



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Biotechnology

Subject Code: BE05004071

Subject Name: Biomaterials for Engineering

w. e. f. Academic Year:	2026-2027
Semester:	5
Category of the Course:	Professional Elective Course - 2

Prerequisite:	None
Rationale:	Biomaterials play a crucial role in the interface between engineering and biological systems. Understanding their structural, mechanical, and chemical properties is essential for developing medical devices, implants, and tissue-engineered products. This subject provides insight into material selection, biocompatibility, and degradation for biomedical applications.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Describe the types, structure, and properties of commonly used biomaterials.	20
CO-2	Evaluate the interaction between biological systems and engineering materials.	15
CO-3	Analyze the mechanical and biological performance of biomaterials in biomedical devices.	15
CO-4	Explain principles of biomaterial degradation, corrosion, and wear.	15
CO-5	Apply concepts in designing biocompatible and functional materials for healthcare applications.	15

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/ CA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

Content:

Sr. No.	Content	Total Hrs
1	Introduction to Biomaterials Definition, classification, and applications of biomaterials; metals, ceramics, polymers, and composites; material selection criteria for biomedical use.	10
2	Material Properties and Characterization	10



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	Mechanical, physical, and surface properties; testing methods (tensile, compressive, hardness, fatigue); surface modification and coating techniques.	
3	Biocompatibility and Toxicity Host responses to implants, cytotoxicity, hemocompatibility, immune response, inflammation; biocompatibility testing standards (ISO, ASTM).	10
4	Degradation and Failure of Biomaterials Corrosion, wear, and fatigue of metallic implants; degradation of polymers; ceramic stability; sterilization and aging effects.	10
5	Applications and Emerging Trends Tissue engineering scaffolds, drug delivery systems, dental and orthopedic implants, biosensors, 3D printing in biomaterials.	05
TOTAL		45

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	20	20	10	10

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

The syllabus of Advanced Power Electronics directly contributes to

SDG 3	The syllabus contributes to the development of biomedical implants, drug delivery systems, tissue engineering scaffolds, and healthcare materials that improve patient treatment and quality of life.
SDG 9	Biomaterials engineering promotes innovation in biomedical devices, implant technologies, nanobiomaterials, and advanced healthcare infrastructure.
SDG 12	The subject supports sustainable material selection, biodegradable polymers, and environmentally responsible manufacturing of biomedical materials.
SDG 3	Understanding biocompatibility, toxicity, and biomaterial degradation helps ensure safer medical devices and improved therapeutic outcomes.
SDG 10	Advances in affordable biomaterials and healthcare technologies can improve accessibility to medical treatments and implants across diverse populations.

Reference Books:

1. Joon B. Park and R.S. Lakes, *Biomaterials: An Introduction*, Springer.
2. Buddy D. Ratner et al., *Biomaterials Science*, Elsevier.
3. Sujata V. Bhat, *Biomaterials*, Narosa Publishing.



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4. Vishu Shah, *Handbook of Plastics Testing and Failure Analysis*.

List of Experiments / Practical Demonstrations

1. Tensile strength testing of polymeric biomaterials.
2. Surface roughness analysis using profilometer.
3. Contact angle measurement to determine wettability.
4. Cytotoxicity evaluation using cell culture assay.
5. Study of corrosion rate of metallic implant materials.
6. Fabrication of hydrogel scaffold and characterization.

Major Equipment

1. Universal testing machine
2. Profilometer
3. Contact angle analyzer
4. Spectrophotometer
5. Incubator and laminar air flow
6. Autoclave and sterilizer

Open-Source Software / Learning Websites

1. NPTEL: Biomaterials and Tissue Engineering
2. MIT OpenCourseWare: Biological Engineering
3. Coursera: Biomaterials for Healthcare

List of suggested activities for Project Based Learning (PBL):

Sr. No.	PBL Category	Name of the Activity	No. of Hours	Evaluation Criteria
1	Industry / Research Laboratory Visit	Visit to biomedical implant manufacturing unit / tissue engineering laboratory / biomaterials testing laboratory	Visit = 5 hrs, Report preparation = 5 hrs Total = 10 hrs	Based on report submitted. Report should contain observations on biomaterial fabrication, implant design, sterilization, quality testing, and biomedical applications.
2	Video Based Learning	Technical video-based learning related to biomaterials, tissue engineering, biomaterial characterization, and biomedical implants (MOOC/NPTEL)	Video duration = 5 hrs, Report preparation = 5 hrs Total = 10 hrs	Report/presentation based on learning outcomes and understanding of biomaterial concepts.
3	Assignment / Technical Writing / Research Writing	Numerical and theory-based assignments related to biomaterial characterization, mechanical properties,	5 assignments × 2 hrs = 10 hrs	Based on assignment quality, technical understanding, analysis, and presentation.



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		degradation, and implant design		
4	Complex Problem-Solving Targeting Relevant SDGs / Mini Project	Design and comparative analysis of biodegradable polymer composites for tissue engineering or implant applications	15 hrs	Based on problem-solving ability, material selection, design feasibility, and innovation.
5	Research Paper Review / Analysis	Review of SCOPUS-indexed research papers on biomaterials, tissue engineering, implant materials, or nanobiomaterials	5 research papers = 20 hrs	Based on critical review, technical depth, summary, and evaluation of scientific parameters.
6	Poster / Chart / PowerPoint Presentation	Preparation of poster/PPT on topics such as Biocompatibility, Biomaterial Degradation, Drug Delivery Systems, 3D Bioprinting	6 hrs	Based on creativity, technical content, presentation quality, and communication skills.
7	Mini Project	Working/non-working model of hydrogel scaffold, biodegradable implant material, drug delivery system, or biomaterial coating	10 hrs	Based on innovation, technical relevance, functionality, and evaluation.
8	Group Discussion / Quiz / Simulation	Group discussion on emerging areas such as Smart Biomaterials, Biofabrication, Regenerative Medicine, Nanobiomaterials	1 hr each	Based on participation, technical knowledge, and communication skills.
	Online Technical Quizzes / Simulations	Multiple quizzes or simulations on biomaterial properties, implant failures, degradation mechanisms	Multiple quizzes summing to 10 hrs	Based on quiz performance and reflection report.
9	Case Study Analysis / Seminar	Case study on hip/knee implant biomaterials, implant failure analysis, or biomaterial toxicity	Data collection/study = 5 hrs, Report preparation = 5 hrs Total = 10 hrs	Based on technical depth, in-depth analysis, fact-finding, and conclusions.
10	Other	Patent Search and Innovation Gap Identification in biomaterials, tissue engineering scaffolds, implants, or drug delivery systems	10 hrs (Search + Report)	Based on number of patents reviewed and innovation scope identified.

Note:

1. Mini Project – 10 Marks , Micro Project – 5 Marks
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
