MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

odule Information معلومات المادة الدراسية					
Module Title	**Engineering Materials**			**Module Delivery**	
Module Type	**Core**			☒ **Theory** ☐ **Lecture** ☒ **Lab** ☐ **Tutorial** ☐ **Practical** ☐ **Seminar**	
Module Code	**PM 204**				
ECTS Credits	**8**				
SWL (hr/sem)	**200**				
Module Level	2		**Semester of Delivery**	4	
Administering Department	PM		**College**	TEMO	
Module Leader	Dr. Jamal. N. Sultan		**e-mail**	Jamal.nayyef@ntu.edu.iq	
Module Leader's Acad. Title	Professor		**Module Leader's Qualification**	Ph.D.	
Module Tutor			**e-mail**		
Peer Reviewer Name			**e-mail**		
Scientific Committee Approval Date	01/06/2023		**Version Number**		

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 the Structure of Materials: Learn about the atomic and molecular structure of materials, including the arrangement of atoms, crystal structures, and the relationship between structure and material properties. 2. Study Material Properties: Explore the various physical and mechanical properties of materials such as strength, hardness, elasticity, conductivity, thermal expansion, and corrosion resistance. Understand how these properties influence the behavior of materials in different applications. 3. Learn about Material Processing: Gain knowledge about different manufacturing and processing techniques used to modify the structure and properties of materials. This may include topics such as casting, forging, welding, heat treatment, and surface treatment. 4. Comprehend Material Selection: Understand the principles and criteria for selecting materials for specific engineering applications. Consider factors such as mechanical requirements, environmental conditions, cost, and sustainability in the material selection process. 5. Explore Material Failure and Fracture: Study the causes and mechanisms of material failure, including fracture, fatigue, creep, and wear. Learn how to analyze and prevent failures through the application of material science principles. 6. Examine Material Testing and Characterization: Familiarize yourself with different experimental techniques and methods used to evaluate material properties and performance. This may include tensile testing, hardness testing, microscopy, spectroscopy, and non-destructive testing. 7. Understand Material Behavior under Different Conditions: Learn how materials respond to external factors such as temperature, pressure, and loading conditions. Study the concepts of elasticity, plasticity, viscoelasticity, and the behavior of materials at extreme temperatures. 8. Gain Knowledge of Material Sustainability: Explore the concepts of sustainable materials, recycling, and environmental impact assessment. Understand the importance of considering the lifecycle of materials and their ecological footprint. 9. Develop Material Design Skills: Apply material selection principles and knowledge of material properties to design components and systems that meet specific engineering requirements. Understand the relationship between material properties, manufacturing processes, and design optimization. 10. Enhance Problem-Solving Abilities: Develop critical thinking and problem-solving skills related to material selection, material performance, and failure analysis. Apply theoretical knowledge to practical engineering challenges.
Module Learning Outcomes	1. Knowledge of Material Properties: Students should gain a comprehensive understanding of the fundamental properties of different engineering materials such as metals, polymers, ceramics, and composites. This includes knowledge of mechanical properties (strength, stiffness, toughness), thermal properties (conductivity, expansion), electrical

مخرجات التعلم للمادة الدراسية	properties, corrosion resistance, and other relevant characteristics. 2. Material Selection and Application: Students should learn how to select appropriate materials for specific engineering applications based on their properties, performance requirements, and cost considerations. They should be able to analyze and evaluate material properties and make informed decisions regarding material selection for various engineering designs and applications. 3. Material Processing and Manufacturing: Students should acquire knowledge of different material processing and manufacturing techniques, including casting, forming, machining, welding, heat treatment, and surface treatment. They should understand how these processes affect material properties and performance, and be able to choose appropriate manufacturing methods for specific materials and applications. 4. Material Testing and Characterization: Students should learn various techniques for testing and characterizing engineering materials, such as tensile testing, hardness testing, impact testing, microscopy, spectroscopy, and non-destructive testing methods. They should gain practical experience in conducting material tests, interpreting test results, and relating them to material properties. 5. Material Failure Analysis: Students should develop an understanding of the causes and mechanisms of material failure, including factors such as fatigue, fracture, creep, and environmental degradation. They should be able to analyze and diagnose material failures and propose appropriate solutions to prevent or mitigate such failures. 6. Material Sustainability and Environmental Impact: Students should gain an awareness of the environmental and sustainability aspects related to engineering materials. This includes understanding the life cycle of materials, recycling and waste management, energy consumption, and the environmental impact of different material choices. They should be able to consider sustainability principles when selecting and designing with materials. 7. Professional and Ethical Considerations: Students should develop an understanding of the professional and ethical responsibilities associated with working with engineering materials. This includes considerations such as safety protocols, regulatory compliance, intellectual property, and ethical practices in material selection, testing, and manufacturing. These learning outcomes aim to provide students with a solid foundation in the properties, selection, processing, testing, and application of engineering materials, enabling them to make informed decisions and contribute effectively in various engineering disciplines.
Indicative Contents المحتويات الإرشادية	Indicative content includes the following. 1. Metals: • Ferrous Metals: Iron, Carbon, Manganese, Chromium, Nickel, Molybdenum, etc. • Non-Ferrous Metals: Aluminum, Copper, Zinc, Lead, Tin, Titanium, etc. 2. Polymers (Plastics): • Polyethylene: Ethylene monomer units

	• Polypropylene: Propylene monomer units • Polyvinyl Chloride (PVC): Vinyl Chloride monomer units • Polystyrene: Styrene monomer units • Polyethylene Terephthalate (PET): Ethylene Glycol, Terephthalic Acid 3. Ceramics: • Traditional Ceramics: Clay, Feldspar, Silica, Alumina • Advanced Ceramics: Zirconia, Silicon Carbide, Aluminum Nitride, Boron Nitride 4. Composites: • Fiber Reinforced Composites: Glass fibers, Carbon fibers, Aramid fibers • Matrix Materials: Epoxy resins, Polyester resins, Thermoplastics 5. Semiconductors: • Silicon: Pure silicon with small amounts of impurities (dopants) like Boron or Phosphorus 6. Concrete: • Cement: Portland cement (mainly composed of Calcium, Silicon, Aluminum, Iron) • Aggregates: Crushed stone, Sand, Gravel 7. Wood: • Cellulose: Main constituent of wood • Lignin: Provides rigidity and strength to wood 8. Glass: • Silica: Main component of glass • Various additives: Sodium carbonate, Calcium oxide, Aluminum oxide, etc.

Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	1. Active Learning: Engage students in hands-on activities, experiments, and projects that involve working with engineering materials. This could include laboratory sessions, case studies, or design projects that require students to apply their knowledge to real-world problems. 2. Visualization Tools: Utilize visualization tools such as diagrams, models, and simulations to help students understand the structure, properties, and behavior of different engineering materials. This can enhance their conceptual understanding and make complex concepts more accessible.

	3. Practical Examples: Provide practical examples of engineering materials used in real-world applications. Showcase the materials' properties and performance in various industries, such as aerospace, automotive, or construction. This can help students connect theoretical knowledge with practical relevance. 4. Collaborative Learning: Encourage collaboration among students through group discussions, team projects, and peer learning. This fosters active engagement and allows students to learn from each other's perspectives and experiences. Assigning group projects that involve materials selection, analysis, or testing can enhance teamwork and problem-solving skills. 5. Problem-Based Learning: Present students with real or hypothetical engineering problems that require material selection or analysis. This approach promotes critical thinking, problem-solving skills, and the application of theoretical knowledge to practical scenarios. Encourage students to research, analyze, and propose solutions using appropriate materials. 6. Multimedia Resources: Utilize multimedia resources such as videos, interactive websites, and online simulations to supplement classroom lectures and textbooks. These resources can provide visual representations, demonstrations, and interactive experiences that enhance understanding and engagement. 7. Guest Speakers and Industrial Visits: Invite industry professionals, researchers, or experts in materials engineering to give guest lectures or organize industrial visits. This exposes students to real-world applications, current research trends, and industry practices, providing valuable insights and networking opportunities. 8. Formative Assessment: Incorporate formative assessment methods such as quizzes, concept maps, or short assignments to gauge students' understanding of engineering materials throughout the learning process. This helps identify areas of improvement and allows for timely feedback and clarification. 9. Scaffolded Learning: Break down complex concepts into smaller, more manageable units and provide scaffolding to support students' learning progression. Start with foundational knowledge and gradually build up to more advanced topics, ensuring students grasp fundamental principles before moving forward. 10. Reflective Practices: Encourage students to reflect on their learning experiences, make connections between theory and practice, and identify areas of improvement. Incorporate reflective exercises, journals, or group discussions to promote metacognitive skills and enhance self-directed learning.

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	93	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	6
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	107	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	7
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	**200**		

Module Evaluation
تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	**Quizzes**	4	10% (10)	2, 6, 12 and 14	LO #1, #3, and #6
	Assignments	5	10% (10)	1, 3, 5, and 9, 15	LO #2, #4 and #5, #7
	Projects / Lab.	10	20% (20)	Continuous	All
	Report				
Summative assessment	**Midterm Exam**	2hr	10% (10)	7	LO #1 - #3
	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 Engineering Materials: • Importance of materials in engineering. • Classification and properties of materials. • Structure of materials: atomic, crystalline, and non-crystalline materials. • FCC, BCC, CPH structures.
Week 2	Atom binding: Ionic bond, covalent bond, metallic bond, Van der Waals forces.
Week 3	Crystalline defects: dislocations, types of dislocations
Week 4	Phase Diagrams and Phase Transformations: • Phase equilibrium and phase diagrams. • Solidification, different crystals form in an ingot, castings defects. • Heat treatment processes (e.g., annealing, quenching, tempering).
Week 5	Mechanical Properties of Materials: • Stress and strain. • Elasticity and plasticity. • Tensile, compressive, and shear behavior. • Hardness, toughness, and impact resistance.
Week 6	Metals and Alloys:

	• Strengthening mechanisms: solid solution, precipitation, and dispersion strengthening. • Ferrous and non-ferrous metals and alloys. • Corrosion and oxidation of metals.
Week 7	Creep test.
Week 8	Fatigue test.
Week 9	Iron-making and steel making.
Week 10	Thermal equilibrium diagram for Iron-iron carbide.
Week 11	Types of steels: carbon steel, alloy steel.
Week 12	Advanced Topics: • Nanomaterials and nanotechnology. • Biomaterials and medical applications.
Week 13	Ceramics: • Structure and properties of ceramics. • Types of ceramics: oxides, non-oxides, composites. • Ceramic processing techniques. • Applications and limitations of ceramics.
Week 14	Polymers and Composite Materials: • Polymer structure and properties. • Polymerization techniques. • Thermoplastics and thermosetting polymers. • Composite materials: types, properties, and applications.
Week 15	Material Selection and Design: • Material selection criteria. • Design considerations and constraints. • Failure analysis and prevention. • Sustainability and environmental aspects of materials.
Week 16	**Preparatory week before the final Exam**

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered
Week 1	Lab 1: Introduction to Mechanical Tests.
Week 2	Lab 2: Impact Test.
Week 3	Lab 3: Fatigue Test.
Week 4	Lab 4: Specimen Preparation For Microscopic Examination.
Week 5	Lab 5: Microscopic Examination of Different Types of Steel.
Week 6	Lab 6: Heat Treatments of Steel.
Week 7	Lab 7 Surface Hardening of Steel.
Week 8	Lab 8: Thermal Equilibrium Diagrams of Two Metals Completely Soluble in Each Other in Liquid States.
Week 9	Lab 9: Microstructure Examination of Stainless Steel .
Week 10	Lab 10: Microstructure Examination of Cast Iron.

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	**Available in the Library?**
Required Texts	1. "Materials Science and Engineering: An Introduction" by William D. Callister Jr. and David G. Rethwisch.	Yes
Recommended Texts	1. "Introduction to Materials Science for Engineers" by James F. Shackelford. 2. "Mechanical Metallurgy" by George E. Dieter. 3. "Fundamentals of Materials Science and Engineering" by William D. Callister Jr. and David G. Rethwisch. 4. "Engineering Materials 1: An Introduction to Properties, Applications, and Design" by Michael F. Ashby and David R. H. Jones.	No
Websites	1. Materials Research Society (MRS) - The MRS website (www.mrs.org) offers a wide range of materials science resources, including journals, publications, news, events, and educational materials. It is a leading organization dedicated to advancing the field of materials research.	

	2. American Ceramic Society (ACerS) - The ACerS website (www.ceramics.org) focuses specifically on ceramic materials. It provides access to journals, conferences, educational resources, and news related to ceramics and other related materials. 3. Materials Today - Materials Today (www.materialstoday.com) is an online platform that covers various aspects of materials science, including news, articles, reviews, and interviews. It covers a broad range of material classes, such as metals, polymers, composites, and nanomaterials. 4. ASM International - ASM International (www.asminternational.org) is an organization that focuses on the science and engineering of materials. Their website provides access to technical publications, educational resources, events, and a knowledge base with information on various materials and their applications. 5. National Institute of Standards and Technology (NIST) - The NIST website (www.nist.gov/materials-science-and-engineering) offers resources related to materials science and engineering, including research papers, databases, measurement techniques, and standards. It is a valuable resource for those interested in materials characterization and properties. 6. Elsevier Materials Science - Elsevier's Materials Science website (www.elsevier.com/physical-sciences/materials-science) provides access to a wide range of scientific journals and publications in the field of materials science. It covers topics such as materials synthesis, characterization, properties, and applications.

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 1

Code	Course/Module Title	ECTS	Semester
PM 204	Engineering Materials	8	4
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
4	2	93	107
Description			

7. Engineering materials are vital substances used in various engineering applications. They possess specific physical and chemical properties that make them suitable for specific purposes. These materials can be classified into metals, ceramics, polymers, composites, and specialized materials.
8. Metals are versatile with excellent strength, ductility, and conductivity. Steel, aluminum, copper, and titanium are commonly used metals in engineering. Ceramics are hard, brittle materials with high melting points. They exhibit resistance to heat, wear, and corrosion. Alumina, silicon carbide, and porcelain are examples of ceramics.
9. Polymers, also known as plastics, are lightweight materials with flexibility and corrosion resistance. They can be easily molded into various shapes. Polyethylene, polystyrene, and PVC are commonly used polymers. Composites are engineered materials made from different constituent materials, providing enhanced properties such as high strength and low weight. Fiberglass and carbon fiber reinforced polymers are examples of composites.
10. Specialized materials include semiconductors for electronic devices, superconductors for energy applications, and biomaterials for medical implants. Each material type has unique characteristics and is selected based on specific engineering requirements.
11. Overall, understanding engineering materials is essential for selecting the right materials for various applications and ensuring optimal performance in engineering projects.