

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: BIO MATERIALS AND IMPLANTS  
(COURSE CODE: 3360306)**

<b>Diploma Programmes in which this course is offered</b>	<b>Semester in which offered</b>
Biomedical engineering	Sixth

**1. RATIONALE**

Biomaterials in the form of implants like sutures, bone plates, joint replacements and medical devices i.e. pacemakers, artificial cardiac valves, blood tubes are widely used to replace and restore the function of traumatized or degenerated tissues or organs, and thus improve the quality of life of the patients. The biocompatibility profiles of materials employed for the replacement or augmentation of biologic tissues has always been a critical concern within the health care disciplines. This course curriculum is important for a diploma biomedical engineer to develop an understanding of the concepts underlying the design and selection of materials for use in prostheses and implants and develop relevant skills to work effectively in health care industries.

**2. COMPETENCY**

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Select appropriate bio-materials and implants as per requirement.**

**3. COURSE OUTCOMES (COs)**

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

- Explain the concept and need of bio-materials, implants and bio compatibilities.
- Describe the types of various metals, alloys and ceramics used for implantation along with their formation and applications
- Explain the use of various polymers used for implantation.
- Elaborate the concept of inflammation, infection and foreign body response.
- Describe the applications of bio-materials and implants.

**4. TEACHING AND EXAMINATION SCHEME**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
4	0	2	06	70	30	20	30	<b>150</b>

**Legends:** L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit ESE - End Semester Examination; PA - Progressive Assessment.

## 5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes ( In Cognitive Domain)	Topics and Sub-topics
<b>Unit – I Introduction of Bio Materials and Implants</b>	1a. Describe biomaterials and implants and their impact. 1b. Describe the construction of biomaterials. 1c. Explain performance of implants. 1d. Describe tissue response to implants. 1e. Describe grafts, stents and explain bio compatibility	1.1. Need of biomaterial 1.2. Construction of bio-material 1.3. Impact of bio-material 1.4. Performance of implants 1.5. Tissue response to implants 1.6. Grafts ,stents 1.7. Biocompatibility
<b>Unit– II Metals and Ceramics</b>	2a. Explain the types of stainless steel along with the formation and its applications. 2b. Describe the types of co-ch along with the formation and its applications. 2c. Describe the types of Ti based alloys and describe formation along with its applications. 2d. Describe the types of nitinol and describe formation along with its applications. 2e. Describe the types of carbons and their formation along with applications. 2f. Describe the types of Al and their formation along with applications. 2g. Describe the types of surface reactive ceramics and and their formation along with applications.	2.1 Stainless steel 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 and other metals 2.5 Carbons 2.6 Alumina 2.7 Surface reactive ceramics: Bio-glass, Ceravital
<b>Unit– III Polymers</b>	3a. Explain polymerization process. and their classification. 3b. Describe the features of polymers used in biomedical field. 3c. Describe the formation of different types of polymer 3d. Explain sterilization process of polymer	3.1 Polymerization: Types of polymer chain, Polymers in bio-medical use 3.2 Polyethylene and polypropylene 3.3 Per fluorinated polymers 3.4 Acrylic polymers 3.5 Polyamides and Poly Methyl Methacrylate (PMMA) 3.6 Silicon rubber 3.7 Sterilization of polymer

Unit	Major Learning Outcomes ( In Cognitive Domain)	Topics and Sub-topics
<b>Unit – IV Inflammation</b>	4a. Explain foreign body response towards any bio material or implant. 4b. Explain acute and chronic inflammation. 4c. Describe the infections due to implants. 4d. Explain the concept of bio compatibility of implants with the human body.	4.1 Foreign body response 4.2 Inflammation 4.3 Acute inflammation 4.4 Chronic inflammation 4.5 Infection 4.6 Blood–Material interactions 4.7 Biocompatibility
<b>Unit – V Application of Bio-Materials and Implants</b>	5a. Describe the vascular implant. 5b. Describe the material, features and working of artificial kidney. 5c. Describe the material used in endocardial electrodes of cardiac pace maker. 5d. Explain circulatory assist device. 5e. Explain intra ocular lens. 5f. Describe impression materials, fillings and restoration materials.	5.1 Vascular implants: Implantable artificial kidney, Cardiac pacemaker, Circulatory assist device, Valve implants 5.2 Optical implants 5.3 Dental implants: Impression materials, Fillings and restoration materials 5.4 Orthopedic implant: Knee joint and hip replacement

## 6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (Theory)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction of Bio Materials and Implants	08	04	04	02	10
II	Metals and Ceramics	12	05	05	05	15
III	Polymers	12	05	05	05	15
IV	Inflammation	10	04	04	04	12
V	Application of Bio-Materials and Implants	14	06	06	06	18
	<b>Total</b>	<b>56</b>	<b>24</b>	<b>24</b>	<b>22</b>	<b>70</b>

**Legends:** R = Remember, U = Understand, A= Apply and above Level (Bloom's revised 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

## 7. SUGGESTED EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

**Note:** Here only outcomes mainly in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Approx. Hours Required
1	I	Identify various implants used in biomedical field.	2
2	II	Identify various metals and alloys used in biomedical field.	2
3	II	Identify various ceramics used in biomedical field.	2
4	III	Identify various polymers used in biomedical field.	2
5	IV	List characteristics of tissue response to implants.	2
<b>Demonstration Exercises by Expert</b>			
6	V	Study models of different dental implantations and draw the dental implant shape with its material specifications..	4
7	V	Study models of cardiac valve implantations and draw the cardiac valve implant shape with its material specifications.	4
8	V	Study cardiac pacemaker implantations and draw its circuit diagram with working principle.	4
9	V	Study models of intra ocular lens implantations and draw the implantation with its material specifications.	4
10	V	Study models of knee joint or hip replacements and draw the knee joint/hip replacements implant shape with its material specifications.	4
<b>Total</b>			<b>30</b>

## 8. SUGGESTED STUDENT ACTIVITIES

Following are the list of proposed student activities such as:

- i. Collect information to become aware of the materials being used in body implantation.
- ii. Collect information to become aware of implantation techniques.
- iii. Collect pictures of various as biomaterials and bio-implants.

## 9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- i. Arrange Seminars/Symposiums by giving topics to students (and ask them to explore the details from Internet/suppliers of implants.)
- ii. Show animations/video films to explain the concepts
- iii. Arrange visit to an advanced hospital and reputed suppliers of implants to study the different types of bio-materials and implants.
- iv. Arrange expert lectures.

## 10. SUGGESTED LEARNING RESOURCES

### A) Books

S. No.	Title of Book	Author	Publication
1.	Biomaterials	Bhatt Sujata V.	Alpha science international-2005
2.	Biomedical Materials	Roger Narayan	Springer Publication-2009
3.	Biomaterials Principles And Applications	Park Joon B.	CRC press, Boca London, 2003
4.	Introduction to Biomaterials	Donglu shi	Tsinghua university Press, World scientific-2005

### B) Major Equipment/ Instrument with Broad Specifications

- i. Pacemaker
- ii. Dental implants
- iii. Artificial knee joint/hip joints
- iv. Sample of cardiac valves
- v. Models/Samples of artificial kidneys

### C) Software/Learning Websites

- i. [www.implantdirect.com](http://www.implantdirect.com)
- ii. [www.biomaterials.pl](http://www.biomaterials.pl)
- iii. [www.umcg.nl](http://www.umcg.nl)
- iv. <http://ocw.mit.edu/courses/materials-science-and-engineering/3-051j-materials-for-biomedical-applications-spring-2006/>
- v. <http://ocw.mit.edu/courses/mechanical-engineering/2-782j-design-of-medical-devices-and-implants-spring-2006/>

## 11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics

- **Prof. B.C.Chaudhari**, Lecturer, Dept of Biomedical Engineering, G.P.Gandhinagar
- **Prof. D.C.Shreegod**, Lecturer, Dept of Biomedical Engineering, G.P.Gandhinagar
- **Prof. P.G.Lakhani**, Lecturer, Dept of Biomedical Engineering, G.P.Gandhinagar
- **Prof. A.K.Bula**, Lecturer, Dept of Instrumentation and Control Engineering, G.P.Gandhinagar

### Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. (Mrs.) Susan S. Mathew**, Associate Professor, Dept. of Electrical and Electronics Engineering.
- **Dr. Shashi Kant Gupta**, Professor and Coordinator for State of Gujarat