

# **UNIVERSITY OF MUMBAI**



## **Bachelor of Biomedical Engineering**

**Third Year and Final Year Engineering**

**Sem. VIII**

**Revised course (Rev- 2012)**

**From Academic Year 2012 -13**

**Under**

## **FACULTY OF TECHNOLOGY**

(As per Semester Based Credit and Grading System)

## Syllabus Scheme for B.E. Semester VIII Biomedical Engineering

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BEBM801	Nuclear Medicine	4	-	1	4	-	1	5
BEBM802	Biomedical Microsystems	4	2	-	4	1	-	5
BEBM803	Hospital Management	4	-	1	4	-	1	5
BEBM804	Elective	4	2	-	4	1	-	5
BEBM805	Project Stage – II	-	12	-	-	6	-	6
	<b>TOTAL</b>	<b>16</b>	<b>16</b>	<b>2</b>	<b>16</b>	<b>8</b>	<b>2</b>	<b>26</b>

Electives:

1. Lasers and Fiber Optics
2. Robotics in Medicine
3. Health care Informatics
4. Rehabilitation Engineering

Sub Code	Subject Name	Examination scheme								
		Theory Marks				End Sem exam	Term work	Pract.	Oral	Total
		Internal Assessment			Avg.					
		Test 1	Test 2	Avg.						
BEBM801	Nuclear Medicine	20	20	20	80	25	-	25	150	
BEBM802	Biomedical Microsystems	20	20	20	80	25	-	25	150	
BEBM803	Hospital Management	20	20	20	80	25	-	25	150	
BEBM804	Elective	20	20	20	80	25	-	25	150	
BEBM805	Project Stage – II	-	-	-	-	50	-	100	150	
<b>TOTAL</b>				<b>80</b>	<b>320</b>	<b>150</b>		<b>200</b>	<b>750</b>	

## **Project Guidelines**

Project –I and II: Students groups and load of faculty per week

Project Groups: Students can form groups with minimum 2 (Two) and not more than 4 (Four)

Faculty Load: In semester VII – 1/2 (half) period of 1/2 hour per week per project group

In semester VIII - 1 (One) periods of 1 hour each per week per project group

Each faculty is permitted to take (guide) maximum 4 (Four) project groups.

## Syllabus Scheme for B.E. Semester VIII Biomedical Engineering

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BEBM801	Nuclear Medicine	4	-	1	4	-	1	5
BEBM802	Biomedical Microsystems	4	2	-	4	1	-	5
BEBM803	Hospital Management	4	-	1	4	-	1	5
BEBM804	Elective	4	2	-	4	1	-	5
BEBM805	Project Stage – II	-	12	-	-	6	-	6
	<b>TOTAL</b>	<b>16</b>	<b>16</b>	<b>2</b>	<b>16</b>	<b>8</b>	<b>2</b>	<b>26</b>

Electives:

1. Lasers and Fiber Optics
2. Robotics in Medicine
3. Health care Informatics
4. Rehabilitation Engineering

Sub Code	Subject Name	Examination scheme								
		Theory Marks				End Sem exam	Term work	Pract.	Oral	Total
		Internal Assessment			Avg.					
		Test 1	Test 2							
BEBM801	Nuclear Medicine	20	20	20	80	25	-	25	150	
BEBM802	Biomedical Microsystems	20	20	20	80	25	-	25	150	
BEBM803	Hospital Management	20	20	20	80	25	-	25	150	
BEBM804	Elective	20	20	20	80	25	-	25	150	
BEBM805	Project Stage – II	-	-	-	-	50	-	100	150	
<b>TOTAL</b>				<b>80</b>	<b>320</b>	<b>150</b>		<b>200</b>	<b>750</b>	

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BEEM801	Nuclear Medicine (abbreviated as NM)	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BEEM801	Nuclear Medicine	20	20	20	80	25	-	25	150

Course Objectives	To enable the students to understand the basic science of nuclear medicine, operating principles and quality control aspects of various nuclear medicine equipment. To keep the students abreast with the technological developments in the field of nuclear medicine.
Course Outcomes	The students will be able to understand essential physics, concepts of radiopharmaceuticals and how they are employed in nuclear medicine diagnosis and therapy. The students will also get familiar with the current In-vivo and In-vitro techniques of nuclear medicine along with their clinical applications. The students will also be able to apprehend the importance of radiation safety and radioactive waste management.

Module	Contents	Time
1.	<p><b>Basics of Nuclear Physics:</b> Radioactivity, Radioactive Decay Law, Radioactive Decay Processes, Units of Radioactivity Measurement, Successive Decay Equations. Statistics of Counting, Interaction of Radiation with Matter</p> <p><b>Production of Radionuclide:</b> Methods of radionuclide production: Nuclear Reactor, Medical Cyclotron &amp; Radionuclide Generators Spectra of commonly used radio nuclides e.g. I-131, Tc-99m, Cr-51, Cs-137. Problems in radiation measurements.</p>	10
2.	<p><b>Radiopharmaceuticals:</b> Ideal Radiopharmaceutical, Methods of Radiolabeling</p> <p><b>Internal Radiation Dosimetry:</b> Absorbed Dose Calculations to Target &amp; Non-Target Tissues, MIRD Methodology</p> <p><b>Radiation Safety:</b> Natural &amp; Artificial Radiation Exposure, External &amp; Internal Radiation Hazard, Methods of Minimizing External Exposure, Methods of Preventing Internal Exposure, Evaluation of External &amp; Internal Hazard, Biological Effects of Radiation, Radioactive Waste Management, Ethics in Nuclear medicine.</p>	08

3.	<p><b>Detectors in Nuclear Medicine &amp; Counting and Measuring System:</b> Gas filled Detectors, Scintillation Detectors and Solid State Detectors, Scintillation Counting System, Gamma Ray Spectrometry, Radionuclide Dose Calibrator, Properties of Detectors.</p> <p><b>In Vitro techniques(Brief Description):</b> Introduction, Single and Double Isotope method, Radioimmunoassay, RIA Counting System, Liquid scintillation Counting system, RIA Applications.</p>	10
4.	<p><b>In Vivo Techniques:</b> General Principle, Uptake Monitoring System, Rectilinear Scanner, Gamma Camera Fundamentals, Position Circuitry and working, Computer Interface, Performance Parameters, Quality Control Functions</p>	09
5.	<p><b>Emission Tomography Techniques and Clinical Applications:</b> Introduction, Principles and applications of SPECT, Principles and applications of PET, System performance parameters and Quality Control Functions.</p> <p><b>Introduction to Hybrid Modalities:</b> PET/CT, SPECT/CT</p> <p><b>Clinical Applications</b> Clinical Applications of PET, SPECT and Hybrid Modalities in Cardiology, Neurology and Oncology.</p>	08
6.	<p><b>Radionuclide Therapy</b> Choice of a Radionuclide in Therapeutic Nuclear Medicine Treatment of Benign &amp; Malignant Diseases Palliative &amp; Curative Procedures:</p>	03

**Text books:**

1. Textbook of Nuclear medicine: J. Harbert and A.F.G. Rocha, Second Edition, Lea& Febiger.
2. Handbook of Nuclear medicine Instruments, B.R. Bairi, Balvinder Singh, N.C. Rathod and P.V. Narurkar, Tata McGraw – Hill.
3. Fundamentals of Nuclear Pharmacy, Gopal B. Saha, Springer Science Business Media
4. Introductory Physics of Nuclear Medicine, Ramesh Chandra, Lea& Febiger

**Reference Books:**

1. Medical Radiation Physics William R. Hendee, , Year Book Medical Publishers
2. Instrumentation of Nuclear medicine G. Hine, , Academic Press
3. Radiation Detection & Measurement Glenn F. Knoll, , John Wiley & Sons.

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

**End Semester Examination:**

Question paper will comprise of total 6 questions, each of 20 marks.

Only 4 questions need to be solved.

Q.1 will be compulsory and based on the entire syllabus.

Remaining questions will be mixed in nature.

In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

**Term Work:**

Term work consists of minimum eight experiments / assignments and one presentation based on any topic on the recent trends in the subject. Students are supposed carryout thorough literature survey, collect data and prepare their presentation.

The distribution of the term work shall be as follows:

Laboratory work (Experiments / assignment and Journal):10 marks

Presentation : 5 marks

Attendance (Practical and Theory) :10 marks

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BEBM802	Biomedical Microsystems (abbreviated as BM)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BEBM802	Biomedical Microsystems	20	20	20	80	25	-	25	150

Course Objectives	To provide students with necessary skills to understand recent advancements in Biomedical Engineering for a successful career in the area of nanotechnology
Course Outcomes	Graduates will demonstrate skills to use MEMS background and software to analyze and design advanced miniaturized Biomedical problems

Module	Contents	Time
1.	<b>BASICS OF MINIATURIZATION &amp; MATERIALS</b> Dimensional effect on engineering systems Clean room classification Scaling Laws in Miniaturization MEMS & Micro system products Substrates and Wafers Properties of Silicon Compounds SiO <sub>2</sub> , Si <sub>3</sub> N <sub>4</sub> , Polysilicon, Amorphous silicon Polymers: Dielectric polymers, Conducting polymers, and piezoelectric polymers	08
2.	<b>MEMS FABRICATION PROCESSES</b> Fabrication techniques in MEMS: Bulk micromachining, Surface micromachining, and LIGA Cleaning processes: RCA, Piranha Deposition processes for metals: e-beam evaporation, thermal evaporation and DC Sputter Deposition processes for dielectrics: Physical (RF Sputter) and Chemical Techniques (CVD: APCVD, LPCVD, PECVD, and HWCVD). Polymers coating techniques: spinning, spraying and electrodeposition Photolithography: light sources (UV, DUV, and EUV), photoresist, mask design and fabrication using EBL, dark and bright field photo-mask, different projection systems in lithography, detailed study of lithography process, study of fabrication processes	16



	<p>like optical grating structure, SiO<sub>2</sub> cantilever , SiN<sub>x</sub> cantilever and basics of EBL</p> <p>Etching Processes : Dry (RIE, DRIE) and wet etching</p> <p>Doping – ion implantation and diffusion</p> <p>Soft lithography: Micro contact Printing, Imprinting or hot embossing, and Replica Molding</p> <p>Surface characterization techniques: AFM, SEM, Profilometer, Elipsometer, Fluorimeter</p>	
3.	<p><b>MICRO TOTAL ANALYSIS SYSTEMS (μTAS)</b></p> <p>Basic block diagram: importance of μ-TAS</p> <p>Flow techniques in μ-fluidics: pressure driven force, electro-kinematics; electro-osmosis, electrophoresis, dielectrophoresis</p> <p>Components in μ-TAS: Micropump, microvalves, microchannels</p> <p>μ-TAS: separation and mixing techniques</p> <p>fabrication of micro-channels: SU8 channel, glass channel, silicon channel</p>	08
4.	<p><b>MICRO/ NANO BIOSENSORS</b></p> <p>Biosensor: definition, block diagram and working</p> <p>Classification based on the basis of detection techniques: Electric Magnetic, Optical, Thermal, Mechanical, and Chemical.</p> <p>Basic steps involved in the development of biosensors: surface modification, immobilization, integration with transducer</p> <p>Examples: (i) Design, fabrication of SiO cantilever for antibody detection, (ii) Design, fabrication of Optical waveguide biosensor, (iii) Microfluidics based biosensor</p>	08
5.	<p><b>DRUG DELIVERY DEVICES</b></p> <p>Overview of drug delivery systems, Types of drug delivery systems, Different parts of drug delivery system, MEMS based drug delivery systems: Implantable drug delivery systems (IDDS), Micro needles and its fabrication, Micro particles for oral drug delivery</p>	04
6.	<p><b>MICROSYSTEM PACKAGING</b></p> <p>Importance of packaging</p> <p>Packaging materials</p> <p>Packaging techniques</p> <p>Wafer bonding</p>	04

#### List of Experiment/ Tutorials:

- 1.Literature review on MEMS technology and growth
- 2.Materials in MEMS technology: Single crystal Silicon, Dielectrics, and metals
- 3.Numericals on Polymer spinning, Dry and Wet oxidation
- 4.Detailed fabrication process for SiO<sub>2</sub> cantilever
- 5.Importance of soft-lithography with example (compare with traditional method)

6. Different flow techniques in  $\mu$ -TAS
7. Detailed fabrication process for glass-glass microfluidic channel
8. Design, fabrication of Biosensor (all three listed in Chapter 6)
9. Drug delivery systems
10. Over view on MEMS packaging

**Text books:**

1. MEMS & Microsystems: Design, Manufacture, and Nanoscale Engineering, 2nd Edition  
Tai-Ran Hsu, ISBN: 978-0-470-08301-7
2. MEMS and Microsystems: Design and Manufacture," mcgraw-Hill, Boston, 2002 (ISBN 0-07-239391-2).

**Reference Books:**

1. "Fundamentals of Microfabrication" Marc Madou, by, CRC Press, 1997. Gregory Kovacs,
2. "Fundamentals of BioMEMS and Medical Microdevices", Steven S. Saliterman, (SPIE Press Monograph Vol. PM153 by Wiley Interscience
3. "Microsystem Technology", W. Menz, J. Mohr, O. Paul, WILEY-VCH, ISBN 3-527-29634-4
4. "Electro Mechanical System Design", James J. Allen, Taylor & Francis Group, LLC, ISBN-0-8247-5824-2, 2005
5. "MICROSYSTEM DESIGN", Stephen D. Senturia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-306-47601-0
6. "Introduction to Microfabrication", Sami Franssila John Wiley & Sons Ltd, ISBN 0-470-85106-6
7. "Microelectromechanical Systems", Nicolae Lobontiu, Ephraim Garcia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-387-23037-8
8. "BIOMEDICAL NANOTECHNOLOGY", Neelina H. Malsch CRC PRESS, Taylor and Francis Group, ISBN 10: 0-8247-2579-4

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

**End Semester Examination:**

Question paper will comprise of 6 questions, each carrying 20 marks.

The students need to solve total 4 questions.

Question No.1 will be compulsory and based on entire syllabus.

Remaining question (Q.2 to Q.6) will be selected from all the modules.

**Term Work:**

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:

Laboratory work (Experiments and Journal)	:15 marks
Attendance (Practical and Theory)	:10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
<b>BEBM803</b>	<b>Hospital Management (abbreviated as HM)</b>	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
<b>BEBM803</b>	<b>Hospital Management</b>	20	20	20	80	25	-	25	150

Course Objectives	To promote the development of high quality of hospital care in the community and so as to provide a satisfactory environment to the patient and also to the doctors for clinical research.
Course Outcomes	Understand and apply resource management concepts (personnel, finance, and material resources) and the processes and strategies needed in specific hospital sectors Communicate effectively and develop their leadership and teambuilding abilities Apply modern change management and innovation management concepts to optimize structures Analyze existing hospital service policies and enhance their alignment within the local and national context

Module	Contents	Time
1.	<b>Process of management:</b> Principles of management, Leadership, Motivation, Time management, Communication in hospital, H.R. management (Recruitment, Performance appraisal, Reward management, Training and development, Conflict resolution and labor relations), Accounting - Types of Budget	10
2.	<b>Organization of the hospital &amp; Hospital Planning:</b> Management structure, Types of hospitals, Governing body, Hospital committee and hospital functionaries ,Duties and responsibilities of various positions Guiding principles in planning hospital facilities and services and planning the hospital building	06
3.	<b>Planning for Clinical and Supportive Services :</b> A) Clinical Services: Emergency, IN patient, OUT patient, Intensive care unit, Operation Theatre, Laboratory, Blood Bank, Radiology B) Utility/ Supportive services: Registration Medical record department, Central Sterile Service Dept, Pharmacy, Laundry and Linen Medical social service Dept. Hospital security, Housekeeping, Dietary (Food services)	14
4.	<b>Planning for Engineering and Auxiliary Services :</b> A) Engineering Services : Maintenance, Biomedical Dept.: Need and responsibilities,	11

	Installation, Maintenance, Calibration, Electrical & HVAC (Hospital Ventilation and Air Conditioning), Medical Gas systems, Communication, Transport Services (Ambulance) Hospital information systems B) Auxiliary Services : Waste management, Hospital Infection control, Disaster management Marketing Department	
5.	<b>Material Management &amp; Inventory Control</b> Classification of Materials Purchase Management: Purchase system (Centralized, Decentralized, Local purchase), Purchase Procedures: Selection of Suppliers, Tendering procedures, Analyzing bids, Price negotiations, Issue of purchase orders, Rate Contracts, Follow up action Store Management: Organization & layout, Functions of Store Manager, Materials handling, Flow of goods/FIFO, Computerization of inventory transactions, Security of stores, Disposal of scrap/unserviceable materials Inventory Control: Lead-time, Buffer stock, Reorder level, Two Bin System, EOQ	04
6.	<b>Legal Aspects in a hospital:</b> Medico legal aspects (with reference to Biomedical Engineer), Preventive Steps for Doctors/Hospitals to Avoid Litigation : Consent Form, Life Support Dying Declaration, Death Certificate, High Risk Post Mortem	03

**Text books:**

1. Hospital Management by Dr. Pradya Pai
2. Hospital Planning, Designing and Management: Kundurs G D, Gopinath, A katakam (Private Pub Bangalore)

**Reference Books:**

1. Computers in Medicine: R. D. Lele (TMH Pub)
2. Hospital Care and Hospital Management AICTE Journal Vol. 1,2,3 by Dr. Kalanidhi. (AICTE Pub Bangalore)
3. Careers in Biomedical : Shantanu Thatte.

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

**End Semester Examination:**

Question paper will comprise of 6 questions, each carrying 20 marks.  
The students need to solve total 4 questions.  
Question No.1 will be compulsory and based on entire syllabus.  
Remaining question (Q.2 to Q.6) will be selected from all the modules.

**Term Work:**

Term work consists of minimum eight experiments / assignments and one presentation based on the any one department in the hospital. Students are supposed to visit hospital, collect data and prepare their presentation.

The distribution of the term work shall be as follows:

Laboratory work (Experiments / assignment and Journal):10 marks

Presentation : 5 marks

Attendance (Practical and Theory) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BEBM804	<b>Elective: Lasers and Fiber Optics (abbreviated as LFO)</b>	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BEBM804	<b>Lasers and Fiber Optics</b>	20	20	20	80	25	-	25	150

Course Objectives	To understand the fundamentals in Laser and Fiber Optics. It also discusses all about the applications of Laser and Fiber optics in health sector
Course Outcomes	Students will be well versed with the fundamentals and clinical applications of Laser and Fiber Optics. By this they will be able to correlate the knowledge of medicine and engineering for the wellness of human being. Also a biomedical student will understand the safety aspects while dealing with Laser and Fiber Optic Units

Module	Contents	Time
1.	<b>Laser Fundamentals</b> Fundamental wave properties and quantum properties of light, Energy levels and Radiative properties, Absorption and Stimulated Emission, Laser Amplifiers, Laser Oscillation above threshold, Requirements for obtaining Population Inversion, Laser pumping requirements and techniques, Laser Resonators, Cavity modes, Laser interaction with tissue- Effects and principles, Thermal interaction between laser and tissue.	10
2.	<b>Laser Types ,construction and working</b> Laser system involving low density gain medium: He-Ne laser, Argon Ion Laser, He-Cadmium laser, Carbon dioxide Laser, Excimer laser, Nitrogen Laser Laser system involving high density gain medium: Solid State laser like Ruby laser, Nd-YAG Laser, Titanium Sapphire Laser, Fiber Lasers, Semiconductor Diode Laser	10
3.	<b>Laser safety:</b> Practical Laser Safety requirements, Environmental safety, Equipment safety, personnel protection, Education/training for handling laser equipments, Role of Laser Safety officer, Standards of practice for the use of Laser in medicine and Surgery, Recommendation Regarding the Laser safety officer, Hospital Laser Committee	06

4.	<b>Optic Fibers Fundamentals</b> Light transmission in optical fibers- principles, optical properties of optical fibers, Fiber materials ,Types of Optical fibers, Modes, Losses, Fabrication of optical fibers, Methods and Principle,Fiber Splicing, Fiber optic imaging, Biomedical Optical fibers, Invivo Applications.	10
5.	<b>Laser and Fiber Optics in surgery</b> Introduction, fiber optic laser systems in cardiovascular disease, gastroenterology, gynecology, neurosurgery, oncology, ophthalmology, orthopedics, otolaryngology (ENT), urology, and flow diagram for laser angioplasty ,Laser and Fiber optics used in Skin	06
6.	<b>Endoscopy</b> Basic Principle, System components and functions, Types of endoscopes, Video Endoscopes, Accessories, Maintenance , Endoscopy Processing room requirements, Medical Application, Leakage tester and Trouble shooting	06

**Text books:**

1. Lasers and Optical Fibers in Medicine – AbrahamCatzir Academic press 1998
2. Optical Fiber Communication by Gerd Keiser

**Reference Books:**

1. Therapeutic Lasers – G David Baxter – Churchill Living stone publications
2. Medical Laser and their safe use – David H Shiny Stiffen and L Trokel Springer Publications
3. Element of Fiber optics – S. L. Wymer Regents PHI
4. Lasers in Urologic Surgery – Joseph A.Smith,Jr, Barry S.Stein, Ralph C.Benson,Jr, Mosby Publication
5. Laser Fundamentals-William T.Silfvast, Cambridge University Press
- 6.Lasers in Medicine, Volume-1,Hans K. Koebner, John Wiley & Sons

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

**End Semester Examination:**

Question paper will comprise of 6 questions, each carrying 20 marks.

The students need to solve total 4 questions.

Question No.1 will be compulsory and based on entire syllabus.

Remaining question (Q.2 to Q.6) will be selected from all the modules.



**Term Work:**

Term work consists of minimum eight experiments / assignments and one presentation based on any topic on the recent trends in the subject. Students are supposed carryout thorough literature survey, collect data and prepare their presentation.

The distribution of the term work shall be as follows:

Laboratory work (Experiments / assignment and Journal):10 marks

Presentation : 5 marks

Attendance (Practical and Theory) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
<b>BEBM804</b>	<b>Elective: Robotics in Medicine (abbreviated as RIM)</b>	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
<b>BEBM804</b>	<b>Robotics in Medicine</b>	20	20	20	80	25	-	25	150

Course Objectives	Students will be introduced to basics of Robotics, Kinematics, Inverse Kinematics, vision and motion planning. Students will also be introduced to various applications of Robots in Medicine.
Course Outcomes	Students will be able to design basic Robotics system and formulate Kinematic, Inverse Kinematic motion planning solutions for various Robotic configurations. Students will be able to design Robotic systems for Medical application.

Module	Contents	Time
1.	Introduction Automation and Robots, Classification, Application, Specification, Notations	06
2.	Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation, (Five- axis robot, Four-axis robot, Six-axis robot)	08
3.	Inverse Kinematics General properties of solutions tool configuration Five axis robots, Three-Four axis, Six axis robot(Inverse Kinematics). Workspace analysis and trajectory planning work envelope and examples, workspace fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.	10
4.	Robot Vision Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation (Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration).	10
5.	Task Planning Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation.	08
6.	Applications in Biomedical Engineering Application in rehabilitation, Clinical and Surgery	06

**Text books:**

1. Fundamentals of Robotics-Analysis and control, Robert Schilling, Prentice Hall of India.
2. Robotics, Fu, Gonzales and Lee, McGraw Hill
3. Introduction to Robotics, J.J, Craig, Pearson Education

**Reference Books:**

1. Robotics and AI, Staughard, Prentice Hall Of India.
2. Industrial Robotics - Grover, Wiess, Nagel, Oderey, , McGraw Hill.
3. Robotics and Mechatronics. Walfram Stdder,
4. Introduction to Robotics, Niku, Pearson Education.
5. Robot Engineering, Klafter, Chmielewski, Negin, Prentice Hall Of India.
6. Robotics and Control, Mittal, Nagrath, Tata McGraw Hill publications.

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

**End Semester Examination:**

Question paper will comprise of 6 questions, each carrying 20 marks.  
The students need to solve total 4 questions.  
Question No.1 will be compulsory and based on entire syllabus.  
Remaining question (Q.2 to Q.6) will be selected from all the modules.

**Term Work:**

Term work consists of minimum eight experiments / assignments and one presentation based on any topic on the recent trends in the subject. Students are supposed carryout thorough literature survey, collect data and prepare their presentation.

The distribution of the term work shall be as follows:

Laboratory work (Experiments / assignment and Journal):	10 marks
Presentation	: 5 marks
Attendance (Practical and Theory)	:10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
<b>BEBM804</b>	<b>Elective: Health Care Informatics (abbreviated as HCI)</b>	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
<b>BEBM804</b>	<b>Health Care Informatics</b>	20	20	20	80	25	-	25	150

Course Objectives	Understand the healthcare interoperability semantic and syntactic. Understand the standards of healthcare interoperability standards for Medical Images and Medical Messages
Course Outcomes	After completing this course student will be able to fabricate information messages associated with healthcare event. Students will be able to fabricate and understand the information exchange messages for transfer of medical Image Data.

Module	Contents	Time
1.	<b>Healthcare Interoperability</b> Introduction: Standards In Healthcare System, Categorizing Standards, Standard Development, Various Healthcare Informatics Standards	04
2.	<b>XML</b> The Need for XML, Concepts and Definition, XML Syntex, Content Of an XML Document, Structure of an XML document, Validation, Access to the content of the Document	06
3.	<b>Health Level 7</b> HL7 version 2.X, Message communication Concept, Segments, Fields, Components, Subcomponents, Message delimiters, Data types, Rules for message formation, Trigger Event, ADT Segments	10
4.	<b>DICOM standard</b> DICOM SOPs, Unit Identification on n/w, Services and Data, DIMSE Example: C-Echo, Storage, Query: Find, C-Find IOD, C-Find DIMSE, C-Cancel, Modality Worklist, Basic DICOM Retrieval: C-Get, Advanced DICOM Retrieval: C-Move, DICOM: Ping, Push and Pull	10
5.	<b>DICOM Communications</b> DICOM SOPs, Unit Identification on n/w, Services and Data, DIMSE Example: C-Echo, Storage, Query: Find, C-Find IOD, C-Find DIMSE, C-Cancel, Modality Worklist, Basic DICOM Retrieval: C-Get, Advanced DICOM Retrieval: C-Move,	08

	DICOM: Ping, Push and Pull	
6.	<b>DICOM Associations</b> Association Establishment, Transfer Syntax, Application Context, Presentation Context, User Information, Protocol Data Unit (PDU) <b>DICOM Media: Files, Folders, and DICOMDIRs</b> DICOM File Format, DICOM File Services, Storing DICOM Data in PACS	10

**Text books:**

- 1) CDA™ Book, By Keith Boone, Springer Publication
- 2) Digital Imaging and Communication in Medicine by Oleg S. Pianykh, Springer Publication

**Reference Books:**

- 1) Principles of Health Interoperability HL7 and SNOMED (Health Information Technology Standards), Springer Publication by Tim Benson
- 2) Informatics in Medical Imaging, George C. Kagadis, Steve G. Langer  
CRC Press

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

**End Semester Examination:**

Question paper will comprise of 6 questions, each carrying 20 marks.

The students need to solve total 4 questions.

Question No.1 will be compulsory and based on entire syllabus.

Remaining question (Q.2 to Q.6) will be selected from all the modules.

**Term Work:**

Term work consists of minimum eight experiments / assignments and one presentation based on any topic on the recent trends in the subject. Students are supposed carryout thorough literature survey, collect data and prepare their presentation.

The distribution of the term work shall be as follows:

Laboratory work (Experiments / assignment and Journal):10 marks

Presentation : 5 marks

Attendance (Practical and Theory) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
<b>BEBM804</b>	<b>Elective: Rehabilitation Engineering (abbreviated as RE)</b>	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
<b>BEBM804</b>	<b>Rehabilitation Engineering</b>	20	20	20	80	25	-	25	150

Course Objectives	This course will introduce students to basics of Kinetics and Kinematics, Flow properties of blood and give overview of Rehabilitation Engineering.
Course Outcomes	The course will build foundation for students enabling the students to pursue higher studies with specialization in Rehabilitation Engineering.

Module	Contents	Time
1.	<b>Introduction and socio-legal aspects of Rehabilitation Engineering:</b> Medical Rehabilitation, Epidemiology of Rehabilitation, preventive Rehabilitation, Impairment Disability and Handicap. Delivery of Rehabilitation Care: The team-Medical, Paramedical , Socio-vocational	06
2.	<b>Orthotics, Amputation, and Prosthetics, Activities of Daily Living (ADL):</b> Orthotics: General Principles of Orthotics, Biomechanics of orthotics, Classification: Upper & Lower Extremity orthotics, spinal Orthotics Amputation & Prosthetics: Causes of Amputation, Types of Amputation, and Levels of Amputation for upper and lower Extremity. Preoperative and post-operative period. Pre-prosthetic stage. Endo & Exo-skeletal Prosthetics. Classification: Upper & lower limb Prosthetics Activities of Daily Living: ADL grouping, Barthel's Index of ADL. Functional Independence, Measures, Environmental control system, communication, ADL training.	13
3.	<b>Mechanical principles of Kinematics and Kinetics:</b> Planar classification of position and motion, Rotary and translatory motion, Degree of freedom, Kinematic Chain Theories of motion, Levers, Torque, Parallel force, Resolution of force, Calculation of muscle and joint forces Clinical application on weight and center of gravity ,applied weights and resistance,	08

	muscle force and leverage, joint forces, Clinical application on stretching versus joint mobilization	
4.	<b>Flow properties of blood:</b> An outline of Blood Rheology, Constitutive equation of blood based viscometric Data and Casson's equation, laminar flow of blood in a tube, fluid mechanical interaction of RBCs with a solid wall, thrombus formation and dissolution, medical application of Blood Rheology	08
5.	<b>Common deformities and role of surgery in rehabilitation engineering.</b> Types of deformities, Management of 1 <sup>st</sup> and 2 <sup>nd</sup> degree deformities. Common deformities of lower limb. Treatment for partial foot deformities. Deformities of the foot. Arm deformities. Torticollis	05
6.	<b>An overview of rehabilitation of muscular dystrophy, paraplegia, and quadriplegia:</b> Muscular Dystrophy, Duchenne Muscular Dystrophy, Rehabilitation, facioscapulohumeral Muscular Dystrophy Paraplegia: Etiology, mechanism of injury, Identification of level of lesion, Management of active spinal cord injury, Rehabilitation, Gait training Quadriplegia: Mobility, Training, Level of injury & outcome, Management	08

**Text books:**

1. BRUNNSTROM'S CLINICAL KINESIOLOG, By Laura K Smith, Elizabeth Laurance Weiss; Jaypee brothers Publication
2. Mechanical properties of living tissues by Y. C. Fung
3. Textbook of Rehabilitation by S. Sundar, 3rd edition Jaypee publication

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Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
<b>BEBM805</b>	<b>Project Stage - II</b>	-	12	-	-	6	-	6

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
<b>BEBM706</b>	<b>Project Stage - II</b>	-	-	-	-	50	-	100	150

### Project Guidelines

Project Groups: Students can form groups with minimum 2 (Two) and not more than 4 (Four)

Faculty Load: In semester VIII - 1 (One) periods of 1 hour each per week per project group

Each faculty is permitted to take (guide) maximum 4 (Four) project groups.