



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3150301

Semester – V

Biomaterial and Implants

Type of course: Professional Elective Course

Prerequisite: Human anatomy and physiology, mechanics of solids, structure of polymers, protein, polysaccharides, ceramics, metals and non-metal elements, atomic bonding.

Rationale: The purpose of this course is to acquaint each student with the field of material Science and the bio materials that are used in medical devices or in contact with biological systems. The effectiveness of the technology depends on the behaviour of the Bio-materials and the Medical devices with Human body.

Teaching and Examination Scheme:

Teaching Scheme			Credits	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	% Weightage
1	<u>Introduction to Biomaterials:</u> Biomaterial, Types of Biomaterials, Biocompatibility, Biological material, Biodegradable material, Bioresorbable material, Bio-inert material, Bio-active material, Pyrogenicity, Minimum Requirements of Biomaterials, Surface Properties of Biomaterials, Desirable Properties of Biomaterial, Performance of Biomaterials, Applications of Biomaterials with examples.	4	10
2	<u>Metallic & Ceramic Biomaterials:</u> Metallic Biomaterials: Introduction, Stainless steel, Co-Cr Alloys, Ti-Alloys, Nitinol, Dental metals, Corrosion of Metallic implants, Manufacturing of Metallic implants, Applications. Ceramic Biomaterials: Introduction, Types of Ceramics, Bio-inert ceramics: Alumina, Zirconia, Carbon, Bioresorbable ceramics: Calcium Phosphate, Bio-active ceramics: Glass ceramics, Applications.	10	20
3	<u>Polymeric & Composite Biomaterials:</u> Polymeric Biomaterials: Introduction, Basic structures of Polymers, Polymerization and its Types, Polyethylene, Polypropylene, Polyamides, Polyacrylates, Hydrogel, Bone cement, Fluorocarbon polymers, Silicon Rubber, Bioactive Polymers, Biodegradable Polymers, Applications. Composite Biomaterials: Introduction, Dental filling Composites & cement, Porous Composites, Fibrous & Particulate composites.	9	20



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4	<u>Biocompatibility Testing & Response of Biomaterial to Human Body:</u> Biocompatibility Testing: Introduction, In-Vitro Testing, In-Vivo Testing, Hypersensitivity, Haemocompatibility, Odontocompatibility, Osteocompatibility, Cytotoxicity, Genotoxicity, Carcinogenicity. Response of Biomaterial to Human Body: Blood-Biomaterial Interactions, Biomaterials-Tissue Interactions, Tissue response to Implants, Inflammation, Wound Healing, Foreign Body Response, Infection and Tumorigenesis of Biomaterials.	9	20
5	<u>Bio-implants & Surgical Aids:</u> Stent, Vascular grafts, Artificial Heart valves, Inferior Vena cava filter, Contact lenses, Intra-ocular lenses, Artificial Silicon Retina, Temporary fixation Devices, Total Hip Replacement, Total Knee Replacement, Dental filling & Restoration material, Dental implants, Suture materials, Wound dressings, Tissue Adhesives.	10	30
	Total	42	100%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20%	25%	30%	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) Biomaterials, By Sujata V. Bhatt, Narosa Publishing House, New Delhi, India
- 2) Biomaterials: An introduction, By Joon B. Park, Roderic S. Lakes, Springer.
- 3) Biomaterials Science: An introduction to materials in medicine, Edited by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, Elsevier.
- 4) Biomedical Materials, R. Narayan (ed.), Springer Science.
- 5) Biomaterials: Principles and Applications, Edited by Joon B. Park, Joseph D. Bronzino, CRC Press.
- 6) Biomaterials Medical Devices and Tissue Engineering By Fredrick H. Silver Chapman and Hall.
- 7) Biomaterials science and engineering By J. B. Park Plenum press, New York.

Course Outcomes:

After learning this subject, students will be able to:



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Sr. No.	CO Statement	Marks % weightage
CO-1	Describe biomaterials, classifications, their properties, performance specification and biological applications.	10
CO-2	Explain the types, composition, properties, manufacturing and applications of Metallic & Ceramic biomaterials.	20
CO-3	Illustrate the types, composition, properties, manufacturing and applications of Polymeric & Composite biomaterials.	20
CO-4	Decide the testing procedure for specific biomaterial/implant and evaluate the response of biomaterial/Implant to Human body.	20
CO-5	Apply the knowledge of biomaterials to judge which material/implant should be used for what kind of application according to nature of diseased and ill area of the body.	30

Suggested List of Study Practical's:

Sr. No.	Title	Duration (Hours)
1.	To study about Introduction of Biomaterials and its Properties.	2
2.	To study about Metal as a Biomaterials and its applications.	2
3.	To study about Ceramic as a Biomaterials and its applications.	2
4.	To study about Polymer as a Biomaterial and its applications.	2
5.	To study about Composite as a Biomaterial and its applications.	2
6.	To study about introduction to Biomaterial Testing.	2
7.	Study of Biological Interactions of Biomaterials.	2
8.	To study about Cardiovascular implants.	2
9.	To study about Ocular Implants.	2
10.	To study about Orthopaedic Implants.	2
11.	To study about Dental Implants.	2
12.	To study about Surgical aids.	2

Major Software: -

List of Open Source Software/learning website:



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1. <https://nptel.ac.in/courses/113104009/>