UNIVERSITY OF MUMBAI

Bachelor of Engineering

Biomedical Engineering (Fourth Year Sem VII & VIII)

Revised Course (Rev- 2012)

With effect from Academic Year 2015 -16

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)
Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO’s) and give freedom to affiliated Institutes to add few (PEO’s) and Course objectives and Course outcomes to be clearly defined for each Course, so that all faculty members in affiliated institutes understand the depth and approach of Course to be taught, which will enhance Learners’s learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to Learners-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade Learners’s performance. Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai
Preamble

The overall technical education in our country is changing rapidly in manifolds. Now it is very much challenging to maintain the quality of education with its rate of expansion. To meet present requirement a systematic approach is necessary to build the strong technical base with the quality. Accreditation will provide the quality assurance in higher education and also to achieve recognition of the institution or program meeting certain specified standards. The main focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a Learner will have at the time of graduation from the program that is being accredited. Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as Chairman, Board of Studies in Electrical Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for undergraduate program in Electrical Engineering, more than twenty senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for undergraduate program in Electrical Engineering are listed below;

- To provide the overall strong technical foundation to formulate, solve and analyse engineering problems during undergraduate program.
- To prepare Learners to demonstrate an ability to identify, formulate and solve electrical based issues.
- To prepare Learners to demonstrate an ability in the area of design, control, analyse and interpret the electrical and electronics systems.
- To prepare Learners for successful career in industry, research and development.
- To develop the ability among Learners for supervisory control and data acquisition for power system application.
- To provide opportunity for Learners to handle the multidisciplinary projects.
- To create the awareness of the life-long learning and to introduce them to professional ethics and codes of professional practice.

The affiliated institutes may include their own PEOs in addition to the above list.

To support the philosophy of outcome based education, in addition to stated PEOs, objectives and expected outcomes are also included in the curriculum. I know, this is a small step taken to enhance and provide the quality education to the stake holders.

Dr. M. V. Bhatkar
Chairman,
Board of Studies in Electrical Engineering,
University of Mumbai
# Syllabus Scheme for B.E. Semester VIII Biomedical Engineering

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Pract.</td>
</tr>
<tr>
<td>BMC801</td>
<td>Nuclear Medicine</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>BMC802</td>
<td>Biomedical Microsystems</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>BMC803</td>
<td>Hospital Management</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>BME804</td>
<td>Elective</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>BMP805</td>
<td>Project Stage – II</td>
<td>-</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

** Learner is allotted 12hrs per week for the project work.

Electives:
BME8011. Lasers and Fiber Optics
BME8012. Robotics in Medicine
BME8013. Health care Informatics
BME8014. Rehabilitation Engineering

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
</tr>
<tr>
<td>BMC801</td>
<td>Nuclear Medicine</td>
<td>20</td>
</tr>
<tr>
<td>BMC802</td>
<td>Biomedical Microsystems</td>
<td>20</td>
</tr>
<tr>
<td>BMC803</td>
<td>Hospital Management</td>
<td>20</td>
</tr>
<tr>
<td>BME804</td>
<td>Elective</td>
<td>20</td>
</tr>
<tr>
<td>BMP805</td>
<td>Project Stage – II</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>80</td>
</tr>
</tbody>
</table>
Course Code | Course Name | Teaching Scheme | Credits Assigned
--- | --- | --- | ---
BMC801 | Nuclear Medicine (abbreviated as NM) | 4 - 1 | 4 - 1 | 5

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test 1</td>
</tr>
</tbody>
</table>
| BMC801 | Nuclear Medicine | 20 | 20 | 20 | 80 | 25 | - | 25 | 150

Course Objectives
1. To enable the learners to understand the basic science of nuclear medicine, operating principles and quality control aspects of various nuclear medicine equipment.
2. To keep the Learners abreast with the technological developments in the field of nuclear medicine.

Course Outcomes
A Learners will able to
1. Understand essential physics, concepts of radiopharmaceuticals and how they are employed in nuclear medicine diagnosis and therapy.
2. Be familiar with the current In-vivo and In-vitro techniques of nuclear medicine along with their clinical applications.
3. Apprehend the importance of radiation safety and radioactive waste management.

Module | Contents | Time
--- | --- | ---
Ethics in Nuclear medicine.

3. **Detectors in Nuclear Medicine & Counting and Measuring System:**
   **In Vitro techniques (Brief Description):**
   Introduction, Single and Double Isotope method, Radioimmunoassay, RIA Counting System, Liquid scintillation Counting system, RIA Applications.

4. **In Vivo Techniques:**
   General Principle, Uptake Monitoring System, Rectilinear Scanner, Gamma Camera Fundamentals, Position Circuitry and working, Computer Interface, Performance Parameters, Quality Control Functions

5. **Emission Tomography Techniques and Clinical Applications:**
   Introduction, Principles and applications of SPECT, Principles and applications of PET, System performance parameters and Quality Control Functions.
   **Introduction to Hybrid Modalities:**
   PET/CT, SPECT/CT
   **Clinical Applications**
   Clinical Applications of PET, SPECT and Hybrid Modalities in Cardiology, Neurology and Oncology.

6. **Radionuclide Therapy**
   Choice of a Radionuclide in Therapeutic Nuclear Medicine
   Treatment of Benign & Malignant Diseases
   Palliative & Curative Procedures:

**Text books:**
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

**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 Course. Learners 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: 10 marks
Attendance (Practical and Theory): 05 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 learner.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Pract.</td>
</tr>
<tr>
<td>BMC802</td>
<td>Biomedical Microsystems</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test 1</td>
</tr>
</tbody>
</table>

Course Objectives
1. To understand various fabrication technology for MEMS devices.
2. To apply the knowledge of MEMS in Biomedical field.
3. To understand recent advancements in Biomedical Engineering for a successful career in the area of nanotechnology.

Course Outcomes
A learner will be able to
1. Use the knowledge of MEMS to develop various miniaturized Biomedical devices.

Module | Contents                                                                                          | Time |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>BASICS OF MINIATURIZATION &amp; MATERIALS</strong></td>
<td>08</td>
</tr>
<tr>
<td></td>
<td>Dimensional effect on engineering systems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clean room classification</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scaling Laws in Miniaturization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MEMS &amp; Micro system products</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Substrates and Wafers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Properties of Silicon Compounds SiO2, Si3N4, Polysilicon, Amorphous silicon</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polymers: Dielectric polymers, Conducting polymers, and piezoelectric polymers</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td><strong>MEMS FABRICATION PROCESSES</strong></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Fabrication techniques in MEMS: Bulk micromachining, Surface micromachining, and LIGA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cleaning processes: RCA, Piranha</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deposition processes for metals: e-beam evaporation, thermal evaporation and DC Sputter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deposition processes for dielectrics: Physical (RF Sputter) and Chemical Techniques (CVD: APCVD, LPCVD, PECVD, and HWCVD).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Polymers coating techniques: spinning, spraying and electrodeposition</td>
<td></td>
</tr>
</tbody>
</table>
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 like optical grating structure, SiO2 cantilever, SiNx cantilever and basics of EBL

Etching Processes: Dry (RIE, DRIE) and wet etching

Doping: ion implantation and diffusion

Soft lithography: Micro contact Printing, Imprinting or hot embossing, and Replica Molding

Surface characterization techniques: AFM, SEM, Profilometer, Elipsometer, Fluorimeter

3. **MICRO TOTAL ANALYSIS SYSTEMS (µTAS)**
   - Basic block diagram: importance of µ-TAS
   - Flow techniques in µ-fluidics: pressure driven force, electro-kinematics; electro-osmosis, electrophoresis, dielectrophoresis
   - Components in µ-TAS: Micropump, microvalves, microchannels
   - µ-TAS: separation and mixing techniques
   - fabrication of micro-channels: SU8 channel, glass channel, silicon channel

4. **MICRO/ NANO BIOSENSORS**
   - Biosensor: definition, block diagram and working
   - Classification based on the basis of detection techniques: Electric Magnetic, Optical, Thermal, Mechanical, and Chemical.
   - Basic steps involved in the development of biosensors: surface modification, immobilization, integration with transducer
   - Examples: (i) Design, fabrication of SiO cantilever for antibody detection, (ii) Design, fabrication of Optical waveguide biosensor, (iii) Microfluidics based biosensor

5. **DRUG DELIVERY DEVICES**
   - 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

6. **MICROSYSTEM PACKAGING**
   - Importance of packaging
   - Packaging materials
   - Packaging techniques
   - Wafer bonding

**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 SiO2 cantilever
5. Importance of soft-lithography with example (compare with traditional method)
6. Different flow techniques in µ-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:


Reference Books:


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 Learners 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) : 20 marks
Attendance (Practical and Theory) : 05 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 learner.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Pract.</td>
</tr>
<tr>
<td>BMC803</td>
<td>Hospital Management (abbreviated as HM)</td>
<td>4</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test 1</td>
</tr>
<tr>
<td>BMC803</td>
<td>Hospital Management</td>
<td>20</td>
</tr>
</tbody>
</table>

**Course Objectives**

1. To promote the development of high quality of hospital care in the community.
2. To provide a satisfactory environment to the patient and also to the doctors for clinical research.
3. To understand the design considerations in a hospital for designing of various departments in the hospital.
4. To develop skills enabling Biomedical Engineers to serve Hospitals, National and International Industries and Government Agencies.
5. To understand the role of Biomedical Engineer in hospitals.

**Course Outcomes**

A learner will be able to

1. Understand and apply resource management concepts (personnel, finance, and material resources) and the processes and strategies needed in specific hospital sectors.
2. Communicate effectively and develop their leadership and teambuilding abilities.
3. Apply modern change management and innovation management concepts to optimize structures.
4. Analyze existing hospital service policies and enhance their alignment within the local and national context.

**Module Contents**

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Process of management:</strong> 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</td>
<td>10</td>
</tr>
<tr>
<td>2.</td>
<td><strong>Organization of the hospital &amp; Hospital Planning:</strong> 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</td>
<td>06</td>
</tr>
<tr>
<td>3.</td>
<td><strong>Planning for Clinical and Supportive Services:</strong></td>
<td>14</td>
</tr>
</tbody>
</table>
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)

4. **Planning for Engineering and Auxiliary Services**

A) Engineering Services : Maintenance, Biomedical Dept.: Need and responsibilities, 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. **Material Management & Inventory Control**

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

6. **Legal Aspects in a hospital:**

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

**Text books:**
6. Hospital Management by Dr. Pradyuna Pai
7. Hospital Planning, Designing and Management: Kundres G D, Gopinath, A katakam (Private Pub Bangalore)

**Reference Books:**
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 Learners 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. Learners 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 :10 marks
Attendance (Practical and Theory) :05 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 learner.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Course Name</td>
<td>Theory</td>
<td>Pract.</td>
</tr>
<tr>
<td>BME8011</td>
<td>Elective: Lasers and Fiber Optics (abbreviated as LFO)</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Theory Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Term work</td>
</tr>
<tr>
<td>BME8011</td>
<td>Lasers and Fiber Optics</td>
<td>20</td>
</tr>
</tbody>
</table>

Course Objectives
1. To understand the fundamentals in Laser and Fiber Optics.
2. To understand the applications of Laser and Fiber optics in health sector.

Course Outcomes
A Learners will be able to
1. Understand the fundamentals and clinical applications of Laser and Fiber Optics.
2. Correlate the knowledge of medicine and engineering for the wellness of human being.
3. Understand the safety aspects while dealing with Laser and Fiber Optic Units.

Module | Contents | Time |
|-------|----------|------|
| 1.    | Laser Fundamentals
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.    | Laser Types, construction and working
| 3.    | Laser safety:
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 |
<p>| 4.    | Optic Fibers Fundamentals | 10 |</p>
<table>
<thead>
<tr>
<th>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, In vivo Applications.</th>
</tr>
</thead>
</table>
| **5. Laser and Fiber Optics in surgery**
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 |
| **6. Endoscopy**
Basic Principle, System components and functions, Types of endoscopes, Video Endoscopes, Accessories, Maintenance, Endoscopy Processing room requirements, Medical Application, Leakage tester and Trouble shooting |

**Text books:**
2. Optical Fiber Communication by Gerd Keiser

**Reference Books:**
1. Therapeutic Lasers – G David Baxter – Churchill Living stone publications
3. Element of Fiber optics – S. L. Wymer Regents PHI

**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 Learners 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 Course. Learners are supposed carry out 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: 10 marks
Attendance (Practical and Theory): 05 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 learner.
### Course Objectives

1. To introduce to basics of Robotics, Kinematics, Inverse Kinematics, vision and motion planning.
2. To introduce to various applications of Robots in Medicine.

### Course Outcomes

A Learner will be able to
1. Design basic Robotics system and formulate Kinematic, Inverse Kinematic motion planning solutions for various Robotic configurations.
2. Design Robotic systems for Medical application.

### Module Contents

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Introduction Automation and Robots, Classification, Application, Specification, Notations</td>
<td>06</td>
</tr>
<tr>
<td>2.</td>
<td>Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation, (Five-axis robot, Four-axis robot, Six-axis robot)</td>
<td>08</td>
</tr>
<tr>
<td>3.</td>
<td>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.</td>
<td>10</td>
</tr>
<tr>
<td>4.</td>
<td>Robot Vision Image representation, Template matching, Polyhedral objects, Shane analysis, Segmentation (Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration).</td>
<td>10</td>
</tr>
<tr>
<td>5.</td>
<td>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.</td>
<td>08</td>
</tr>
<tr>
<td>6.</td>
<td>Applications in Biomedical Engineering Application in rehabilitation, Clinical and Surgery</td>
<td>06</td>
</tr>
</tbody>
</table>
Text books:
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.
3. Robotics and Mechatronics. Walfram Stdder,
4. Introduction to Robotics,Niku, Pearson Education.
5. Robot Engineering, Klafter, Chmielewski, Negin, Prentice Hall Of India.

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 Learners 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 Course . Learners 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 :10 marks
Attendance (Practical and Theory) :05 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 learner.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Pract.</td>
</tr>
<tr>
<td>BME8013</td>
<td>Elective: Health Care Informatics (abbreviated as HCI)</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test 1</td>
</tr>
<tr>
<td>BME8013</td>
<td>Health Care Informatics</td>
<td>20</td>
</tr>
</tbody>
</table>

**Course Objectives**
1. To understand the healthcare interoperability semantic and syntactic.
2. To understand the standards of healthcare interoperability standards for Medical Images and Medical Messages.

**Course Outcomes**
A learner will be able to
1. Fabricate information messages associated with healthcare event.
2. Fabricate and understand the information exchange messages for transfer of medical image data.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Healthcare Interoperability</strong></td>
<td>04</td>
</tr>
<tr>
<td>2.</td>
<td><strong>XML</strong></td>
<td>06</td>
</tr>
<tr>
<td></td>
<td>The Need for XML, Concepts and Definition, XML Syntax, Content Of an XML Document, Structure of an XML document, Validation, Access to the content of the Document</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td><strong>Health Level 7</strong></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>HL7 version 2.X, Message communication Concept, Segments, Fields, Components, Subcomponents, Message delimiters, Data types, Rules for message formation, Trigger Event, ADT Segments</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td><strong>DICOM standard</strong></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>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</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td><strong>DICOM Communications</strong></td>
<td>08</td>
</tr>
<tr>
<td></td>
<td>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</td>
<td></td>
</tr>
</tbody>
</table>
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 Learners 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 Course. Learners 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 :10 marks
Attendance (Practical and Theory) :05 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 learner.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory</td>
<td>Pract.</td>
</tr>
<tr>
<td>BME8014</td>
<td>Elective:</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Rehabilitation Engineering (abbreviated as RE)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Theory Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test 1</td>
</tr>
<tr>
<td>BME8014</td>
<td>Rehabilitation Engineering</td>
<td>20</td>
</tr>
</tbody>
</table>

Course Objectives
1. To introduce learners to basics of Kinetics and Kinematics, Flow properties of blood and give overview of Rehabilitation Engineering.

Course Outcomes
A learner will be able to
1. Build foundation for learners enabling the learners to pursue higher studies with specialization in Rehabilitation Engineering.

<table>
<thead>
<tr>
<th>Module</th>
<th>Contents</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><strong>Introduction and socio-legal aspects of Rehabilitation Engineering:</strong> Medical Rehabilitation, Epidemiology of Rehabilitation, preventive Rehabilitation, Impairment Disability and Handicap. Delivery of Rehabilitation Care: The team-Medical, Paramedical, Socio-vocational</td>
<td>06</td>
</tr>
<tr>
<td>3.</td>
<td><strong>Mechanical principles of Kinematics and Kinetics:</strong> 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,</td>
<td>08</td>
</tr>
</tbody>
</table>
muscle force and leverage, joint forces, Clinical application on stretching versus joint mobilization

4. **Flow properties of blood**: 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


6. **An overview of rehabilitation of muscular dystrophy, paraplegia, and quadriplegia**: 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

**Text books:**
3. **BRUNNSTROM’S CLINICAL KINESIOLOG**, By Laura K Smith, Elizabeth Laurance Weiss; Jaypee brothers Publication
4. Mechanical properties of living tissues by Y. C. Fung
3. Textbook of Rehabilitation by S. Sundar, 3rd edition Jaypee publication

**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:**
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The Learners need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. 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 Course. Learners 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: 10 marks
Attendance (Practical and Theory): 05 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 learner.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme</th>
<th>Credits Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMP805</td>
<td>Project Stage - II</td>
<td></td>
<td>Theory Pract. Tut</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>** 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Examination scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMP805</td>
<td>Project Stage – II</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Theory Marks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal Assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test 1 Test 2 Avg.</td>
</tr>
</tbody>
</table>

** Learner is allotted 12hrs per week for the project work.

**Guidelines for Project**
- Learners should do literature survey/visit industry/analyze current trends and identify the problem for Project and finalize in consultation with Guide/Supervisor. Learners should use multiple literatures and understand the problem. Learners should attempt solution to the problem by experimental/simulation methods. The solution to be validated with proper justification and compile the report in standard format.

**Guidelines for Assessment of Project II**
- Project II should be assessed based on following points
  - Quality of problem selected
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Project II should be assessed through a presentation jointly by Internal and External Examiners approved by the University of Mumbai.
- Learners should be motivated to publish a paper based on the work in Conferences/students competitions.

**Project Guidelines**

Project Groups: Learners 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.