University of Mumbai
Syllabus Structure (R-2007)

B.E. Biomedical Engineering

Semester-VII

Sr. No.	Subject	Scheme of Instructions Periods per Week (Each 60 min.)		Scheme of Evaluation					
		Theory	Practical/ Tutorial	Paper		TW	Practical /Oral	Oral	Total Marks
				Hours	Marks				
1.	Medical Imaging-II	04	02	3	100	25	---	50	175
2.	Biomedical Instrumentation-III	04	02	3	100	25	---	25	150
3.	Principles of Image Processing	04	02	3	100	25	50	---	175
4.	Networking and Information System in Medicine	04	02	3	100	25	---	25	150
5.	Installation, Maintenance and Servicing	04	---	---	---	50	---	50	100
6.	Project Stage-I	--	04	---	---	25	---	25	50
	Total	20	12	---	400	175	50	175	800

B.E. (BIOMEDICAL ENGINEERING)
<u>SEMESTER - VII</u>

University of Mumbai		
Class: B.E.	**Branch:** Biomedical Engineering	**Semester: VII**
Subject: <u>MEDICAL IMAGING- II</u>		

Periods per Week (Each 60 min.)	Lecture	04	
	Practical	02	
	Tutorial	---	

		Hours	Marks
Evaluation System	Theory	03	100
	Practical & Oral	--	--
	Oral	02	50
	Term Work	---	25
	Total	05	175

Module	Content	Time (hrs)
1.	**Computed Tomography**.	
	Principle of Computed tomography	**02**
	Scanner configurations/generations, CT system: Scanning unit (gantry), detectors, data acquisition system, spiral CT, scanner parameters, CT Number	**08**
	Reconstruction techniques, Radon Transform, Filtered Back projection, Fourier Reconstruction Technique, Iterative reconstruction Technique, Image quality and artifacts, Clinical applications of CT	**08**
	Multi-detector computed tomography (MDCT), Flat panel detectors	**03**
	CT-Angiography	**01**
2.	**Magnetic Resonance Imaging** Physics of MRI, Relaxation Parameters and Spin Echoes, Magnetic Field Gradients, Slice selection and Frequency Encoding, Pulse sequences	**08**
	Hardware: Magnets, Gradient systems, RF coils,	**02**
	Fourier Reconstruction techniques, Image contrast, Resolution and Factors affecting signal-to-noise	**04**

	Safety Considerations/Biological Effects of MRI	02
3.	**Magnetic Resonance Spectroscopy (MRS)** Basic Principle of MRS and localization techniques, Chemical Shift Imaging, Single-voxel and Multivoxel MRS, Water Suppression techniques	06
4.	**Basics of Electrical Impedance Tomography**	02
5.	**Hybrid Imaging modalities and its clinical application**	02

Theory Examination:
1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Oral Examination:

Oral will be based on entire subject for 25 marks and also on the basis of the Hospital/Industry visits for 25 marks separately.

Term work:

Term work will consist of at least Eight Assignments/ Laboratory Experiments based on the above syllabus and a written test. Test and Seminars be suitably graded by teachers and attached in the journal. The distribution of the term work shall be as follows,

Lab work (Assignments/ Laboratory Experiments & Seminar)   :15marks
Test (at least one)   :10 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.   .

Text Books:
1. Christensen's Physics of Diagnostic Radiology, Lipimcott William, (willkins Publication)
2. Medical Imaging Physics William R. Hendee (Wiley-Liss Publication)

References:
 1. Biomedical Technology and Devices Handbook by James Moore
    George Zouridakis (CRC Press)
2. Biomedical Engineering Handbook by Bronzino (CRC Press)
3. Physics of Diagnostic Imaging –Dowsett

B.E. (BIOMEDICAL ENGINEERING)
SEMESTER - VII

University of Mumbai		
Class: B.E.	**Branch:** Biomedical Engineering	**Semester: VII**
Subject: BIOMEDICAL INSTRUMENTATION -III		
Periods per Week (Each 60 min.)	Lecture	04
	Practical	02
	Tutorial	---

		Hours	Marks
Evaluation System	Theory	03	100
	Practical & Oral	--	--
	Oral	02	25
	Term Work	---	25
	Total	05	150

Module	Content	Time (hrs)
1.	**Physiotherapy, Electrotherapy and Radiation Therapy Equipments:** Basic principle, working and technical specifications of Shortwave Diathermy, Ultrasonic therapy unit, Infrared and UV lamps, Nerve and Muscle Stimulator, Radiation and Physical therapy Units.	10
2.	**Surgical Instruments:** Surgical Diathermy machine, electrodes used with surgical diathermy, safety aspects in electronic surgical units, surgical diathermy analyzers.	07
3.	**Cardiac Pacemakers:** Modes of operation, leads and electrodes. Power supply sources. External and Implantable Pacemaker, Performance aspects of Implantable Pacemaker.	07
4.	**Cardiac Defibrillators:** DC defibrillator, Modes of operation and electrodes, Performance aspects of dc-defibrillator, defibrillator analyzers. Implantable defibrillator and defibrillator analyzer.	06
5.	**Hemodialysis Machine:** Basic principle of Dialysis. Different types of dialyzer membrane, Portable type.	04
6.	**Laser Applications in Biomedical Engineering** Laser Classifications, Types of Lasers, Medical Applications,	08

	Laser Delivery Systems.	
7.	**Heart rate variability measurement and applications.**	02

Theory Examination:
1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Oral Examination:

Oral examination will be based on the entire subject.

Term work:

Term work will consist of at least Six Laboratory Experiments based on the above syllabus and a written test. Test and Assignments/Seminars be suitably graded by teachers and attached in the journal. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal)   :15 marks
Test (at least one)   :10 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work. .

Text Books:

1. Handbook of Biomedical Instrumentation: R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)

Reference:

1. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I,II,III,IV (PH Pub)
2. Various Instruments Manuals.

B.E. (BIOMEDICAL ENGINEERING)
SEMESTER - VII

University of Mumbai		
Class: B.E.	**Branch:** Biomedical Engineering	**Semester:** VII
Subject: Principles of Image Processing		
Periods per Week (Each 60 min.)	Lecture	04
	Practical	02
	Tutorial	---
		Hours	Marks
Evaluation System	Theory	03	100
	Practical and Oral	02	50
	Oral	---	---
	Term Work	---	25
	Total	05	175

Module	Content	Time (hrs)
1	**Basics of Image processing**: Image acquisition, Processing, communication, display, Electromagnetic Spectrum, Visual perception, structure of the human eye, image formation in the eye, uniform and Non-Uniform Sampling, Quantization, Image formats	05
2	**Image Enhancement**: Spatial Domain-Point processing techniques, histogram processing, Neighbourhood processing, Frequency Domain techniques- 2D-DFT, Properties of 2 D-DFT, Low pass, High pass, Noise removal, Homomorphic filters, Basics of Colour image processing	14
3	**Image Segmentation**: Detection of discontinuities, point line, edge detection, Edge linking, Hough transform, Region Based segmentation	08
4	**Image transforms**: DFT, FFT, DCT, DST, Hadamard, Walsh, Haar, Slant, K-L Transforms, Basis Functions and basis images	07

5	**Image Compression**: Fundamentals of Image compression models, Lossless Compression- RLE, Huffman, LZW, Arithmetic coding techniques Lossy Compression- IGS coding, Transform coding, JPEG, Predictive Coding.	**07**
6	**Representation and Description**: Morphology-dilation, Erosion, open, close, Hit and miss, Boundary extraction, region filling, skeletonization, Feature extraction, Moments	**07**

List of Experiments (Software Matlab / C/ Labview/ Similar software)

1. Point Processing techniques (At least 4 experiments)
2. Histogram Processing (Histogram Stretching and Equalisation)
3. Frequency Domain processing (Plotting 2D-DFT, Low pass and High Pass- Ideal, Butterworth and Gaussian Filters)
4. Segmentation-Gradient operators
5. Transforms- DCT

Theory Examination:
1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Practical & Oral Examination:
Practical examination will be based on one experiment performed from the list of experiments given in the syllabus & Oral examination will be based on the entire syllabus.

Term work:

The distribution of the term work shall be as follows,

Lab work (Assignments/ Laboratory Experiments & Seminar)   :15 marks
Test (at least one)   :10 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.   .

Text Books:
1. Digital Image Processing, Gonzalez and Woods- Pearson Education
2. Fundamentals of Digital Image Processing, A.K. Jain –P.H.I.
3. Digital Image Processing and Analysis, Chanda Majumder- Printice Hall India.

Reference:
1. Digital Image Processing and Computer Vision, Sonka, Hlavac,Boyle- Cenage learning.
2. Digital Image Processing, William Pratt- John Wiley

B.E. (BIOMEDICAL ENGINEERING)
SEMESTER - VII

University of Mumbai		
Class: B.E.	**Branch:** Biomedical Engineering	**Semester:** VII
Subject: NETWORKING AND INFORMATION SYSTEM IN MEDICINE		
Periods per Week (Each 60 min.)	Lecture	04
	Practical	02
	Tutorial	---

		Hours	Marks
Evaluation System	Theory	03	100
	Practical & Oral	---	---
	Oral	02	25
	Term Work	---	25
	Total	05	150

Module	Contents	Time
1	Networking technology	6
	WAN/LAN, T1, ISDN, DSL, Internet (http, url, domains), ISO model, Ethernet, TCP/IP, Packet switching, circuit switching, Throughput, bandwidth, level of service parameters	
2	Basic Security Concepts	3
	System security in general, Authentication, Authorization, Confidentiality, Integrity	
3	Radiology Imaging basics	4
	Principles of different modalities (CR, DR, XR, XA, RF, US, MR, NM, CT), Image characteristics for each modality	
4	Workflow Steps in Radiology and Planning, Designing and Implementing film less Hospital	4
5	Introduction to RIS and PACS and HIS/RIS/PACS integration	4
6	Reengineering workflow: Focus on personnel and process Interoperability and Workflow integration issues	3
7	Reengineering workflow: Radiologist's Perspective	3
8	Image acquisition and compression	3
9	PACS Architecture Networking and Security	10
10	Server and operating system	2
11	Storage and Enterprise Archiving	2
12	Image Displays	2

13	Tele-radiology	2
15	Legal Issues and formal policies	2

Theory Examination:
1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Q.1 will be compulsory and based on the entire syllabus.
4. Remaining questions will be mixed in nature.
5. In question paper wightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

Oral Examination:
Oral exam will be based on entire subject.

Term work:
Term work consists of minimum two assignments and a written test. The distribution of the term work shall be as follows,

Laboratory work (Assignments and Journal)   :15 marks
Test (at least one)   :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Text Book:
1. PACS Guide to Digital Revolution by Keith J. Dreyer (Springer)
2. Governance of Picture Archiving and Communications Systems by Carrison K.S. Tong (Medical Information Science Reference)
3. PACS and Imaging Informatics by H.K. Huang, John Wiley
4. Data Communication and Networking by Behrouz A. Forouzan McGrow Hill

Reference Book:
1. Computer Networks by A.S. Tanenbaum, Pearson Education
2. Practical_Imaging_Informatics.pdf
3. PACS fundamentals- By Herman Oosterwijk
4. DICOM Standard (http://www.dclunie.com/dicom-status/status.html)

B.E. (BIOMEDICAL ENGINEERING)
SEMESTER - VII

University of Mumbai		
Class: B.E.	**Branch:** Biomedical Engineering	**Semester:** VII
Subject: Installation, Maintenance and Servicing		

Periods per Week (Each 60 min.)	Lecture/Demo	04	
	Practical	--	
	Tutorial	---	
		Hours	Marks
Evaluation System	Theory	---	--
	Practical & Oral	---	---
	Oral	02	50
	Term Work	---	50
	Total	02	100

Module	Contents	Time
1	• **Importance of Biomedical engineering Department in the hospital** • **Role of Biomedical Engineer in the hospital**	**4**
2	• **Various jobs carried out by Biomedical engineer in the industry such as – Sales and Marketing, Servicing and Maintenance, Research and development, Application specialist**	**3**
3	**Installation Techniques and / or methods:** • **Pre-installation techniques** • **Precautions to be taken** • **Assembly of instrument / system** • **Testing of instrument before final handover.**	**4**
4	**Installation of medical equipments in various departments such as** • **Cardiac Equipments** • **O. T. and O.T. equipments** • **Radiology equipments** • **Pathology equipments** • **Life saving equipments** • **I.C.U., I.C.C.U., N.I.C.U. etc.** • **Medical Gas**	**16**
5	**Maintenance and Servicing**	**8**

	• **Preventive Maintenance and Calibration checks** • **Types of Maintenance contracts – CMC and AMC** • **Overall maintenance, Servicing and safety precautions of Medical and Non-medical equipments** • **Insurance of Medical Equipments**	
6	**Introduction to System operating protocol (SOP) for** • **ISO certification** • **NABH certification**	**2**

Oral Examination:

Oral exam will be based on entire subject and the expert should be called from Hospitals/Industries.

Term work:

Term work consists of assignments based on the syllabus and demonstration etc.
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Text books & Reference books

• **Manuals of various equipments**