



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering

Subject Code: 3723115

Semester – II

Subject Name: Advanced Biomaterials

Type of course: Core Biomedical Engineering

Prerequisite: Material science, Biomaterials and Implants, Chemistry, Mechanics of solids.

Rationale: Manmade and naturally available materials used for medical implants and artificial organs. Advanced Biomaterials intended to focus on advanced materials used for biological purposes. This subject also focuses on processing of biomaterials. Along with the overview of various materials and its properties, this subject intended to various applications of Biomaterials for enhancing human capabilities and health.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
			ESE (E)	PA (M)	ESE (V)	PA (I)		
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Fundamentals of Biomaterials and Biocompatibility: Biomaterial, Biocompatibility, Host response, cell-material interactions, Evaluation of Biocompatibility, Characterization of Biomaterials.	04
2	Fundamentals of hydroxyapatite and related calcium phosphates, materials for orthopedic applications, the micro macroporous biphasic calcium phosphate concept for bone reconstruction and tissue engineering, science and technology integrated titanium dental implant systems, nanomaterial for improved orthopedic and bone tissue engineering applications.	10
3	Introduction to processing of biomaterials, laser processing of orthopedic biomaterials, functionally graded all ceramic hip joint, medical devices based on bio inspired ceramics, ionomer glasses: design and characterization, designing Nano fibrous scaffolds for tissue engineering, design of supermacroporous biomaterials Via gelation at subzero temperatures—cryogelation.	10
4	Biomaterial applications, cell-based Nano composites and biomolecules for bone tissue engineering, orthopedic interface tissue engineering: building the bridge to integrated musculoskeletal, cells of the nervous system and electrical stimulation tissue systems,	10



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	placental umbilical cord blood: a true blood substitute, supported cell mimetic monolayers and their blood compatibility, titanium nitride and diamond like carbon coatings for cardiovascular applications.	
5	Injectable Hydrogels as Biomaterials: Injectable in Situ Forming Gels, Photo - Gelling Polymers, Hydrogels Formed by Fast Chemical Reaction/Physical Transitions, Thermogelling Polymers.	08

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	10	10	15	15	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Advanced Biomaterials Fundamentals, Processing, And Applications: Bikramjit Basu, Dharendra Katti, and Ashok Kumar: John Wiley & Sons, 2009, ISBN 978-0-470-19340-2.
2. Handbook of Biomaterial Properties, Second Edition, William Murphy, Jonathan Black Garth Hastings, Springer Science, 2016, ISBN 978-1-4939-3303-7, ISBN 978-1-4939-3305-1 (eBook)
3. Introduction to Biomaterials: Basic Theory with Engineering Applications, C. M. Agrawal, J. L. Ong, M. R. Appleford and G. Mani, 2014, Cambridge University Press, ISBN 978-0-521-11690-9,
4. Clinical Applications of Biomaterials State-of-the-Art Progress, Trends, and Novel Approaches, Gurbinder Kaur, Springer, 2017, ISBN 978-3-319-56058-8, ISBN 978-3-319-56059-5 (eBook)

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	To classify Biomaterials with its properties and application.	10
CO-2	To understand various biomaterials for dental and orthopaedic applications.	20



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CO-3	To understand processing of Biomaterials for intended use.	20
CO-4	Application of knowledge for blood substitution and cardiovascular applications.	25
CO-5	To understand use of injectable hydrogels, their processing and applications.	25

List of Experiments:

1. To study various biomaterials and its properties.
2. To study hydroxyapatite's structure and its applications.
3. To study materials for orthopedic applications.
4. To study use of coatings on metal for surface modifications.
5. To study Physical, Chemical and Biological Properties of Biphasic Calcium Phosphate Bioceramics.
6. To study injectable hydrogels as biomaterials.
7. To prepare report on comparative analysis of current orthopedic implants and Nanomaterials for Improved Orthopedic and Bone Tissue Engineering Applications.
8. To study processing techniques of various biomaterials.
9. To study Structural Characterization of Ionomer Glasses by Solid State MAS - NMR Spectroscopy.
10. To study Polymers Used for Synthesizing Nano fibrous Structures Using the Electro-Spinning Technique.

Major Equipment: Electrospinning machine for Nano-fiber fabrication, Microscope for characterization of nano and micro fibers (Computer supported with image analysis software).

List of Open Source Software/learning website:

1. ImageJ software
2. <https://ocw.mit.edu/search/ocwsearch.htm?q=biomaterial>
3. <https://ocw.mit.edu/courses/materials-science-and-engineering/3-051j-materials-for-biomedical-applications-spring-2006/>