



Republic of Yemen
Ministry of Higher Education & Scientific Research
Council of Academic Accreditation & Quality
Assurance of Higher Education (CAQA)



21 September University for medical and Applied Science

Faculty of Engineering and Computer

Department of Biomedical Engineering

Program of Biomedical Engineering

Course Specification of

Biomaterials

Course Code. (07.02.715)

2024



T4: This Template is Developed and Approved by CAQA-Yemen, 2023

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Mushtaq Alazazi	Dr. Awadh Al-Kubati	Dr. Awadh Al-Kubati	Dr. Mohammed Al-shamahi	Dr. Abdulrahman Obaid

I. General Information:

1.	Course Title:	Biomaterials				
2.	Course Code:	(07.02.715)				
3.	Credit Hours:	Credit Hours	Theory Contact Hours		Practical Contact Hours	
			Lecture	Tutorial /Seminar	Lab	Clinical
		2	2	--	--	--
4.	Level/ Semester at which this Course is offered:	3 rd Level / 1 st Semester				
5.	Pre –Requisite (if any):	07.02.708				
6.	Co –Requisite (if any):					
7.	Program (s) in which the Course is Offered:	Bachelor of Biomedical Engineering				
8.	Language of Teaching the Course:	English/Arabic				
9.	Location of Teaching the Course:	Faculty of Medical Technology				
10.	Prepared by:	Dr. Mushtaq Alazazi				
11.	Date and Number of Approval by Council:					

II. Course Description:

This course explores the properties, design, and applications of biomaterials used in medical devices and implants. It covers material science principles, including biocompatibility, mechanical behavior, and interaction with biological tissues. Topics include metals, ceramics, polymers, and composites, along with their roles in tissue engineering, drug delivery systems, and regenerative medicine, the course also emphasizes ethical considerations and regulatory standards for biomaterials in healthcare.

III. Course Intended Learning Outcomes (CILOs) :
Upon successful completion of the course,
students will be able to:

Referenced PILOs

A. Knowledge and Understanding:		I, P or M/A		
a1	Demonstrate an understanding of the fundamental properties, theories, and mathematical models of biomaterials, and their	I	A1	Explain the appropriate models, theories, mathematical foundations, and techniques related to

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	application in biomedical engineering technologies, ensuring biocompatibility, performance optimization, and adherence to ethical and regulatory standards.			biomedical engineering technology context.
a2	Recognize and address healthcare needs by developing biomaterial-based solutions that adhere to high standards of professional, ethical behavior, and health and safety requirements, ensuring effective management and responsibility in solving real healthcare problems.	M	A3	Recognize the user and healthcare needs to provide based solutions on a high level of management, professional and ethical behavior, responsibility, standards, health and safety requirements in biomedical systems to real-healthcare problem.
a3	Understand the testing standards applied for biomaterials and their interactions with biological environment.	M	A4	Understand an examples of a biomedical engineering technology concept and methods related to maintenance, measurement techniques, programming, creative engineering solutions, analytical skills, applied to healthcare quality and problems of medical devices issues.
B. Intellectual Skills:				
b1	Apply scientific knowledge, mathematical theories, and engineering principles to critically analyze, evaluate, and solve problems related to the selection, design, and performance of biomaterials in biomedical applications.	P	B4	Apply the basic science, mathematical theories, engineering principles to analyze the problems of devices and/or processes relevant to biomedical engineering fields.
b2	Propose the suitable materials for specific applications in biomedical systems and explain how to overcome complexity of natural tissue structure that seeks to replace with biomaterials.	P	B1	Use the basic science, mathematical theories, engineering principles to analyze the problems of devices and/or processes relevant to biomedical engineering fields.
C. Professional and Practical Skills:				
c1	Integrate knowledge of biomaterials, life sciences, and	P	C1	Relate integrally knowledge of life science, biomedical

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	biomedical engineering principles to design, evaluate, and solve complex problems related to the development and optimization of biomaterials for medical applications.			engineering technology practice concepts, principles of engineering and techniques evaluation to solve problems relevant to biomedical engineering.
c2	Evaluate an engineering techniques, modern analytical tools, and computer programs to design, analyze, and solve problems related to the performance and safety of biomaterials in medical devices.	P	C2	Evaluate an engineering technique, modern analytical tools and required computer programs to analyzing and solve the problems of medical devices.
D. Transferable Skills:				
d1	Perform effectively at work both as an individual and as a collaborative team member or leader in biomedical engineering projects related to biomaterials, utilizing strong communication, problem-solving, and organizational skills to achieve shared goals.	M/A	D1	Function effectively as an individual, team member, or leader in activities relevant to biomedical engineering, and collaborating to achieve a shared objective.
d4	Engage in life-long self-learning to overcome challenges and further development in biomaterials.	M/A	D4	Pursue ongoing professional development and lifelong learning in the biomedical engineering filed.
I= Introduced, P=Practiced or M/A= Mastered/Advanced				

(A) Alignment of Course Intended Learning Outcomes (Knowledge and Understanding) to Teaching Strategies and Assessment Methods:			
	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
a1	Demonstrate an understanding of the fundamental properties, theories, and mathematical models of biomaterials, and their application in biomedical engineering technologies, ensuring biocompatibility, performance optimization, and adherence to ethical and regulatory standards	<ul style="list-style-type: none"> ▪ Lectures ▪ Tutorials ▪ Discussion ▪ Presentation ▪ Self-learning 	<ul style="list-style-type: none"> ▪ Written exam (mid and final terms and quizzes), ▪ Assignments (Homework, oral presentation)
a2	recognize and address healthcare needs by developing biomaterial-based solutions that adhere to high		

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	standards of professional, ethical behavior, and health and safety requirements, ensuring effective management and responsibility in solving real healthcare problems.		
a3	Understand the testing standards applied for biomaterials and their interactions with biological environment.		
(B) Alignment of Course Intended Learning Outcomes (Intellectual Skills) to Teaching Strategies and Assessment Methods:			
	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
b1	Apply scientific knowledge, mathematical theories, and engineering principles to critically analyze, evaluate, and solve problems related to the selection, design, and performance of biomaterials in biomedical applications.	<ul style="list-style-type: none"> ▪ Lectures ▪ Tutorials ▪ Discussion ▪ Self-learning ▪ Case Study (CBL) ▪ Problem Based Learning (PBL) 	<ul style="list-style-type: none"> ▪ Written exam (mid and final terms and quizzes), ▪ Homework, ▪ presentation
b2	Propose the suitable materials for specific applications in biomedical systems and explain how to overcome complexity of natural tissue structure that seeks to replace with biomaterials.		
(C) Alignment of Course Intended Learning Outcomes (Professional and Practical Skills) to Teaching Strategies and Assessment Methods:			
	Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies
c1	Apply integrated knowledge of biomaterials, life sciences, and biomedical engineering principles to design, evaluate, and solve complex problems related to the development and optimization of biomaterials for medical applications.	<ul style="list-style-type: none"> ▪ Tutorials ▪ Case studies (CBL) ▪ Problem Solving Learning (PSL) ▪ Problem Based Learning (PBL) 	<ul style="list-style-type: none"> ▪ Written exam (mid and final terms and quizzes), ▪ Homework assignments
c2	Apply engineering techniques, modern analytical tools, and computer programs to design, analyze, and solve problems related to the performance and safety of biomaterials in medical devices.		
(D) Alignment of Course Intended Learning Outcomes (Transferable Skills) to Teaching Strategies and Assessment Methods:			

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Course Intended Learning Outcomes		Teaching Strategies	Assessment Strategies
d1	Demonstrate the ability to work effectively both as an individual and as a collaborative team member or leader in biomedical engineering projects related to biomaterials, utilizing strong communication, problem-solving, and organizational skills to achieve shared goals.	<ul style="list-style-type: none"> ▪ Discussion ▪ Case studies (CBL) ▪ Presentation 	<ul style="list-style-type: none"> ▪ Presentation
d4	Engage in life-long self-learning to overcome challenges and further development in biomaterials		

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	Biomaterials Science and Engineering	<ul style="list-style-type: none"> – Course Overview – Materials Science and Engineering – Definitions of Biomaterials, Biomedical Materials, and Biological Materials, – Multilevel of Structure and Categorization of Materials – Four Categories of Materials, – Examples of Biomaterials Applications, – Advantages and Disadvantages of Biomaterials. – Definitions of Toxicology and Biocompatibility 	1	2	a1, a2
2	Structure of Materials	<ul style="list-style-type: none"> – Atomic Structure – Atomic Bonding – Crystal Structure of Metals, Ceramics and Polymers. – Defects in Solids – Diffusion in Solids. 	1	2	a1, b1
3	Bulk and Surface Properties of Materials	<ul style="list-style-type: none"> – Role of Implant Biomaterials Bulk Versus Surface – Mechanical Properties of General Importance – Bulk Mechanical Properties Determined from Stress–Strain Plots – Mechanical Properties Terms 	1	2	a1, c2

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No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
		<p>Used in the Medical Community</p> <ul style="list-style-type: none"> – Failure – Other Bulk Properties – Surface Properties of Biomaterials – General Surface Considerations and Definitions – What Surface Properties Are We Interested in? – Surface Analysis Techniques: Principles and Methods 			
4	Phase Diagram	<ul style="list-style-type: none"> – Introduction to Phase Diagrams – Single Phase Diagram – Gibbs Phase Law – Lever Rule – Multiphase Materials Phase Diagrams, – Equilibrium Phase Transformation, – Microstructure Development 	1	2	b1, d4
5	Toxicity and Corrosion	<ul style="list-style-type: none"> – Biological Roles and Toxicities of Trace Elements – Selection of Metallic Elements in Medical-Grade Alloys – Definition of Degradation, Erosion, Bulk, and Surface Processes – Biodegradation of Metals – Biodegradation of Ceramics – Degradable and Resorbable Polymers 	1	2	a1, a2, b1
6	Metallic Biomaterials	<ul style="list-style-type: none"> – Basic Principles and Concepts – Development of Metallic Biomaterials – Metallic Biomaterials in Orthopedic 	1	2	b2, c2

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No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
		<ul style="list-style-type: none"> – Implants – Stainless Steels – Cobalt-Based Alloys – Titanium Alloys – Dental Materials – NiTi Shape-Memory Alloys – Other Clinically Applied Metallic Materials – New Metallic Materials. 			
7	Ceramic Biomaterials	<ul style="list-style-type: none"> – Basic Principles and Concepts – Overview of Bio ceramics – Bioinert Ceramics – Bioactive and Bioresorbable Ceramics 	1	2	b2
8	Mid-Term Theoretical Exam	– All Preceding Lectures	1	2	a1, a2, b1, b2, c2
9	Polymeric Biomaterials	<ul style="list-style-type: none"> – Basic Principles and Concepts – Overview and Classification of Polymeric Biomaterials – Bioinert Polymers – Bioresorbable Polymers – Hydrogels: Classification Basic – Structures and Synthesis – Swelling Behavior of Hydrogels – Determination of Structural Characteristics – Biomedical Hydrogels – Smart Hydrogels and Their Applications – Biomedical Applications of Hydrogels 	2	4	b2, c1
10	Biomaterials Tissue	<ul style="list-style-type: none"> – Inflammation, – Wound Healing, 	1	2	a2, c1

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No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
	Interactions	<ul style="list-style-type: none"> – Foreign Body Reaction, – Blood Material Interaction – Tumorigenesis 			
11	Biological Testing of Biomaterials	<ul style="list-style-type: none"> – In Vitro Test – In Vivo Test – Standard Testing Procedures 	1	2	a3, c2
12	Non-blood Interfacing Implant	<ul style="list-style-type: none"> – Non-blood-interfacing Implants for Soft Tissue. – Choose Materials for The Implants. – Non-Blood-Interfacing Implant – Characteristics 	1	2	a2, d1
13	Blood Contacting Implant	<ul style="list-style-type: none"> – Blood Contacting Implants. – Primary Requirements of Biomaterials for Blood Contacting Implant. – Choose Materials for the Implants. – Common Problems for Various Blood Contacting Implants 	1	2	a2, d1
14	Hard Tissue Replacement	<ul style="list-style-type: none"> – Types of Internal Fixation – Materials for the Fixations. – Failure Modes of Internal Fixation – Devices – Types of Joint Replacements. – Types of Fixation Methods. – Choose Biomaterials for Each – Component of Joint Replacements. – Types of Dental Implant 	1	2	c1, d1

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No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
		– Dental Implant Materials			
15	Tissue Engineering and Scaffold	<ul style="list-style-type: none"> – History, Scope and Potential of Tissue Engineering. – Tissue Engineering Development. – Properties of Scaffolds. – Scaffold Materials. – Scaffold Production Methods 	1	2	b2, c1, d4
16	Final Theoretical Exam	– All Preceding Lectures	1	2	a1, a2, a3, b1, b2, c1, c2
Number of Weeks /and Units Per Semester			16	32	

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	Assignments	weekly	5	5%	a3, b2, c2, d1, d2
2	Quizzes	5 & 10	5	5%	a1, a2, a3, b1, b2, c1, c2
3	Midterm Theoretical Exam	8	20	20%	a1, a2, b1, b2, c2
4	Final Theoretical Exam	16	70	70%	a1, a2, a3, b1, b2, c1, c2
Total			100%	100%	-

IX. Learning Resources:

- *Written in the following order:* Author, Year of publication, Title, Edition, Place of publication, Publisher.

1- Required Textbook(s) (maximum two):

1. Qizhi Chen and George Thouas, 2015, Biomaterials: A Basic Introduction, 1st

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Edition,
USA, CRC Press.

2. Callister W.D., 2008, Fundamentals of Materials Science and Engineering: An Integrated Approach, 3rd Edition, USA, John Wiley.

2- Essential References:

1. J.S Temenoff and A.G. Mikos. 2008, Biomaterials: The intersection of Biology and Material Science, USA, Pearson Prentice Hall.
2. Buddy D. Ratner, Allon S. Hoffman, Frederick J. Schoen, Jack E. Lemons, 2013, Biomaterials Science An Introduction to Materials in Medicine, 3rd Edition, USA, Elsevier Academic Press.
3. Park, J. B.; Lakes R. S., 2007, Biomaterials: An Introduction, 3rd Edition, , New York, Plenum Press.
4. Sujata V. Bhatt, 2005, Biomaterials, 2nd Edition, Narosa Publishing House,.
5. Sreeram Ramakrishna, Murugan Ramalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, 2010, Biomaterials: A Nano Approach, 1st Edition, USA, CRC Press, 2010
6. Myer Kutz, 2003, Standard Handbook of Biomedical Engineering & Design, McGraw Hill,
7. John Enderle, Joseph D. Bronzino, Susan M. Blanchard, 2005, Introduction to Biomedical Engineering, Elsevier, 2005.
8. Park J.B., 1984, Biomaterials Science and Engineering, Plenum Press..

3- Electronic Materials and Web Sites etc.:

Websites:

- Biomaterials Journals
1. Advanced Drug Delivery Reviews (Elsevier)
 2. American Society of Artificial Internal Organs Transactions
 3. Annals of Biomedical Engineering (Blackwell—Official Publication of the Biomedical Engineering Society)
 4. Artificial Organs (Raven Press)
 5. Biomaterials, Artificial Cells and Artificial Organs (T. M.S. Chang, ed.)
 6. Biomaterials forum (Society For Biomaterials)
 7. Biomaterials: Processing, Testing and Manufacturing Technology (Butterworth)

X. Course Policies: (Based on the Uniform Students' By law (2007)

1	Class Attendance: Class Attendance is mandatory. A student is considered absent and shall be banned from taking the final exam if his/her absence exceeds 25% of total classes.
2	Tardiness: A student will be considered late if he/she is not in class after 10 minutes of the start time of class.
3	Exam Attendance/Punctuality: No student shall be allowed to the exam hall after 30 minutes of the start time, and

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	shall not leave the hall before half of the exam time has passed.
4	Assignments & Projects: Assignments and projects must be submitted on time. Students who delay their assignments or projects shall lose the mark allocated for the same.
5	Cheating: Cheating is an act of fraud that results in the cancelation of the student's exam or assignment. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
6	Forgery and Impersonation: Forgery/Impersonation is an act of fraud that results in the cancelation of the student's exam, assignment or project. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
7	Other policies: The University official regulations in force will be strictly observed and students shall comply with all rules and regulations of the examination set by the Department, Faculty and University Administration.

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Faculty of Medical Technology

Department of Biomedical Engineering

Program of Biomedical Engineering

Course Plan (Syllabus) of

Biomaterials

Course Code. (07.02.715)

I. Information about Faculty Member Responsible for the Course:							
Name of Faculty Member:		Office Hours					
Location & Telephone No.:							
E-mail:		SAT	SUN	MON	TUE	WED	THU

2024/2025

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I. General Information:						
11.	Course Title:	Biomaterials				
12.	Course Code:	(07.02.715)				
13.	Credit Hours:	Credit Hours	Theory Contact Hours		Practical Contact Hours	
			Lecture	Tutorial /Seminar	Lab	Clinical
		2	2	--	--	--
14.	Level/ Semester at which this Course is offered:	3 rd Level / 1 st Semester				
15.	Pre –Requisite (if any):	07.02.708				
16.	Co –Requisite (if any):					
17.	Program (s) in which the Course is Offered:	Bachelor of Biomedical Engineering				
18.	Language of Teaching the Course:	English/Arabic				
19.	Location of Teaching the Course:	Faculty of Medical Technology				
20.	Prepared by:	Dr. Mushtaq Alazazi				
11	Date and Number of Approval by Council:					

II. Course Description:	
<p>This course explores the properties, design, and applications of biomaterials used in medical devices and implants. It covers material science principles, including biocompatibility, mechanical behavior, and interaction with biological tissues. Topics include metals, ceramics, polymers, and composites, along with their roles in tissue engineering, drug delivery systems, and regenerative medicine, the course also emphasizes ethical considerations and regulatory standards for biomaterials in healthcare.</p>	

III. Course Intended Learning Outcomes (CILOs) :	
Upon successful completion of the course, students will be able to:	
A. Knowledge and Understanding:	
a1	Demonstrate an understanding of the fundamental properties, theories, and mathematical models of biomaterials, and their application in biomedical engineering technologies, ensuring biocompatibility, performance optimization, and adherence to ethical and regulatory

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	standards.
a2	Recognize and address healthcare needs by developing biomaterial-based solutions that adhere to high standards of professional, ethical behavior, and health and safety requirements, ensuring effective management and responsibility in solving real healthcare problems.
a3	Understand the testing standards applied for biomaterials and their interactions with biological environment.
B. Intellectual Skills:	
b1	Apply scientific knowledge, mathematical theories, and engineering principles to critically analyze, evaluate, and solve problems related to the selection, design, and performance of biomaterials in biomedical applications.
b2	Propose the suitable materials for specific applications in biomedical systems and explain how to overcome complexity of natural tissue structure that seeks to replace with biomaterials.
C. Professional and Practical Skills:	
c1	Integrate knowledge of biomaterials, life sciences, and biomedical engineering principles to design, evaluate, and solve complex problems related to the development and optimization of biomaterials for medical applications.
c2	Evaluate an engineering techniques, modern analytical tools, and computer programs to design, analyze, and solve problems related to the performance and safety of biomaterials in medical devices.
D. Transferable Skills:	
d1	Perform effectively at work both as an individual and as a collaborative team member or leader in biomedical engineering projects related to biomaterials, utilizing strong communication, problem-solving, and organizational skills to achieve shared goals.
d4	Engage in life-long self-learning to overcome challenges and further development in biomaterials.

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	Biomaterials Science and Engineering	– Course Overview – Materials Science and Engineering – Definitions of Biomaterials, Biomedical Materials, and Biological Materials, – Multilevel of Structure and Categorization of Materials – Four Categories of	1	2

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No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		Materials, – Examples of Biomaterials Applications, – Advantages and Disadvantages of Biomaterials. – Definitions of Toxicology and Biocompatibility		
2	Structure of Materials	– Atomic Structure – Atomic Bonding – Crystal Structure of Metals, Ceramics and Polymers. – Defects in Solids – Diffusion in Solids.	1	2
3	Bulk and Surface Properties of Materials	– Role of Implant Biomaterials Bulk Versus Surface – Mechanical Properties of General Importance – Bulk Mechanical Properties Determined from Stress–Strain Plots – Mechanical Properties Terms Used in the Medical Community – Failure – Other Bulk Properties – Surface Properties of Biomaterials – General Surface Considerations and Definitions – What Surface Properties Are We Interested in? – Surface Analysis Techniques: Principles and Methods	1	2
4	Phase Diagram	– Introduction to Phase Diagrams – Single Phase Diagram – Gibbs Phase Law – Lever Rule – Multiphase Materials Phase Diagrams, – Equilibrium Phase Transformation, – Microstructure Development	1	2
5	Toxicity and Corrosion	– Biological Roles and Toxicities of Trace Elements – Selection of Metallic Elements in Medical-Grade Alloys – Definition of Degradation,	1	2

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No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		<ul style="list-style-type: none"> Erosion, Bulk, – and Surface Processes – Biodegradation of Metals – Biodegradation of Ceramics – Degradable and Resorbable Polymers 		
6	Metallic Biomaterials	<ul style="list-style-type: none"> – Basic Principles and Concepts – Development of Metallic Biomaterials – Metallic Biomaterials in Orthopedic – Implants – Stainless Steels – Cobalt-Based Alloys – Titanium Alloys – Dental Materials – NiTi Shape-Memory Alloys – Other Clinically Applied Metallic Materials – New Metallic Materials. 	1	2
7	Ceramic Biomaterials	<ul style="list-style-type: none"> – Basic Principles and Concepts – Overview of Bio ceramics – Bioinert Ceramics – Bioactive and Bioresorbable Ceramics 	1	2
8	Mid-Term Theoretical Exam	– All Preceding Lectures	1	2
9	Polymeric Biomaterials	<ul style="list-style-type: none"> – Basic Principles and Concepts – Overview and Classification of – Polymeric Biomaterials – Bioinert Polymers – Bioresorbable Polymers – Hydrogels: Classification Basic – Structures and Synthesis – Swelling Behavior of Hydrogels – Determination of Structural – Characteristics 	2	4

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No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		<ul style="list-style-type: none"> - Biomedical Hydrogels - Smart Hydrogels and Their Applications - Biomedical Applications of Hydrogels 		
10	Biomaterials Tissue Interactions	<ul style="list-style-type: none"> - Inflammation, - Wound Healing, - Foreign Body Reaction, - Blood Material Interaction - Tumorigenesis 	1	2
11	Biological Testing of Biomaterials	<ul style="list-style-type: none"> - In Vitro Test - In Vivo Test - Standard Testing Procedures 	1	2
12	Non-blood Interfacing Implant	<ul style="list-style-type: none"> - Non-blood-interfacing Implants for Soft Tissue. - Choose Materials for The Implants. - Non-Blood-Interfacing Implant - Characteristics 	1	2
13	Blood Contacting Implant	<ul style="list-style-type: none"> - Blood Contacting Implants. - Primary Requirements of Biomaterials for Blood Contacting Implant. - Choose Materials for the Implants. - Common Problems for Various Blood Contacting Implants 	1	2
14	Hard Tissue Replacement	<ul style="list-style-type: none"> - Types of Internal Fixation - Materials for the Fixations. - Failure Modes of Internal Fixation - Devices - Types of Joint Replacements. - Types of Fixation Methods. - Choose Biomaterials for Each - Component of Joint Replacements. 	1	2

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No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
		<ul style="list-style-type: none"> - Types of Dental Implant - Dental Implant Materials 		
15	Tissue Engineering and Scaffold	<ul style="list-style-type: none"> - History, Scope and Potential of Tissue Engineering. - Tissue Engineering Development. - Properties of Scaffolds. - Scaffold Materials. - Scaffold Production Methods 	1	2
16	Final Theoretical Exam	- All Preceding Lectures	1	2
Number of Weeks /and Units Per Semester			16	32

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	Assignments	weekly	5	5%
2	Quizzes	5 & 10	5	5%
3	Midterm Theoretical Exam	8	20	20%
4	Final Theoretical Exam	16	70	70%
Total			100%	100%

IX. Learning Resources:

- *Written in the following order:* Author, Year of publication, Title, Edition, Place of publication, Publisher.

1- Required Textbook(s) (maximum two):

1. Qizhi Chen and George Thouas, 2015, Biomaterials: A Basic Introduction, 1st Edition, USA, CRC Press.
2. Callister W.D., 2008, Fundamentals of Materials Science and Engineering: An Integrated Approach, 3rd Edition, USA, John Wiley.

2- Essential References:

1. J.S Temenoff and A.G. Mikos. 2008, Biomaterials: The intersection of Biology and Material Science, USA, Pearson Prentice Hall.

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Mushtaq Alazazi	Dr. Awadh Al-Kubati	Dr. Awadh Al-Kubati	Dr. Mohammed Al-shamahi	Dr. Abdulrahman Obaid

2. Buddy D. Ratner, Allon S. Hoffman, Frederick J. Schoen, Jack E. Lemons, 2013, Biomaterials Science An Introduction to Materials in Medicine, 3rd Edition, USA, Elsevier Academic Press.
3. Park, J. B.; Lakes R. S., 2007, Biomaterials: An Introduction, 3rd Edition, , New York, Plenum Press.
4. Sujata V. Bhatt, 2005, Biomaterials, 2nd Edition, Narosa Publishing House,.
5. Sreeram Ramakrishna, Murugan Ramalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, 2010, Biomaterials: A Nano Approach, 1st Edition, USA, CRC Press, 2010
6. Myer Kutz, 2003, Standard Handbook of Biomedical Engineering & Design, McGraw Hill,
7. John Enderle, Joseph D. Bronzino, Susan M. Blanchard, 2005, Introduction to Biomedical Engineering, Elsevier, 2005.
8. Park J.B., 1984, Biomaterials Science and Engineering, Plenum Press.

3- Electronic Materials and Web Sites etc.:

Websites:

Biomaterials Journals

1. Advanced Drug Delivery Reviews (Elsevier)
2. American Society of Artificial Internal Organs Transactions
3. Annals of Biomedical Engineering (Blackwell—Official Publication of the Biomedical Engineering Society)
4. Artificial Organs (Raven Press)
5. Biomaterials, Artificial Cells and Artificial Organs (T. M.S. Chang, ed.)
6. Biomaterials forum (Society For Biomaterials)
7. Biomaterials: Processing, Testing and Manufacturing Technology (Butterworth)

X. Course Policies: (Based on the Uniform Students' By law (2007)

1	Class Attendance: Class Attendance is mandatory. A student is considered absent and shall be banned from taking the final exam if his/her absence exceeds 25% of total classes.
2	Tardiness: A student will be considered late if he/she is not in class after 10 minutes of the start time of class.
3	Exam Attendance/Punctuality: No student shall be allowed to the exam hall after 30 minutes of the start time, and shall not leave the hall before half of the exam time has passed.
4	Assignments & Projects: Assignments and projects must be submitted on time. Students who delay their assignments or projects shall lose the mark allocated for the same.
5	Cheating: Cheating is an act of fraud that results in the cancelation of the student's exam or assignment. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Mushtaq Alazazi	Dr. Awadh Al-Kubati	Dr. Awadh Al-Kubati	Dr. Mohammed Al-shamahi	Dr. Abdulrahman Obaid

6	Forgery and Impersonation: Forgery/Impersonation is an act of fraud that results in the cancelation of the student's exam, assignment or project. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
7	Other policies: The University official regulations in force will be strictly observed and students shall comply with all rules and regulations of the examination set by the Department, Faculty and University Administration.

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
Dr. Mushtaq Alazazi	Dr. Awadh Al-Kubati	Dr. Awadh Al-Kubati	Dr. Mohammed Al-shamahi	Dr. Abdulrahman Obaid