



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Biomedical Engineering

Subject Code: DI04003051

Subject Name: Biomaterials & Implants

w. e. f. Academic Year:	2025-26
Semester:	4 th
Category of the Course:	Professional Elective - I

Prerequisite:	Basic knowledge of human anatomy and physiology, fundamental biology, basic chemistry, and material science concepts related to metals, polymers, and ceramics.
Rationale:	Biomaterials and implants are essential in modern healthcare for repairing and replacing body parts. This subject introduces the properties, selection, and applications of biomaterials, their interaction with tissues, and their use in medical implants, preparing learners for clinical, industrial, and higher education opportunities.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
1	Explain the concept and need of bio-materials, implants and bio compatibilities.	R,U,A
2	Recognize the types of various metals, alloys and ceramics used for implantation according to their formation and applications	R,U,A
3	Describe the use of various polymers used for designing implants.	R,U
4	Identify different biomaterial uses for cardiovascular, optical implants and auditory Implant.	R,U,A
5	Select appropriate biomaterial for Dental and Orthopedic Implant	R,U,A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR		C	Theory		Tutorial / Practical	
			ESE(E)		PA(M)	PA(I)	ESE(V)	
3	0	2	4	70	30	20	30	150



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Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	Introduction of Biomaterials and Implants	09	20 %
	1.1. Introduction To Biomaterial and Biological <ul style="list-style-type: none">Define: Biomaterial, Implant, Biological Material, Bio compatibility. 1.2. Need Of Biomaterial 1.3. Classification Of Biomaterial 1.4. Introduction to Implant <ul style="list-style-type: none">Classification of Implant 1.5. Tissue Response to Implants <ul style="list-style-type: none">BiocompatibilityInflammation and Infection		
2	Metals, Ceramics and Composite	12	25.7 %
	Introduction, Composition, Properties and Application of Metals and Ceramics: 2.1 Stainless steel 316 and 316L 2.2 Cobalt-chromium alloys: Cast alloys, Wrought alloys, Forged alloys. 2.3 Titanium based alloys: Cast alloys, Wrought alloys, Forged alloys 2.4 Nitinol 2.5 Carbons 2.6 Alumina 2.7 Ceramics-Surface reactive ceramics: Bioglass, Ceravital 2.8 Composite: Introduction structure and Application.		
3	Polymers	06	3.1 %
	3.1 Polymerization: Types of polymer chain, Polymers in biomedical use. 3.2 Polyethylene and polypropylene 3.3 Perfluorinated polymers 3.5 Acrylic polymers 3.5 Polyamides and Poly Methyl Methacrylate(PMMA) 3.6 Sterilization of polymer.		



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4	Cardiovascular, Optical and Auditory Implant	09	20 %
	4.1 Cardiovascular Implant: 4.1.1 Vascular grafts, 4.1.2 Heart valves: Mechanical (Caged-ball valve, Tilting disc valve and Bi-leaflet valve) and Biological (Xenografts (porcine and bovine), allografts or homografts) 4.1.3 Cardiac assisting devices: LVAD 4.1.4 Stent, 4.1.5 Implantable pacemaker 4.2 Optical Implants: 4.2.1 Contact Lenses – Soft and Hard Lenses 4.2.2 Disposable Lenses 4.2.3 Intraocular Lenses(IOLS), 4.3 Auditory Implant: Cochlear Implant		
5	Dental Implant and Orthopedic Implant	09	20 %
	5.1 Dental Implant: 5.1.1. Endosteal Implants, 5.1.2 Subperiosteal implants. 5.2 Orthopedic implant: 5.2.1 Total Hip replacement 5.2.2 Total knee replacements		
Total		45 Hrs.	100 %

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	U Level	A Level	N Level	E Level	C Level
32.9 %	37.1 %	30.0 %	--	--	--

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. " Biomaterials" Sujata V. Bhatt, Second Edition, Narosa
2. "Biomaterials -Principles and Applications" Joon B. Park Joseph D. Bronzino CRC Press, 2003



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3. Biomaterials Medical Devices and Tissue Engineering Fredrick H. Silver Chapman and Hall London J.V. Park, Biomaterials Science and Engineering, Plenum Press, New York
4. "Biomaterials Science An introduction to materials in medicine" Buddy D. Ratner, Allan S. Hoffman, Frederick j. Schoen, Jack E. Lemons Edition: Third Edition Publisher: Academic Press Publication Year: 2013 Place of Publication: Burlington, MA, USA ISBN-13: 978-0123746269 ISBN-10: 0123746264

(b) Open-source software and website:

- <https://nptel.ac.in/courses/102106057>
- <https://nptel.ac.in/courses/113108071>

Suggested Course Practical List: If any

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. hours required.
1	Identify various implants used in the biomedical field	I	02
2	To Study about characteristics of tissue response to implants.	I	02
3	To Study about characteristics of biocompatibility.	I	02
4	Identify various metals and alloys used in the biomedical field.	II	02
5	Identify various stainless used in the biomedical field.	II	02
6	Identify various ceramics used in the biomedical field	II	02
7	Identify various polymers used in the biomedical field.	III	02
8	To Study about Sterilization process for various polymers used in the biomedical field.	III	02
9	To Study about cardiac valve implant shape with its material specifications.	IV	02
10	To Study about cardiac pacemaker implantations process with safety aspect	IV	02
11	To Study about models of intraocular lens implantations process with safety aspect.	IV	02
12	To Study about models of cochlear implantations process with safety aspect	IV	02
13	To Study about models of knee joints and implant shape with its material specifications.	V	02
14	To Study about models of hip replacements implant shape with its material specifications.	V	02
15	To Study about models of different dental implantations and implant shape with its material specifications.	V	02
	Minimum 14 Practical Exercises		



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List of Laboratory/Learning Resources Required:

The major equipment/instruments and software required to develop PrOs are given below, with broad specifications to facilitate their procurement by the administrators/management of the institutes. This will ensure the conduction of practical skills in all institutions across the state properly so that the desired skills are developed in students.

1. **Dental Implant Model:** Dental implant and crown bridge demonstration model with removable crowns and visible implant fixtures.
2. **Artificial Knee Joint Model):** Life-size knee joint model showing osteoarthritic condition and knee implant, made of durable, unbreakable material.
3. **Hip Joint Model:** Ball and socket joint model demonstrating movements such as abduction, rotation, anteversion, and retroversion with artificial ligaments.
4. **Intraocular Lens Implant Model :** UV-absorbent hydrophilic acrylic intraocular lens model with foldable design and standard optical specifications.

Suggested Project List:

The projects serve as practical learning experiences for students in the field of Biomedical Engineering. These projects integrate theoretical knowledge with hands-on application, fostering competency development across various Course Outcomes (COs). Below are guidelines for designing and executing projects:

- **Project Types:**
 - It can be industry-based, workshop-based, laboratory-based, or field-based.
 - Each project should align with specific COs and address real-world challenges.
- **CO Integration:**
 - It should encompass two or more COs.
 - Integration involves aligning Program Outcomes (PrOs), Unit Outcomes (UOs), and Assessment and Design Outcomes (ADOs).
- **Project Duration:**
 - Students are encouraged to maintain a dated work diary to document their individual contributions and sufficient engagement time for each project should be allocated by faculty during the course.
- **Project Demonstration:**
 - Before submission, students must give a project demonstration on their project.
 - The presentation should highlight the project's objectives, methodology, results, and relevance to industry-oriented COs.
- **Seminar Presentation:**



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- Before submission, students must give a seminar presentation on their project.
- The presentation should highlight the project's objectives, methodology, results, and relevance to industry-oriented COs.

Following are suggestive projects, and additional projects may be designed in alignment with specific course objectives. Learners are encouraged to explore innovative ideas and effectively apply their knowledge of biomaterials and implants.

Using fundamental knowledge of biomaterials, material science, and biomedical engineering, learners may develop mini/micro projects on an individual or team basis to strengthen core concepts related to biomaterials and implant applications. These projects may be developed as conceptual or prototype models addressing healthcare and societal needs. The following is a suggested list of projects:

1. Prepare a chart to describe various Biomaterials.
2. Prepare a chart or describe various types of Implants.
3. Prepare a chart or model to describe inflammation process and concept of biocompatibility
4. Design various implant by using open source designing software.
5. Make a 3d model of dental implants
6. Make a 3d model of Vascular implants
7. Make a 3d model of Optical implants
8. Make a 3d model of Orthopedic implants
9. Prepare a chart for implant waste management
10. Make a working model of cochlear implants

Suggested Activities for Students (Biomaterials & Implants):

In addition to classroom and laboratory learning, learners are encouraged to participate in co-curricular activities that enhance conceptual understanding and practical exposure to **biomaterials and implants**. These activities may be carried out individually or in groups and should be documented in the form of **brief reports (about 5 pages)**. Collection of photographs, models, charts, or samples as physical evidence will support portfolio development and aid during placement interviews.

Hands-on Model Development

- **Activity:** Design and fabricate simple physical or 3D models of implants such as dental implants, hip joints, knee joints, or cardiac valves using low-cost materials.
- **Objective:** Strengthen understanding of implant structure, design, and function.

Material Identification and Analysis

- **Activity:** Identify commonly used metals, polymers, ceramics, and composites in biomedical implants and study their properties.



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- **Objective:** Understand material selection criteria for biomedical applications.

Case Study on Biomaterial Applications

- **Activity:** Study real-world applications or failures of implants due to material or biocompatibility issues.
- **Objective:** Relate theoretical knowledge to clinical outcomes and safety aspects.

Simulation and Design Activity

- **Activity:** Use software tools or visual aids to study implant design, stress distribution, or material behavior.
- **Objective:** Analyze design considerations and performance of implants.

Biocompatibility and Tissue Response Study

- **Activity:** Prepare charts or presentations on tissue response, inflammation, and biocompatibility of different implants.
- **Objective:** Understand interaction between biomaterials and biological tissues.

Mini-Project Group Activity

- **Activity:** In small teams, develop a conceptual or prototype model of a biomedical implant or eco-friendly biomaterial.
- **Objective:** Promote teamwork, problem-solving, and application of biomaterial concepts.

Standards and Datasheet Interpretation

- **Activity:** Study material datasheets and international standards related to implants (e.g., ISO standards).
- **Objective:** Learn to interpret technical specifications for biomedical use.

Expert Lecture or Industry/Hospital Visit

- **Activity:** Organize a guest lecture or visit to a hospital, implant manufacturer, or biomedical industry.
- **Objective:** Connect classroom learning with real-world biomedical practices and industry expectations.

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