

GUJARAT TECHNOLOGICAL UNIVERSITY

BIO-MEDICAL ENGINEERING (03)

BIOMATERIALS & IMPLANTS

SUBJECT CODE: 2150301

B.E. 5th SEMESTER

Type of course: Core

Prerequisite: Human anatomy and physiology, mechanics of solids, structure of polymers, protein, polysaccharides, 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.

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)		
				PA	ALA	ESE	OEP			
4	0	2	6	70	20	10	20	10	20	100

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	<p><u>BIOMATERIAL: INTRODUCTION, TYPES, PROPERTIES</u> Synthetic, Metals and non-metallic alloys, Ceramics, Inorganics and glasses. Bio-resorbable and biologically derived materials, Bio-derived macromolecules, Standard and assessments of biomaterials, Surface properties of biomaterials and their testing.</p>	5	5
2	<p><u>POLYMERS:</u> Polymerization, Polyethylene, Clinical study of soft polymers, Bio-erodible polymers, Blood compatible polymers, Bioactive polymers, Hydrogels; Hard Methacrylats, Drug incorporation polymer gels, Biocompatibility of polymers, blood compatibility improvement, processing techniques for the polymers, assembling medical disposable.</p>	5	10
3	<p><u>METALS AND METALLIC ALLOYS:</u> Stainless steel, Titanium and Titanium alloys, Cobalt based alloy Nitinol, Dental metals, Dental amalgam, Gold, Nickel, and Corrosion of the metals.</p>	14	20
4	<p><u>CERAMICS AND COMPOSITE BIOMATERIALS:</u> Ceramics- Introduction to biomedical usage- bonding natural tissues, Bio-active glass, High density alumina; Calcium phosphate ceramics- Porous materials, Biological interactions, Dental ceramics- High strength materials- Thermal expansions, Fracture toughness, Drug delivery from ceramics, Wet chemical synthesis, Particulate and Fibrous composites, Soft composites, Dental Composites, Saline, Coupling agents, Micro-field materials, White-light systems bonding to teeth, Clinical trials, synthesis of filters, Matrix resins, Mechanical and physical evaluation, Nano-biomaterials: properties, preparation, characterization,</p>	6	10

	applications		
5	<p><u>BIOCOMPATIBILITY:</u></p> <p>Methods for testing and evaluating biocompatibility: In Vitro Testing, In Vivo Testing; Hemocompatibility, Osteocompatibility, Odontocompatibility, Cytotoxicity Testing, Hypersensitivity/ Allergic Responses, Genotoxicity, Tissue reaction to external materials, Blood/biomaterial interaction, Corrosion and wear of biomaterials, Treatment of materials for biocompatibility, Biodegradable materials and their applications, Rheological properties of biological solids- bone, tendons, blood vessels, biological liquids, mucus</p>	10	20
6	<p><u>RESPONSE OF BIOMATERIALS TO HUMAN BODY:</u></p> <p>Biological effects of the implants on the human body: Inflammatory response, coagulation and haemolysis, adaption, systematic distribution and excretion, allergic foreign body response, chemical and foreign body carcinogenesis</p>	6	5
7	<p><u>CARDIAC IMPLANTS:</u> Vascular grafts, Artificial Heart Valves, Synthetic Blood vessels, Inferior Vena Cava Filters</p> <p><u>OPHTHALMIC IMPLANTS:</u> Contact lenses; Soft and hard lenses, Disposable lenses, Intra Ocular Lenses (IOLs), Viscoelastic solution, Vitreous Implants, Eye shields, Drainage tubes in Glaucoma, Acrylic adhesives, Artificial Silicon Retina, Bionic Eye</p> <p><u>ORTHOPEDIC IMPLANTS:</u> Temporary fixation devices, Fracture healing, Repair of the ligaments, ACL reconstruction using biological and synthetic materials, Joint replacements: Total Hip replacement, Total knee replacement, Bone regeneration with re-sorbable material</p> <p><u>DENTAL IMPLANTS:</u> Dental implant modalities: Dentures, Subperiosteal, Endosteal; Blade type, Root form, Packaging and preparation of dental implants, Bases liners and varnishes for cavities, Impression materials</p> <p><u>TISSUE GRAFTS AND SURGICAL AIDS:</u> Tissue grafts and rejection process, Prevention of rejection, Artificial Skin, Artificial Blood, Breast Implants, Maxillofacial implants, Suture Materials, Wound dressings, Tissue Adhesives and sealants, Burn dressings, Catheters, Surgical Tapes</p>	14	30
	TOTAL HOURS	60	100%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30%	30%	30%	5%	5%	-

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
2. Biomaterials Medial Devices and Tissue Engineering By Fredrick H. Silver Chapman and Hall
3. Biomaterials science and engineering By J. B. Park Plenum press, New York
4. Biomaterials Science- An introduction to materials in medicine By Buddy D. Ratner
5. Biomaterials- An introduction By Joon B. Park, Roderic S. Lakes
6. Biomedical Materials, R.Narayan(ed.), Springer Science.

Course Outcome:

After learning the course the students should be able to do:

1. To learn about biomaterials, classifications, their properties, performance specification and biological applications.
2. To judge which material/implant should be used for what kind of application according to nature of diseased and ill area of the body.
3. To decide the testing and selection procedure for specific biomaterial/implant.
4. To develop and design artificial models/materials with the help of software available in market.
5. To compare different materials based on its strength, flexibility, inertness and its response to biological tissues.

List of Experiments: (Outlines)

1. Introduction to Biomaterials.
2. To study about Metal as a Biomaterials.
3. To study about Polymers as a Biomaterial.
4. To Study about Composite as a Biomaterial.
5. To Study about Cardiovascular Implants.
6. To Study about Hip Prosthesis and Knee Prosthesis
7. To Study about Dental Implants.
8. To Study about Ocular Implants.
9. Study of Factors Affecting Degradation of Biomaterials.
10. Study of Biological Interactions of Biomaterials.
11. Introduction to Biomaterial Testing.
12. To study about Biomedical implant design softwares.

Design based Problems (DP)/Open Ended Problem: To design different types of Artificial Heart valve.

Major Equipment: Biomaterial/Implant Simulation Software

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.