnical laboratory testing: Conduct laboratory tests on soil samples to determine engineering properties, including grain size analysis, compaction, permeability, and shear strength. 11. Effective geotechnical report writing: Prepare clear and concise geotechnical reports summarizing site investigations, laboratory testing, analysis, and recommendations for geotechnical design.
Indicative Contents المحتويات الإرشادية	Indicative content includes the following. 1. Introduction to Soil Mechanics: • Definition and scope of Soil Mechanics • Importance of soil mechanics in mining engineering 2. Soil Formation and Composition: • Soil formation processes (weathering, transportation, deposition) • Soil composition and particle size distribution • Soil mineralogy and identification 3. Soil Classification and Index Properties: • Soil classification systems (USCS, AASHTO, etc.) • Index properties of soil (particle size analysis, Atterberg limits)

	• Interpretation and application of soil classification and index properties 4. Soil Water Relationship: • Soil moisture content and its measurement • Capillary rise, permeability, and seepage through soils 5. Effective Stress and Pore Water Pressure: • Introduction to effective stress concept • Total and effective stress calculations • Pore water pressure and its significance 6. Soil Compaction: • Principles of soil compaction • Compaction equipment and methods 7. Shear Strength of Soils: • Shear strength tests (direct shear, triaxial, etc.) • Factors influencing shear strength (cohesion, friction, effective stress) 8. Consolidation and Settlement: • Terzaghi's consolidation theory • One-dimensional consolidation settlement • Settlement calculations and settlement control 9. Ground Improvement Techniques: • Soil stabilization methods (chemical, mechanical, and thermal) • Ground reinforcement techniques (geotextiles, geogrids) • Ground improvement for different engineering applications 10. Geotechnical Laboratory Testing: • Sampling and preparation of soil samples • Laboratory testing for soil properties (grain size analysis, compaction, permeability, shear strength) • Interpretation of laboratory test results 11. Geotechnical Site Investigation: • Site exploration techniques (boring, drilling, sampling) • In-situ testing methods (SPT) • Geotechnical report preparation based on site investigations

Learning and Teaching Strategies استر اتيجيات التعلم و التعليم	
Strategies	Lectures: Traditional lectures can be used to deliver foundational knowledge and theoretical concepts of soil mechanics. Instructors can explain key principles, theories,

	and equations, and provide examples to illustrate their application. Visual aids such as slides, diagrams, and charts can enhance understanding. Laboratory Sessions: Practical laboratory sessions play a crucial role in soil mechanics education. Students can perform various laboratory tests on soil samples to measure properties such as grain size distribution, compaction, permeability, and shear strength. These hands-on activities enable students to observe soil behavior, understand testing procedures, and interpret experimental results. Fieldwork and Site Visits: Field visits to construction sites or geotechnical engineering projects can provide students with real-world exposure to soil mechanics applications. They can observe soil sampling techniques, site investigation methods, and geotechnical instrumentation. Fieldwork also allows students to see the practical implications of soil mechanics principles and understand site-specific challenges. Problem-Solving Exercises: Assigning problem-solving exercises and case studies helps students apply theoretical concepts to practical scenarios. These exercises may involve calculating stresses or predicting settlement. Working through such problems enhances critical thinking, problem-solving skills, and the ability to apply soil mechanics principles. Research Projects and Case Studies: Assigning research projects or case studies allows students to delve deeper into specific aspects of soil mechanics. They can investigate advanced topics, review research papers, and explore emerging technologies or techniques. This approach promotes independent research skills, critical analysis, and a deeper understanding of specialized areas within soil mechanics.

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	78	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	5
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	72	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	5
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	**150**		

Module Evaluation

تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	Quizzes	2	10% (10)	5 and 10	LO #1, #2 and #10, #11
	Assignments	2	10% (10)	2 and 12	LO #3, #4 and #6, #7
	Projects / Lab.	1	10% (10)	Continuous	All
	Report	1	10% (10)	13	LO #5, #8 and #10
Summative assessment	Midterm Exam	2hr	10% (10)	7	LO #1 - #7
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus)

المنهاج الاسبوعي النظري

	Material Covered
Week 1	Introduction in soil
Week 2	Composition of Soils
Week 3	Determination of the Liquid, Plastic, and Shrinkage Limits
Week 4	Soil Classification
Week 5	Soil investigation
Week 6	Effect of Surface water and Groundwater on soil
Week 7	Physical properties of soil
Week 8	Chemical properties of soil

Week 9	Mechanical properties of soil
Week 10	Soil Compaction
Week 11	Soil Strength
Week 12	Soil Consolidation
Week 13	Stress distribution and Type of stresses in soil
Week 14	Soil excavation in mining
Week 15	Soil Improvement
Week 16	Preparatory week before the final Exam

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered
Week 1	Lab 1: Moisture Content
Week 2	Lab 2: Atterberg's Limits Test
Week 3	Lab 3: Specific Gravity
Week 4	Lab 4: Sieve Analysis
Week 5	Lab 5: Hydrometer Tests
Week 6	Lab 6: Compaction Test
Week 7	Lab 7: Consolidation Test
Week 8	Lab 8: Direct Shear Box Test
Week 9	Lab 9: Unconfined Compressive Strength Test
Week 10	Lab 10: Triaxial Compression
Week 11	Lab 11: Permeability Test
Week 12	Lab 12: California Bearing Ratio - CBR
Week 13	Lab 13: Field Density Test
Week 14	Lab 14: Standard Penetration Test (SPT)

Learning and Teaching Resources مصادر التعلم و التدريس		
	Text	**Available in the Library?**
Required Texts	AASHTO T 99. Standard Method of Test for the Moisture-Density Relations of Soils, American Association of State Highway and Transportation Officials, 2001. Annual Book of ASTM Standards. Volume (04.08). Soil and Rock; Dimension Stone; Geotextile, 2004. Budhu. Soil Mechanics Fundamentals, Library of Congress, USA, 2015.	**No**
Recommended Texts	Holtz, R. D., Shang T.Q. and Bergado D.T. Soil Improvement, Chapter 15 in Geotechnical and Geoenviromental Handbook, R.K. Rowe, Editor, Kluwer Academic Publisher, pp.429-462, 2001. K. Head. Soil Laboratory Testing. Volume-1: Soil Classification and Compaction Tests. Pentech Press Ltd, 1982. R. Craig. Soil Mechanics. 2nd ed.,ELBS, 1982. Standard Specifications for Transportation Materials and Methods of Sampling and Testing. Part II. Methods of Sampling and Testing. AASHTO, 1996.	**No**
Websites		

Grading Scheme مخطط الدرجات				
Group	**Grade**	التقدير	**Marks %**	**Definition**
Success Group (50 - 100)	**A** - Excellent	امتياز	90 - 100	Outstanding Performance
	B - Very Good	جيد جدا	80 - 89	Above average with some errors
	C - Good	جيد	70 - 79	Sound work with notable errors
	D - Satisfactory	متوسط	60 - 69	Fair but with major shortcomings
	E - Sufficient	مقبول	50 - 59	Work meets minimum criteria
Fail Group (0 – 49)	**FX** – Fail	راسب (قيد المعالجة)	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.

MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	Rock Drilling and Blasting			**Module Delivery**	
Module Type	C			☒Theory ☒Lecture ☐ Lab ☐Tutorial ☐Practical ☐Seminar	
Module Code	DME322				
ECTS Credits	5				
SWL (hr/sem)	125				
Module Level	UGIII		**Semester of Delivery**	6	
Administering Department	Mining Engineering		**College**	Petroleum and Mining Engineering	
Module Leader	Azealdeen Al-Jawadi		**e-mail**	azealdeenaljawadi@uomosul.edu.iq	
Module Leader's Acad. Title	Asst. Professor		**Module Leader's Qualification**	Ph.D.	
Module Tutor	Islam Kamal Saeed Al-Tayi		**e-mail**	islam.kamal1158@uomosul.edu.iq	
Peer Reviewer Name	Eman Kassim Yahya		**e-mail**	eman.q@uomosul.edu.iq	
Scientific Committee Approval Date	15/10/2025		**Version Number**	1	

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module	None	**Semester**	
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents

أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية

Module Objectives أهداف المادة الدراسية	Rock Blasting Engineering in the field of Mining Engineering are as follows: 1. Understanding the Fundamentals: Gain a comprehensive understanding of the principles and fundamental concepts of rock blasting engineering, including the mechanics of rock fragmentation, energy transfer, and blast design parameters. 2. Blasting Techniques and Methods: Explore various blasting techniques and methods used in mining and civil engineering applications, such as surface and underground blasting, bench blasting, tunnel blasting, and controlled blasting. 3. Blast Design and Planning: Learn how to design and plan effective blasting operations by considering factors such as rock properties, blast geometry, explosive selection, timing, and sequencing. Develop skills to optimize blast designs for desired fragmentation, safety, and efficiency. 4. Blasting Safety and Environmental Considerations: Understand the safety protocols and regulations associated with rock blasting operations, including hazard identification, risk assessment, and mitigation strategies. Gain awareness of environmental impacts and learn techniques for minimizing blasting-related environmental effects. 5. Explosive Materials and Detonation Theory: Familiarize yourself with different types of explosives, their properties, and behavior during detonation. Learn the theory and principles of detonation, including shock wave propagation, initiation, and detonation velocity. 6. Blast Monitoring and Vibration Control: Study techniques for monitoring and controlling blast-induced vibrations, ground vibrations, and air overpressure. Understand the potential effects of vibrations on structures and human welfare, and explore measures to minimize their impact. 7. Blast Optimization and Efficiency: Develop skills to evaluate and optimize blasting operations to improve fragmentation, minimize energy consumption, reduce costs, and increase overall efficiency. Explore the use of computer-based modeling and simulation tools in blast design and optimization.

	By achieving these objectives, students will be equipped with the necessary knowledge and skills to plan, design, and execute safe and efficient rock blasting operations in various mining and civil engineering contexts.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	Completing a rock blasting engineering module will provide students with a solid foundation in the principles, techniques, and safety considerations related to rock blasting operations. 1. Understanding of Rock Blasting Principles: Gain a comprehensive understanding of the fundamental principles of rock blasting, including the mechanics of rock fragmentation, energy transfer, and wave propagation. 2. Knowledge of Blasting Techniques: Acquire knowledge about various blasting techniques used in different applications, such as surface mining, quarrying, construction, and tunneling. Learn about the selection of explosives, initiation systems, and blasting accessories. 3. Safety and Environmental Considerations: Develop an awareness of safety protocols, regulations, and best practices associated with rock blasting operations. Understand the potential environmental impacts of blasting and strategies for mitigating them. 4. Blasting Design and Optimization: Learn the process of designing effective blasting patterns based on rock properties, geological conditions, and project requirements. Explore optimization techniques to improve fragmentation, reduce vibrations, and control flyrock. 5. Blasting Instrumentation and Monitoring: Familiarize yourself with the instrumentation and monitoring tools used in rock blasting. Understand how to measure and analyze blast parameters, such as vibration, air overpressure, and particle velocity. 6. Risk Assessment and Hazard Management: Develop skills to identify potential risks and hazards associated with rock blasting activities. Learn methods for risk assessment, hazard identification, and implementation of appropriate control measures. 7. Blasting Effects and Damage Assessment: Understand the potential effects of blasting on nearby structures, infrastructure, and the environment. Learn techniques for assessing and mitigating blast-induced damage.
Indicative Contents	Typical topics covered in such a module include the following:

المحتويات الإرشادية	Introduction to Rock Blasting Overview of rock blasting as a technique for rock fragmentation Historical development and evolution of rock blasting practices. Rock Properties and Behavior. Properties of different rock types and their impact on blasting. Stress distribution in the rock mass and its effect on fragmentation. Rock Blasting Mechanics. Energy transfer and wave propagation in rock. Blast-induced stress waves and their effects on rock mass. Explosives and Initiation Systems. Types and characteristics of commercial explosives. Initiation systems, including detonators, boosters, and delay elements. Blasting Techniques and Methods. Surface mining blasting techniques (e.g., bench blasting, contour blasting). Quarrying blasting methods (e.g., presplitting, smooth blasting). Blasting in construction and tunneling projects. Blasting Design and Pattern Layout. Factors influencing blast design, such as rock type, geological conditions, and desired fragmentation. Blast pattern layout and drilling techniques. Vibration Control and Flyrock Management. Prediction and control of ground vibration and air overpressure. Techniques to minimize flyrock and ensure safe blasting operations. Blasting Safety and Regulations. Safety protocols and regulations related to rock blasting operations. Personal protective equipment (PPE) and safety procedures.

	Environmental Considerations. Environmental impacts of blasting and mitigation measures. Compliance with environmental regulations and permits. Blasting Instrumentation and Monitoring Instruments for measuring blast parameters, including vibrations, air overpressure, and particle velocity. Data analysis and interpretation for blast performance evaluation. Risk Assessment and Hazard Management. Identification and assessment of potential risks and hazards in rock blasting. Implementation of control measures and safety protocols. Blasting Effects and Damage Assessment. Assessment of blast-induced damage to structures and infrastructure. Techniques for evaluating and mitigating blast effects.

Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	The following learning and teaching methodologies can be used when teaching a Rock Blasting Engineering module to undergraduate Mining Engineering students: 1. Lectures: Conduct comprehensive lectures to introduce key concepts, theories, and principles related to rock blasting engineering. Use multimedia aids, real-life examples, and case studies to enhance understanding and engagement. 2. Practical Demonstrations: Organize practical demonstrations where students can observe the operation of blasting equipment, explosives, and initiation systems. This hands-on approach helps students grasp the practical aspects of rock blasting operations.

	3. Interactive Discussions: Encourage class discussions, debates, and Q&A sessions to facilitate the exchange of ideas, clarification of concepts, and critical thinking. This allows students to engage actively in the learning process. 4. Industry Collaboration: Foster collaboration with mining companies, blasting contractors, or research institutions. This could involve joint research projects, industry-sponsored assignments, or guest lectures from industry practitioners. 5. Online Learning Resources: Provide online resources, including lecture notes, supplementary readings, video tutorials, and discussion forums, to support self-directed learning, revision, and knowledge consolidation. By incorporating a combination of these learning and teaching strategies, students can develop a strong theoretical foundation, practical skills, critical thinking abilities, and an understanding of the real-world applications of rock blasting engineering in the mining industry.

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	48	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	3
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	77	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	4
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	**125**		

Module Evaluation

تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	Quizzes	2	10% (10)	5 and 10	LO #1, #2 and #10, #11
	Assignments	2	10% (10)	2 and 12	LO #3, #4 and #6, #7
	Projects / Lab.	1	10% (10)	Continuous	All
	Report	1	10% (10)	13	LO #5, #8 and #10
Summative assessment	Midterm Exam	2hr	10% (10)	7	LO #1 - #7
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus)

المنهاج الاسبوعي النظري

	Material Covered
Week 1	Introduction to Rock Blasting Engineering Historical Overview of Rock Blasting Importance and Applications of Rock Blasting
Week 2	Rock Fragmentation and Blastability Rock Mass Classification and Its Impact on Blasting
Week 3	Rock Properties Relevant to Blasting Rock Mechanics Principles in Blasting Design
Week 4	Explosives and Explosive Properties Types and Characteristics of Explosives

Week 5	Initiation Systems and Detonators Principles of Detonation and Shock Waves
Week 6	Blast Design Fundamentals Blast Design Parameters and Bench Design
Week 7	Mid-term Exam + Blasthole Drilling Techniques Drill Patterns and Hole Layout Design
Week 8	Blasthole Charging and Loading Techniques Blasthole Loading Design
Week 9	Blast Vibration and Airblast Control Monitoring and Mitigation Measures
Week 10	Flyrock and its Control Measures Safety Precautions and Regulations in Rock Blasting
Week 11	Environmental Impacts of Rock Blasting Best Practices for Environmental Management
Week 12	Blasting in Open Pit Mines Design Considerations and Challenges
Week 13	Blasting in Underground Mines Design Considerations and Challenges
Week 14	Blasting Optimization Techniques
Week 15	Review of Key Concepts and Principles Final Project Presentations or Examinations
Week 16	**Preparatory week before the final Exam**

Learning and Teaching Resources مصادر التعلم و التدريس		
	Text	**Available in the Library?**
Required Texts	Revuelta, Manuel Bustillo. *Mineral resources: from exploration to sustainability assessment*. Springer, 2017. Ghose, Ajoy K., and Akhilesh Joshi, eds. Blasting in Mining-New Trends. CRC Press, 2012.	Yes
Required Texts	Himanshu, Vivek Kumar, et al. Blasting Technology for Underground Hard Rock Mining. Springer Nature, 2023.	Yes
Recommended Texts	Zhang, Zong-Xian. Rock fracture and blasting: theory and applications. Butterworth-Heinemann, 2016.	No
Websites		

Grading Scheme مخطط الدرجات				
Group	**Grade**	التقدير	**Marks %**	**Definition**
Success Group (50 - 100)	**A** - Excellent	امتياز	90 - 100	Outstanding Performance
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	C - Good	جيد	70 - 79	Sound work with notable errors
	D - Satisfactory	متوسط	60 - 69	Fair but with major shortcomings
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MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	Underground Mining Engineering			**Module Delivery**	
Module Type	C			☒Theory ☒Lecture ☐ Lab ☒ Tutorial ☐Practical ☐Seminar	
Module Code	DME323				
ECTS Credits	6				
SWL (hr/sem)	150				
Module Level		UGIII	**Semester of Delivery**		6
Administering Department		Mining Engineering	**College**	Petroleum and Mining Engineering	
Module Leader	Nihad Saoud Najim Aljuboori		**e-mail**	nihadsaoud@uomosul.edu.iq	
Module Leader's Acad. Title		Lecturer	**Module Leader's Qualification**		Ph.D.
Module Tutor	Rahma Sail Al-Auqadi		**e-mail**	Rahma.saeel86@uomosul.edu.iq	
Peer Reviewer Name		Hudhaifa Raad Hamzah	**e-mail**	hudhaifahamzah@uomosul.edu.iq	
Scientific Committee Approval Date		15/9/2025	**Version Number**		1

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module	None	**Semester**	
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Objectives أهداف المادة الدراسية	The objectives of an Underground Mining Engineering module are as follows: 8. Understand the fundamental principles and concepts of underground mining engineering. 9. Identify and evaluate different underground mining methods and their applicability in various geological and operational contexts . 10. Analyze the geotechnical challenges and considerations specific to underground mining operations. 11. Apply mine planning and design principles to optimize underground mining operations. 12. Recognize the importance of safety and risk management in underground mining and implement appropriate measures. 13. Evaluate and select underground mining equipment and technology based on operational requirements. 14. Understand the environmental and social aspects associated with underground mining and implement sustainable practices. By achieving these objectives, students will be equipped with the necessary knowledge and skills to analyze, plan, design, and manage underground mining operations efficiently and responsibly.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	These learning outcomes are intended to provide a broad overview of the knowledge and skills typically covered in an underground mining engineering module. The specific learning outcomes for a particular module may vary depending on the curriculum and educational institution offering the course. 1. Knowledge of Underground Mining Methods: Understand the various methods used in underground mining, including conventional methods (such as room and pillar, cut and fill, and longwall mining) as well as advanced techniques (such as block caving and sub-level caving). 2. Rock Mechanics and Ground Control: Gain an understanding of rock mechanics principles and their application in underground mining. Learn about ground support systems, rock mass classification, stability analysis, and methods for mitigating ground control hazards. 3. Mine Ventilation: Develop knowledge of mine ventilation systems, including the design, operation, and control of ventilation systems in

	underground mines. Understand the importance of air quality, airflow management, and the prevention of gas-related hazards. 4. Mine Planning and Design: Learn the principles and techniques involved in mine planning and design for underground mining operations. This includes topics such as ore reserve estimation, stope optimization, mine layout, production scheduling, and equipment selection. 5. Environmental Impact and Sustainability: Explore the environmental impacts associated with underground mining operations and the strategies for sustainable mining practices. Learn about mine closure planning, reclamation, waste management, and the mitigation of environmental impacts. 6. Mining Equipment and Technology: Gain knowledge of the equipment and technologies used in underground mining, including drilling and blasting techniques, rock excavation machinery, material handling systems, and automation in mining operations. 7. Communication and Collaboration: Enhance communication and teamwork skills by working on group projects and participating in discussions related to underground mining engineering. Develop the ability to effectively convey technical information and work collaboratively in a multidisciplinary mining environment.
Indicative Contents المحتويات الإرشادية	These indicative contents provide a general framework for an undergraduate-level underground mining engineering module. Introduction to Underground Mining: Overview of underground mining methods and their applications Underground mining terminology and concepts Comparison of underground and surface mining methods Rock Mechanics and Ground Control: Rock properties and classification Stress distribution in underground mines Rock support systems and ground control techniques Stability analysis and monitoring in underground mines Mine Planning and Design: Mine development and infrastructure design Stope design and optimization Mine ventilation and airflow management Production scheduling and sequencing

	Underground Mine Ventilation: Ventilation system components and design Airflow modeling and simulation Ventilation network analysis and control Environmental considerations and air quality management Underground Mine Geology: Geological mapping and interpretation for underground mines Rock mass characterization and classification Structural geology and its impact on mining operations Geotechnical data collection and analysis in underground settings Underground Mining Equipment and Methods: Drilling and blasting techniques and equipment Material handling systems in underground mines Mine support and ground control machinery Mine hoisting and transportation systems Mine Safety and Risk Management: Environmental impacts of underground mining operations Mine waste management and reclamation techniques Water management and pollution prevention in underground mines Sustainable mining practices and environmental regulations Case Studies and Practical Applications: Field visits or virtual tours of underground mines Group projects and presentations on underground mining topics

Learning and Teaching Strategies استر اتيجيات التعلم و التعليم	
Strategies	When it comes to teaching an undergraduate-level underground mining engineering module, a combination of various learning and teaching strategies can be employed to enhance student engagement and facilitate effective learning. Here are some common strategies used in such modules: 1. Lectures: Traditional lectures can be used to introduce key concepts, theories, and principles related to underground mining engineering. Lectures can provide a structured overview of the subject matter and help students build a foundational understanding.

	2. Interactive Discussions: Engage students in interactive discussions to encourage critical thinking and deeper understanding of the topics. This can involve class discussions, case studies, problem-solving activities, and debates related to underground mining engineering issues. 3. Field Visits: Organize field visits to operational sites. This allows students to observe real operations, interact with industry professionals, and gain practical insights into the challenges and practices. 4. Group Projects and Presentations: Assign group projects that require students to work collaboratively on real or hypothetical mining engineering problems. This promotes teamwork, communication, and critical thinking skills. Students can present their findings and solutions to the class, fostering presentation skills and knowledge sharing. 5. Guest Lectures and Industry Experts: Industry experts can share their experiences, discuss current industry practices, and address emerging trends and challenges. 6. Online Resources and Multimedia: Supplement classroom teaching with online resources, multimedia materials, and interactive learning platforms. These can include video lectures, online tutorials, virtual simulations, and interactive learning modules, providing students with flexible and self-paced learning opportunities. 7. Assessments: Use a variety of assessment methods, such as exams, quizzes, projects, presentations, and practical demonstrations. This allows students to demonstrate their understanding, problem-solving skills, and application of theoretical knowledge.

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	78	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	5
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	72	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	4
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	150		

Module Evaluation

تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	Quizzes	2	10% (10)	5 and 10	LO #1, #2 and #10, #11
	Assignments	2	10% (10)	2 and 12	LO #3, #4 and #6, #7
	Projects / Lab.	1	10% (10)	Continuous	All
	Report	1	10% (10)	13	LO #5, #8 and #10
Summative assessment	Midterm Exam	2hr	10% (10)	7	LO #1 – #7
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus)

المنهاج الاسبوعي النظري

	Material Covered
Week 1	Introduction to Underground Mining History and Evolution of Underground Mining Underground Mining Methods: Room and Pillar Mining
Week 2	Underground Mining Methods: Cut and Fill Mining Underground Mining Methods: Longwall Mining
Week 3	Underground Mining Methods: Sublevel Stoping Underground Mining Methods: Block Caving
Week 4	Underground Ventilation Systems

	Ground Control and Rock Support in Underground Mining
Week 5	Mine Hoisting Systems Underground Mine Surveying and Mapping
Week 6	Mine Planning and Design for Underground Operations Mine Development and Access Methods
Week 7	Mid-term Exam + Underground Equipment Selection and Optimization
Week 8	Mine Geology and Ore Deposits in Underground Mining
Week 9	Underground Mine Water Management Underground Mine Environmental Considerations
Week 10	Underground Drilling and Blasting Techniques Explosives and Blasting Agents in Underground Mining
Week 11	Underground Mine Geotechnical Engineering Rock Mass Characterization and Stability Analysis
Week 12	Underground Mine Geotechnical Engineering Rock Mass Characterization and Stability Analysis
Week 13	Slope Stability Analysis and Design in Underground Mining Mine Economics and Financial Analysis
Week 14	Mine Closure and Reclamation Digitalization and Data Analytics in Underground Mining Emerging Trends and Innovations in Underground Mining
Week 15	**Group Projects and Presentations**
Week 16	**Preparatory week before the final Exam**

Learning and Teaching Resources

مصادر التعلم والتدريس

	Text	Available in the Library?
Required Texts	Revuelta, Manuel Bustillo. *Mineral resources: from exploration to sustainability assessment*. Springer, 2017.	Yes

Required Texts	Galvin, J. M. Ground engineering-principles and practices for underground coal mining. Springer, 2016.	Yes
Recommended Texts	Okubo, S., and J. Yamatomi. "Underground mining methods and equipment." Civil Engineering-Volume II 2 (2009): 170. Hustrulid, William A., William A. Hustrulid, and Richard L. Bullock, eds. Underground mining methods: Engineering fundamentals and international case studies. SME, 2001.	Yes
Websites		

Grading Scheme مخطط الدرجات				
Group	**Grade**	التقدير	**Marks %**	**Definition**
Success Group (50 - 100)	**A** - Excellent	امتياز	90 - 100	Outstanding Performance
	B - Very Good	جيد جدا	80 - 89	Above average with some errors
	C - Good	جيد	70 - 79	Sound work with notable errors
	D - Satisfactory	متوسط	60 - 69	Fair but with major shortcomings
	E - Sufficient	مقبول	50 - 59	Work meets minimum criteria
Fail Group (0 – 49)	**FX** – Fail	راسب (قيد المعالجة)	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.

MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	Geochemistry			**Module Delivery**	
Module Type	C			☒Theory ☒Lecture ☐Tutorial ☐Practical ☐Seminar	
Module Code	DME324				
ECTS Credits	4				
SWL (hr/sem)	100				
Module Level		UGIII	**Semester of Delivery**		6
Administering Department		Mining Engineering	**College**	Petroleum & Mining Engineering	
Module Leader	Rahma Sail Al-Auqadi		**e-mail**	Rahma.sael86@uomosul.edu.iq	
Module Leader's Acad. Title		Lecturer	**Module Leader's Qualification**		Ph.D.
Module Tutor	None		**e-mail**		
Peer Reviewer Name		Hudhaifa Raad Hamzah	**e-mail**	hudhaifahamzah@uomosul.edu.iq	
Scientific Committee Approval Date		15/09/2025	**Version Number**		2

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module	General Geology, Mineralogy, Basic Geochemistry	**Semester**	1
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents

أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية

Module Objectives أهداف المادة الدراسية	To provide Mining Engineering students with a theoretical understanding of sedimentary rock geochemistry, focusing on chemical processes controlling sediment composition, weathering, diagenesis, and their applications in mineral resources evaluation and mining geology.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	1. Understand the fundamental principles of sedimentary rock geochemistry. 2. Explain the geochemical behavior of major, trace, and rare earth elements. 3. Interpret geochemical data related to sedimentary processes. 4. Identify sedimentary environments associated with mineralization. 5. Apply sedimentary geochemistry concepts in mineral exploration and mining studies.

Indicative Contents

المحتويات الإرشادية

Introduction to Sedimentary Rock Geochemistry	5 hrs	
Chemical Weathering and Element Mobility	10 hrs	
Major Elements in Sedimentary Rocks	10 hrs	
Trace Elements and REE	20 hrs	
Clay Minerals and Geochemical Indicators	15 hrs	
Diagenesis and Geochemical Alterations	10 hrs	
Carbonate Rock Geochemistry	10 hrs	
Siliciclastic Rock Geochemistry	10 hrs	
Sedimentary Environments and Mineralization	10 hrs	
Applied Sedimentary Geochemistry (Mining Case Studies)	10 hrs	

Learning and Teaching Strategies

استر اتيجيات التعلم و التعليم

Strategies	The course is delivered through theoretical lectures supported by presentations, diagrams, and selected mining-related case studies. Emphasis is placed on conceptual understanding and interpretation of geochemical data used in mineral exploration and sediment-hosted ore systems.

Student Workload (SWL)

الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا

Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	48	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب اسبوعيا	3
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	52	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب اسبوعيا	2
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	**100**		

Module Evaluation

تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	**Quizzes**	2	10% (10)	2 and 8	LO #3, #4 and #5
	Assignments	2	10% (10)	2 and 12	LO #3, #54 and #5
	Projects / Lab.	1	10% (10)	Continuous	All
	Report	1	10% (10)	13	LO #3, #4 and #5
Summative assessment	**Midterm Exam**	2hr	10% (10)	7	LO #1 - #5
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus) المنهاج الاسبوعي النظري	
	Material Covered
Week 1	Introduction to Sedimentary Geochemistry
Week 2	Fundamentals of Chemical Elements in Sedimentary Rocks
Week 3	Chemical Weathering and Element Movement
Week 4	Geochemical Processes in Sedimentary Environments
Week 5	Major Elements in Sedimentary Rocks
Week 6	Trace Elements and Their Geochemical Behavior
Week 7	Trace Elements in Sedimentary Rocks
Week 8	Clay Minerals and Geochemical Indicators
Week 9	Geochemical Changes During Lithification
Week 10	Geochemistry of Carbonate Rocks
Week 11	Geochemistry of Clastic Rocks
Week 12	Advanced Application of Trace Elements in Sedimentary Environments
Week 13	Rare Earth Elements (REE)Principles and Geochemical Behavior
Week 14	Applications of Geochemistry in Mineral Exploration
Week 15	Projects and Presentations
Week 16	General Review

Learning and Teaching Resources

مصادر التعلم والتدريس

	Text	Available in the Library?
Required Texts	• Tucker, M. (2001). Sedimentary Petrology. Blackwell Publishing.	no
Recommended Texts	• Boggs, S. (2012). Principles of Sedimentology and Stratigraphy. Pearson. • Faure, G. (1998). Principles and Applications of Geochemistry. Prentice Hall.	no
	• Morse, J.W. & Mackenzie, F.T. (1990). Geochemistry of Sedimentary Carbonates.	yes

Grading Scheme

مخطط الدرجات

Group	Grade	التقدير	Marks %	Definition
Success Group (50 - 100)	**A** - Excellent	امتياز	90 - 100	Outstanding Performance
	B - Very Good	جيد جدا	80 - 89	Above average with some errors
	C - Good	جيد	70 - 79	Sound work with notable errors
	D - Satisfactory	متوسط	60 - 69	Fair but with major shortcomings
	E - Sufficient	مقبول	50 - 59	Work meets minimum criteria
Fail Group (0 – 49)	**FX** – Fail	راسب (قيد المعالجة)	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.

MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	Numerical Analysis Programming			**Module Delivery**	
Module Type	B			☒ Theory ☒ Lecture ☒ Lab ☒ Tutorial ☐ Practical ☐ Seminar	
Module Code	DME325				
ECTS Credits	4				
SWL (hr/sem)	100				
Module Level	UGIII		**Semester of Delivery**	6	
Administering Department	Mining Engineering		**College**	Petroleum and Mining Engineering	
Module Leader	Anas mohamed Younis		**e-mail**	anas.alfarhan@uomosul.edu.iq	
Module Leader's Acad. Title	Assistant Lecturer		**Module Leader's Qualification**	M.Sc.	
Module Tutor			**e-mail**		
Peer Reviewer Name	Hudhaifa Raad Hamzah		**e-mail**	hudhaifahamzah@uomosul.edu.iq	
Scientific Committee Approval Date	15/09/2025		**Version Number**	1	

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module	None	**Semester**	
Co-requisites module	Numerical and Engineering Analyses	**Semester**	5

Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Objectives أهداف المادة الدراسية	1. This course aims to prepare students to understand and develop the skills of programming in the MATLAB language 2. The ability to implement applications in the MATLAB programming language 3. The student should be ready to learn a higher level in the MATLAB programming language 4. Developing his technical ability to solve problems that he may face in the labor market 5. Provide them with information related to programs with numerical analysis 6. Developing their awareness of what is related to the subject of analysis and how to apply the MATLAB program on the computer 7. Get acquainted with the famous engineering and mathematical analysis program (MATLAB) and obtain sufficient information about the use of the program in mathematical analysis and programming, the use of matrices, as well as solving and drawing complex mathematical equations. 8. This course aims to provide students with information on how to use the MATLAB program in numerical analysis problems. This program contains a huge library of functions to solve a variety of mathematical problems. In this course, a group of these functions were presented, including the solution of the nonlinear equation with one variable, finding the maximum and minimum limits of the function, solving the integrals numerically, and solving differential equations of the first order.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	A- Cognitive goals After completing the course, the student will be able to: 1. Understand the nature of numerical analysis work 2. Knowing the types of numerical analysis 3. Familiarity with the well-known mathematical analysis program (MATLAB). 4. Statistical applications on MATLAB 5. Using the MATLAB programming language and implement and solve various engineering applications in the MATLAB programming language. 6. Knowing how to apply the MATLAB program to numerical analysis methods 7. Gaining practical skills on how to deal with modern programs, software simulation methods, and how to deal with variables. 8. Controlling the practical aspects of the course through laboratory sessions. 9. Acquiring MATLAB programming skills and knowing how to deal with variables and how to calculate them effectively and skillfully.
Indicative Contents	Indicative content includes the following.

المحتويات الإرشادية	✓ Open the program and get acquainted with the interfaces and windows of the program, the command window, the workspace window. , Variables Rules for introducing variables and types of variables (numerical variables) and constants (numerical and real constants and symbolic constants) and the rule of precedence in arithmetic expression. ✓ Script file ,editor window, input and out put command ,numbers, arithmetic operations and special characters (integers ,real and complex number) ,relational operations ,reporting format ,mathematical function (trigonometric functions),exponential ✓ Commands (closing Matlab , who, whos ,clear, clear A ,clf, ✓ While statement ,for statement ,if statement ✓ Enter matrix, Transpose ,matrix operation (multiplication ,division, addition and subtraction),colon operator ,matrix inverse ,predefined matrix, matrix algebra ✓ MATLAB Numerical Analysis Applications (Bisection method for finding roots , Newton-Raphson method and its variations , Gaussian elimination and Iterative methods (e.g., Jacobi, Gauss-Seidel), Interpolation techniques (e.g., Lagrange, Newton) and Polynomial interpolation ,Least squares regression and curve fitting ,Numerical integration techniques (e.g., trapezoidal rule, Simpson's rule) ,Ordinary Differential Equations (ODEs) ,Initial value problems and Euler's method , Runge-Kutta methods for solving ODEs ✓ Application of numerical analysis programming to real-world engineering problems

Learning and Teaching Strategies استر اتيجيات التعلم و التعليم	
Strategies	The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials and by considering types of simple lab experiments involving some sampling activities that are interesting to the students.

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	48	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	3
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	52	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	4
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	**100**		

Module Evaluation تقييم المادة الدراسية					
		Time/Number	**Weight (Marks)**	**Week Due**	**Relevant Learning Outcome**
Formative assessment	**Quizzes**	5	10% (10)	5 and 10	LO #1, #2 and #4, #5
	Assignments	2	10% (10)	2 and 12	LO #3, #4 and #6, #7
	Projects / Lab.	1	10% (10)	Continuous	All
	Report				
Summative assessment	**Midterm Exam**	2hr	20% (20)	7	LO #1 - #7
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus) المنهاج الاسبوعي النظري	
	Material Covered
Week 1	Matlab Environment, Basic syntax, Variables
Week 2	Commands, M-files, Data types, Operators
Week 3	Decision making, Loop types, Commands
Week 4	Vectors, Matrix
Week 5	Working with vectors and matrices in MATLAB
Week 6	Error analysis in numerical computations
Week 7	Mid-term Exam + Bisection method for finding roots
Week 8	Newton-Raphson method and its variations
Week 9	Gaussian elimination and Iterative methods (e.g., Jacobi, Gauss-Seidel)
Week 10	Interpolation techniques (e.g., Lagrange, Newton) and Polynomial interpolation
Week 11	Least squares regression and curve fitting
Week 12	Numerical integration techniques (e.g., trapezoidal rule, Simpson's rule) using Matlab
Week 13	Ordinary Differential Equations (ODEs) Initial value problems and Euler's method
Week 14	Runge-Kutta methods for solving ODEs
Week 15	Application of numerical analysis programming to real-world engineering problems
Week 16	**Preparatory week before the final Exam**

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered
Week 1	Lab 1: Introduction to MATLAB environment and its features.
Week 2	Lab 2: Basic programming concepts in MATLAB.
Week 3	Lab 3: MATLAB syntax and data types
Week 4	Lab 4: MATLAB applications about Vectors, Matrix
Week 5	Lab 5: Working with vectors and matrices in MATLAB
Week 6	Lab 6: Error analysis in numerical computations
Week 7	Lab 7: Mid-term Exam + Bisection method for finding roots
Week 8	Lab 8: Newton-Raphson method and its variations
Week 9	Lab 9: Gaussian elimination and Iterative methods (e.g., Jacobi, Gauss-Seidel)
Week 10	Lab 10: Interpolation techniques (e.g., Lagrange, Newton) and Polynomial interpolation
Week 11	Lab 11: Least squares regression and curve fitting
Week 12	Lab 12: Numerical integration techniques (e.g., trapezoidal rule, Simpson's rule)
Week 13	Lab 13: Ordinary Differential Equations (ODEs) Initial value problems and Euler's method
Week 14	Lab 14: Runge-Kutta methods for solving ODEs Systems of ODEs and higher-order ODEs
Week 15	Lab 15: Review and Applications Application of numerical analysis programming to real-world engineering problems

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	**Available in the Library?**
Required Texts	1- Applied Numerical Methods with MATLAB for Engineers and Scientists by Author Steven Chapra, 4th edition ,Feb 6, 2017 2- MATLAB Programming for Engineers by Author Stephen J. Chapman , 6th edition, 2019	No
Recommended Texts		No
Websites	https://www.mathworks.com/	

Grading Scheme مخطط الدرجات				
Group	**Grade**	التقدير	**Marks %**	**Definition**
Success Group (50 - 100)	**A** - Excellent	امتياز	90 - 100	Outstanding Performance
	B - Very Good	جيد جدا	80 - 89	Above average with some errors
	C - Good	جيد	70 - 79	Sound work with notable errors
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MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	Cement Technology			**Module Delivery**	
Module Type	C			☒Theory ☒Lecture ☒Lab ☐Tutorial ☐Practical ☐Seminar	
Module Code	DME326				
ECTS Credits	5				
SWL (hr/sem)	125				
Module Level	UGIII		**Semester of Delivery**	6	
Administering Department	Mining engineering		**College**	Mining and petroleum engineering	
Module Leader	Eman Kassim Yahya		**e-mail**	eman.q@uomosul.edu.iq	
Module Leader's Acad. Title	lecturer		**Module Leader's Qualification**	Ph.D.	
Module Tutor	Yasir Faris Ghanym		**e-mail**	yasser_ghanem@uomosul.edu.iq	
Peer Reviewer Name	Hudhaifa Raad Hamzah		**e-mail**	hudhaifahamzah@uomosul.edu.iq	
Scientific Committee Approval Date	15/09/2025		**Version Number**	1	

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module	None	**Semester**	
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Objectives أهداف المادة الدراسية	The objectives of cement technology may vary depending on the specific course or curriculum. However, here are some common objectives often covered in these modules: 1. Understanding and Evaluating Raw Materials: Enabling the student to identify the primary and additive mining raw materials used in cement manufacturing (such as limestone, clay, silica, and gypsum) and to evaluate their quality and chemical suitability. 2. Comprehending Raw Mix Design Chemical Calculations: Equipping the student with the skills to calculate and model raw material proportions and prepare the "raw mix" based on standard chemical moduli to ensure the production of high-quality clinker. 3. Studying the Mining Aspect and Quarry Management: Introducing the student to the planning of cement raw material extraction from quarries, controlling the homogeneity of the excavated materials, and securing a sustainable feed for the plant. 4. Analyzing Thermal Processes Inside the Kiln: Studying the complex physicochemical reactions that occur in raw materials as they pass through the drying, calcination, and sintering stages inside the rotary kiln. 5. Mastering Crushing and Preparation Technology: Understanding the operational mechanisms of crushers, raw material mills, and final cement mills (ball and vertical roller mills), and becoming familiar with fineness separation and classification technology. 6. Quality Control and Engineering Testing: Training the student to conduct and analyze standard cement tests and to understand the impact of clinker mineralogical composition (C_3S, C_2S, C_3A, C_4AF) on its physical and mechanical properties. 7. Productivity and Efficiency Calculations: Enabling the student to calculate the production capacities of various plant units (crushers, mills, kilns) and to evaluate operational performance efficiency. 8. Understanding Cement Types and Standard Specifications: Studying the different types of cement (Ordinary Portland Cement, sulfate-resistant cement, and blended cement) and checking their compliance with approved standard specifications.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	Upon successful completion of this module, students will be able to achieve the following learning outcomes: 1. Classifying and Evaluating Mining Raw Materials: Identifying the geological and chemical properties of quarry raw materials and evaluating their suitability for clinker production in accordance with standard specifications. 2. Calculating and Designing the Raw Mix: Performing the necessary mathematical and chemical calculations to determine the proportions of kiln feed components based on quality moduli such as (LSF, SM, AM).

	3. Planning Raw Material Extraction: Linking rock extraction operations in the quarry with the quality requirements of the plant, along with the ability to schedule raw material blending ratios to ensure chemical homogeneity. 4. Tracking and Analyzing Thermal Reactions: Interpreting the physical, chemical, and mineralogical changes that occur within the materials inside the rotary kiln at various temperatures to form the four primary clinker phases. 5. Operating and Evaluating Crushing and Preparation Equipment: Comparing the efficiency and operating systems of different mills (ball and vertical roller mills) and selecting the optimum operational conditions to achieve the required cement fineness. 6. Conducting Laboratory Testing and Quality Control: Executing standard physical and mechanical tests for cement (such as fineness, setting time, and compressive strength) and analyzing the results to check compliance with approved specifications. 7. Estimating and Calculating Production Capacities: Calculating the annual and daily production rates and productivity of the production line based on feed data and equipment efficiency. 8. Differentiating and Utilizing Cement Types: Selecting the appropriate type of cement for various engineering applications based on a thorough understanding of its mineralogical composition and resistance to surrounding environmental conditions.
Indicative Contents المحتويات الإرشادية	This indicative content provides a general framework for the Cement Technology module. Covered topics and depth of coverage may vary depending on the academic institution, course level, and duration: 1. Introduction to Cement Industry and Mining Raw Materials Historical development of the cement industry and its main types. Primary mining raw materials: calcium sources (limestone), and sources of silica, aluminum, and iron (clay, shale, sand, iron ore). Additives, corrective materials, and gypsum as a setting time retarder. 2. Quarrying and Mining Operations Planning and designing cement raw material quarries and extraction methods (drilling and blasting). Quarry quality control and controlling the chemical properties of the excavated rocks. Pre-homogenization processes and raw material blending in stockpiles. 3. Raw Mix Design and Proportioning Governing chemical moduli for cement quality: Lime Saturation Factor (LSF) Silica Modulus (SM) Alumina Modulus (AM) Mathematical and chemical calculations for blending raw feed lines (between two, three, or four raw materials). 4. Crushing and Raw Milling Technology

	Types of crushers used in plants (jaw, gyratory, and hammer crushers), along with calculating their efficiency and particle size distribution. Raw mix grinding and drying: ball mills versus modern Vertical Roller Mills (VRM). Air separation and classification systems (separators) and controlling raw meal fineness. 5. Pyroprocessing and Clinkerization Preheating systems (preheaters) and pre-calcination technology (precalciners). The rotary kiln: operational parts, material kinetics, and thermal zones inside the kiln. Thermochemistry: physicochemical reactions from evaporation, calcination (CaCO_3 \rightarrow CaO + CO_2), leading up to the liquid sintering stage and the formation of clinker phases. Clinker cooling technology and its importance in stabilizing mineral phases. 6. Clinker Mineralogy and Chemistry The four primary mineral compounds (according to Bogue Equations): Alite (C_3S) and Belite (C_2S). Aluminate (C_3A) and Ferrite (C_4AF). The effect of mineralogical composition and microstructure on the final properties of cement. 7. Cement Grinding and Silos Adding gypsum to clinker: proportions, operational objectives, and physical purpose. Final cement grinding circuit and controlling the specific surface area (Blaine Fineness). Cement storage (silos), packaging, and shipping systems. 8. Technical Cement Properties and Laboratory Quality Control The hydration process and the chemistry of cement reaction with water. Standard physical and mechanical testing: setting time (initial and final), soundness, and proficiency in compressive strength calculations at 3, 7, and 28 days. A comparative study of standard specifications (Iraqi IQS, British BS, and American ASTM).

Learning and Teaching Strategies استر اتيجيات التعلم و التعليم	
Strategies	A combination of various teaching and learning strategies can be utilized to deliver the Cement Technology module effectively. The following strategies are designed to enhance student engagement and promote active learning:

	1. Interactive Lectures: Presenting theoretical and foundational concepts (such as clinker chemistry and pyroprocessing) using multimedia presentations and production-line flowcharts, while facilitating brainstorming sessions and open discussions to address complex engineering problems. 2. Problem-Based Learning (PBL): Assigning students (individually or in groups) to solve real-world practical problems, such as raw mix design calculations and modeling based on actual chemical analyses of quarry raw materials. 3. Laboratory and Practical Work: Engaging students in conducting hands-on physical and mechanical tests on cement (such as fineness, setting time, and compressive strength) within the laboratory to bridge the gap between theoretical knowledge and standard specifications. 4. Tutorials and Seminars: Dedicating specific hours to review mathematical calculations related to production capacities and the efficiency of crushers and mills, alongside discussing student reports and comparing laboratory outcomes. 5. Cooperative Learning and Mini-Projects: Dividing students into teamwork groups to prepare technical reports evaluating the suitability of specific mining raw materials for cement production, thereby fostering teamwork and analytical thinking skills. 6. Visual Analysis and Simulation: Utilizing 3D engineering videos and illustrative diagrams to demonstrate the internal operations of heavy machinery that are otherwise difficult to view internally (such as material kinetics and temperature distribution inside the rotary kiln and ball mills). 7. Independent Learning: Guiding students to research scientific literature and standard codes (both local Iraqi and international standards) to conduct technical comparative studies on the properties and engineering applications of various cement types.

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	63	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب اسبوعيا	4
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	62	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب اسبوعيا	4
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	125		

Module Evaluation

تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	Quizzes	2	10% (10)	5 and 10	LO #1, #2 and #10, #11
	Assignments	2	10% (10)	2 and 12	LO #3, #4 and #6, #7
	Projects / Lab.	1	10% (10)	Continuous	All
	Report	1	10% (10)	13	LO #5, #8 and #10
Summative assessment	Midterm Exam	2hr	10% (10)	7	LO #1 - #7
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus)

المنهاج الاسبوعي النظري

	Material Covered
Week 1	Introduction to Cement Technology** * Historical development of the cement industry and its economic and engineering significance. * General concept of hydraulic and non-hydraulic cement. * General flowchart of a dry-process cement plant.
Week 2	Primary and Additive Mining Raw Materials** * Study of calcareous rocks (limestone, marl) as a source of calcium oxide (CaO). * Study of argillaceous rocks (shale, clay, sand) as sources of silica, alumina, and iron. * Corrective materials and natural gypsum.
Week 3	: Mining Aspect and Quarry Management**

	* Planning and designing cement raw material quarries and extraction methods. * Controlling the chemical homogeneity of extracted raw materials from the quarry (Quarry Quality Control). * Pre-homogenization and blending operations in stockpiles.
Week 4	Raw Mix Design and Moduli – Part I** * Governing chemical indicators and moduli for the raw mix: * Lime Saturation Factor (LSF). * Silica Modulus (SM). * Alumina Modulus (AM).
Week 5	Raw Mix Design Calculations – Part II** * Mathematical and chemical methods for calculating raw material blending proportions (two and three-material blending). * Practical applications and calculation problems for adjusting the mix to achieve target standard moduli.
Week 6	Crushing and Transport Technology** * Types of crushers used in plants (jaw, gyratory, and hammer crushers). * Calculating crusher production capacity, crushing efficiency, and particle size distribution of raw materials. * Transport systems for transferring mining raw materials to storage silos.
Week 7	Raw Meal Grinding and Drying Technology** * Operational mechanisms of raw material mills: Ball Mills. * Modern Vertical Roller Mills (VRM) and their mining-specific advantages.
Week 8	Air Separation and Raw Meal Fineness Control** * Air separation and classification systems (Separators). * Controlling and adjusting the fineness of raw meal.
Week 9	Midterm Exam and Review** * Evaluation of the first half of the semester. * Discussion and review session for raw mix design calculations and crusher capacities.
Week 10	Thermal Processing and Preheating Systems (Pyroprocessing)** * Concept of calcination and the technology of homogenization and kiln-feed silos.

	* Multi-stage suspension preheater tower systems. * Pre-calcination technology (Precalciners) and its productivity benefits.
Week 11	The Rotary Kiln and Physicochemical Processes** * Engineering and mechanical structure of the rotary kiln and its refractory linings. * Thermal zones inside the kiln and material kinetics. * Chemical and physical reactions of the raw mix from 100°C to 1450°C.
Week 12	Clinker Chemistry and Cooling Stage (Clinkerization)** * Sintering reaction, liquid phase appearance, and clinker nodule formation. * Clinker cooling systems (Clinker Coolers) and the importance of rapid cooling in stabilizing mineral phases. * Production capacity calculations for both the kiln and the cooler.
Week 13	Clinker Mineralogy** * The four primary Bogue compounds (C_3S, C_2S, C_3A, C_4AF). * Crystalline properties of each phase and its contribution to the development of cement's mechanical strength.
Week 14	Final Cement Grinding Technology** * Gypsum addition: calculating its percentage and controlling the false set phenomenon. * Final cement grinding circuit and cooling systems inside mills to prevent gypsum dehydration.
Week 15	Cement Types and Standard Specifications** * Ordinary Portland Cement (Type I) and Sulfate-Resistant Cement (Type V). * Rapid-hardening cement, low-heat cement, and blended (pozzolanic) cement. * Comparative study between local and international standard specifications (ASTM, BS).
Week 16	Cement Hydration and Technical Quality Control** * Chemistry of cement reaction with water and the formation of hydration products (C-S-H gel). * Evolution of mechanical strength and setting time. * Final Course Evaluation.

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered
Week 1	Introduction to Cement Technology Laboratory Overview of health and safety regulations inside the cement laboratory and industrial plants. Review of basic laboratory equipment, measuring tools, and analytical balances.
Week 2	Visual and Physical Inspection of Mining Raw Materials Hand-specimen study of raw materials extracted from quarries (limestone, clay, gypsum, shale). Methods of laboratory sample preparation: primary crushing, grinding, and quartering to obtain a representative sample.
Week 3	Determination of Density, Specific Gravity, and Moisture Content Experiment to measure surface and absorbed moisture content in mining raw materials. Calculating the bulk density of limestone and loose bulk materials.
Week 4	Raw Mix Design and Moduli (Practical/Computer Lab) – Part I Manual application of calculations for Lime Saturation Factor (LSF), Silica Modulus (SM), and Alumina Modulus (AM). Solving practical examples for blending two materials (limestone and clay) to achieve the target mix.
Week 5	Raw Mix Design and Moduli (Practical/Computer Lab) – Part II Calculating blending proportions for three and four raw materials when adding corrective materials (iron ore or sand). Utilizing spreadsheets (Excel) to model and calculate kiln-feed components.
Week 6	Fineness Analysis by Mechanical Methods (Sieve Analysis) Fineness testing of raw meal and final cement using standard sieves (90\mu\text{m} and 45\mu\text{m} meshes). Calculating the percentage of residue and evaluating mechanical grinding efficiency.
Week 7	Week 7: Fineness Measurement by Blaine Air Permeability Apparatus Operating the Blaine air permeability apparatus. Conducting the experiment to calculate the specific surface area of cement (cm2g or m^2/ kg) and understanding its effect on reaction rates.
Week 8	Week 8: Practical Midterm Exam Evaluation of students' skills in previous experiments, raw mix calculations, and fineness tests.
Week 9	Week 9: Determination of Standard Consistency of Cement Paste

	Operating the Vicat apparatus with the standard plunger. Determining the optimum water content (as a percentage of cement weight) required to prepare a cement paste of standard consistency.
Week 10	Week 10: Measurement of Initial and Final Setting Time Utilizing the Vicat apparatus to monitor the setting and hardening process of standard consistency cement paste over time. Recording the initial setting time (onset of plasticity loss) and final setting time (complete hardening).
Week 11	Week 11: Soundness Testing of Cement Utilizing the Le Chatelier apparatus. Measuring expansion caused by free lime (Free~CaO) or magnesia (MgO) after curing specimens in boiling water to ensure future concrete durability against cracking.
Week 12	Week 12: Bogue Equations for Clinker Mineralogical Composition Laboratory calculation session to convert clinker oxide chemical analysis results (CaO, SiO_2, Al_2O_3, Fe_2O_3) into the percentages of main mineral compounds (C_3S, C_2S, C_3A, C_4AF).
Week 13	Week 13: Preparation of Standard Mortar Prisms for Mechanical Testing Blending cement, standard sand, and water at specific ratios according to standard specifications. Molding the mixture into standard steel molds (40 \times 40 \times 160\text{ mm}), using a vibrating table for compaction, and placing prisms in water curing tanks.
Week 14	Week 14: Compressive and Flexural Strength Testing Testing cement prisms at the ages of (3 and 7 days) using a standard hydraulic compression testing machine. Calculating mechanical stress in (MPa or N/mm2) and comparing results with standard codes to verify cement classification and grade.
Week 15	Week 15: Discussion of Comprehensive Lab Reports and Specifications Review Reviewing graphical curves of strength development over time and the impact of fineness and mineralogical composition on it. Comparing students' laboratory results with the limits specified by the Iraqi Quality Standard (IQS No. 5) for Portland Cement.
Week 16	Week 16: Final Practical Evaluation and Comprehensive Report Submission Submission of the final integrated laboratory report and comprehensive practical evaluation.

Learning and Teaching Resources مصادر التعلم و التدريس		
	Text	**Available in the Library?**
Required Texts	• Hewlett, P. C., & Liska, M. (Eds.). (2019). *Lea's chemistry of cement and concrete* (5th ed.). Butterworth-Heinemann. Alsop, P. A. (2020). The cement plant operations handbook (7th ed.). Tradeship Publications.	Yes
Required Texts		Yes
Recommended Texts	البلاوالي، غ. (2018). انتاج الاسمنت بالطريقة الجافة (ط. 2). منشور الكتروني	No
Websites		

Grading Scheme مخطط الدرجات				
Group	**Grade**	التقدير	**Marks %**	**Definition**
Success Group (50 - 100)	**A** - Excellent	امتياز	90 - 100	Outstanding Performance
	B - Very Good	جيد جدا	80 - 89	Above average with some errors
	C – Good	جيد	70 - 79	Sound work with notable errors
	D - Satisfactory	متوسط	60 - 69	Fair but with major shortcomings
	E - Sufficient	مقبول	50 - 59	Work meets minimum criteria
Fail Group (0 – 49)	**FX** – Fail	راسب (قيد المعالجة)	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.