	Ministry of Higher Education and Scientific Research - Iraq Al-Mustaqbal University College for engineering and technology Department of Biomedical Engineering	

MODULE DESCRIPTOR FORM
نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	Biomaterials Engineering			**Module Delivery**	
Module Type	Core			✓ **Theory** ✓ **Lecture** **Lab** **Sem**	
Module Code	UOMU0101044				
ECTS Credits	6				
SWL (hr/sem)	150				
Module Level	2	**Semester of Delivery**	2		
Administering Department		**College**			
Module Leader		**e-mail**			
Module Leader's Acad. Title		**Module Leader's Qualification**			
Module Tutor	None	**e-mail**	None		
Peer Reviewer Name		**e-mail**			
Review Committee Approval		**Version Number**			

Relation With Other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module		**Semester**	4
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Aims أهداف المادة الدراسية	The Biomaterials Engineering module aims to provide students with an understanding of the fundamental principles and applications of biomaterials in the field of engineering. The module focuses on the development, characterization, and use of materials that interact with biological systems, with the goal of improving medical treatments, diagnostics, and healthcare technologies. 1. **To provide students with an understanding of the properties and structure of biomaterials.** This includes understanding the different types of biomaterials, their mechanical, physical, and chemical properties, and how these properties affect their performance in biological applications. 2. **To develop students' understanding of the biological response to biomaterials.** This includes understanding how biomaterials interact with the body's tissues, how they are broken down by the body, and how they can cause an immune response. 3. **To teach students how to design and engineer biomaterials for specific applications.** This includes understanding the principles of biomaterial design, how to select the right materials for a particular application, and how to test the performance of biomaterials. 4. **To prepare students for careers in biomaterials engineering.** This includes teaching students about the different career paths in biomaterials engineering, the skills and knowledge they need to succeed in these careers, and how to network with other professionals in the field
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	These learning outcomes aim to provide undergraduate students with a strong foundation in Biomaterials engineering principles, techniques, and applications, preparing them for further studies, research, or careers in the field of Biomaterials engineering . 1. Engineering Knowledge: Demonstrate a deep understanding of biomaterials engineering principles, including material selection, processing, and characterization, as well as their application in medical devices and tissue engineering.

	2. Problem Solving: Apply biomaterials engineering knowledge and techniques to identify, formulate, and solve complex engineering problems related to biomaterials, considering ethical, social, and environmental factors. 3. Design and Development: Design biomaterials and biomedical devices that meet specific requirements, considering factors such as biocompatibility, mechanical properties, and manufacturing processes. Use appropriate engineering tools and software to analyze and optimize designs. 4. Experiments and Analysis: Plan, conduct, and interpret experiments to evaluate the performance of biomaterials and biomedical devices. Analyze and interpret experimental data using statistical methods and apply it to improve designs and processes. 5. Teamwork and Communication: Work effectively in multidisciplinary teams to develop biomaterials-based solutions. Communicate ideas and technical information clearly and concisely through written reports, oral presentations, and visual aids. 6. Professionalism and Ethics: Understand and adhere to professional and ethical responsibilities in biomaterials engineering. Recognize the importance of safety, sustainability, and societal impact in the design and use of biomaterials.
Indicative Contents المحتويات الإرشادية	1. Introduction to Biomaterials: • Definition and classification of biomaterials • Properties and requirements of biomaterials for medical applications • Biomaterials in historical context 2. Structure and Properties of Biomaterials: • Atomic and molecular structure of biomaterials • Mechanical, thermal, and electrical properties of biomaterials • Surface properties and their impact on biocompatibility 3. Biomaterials Characterization: • Microscopy techniques (e.g., light microscopy, electron microscopy) • Spectroscopy techniques (e.g., FTIR, Raman spectroscopy) • Mechanical testing and analysis

	• Surface analysis techniques (e.g., XPS, AFM) 4. Biocompatibility and Biodegradation: • Biological response to biomaterials • Host tissue interactions • Immunological responses • Factors affecting biodegradation and resorption 5. Biomaterials Processing: • Fabrication techniques (e.g., casting, molding, electrospinning) • Surface modification methods (e.g., coatings, plasma treatment) • Sterilization techniques 6. Biomaterials in Medical Devices and Implants: • Biomaterials for orthopedic applications (e.g., joint replacements, bone grafts) • Biomaterials for cardiovascular applications (e.g., stents, heart valves) • Biomaterials for tissue engineering and regenerative medicine 7. Biomaterials in Drug Delivery: • Controlled release systems • Drug encapsulation and delivery mechanisms • Targeted drug delivery using biomaterials 8. Regulatory and Ethical Considerations: • Standards and regulations for biomaterials in medical devices • Ethical considerations in biomaterials research and applications • Safety and risk assessment in biomaterials engineering 9. Case Studies and Research Trends: • Review of notable biomaterials and their applications • Emerging trends in biomaterials research • Current challenges and future directions in the field
Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	• **Lectures:** Lectures can be used to provide students with a broad overview of the field of artificial organs. Lectures can also be used to introduce students to the key concepts and theories of artificial organ design. • **Research projects:** Research projects can be used to give students the opportunity to apply the knowledge and skills they

	have learned in the module. Research projects can also be used to help students develop their independent research skills. • **Active learning:** Active learning is a teaching strategy that involves students in the learning process. Active learning can be achieved through a variety of activities, such as group work, problem-solving exercises, and simulations. • **Problem-based learning:** Problem-based learning is a teaching strategy that involves students in solving problems. Problem-based learning can be used to help students develop their critical thinking skills and to apply the knowledge and skills they have learned. • **Project-based learning:** Project-based learning is a teaching strategy that involves students in completing projects. Project-based learning can be used to help students develop their problem-solving skills, their teamwork skills, and their communication skills.

Student Workload (SWL)
الحمل الدراسي للطالب

Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	78	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	5.2
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	72	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	4.8
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, 10	LO #1, 2, 6, 7, 8 and 10
	Assignments	2	10% (10)	2, 12	LO # 3, 4, 6 and 7
	Report	1	10% (10)	13	LO # 5, 8 and 10
Summative assessment	**Midterm Exam**	3 hr	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	Lecture 1: Introduction to Biomaterials • Definition and classification of biomaterials • Properties and requirements of biomaterials for medical applications
Week 2	Lecture 2: Biomaterials properties • Structure and Properties of Biomaterials • Atomic and molecular structure of biomaterials • Mechanical, thermal, and electrical properties of biomaterials
Week 3	Lecture 3: Biomaterials classifications • Classification based on Origin: A. Natural Biomaterials B. Synthetic Biomaterials • Classification based on Degradability: A. Biodegradable Biomaterials B. Non-biodegradable Biomaterials
Week 4	Lecture 4: Biomaterials classifications • Classification based on Chemical Composition and Structure: A. Metallic Biomaterials B. Ceramic Biomaterials C. Polymeric Biomaterials • Classification based on Biological Interaction: A. Bioactive Biomaterials B. Bioinert Biomaterials
Week 5	Lecture 5: Characterization and design of biomaterials • Biomaterials Characterization • Principles of biomaterial design and fabrication • Selection of materials
Week 6	Lecture 6: Testing of biomaterials • Different methods for testing the performance of biomaterials • Mechanical testing • Chemical testing • Biological testing
Week 7	Mid Exam
Week 8	Lecture 8: Biomaterials Characterization

	• Biomaterials Characterization (continued) • Mechanical testing and analysis • Surface analysis techniques
Week 9	Lecture 9: Biomaterial-Cell Interactions • Biocompatibility and Biodegradation • Biological response to biomaterials • Host tissue interactions
Week 10	Lecture 10: Biomaterial-Cell Interactions • Biocompatibility and Biodegradation (continued) • Immunological responses • Factors affecting biodegradation and resorption
Week 11	Lecture 11: Processing and Fabrication of Biomaterials • Biomaterials Processing • Fabrication techniques • Surface modification methods
Week 12	Lecture 12: Processing and Fabrication of Biomaterials • Biomaterials Processing (continued) • Sterilization techniques
Week 13	Lecture 13: • Biomaterials in Medical Devices and Implants • Biomaterials for orthopedic applications • Biomaterials for cardiovascular applications
Week 14	Lecture 14: • Biomaterials in Medical Devices and Implants (continued) • Biomaterials for tissue engineering and regenerative medicine
Week 15	Lecture 15: Preparatory Week • Biomaterials in Drug Delivery • Controlled release systems • Drug encapsulation and delivery mechanisms
Week 16	**Final Exam**

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered

Week 1	Introduction to Biomaterials Engineering • Overview of biomaterials and their applications • Introduction to lab safety protocols and equipment
Week 2	Characterization Techniques • Introduction to various characterization techniques for biomaterials • Lab demonstration of microscopy techniques (light microscopy, electron microscopy)
Week 3	Mechanical Testing of Biomaterials • Introduction to mechanical properties of biomaterials • Lab session on tensile testing and hardness testing of biomaterials
Week 4	Surface Analysis and Modification • Lab session on surface analysis techniques (SEM, AFM) • Introduction to surface modification techniques for biomaterials
Week 5	Biocompatibility Assessment • Introduction to biocompatibility and its importance in biomaterials engineering • Lab session on cytotoxicity testing and cell culture techniques
Week 6	Biomaterials Fabrication Techniques • Overview of biomaterials fabrication methods (e.g., casting, electrospinning) • Lab session on fabrication of scaffolds using different techniques
Week 7	Degradation and Stability Analysis • Introduction to degradation mechanisms of biomaterials • Lab session on degradation testing and stability analysis of biomaterials
Week 8	Drug Delivery Systems • Introduction to biomaterials-based drug delivery systems • Lab session on formulation and characterization of drug-loaded biomaterials
Week 9	Tissue Engineering Applications • Overview of tissue engineering and regenerative medicine • Lab session on cell seeding and culturing on biomaterial scaffolds
Week 10	Nanotechnology in Biomaterials • Introduction to nanotechnology applications in biomaterials engineering • Lab session on synthesis and characterization of nanomaterials for biomedical applications
Week 11	Bioactive Materials • Introduction to bioactive materials and their properties • Lab session on bioact
Week 12	Biomaterials in Implant Design • Overview of biomaterials in implantable medical devices • Lab session on design and evaluation of implantable biomaterials
Week 13	Biodegradable Materials

	• Introduction to biodegradable biomaterials and their applications • Lab session on degradation testing and evaluation of biodegradable materials
Week 14	Regulatory and Ethical Considerations • Overview of regulatory requirements and ethical considerations in biomaterials engineering • Discussion on case studies and ethical dilemmas in biomaterials research
Week 15	Project Presentations and Wrap-up • Students present their biomaterials engineering projects • Final discussions, feedback, and course evaluation

Learning and Teaching Resources
مصادر التعلم والتدريس

	Text	Available in the Library?
Required Texts	**Textbooks:** There are many textbooks available on Biomaterials Engineering. Some popular textbooks include: 1. "Biomaterials Science: An Introduction to Materials in Medicine" by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, and Jack E. Lemons. 2. "Introduction to Biomaterials: Basic Theory with Engineering Applications" by C. Mauli Agrawal, Joo L. Ong, and Mark R. Appleford. 3. "Biomaterials: The Intersection of Biology and Materials Science" by Johnna S. Temenoff and Antonios G. Mikos.	Yes
Recommended Texts	1. "Principles of Biomaterials Science" by Robert L. Reis, Buddy D. Ratner, and Allan S. Hoffman. 2. "Biomaterials: A Basic Introduction" by Qizhi Chen.	No
Websites	**Online resources:** There are many online resources available on Biomaterials engineering. Some popular online resources include: 1. National Institutes of Health (NIH) - Biomaterials: The NIH provides extensive information on biomaterials, including research articles, publications, and resources related to biomaterials engineering and	

	applications. Visit their website at https://www.nih.gov/ for more information. 2. Biomaterials Science - Online Lecture Series: This online lecture series by Professor David Williams from the University of Liverpool covers various topics in biomaterials science and engineering. The lectures are available on YouTube and provide a comprehensive introduction to the field. You can access the lectures at https://www.youtube.com/playlist?list=PLik3JvoH2ajzM-OaD23wuEmDhkpBgsj2t. 3. Materials Today - Biomaterials: Materials Today is a platform that covers various areas of materials science and engineering. Their biomaterials section provides access to articles, news, and research updates in the field. Visit their website at https://www.materialstoday.com/biomaterials/ for more information. 4. Biomaterials Science and Engineering: This online course offered by MIT OpenCourseWare provides lectures, lecture notes, and additional resources on biomaterials science and engineering. The course materials are available for free and can be accessed at https://ocw.mit.edu/courses/health-sciences-and-technology/hst-542j-biomaterials-science-and-engineering-spring-2006/.

APPENDIX:

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	مقبول بقرار	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required
Note:				

NB 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.