UNIVERSITY OF MUMBAI

Bachelor of Biomedical Engineering

Final Year Engineering

Sem. VII

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 VII Biomedical Engineering

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BEBM701	Biomedical Instrumentation-III	4	2	-	4	1	-	5
BEBM702	Medical Imaging – II	4	2	-	4	1	-	5
BEBM703	Biomechanics Prosthesis and Orthosis	4	2	-	4	1	-	5
BEBM704	Very Large Scale Integrated Circuits	4	2	-	4	1	-	5
BEBM705	Networking and Information System in Medicine	4	2	-	4	1	-	5
BEBM706	Project Stage – I	-	6	-	-	3	-	3
	TOTAL	**20**	**16**	**-**	**20**	**8**	**-**	**28**

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BEBM701	Biomedical Instrumentation-III	20	20	20	80	25	-	25	150
BEBM702	Medical Imaging – II	20	20	20	80	25	-	25	150
BEBM703	Biomechanics Prosthesis and Orthosis	20	20	20	80	25	-	25	150
BEBM704	Very Large Scale Integrated Circuits	20	20	20	80	25	-	25	150
BEBM705	Networking and Information System in Medicine	20	20	20	80	25	-	25	150
BEBM706	Project Stage – I	-	-	-	-	25	-	25	50
TOTAL				**100**	**400**	**150**	**-**	**150**	**800**

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.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BEBM701	Biomedical Instrumentation-III (abbreviated as BMI-III)	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.					
BEBM701	Biomedical Instrumentation-III	20	20	20	80	25	-	25	150

Course Objectives	The life of an individual being the most precious thing in the world, this section of curriculum aims to understand the various new biomedical devices which are deployed for life saving, support and betterment in lifestyle. The most gracious category of equipment which have importance all time above the life accessory equipments! The innovation in technology has resulted in new devices which can save the life of extremely critically ill patient. This curriculum enables the students to deal with various aspect of life saving and support. Students will be able to understand the design considerations, application techniques for these equipments, keeping in mind their everlasting importance.
Course Outcomes	Students will demonstrate the principles of electronics used in designing various diagnostic equipments. Students will be able to understand the working principle and applications of various diagnostic equipments. Students understands the need of emergency and presence of mind lifesaving protocols. Students who can participate and succeed in competitive exams.

Module	Contents	Time
1.	**Physiotherapy, Electrotherapy Equipments**: Basic principle, working and technical specifications of Shortwave Diathermy, Ultrasonic therapy unit, Infrared and UV lamps, Nerve and Muscle Stimulator.	14
2.	**Surgical Instruments:** Surgical Diathermy machine, electrodes used with surgical diathermy, safety aspects in electronic surgical units, surgical diathermy analyzers.	10
3.	**Cardiac Pacemakers:** Modes of operation, leads and electrodes. Power supply sources. External and Implantable Pacemaker, Performance aspects of Implantable Pacemaker.	8
4.	**Cardiac Defibrillators:** DC defibrillator, Modes of operation and electrodes, Performance aspects of dc-defibrillator, defibrillator analyzers. Implantable defibrillator and defibrillator analyzer.	8

5.	**Hemodialysis Machine:** Basic principle of Dialysis and its type. Different types of dialyzer membrane, Portable type. Various monitoring circuits.	4
6.	**Laser Applications in Biomedical Engineering** Laser classifications, Types of Lasers, Medical Applications, Laser delivery Systems and safety.	4

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 Books:

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

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
BEBM702	Medical Imaging-II (abbreviated as MI-II)	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.					
BEBM702	Medical Imaging-II	20	20	20	80	25	-	25	150

Course Objectives	To familiarize the students with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities. To keep the students abreast with the technological developments in the field of Medical Imaging
Course Outcomes	The students will able to understand essential physics, concepts of Medical Imaging and how they are employed in diagnosis and therapy. The students will also get familiar with the current techniques of medical Imaging along with their clinical applications. The students will also be able to apprehend the importance of radiation constructive utilization and safety.

Module	Contents	Time
1.	**Principle of Computed tomography** Scanner configurations/generations, CT system: Scanning unit(gantry), detectors, data acquisition system, spiral CT, scanner parameters, CT Number Reconstruction techniques, Radon Transform, Filtered Back projection, Fourier Reconstruction Technique, Iterative reconstruction Technique, Image quality and artifacts, Clinical applications of CT	10
2.	**Advancements in CT** Multi-detector computed tomography (MDCT), Flat panel detectors CT-Angiography contrast agents in CT	06
3.	**Nuclear Magnetic Resonance:** Physics of MRI, Relaxation Parameters and Spin Echoes, Magnetic Field Gradients, Slice selection and Frequency Encoding	06
4.	**Magnetic Resonance Imaging** Hardware: Magnets, Gradient systems, RF coils, Fourier Reconstruction techniques, Image contrast, Resolution and Factors affecting signal-to-noise. Safety Considerations/Biological Effects of MRI	10
5.	Pulse sequences in MRI,Contrst agents MR Angiography,Perfusion MRI, Clinical applications	08

6.	**Magnetic Resonance Spectroscopy (MRS)** Basic Principle of MRS and localization techniques, Chemical Shift Imaging, Single-voxel and Multivoxel MRS, Water Suppression techniques	08

Text books:

1. Physics of Diagnostic Radiology :Christensen
2. Medical Imaging Physics William .R.Hendee

Reference Books:

1. Biomedical Technology and Devices by James Moore .
2. Biomedical Engineering Handbook by Bronzino
3. Physics of Diagnostic images –Dowsett

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
BEBM703	Biomechanics Prosthesis and Orthosis (abbreviated as BPO)	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.					
BEBM703	Biomechanics Prosthesis and Orthosis	20	20	20	80	25	-	25	150

Course Objectives	This course will enable students : Recall the general characteristics, mechanical properties of bone and tissues. Analyze the forces at joints for various static and dynamic human activities; analyze the stresses and strains in biological tissues. Understand principles used in designing orthoses and prostheses Study different materials used for orthoses and prosthesis. Understand the fabrication of prostheses and orthoses.
Course Outcomes	This course assigned lectures, experiments, assignments and industrial visit which enables the students to: Understand the definition of biomechanics, prostheses orthoses and its classification and design principles. Students are expected to have developed a better understanding of how mechanical principles influence human motion during everyday life.

Module	Contents	Time
	BIOMECHANICS	
1.	**Force system:** Classification of force system. Equilibrium of force system.	02
2.	**Tissue Biomechanics**: Direct shear, bending and torque actions and the corresponding stresses and strains in biological tissues. Stress relaxation and creep. Bone structure & composition, Mechanical properties of bone, Fracture mechanism & crack propagation in bones. Soft connective (skin, tendon, ligaments, etc.) covering structure function, and physiological factors.	12
3.	**Movement Biomechanics:** Study of joints and movements. Anatomical levers, Gait Analysis.	08
4.	**Joint analysis**: Instrumentation for gait analysis: Measurement devices-footswitches, instrumented walkway, Motion analysis- interrupted light photography, film/video, Selspot, Goniometers.	07

	PROSTHETICS AND ORTHOTICS	
5.	**Principles in designing orthoses and prostheses:** Principles of three point pressure, total contact, partial weight bearing.	06
6.	**Classification in prosthetics and orthotics:** Lower Extremity orthoses and prostheses, Upper Extremity orthoses and prostheses. Spinal orthoses.	13

List of Experiments:

1. To study the concurrent coplanar force system.
2. To study the Stress – Strain relation of Mild steel
3. To study the Classification of the human bones
4. To study different types of joints in human body and joint movements
5. To study the Classification of Muscles
6. To simulate elbow joint using bell crank lever.
7. To study the human gait cycle
8. To study the Gait Cycle Parameters
9. Fabrication of PTB/socket.

The concerned teachers of the subject BPO can arrange the visit in rehabilitation centre.

Text books:

1. Basic Biomechanics- Susan J. Hall, MC Graw Hill.
2. Basics of Biomechanics" by Dr. Ajay Bahl and others
3. Basic Biomechanics of the Musculoskeletal System,M. Nordin, V.Frankel
4. Human Limbs and their substitutes – Atlas, C. V. Mosby
5. American Atlas of Orthopedics: Prosthetics, C. V. Mosby.
6. American Atlas of Orthopedics: Orthotics, C. V. Mosby
7. Biomechanics - Prof Ghista (Private Publication UAE)
8. Biomechanics – By White and Puyator (Private Publication UAE)

Reference Books:

1. Introductory Biomechanics: from cells to tissues by Ethier and Simmons
2. Biomechanics: Mechanical properties of living tissues by Y. C. Fung

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
BEBM704	Very Large Scale Integrated Circuits (abbreviated as VLSI)	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.					
BEBM704	Very Large Scale Integrated Circuits	20	20	20	80	25	-	25	150

Course Objectives	Students are introduced to various fabrication technologies for electronic devices. They get exposure to hardware description language which will help them to understand and design various tools for the devices
Course Outcomes	Students will be able to understand the technology behind the integrated circuits and will be able to design them as per the requirement.

Module	Contents	Time
1.	Introduction to VHDL hardware description language, core features of VHDL, data types, concurrent and sequential statements, data flow, behavioral, structural architecture. Architecture of Xilinx XC4000 FPGA family	08
2.	Combinational and Sequential Logic design using VHDL .Using VHDL combinational circuit design examples- multipliers, decoders and encoders, cascading comparator. VHDL sequential circuit design features. Implementation of counters and registers in VHDL	08
3.	Very Large Scale Integration (VLSI) Technology Physics of NMOS, PMOS, enhancement and depletion mode transistor, MOSFET, threshold voltage, flatband condition, linear and saturated operation, FET capacitance, short channel and hot electron effect.	08
4.	MOS Transistors, MOS transistor switches, Basic MOS inverter and its working, types of MOS invertors viz active load nMOS inverter, MOSFET Inverter with E-nMOS as pull up, MOSFET Inverter with D- nMOS as pull up, MOSFET Inverter with pMOS as pull up, cmos inverter, voltage transfer characteristics, noise immunity and noise margins, power and area considerations ,Parameter measurement in MOS circuits	08
5.	Silicon Semiconductor Technology Wafer processing, mask generation, oxidation, epitaxy growth diffusion, ion implantation, lithography, etching, metalization, basic NMOS and PMOS processes. Latch up in CMOS and CMOS using twin tub process. Scaling of MOS circuits, types of scaling and limitations of scaling.	08

6.	Design rules and Layout NMOS and CMOS design rules and layout, Design of NMOS and CMOS inverters, NAND and NOR gates. Interlayer contacts, butting and buried contacts, stick diagrams, layout of inverter, NAND and NOR gates. Design of basic VLSI circuits Design of circuits like multiplexer, decoder, priority encoder, Flip flops, shift registers using MOS circuits	08

List of Experiments:

1. Study of NMOq W modulation of NMOS channel (Using ORCAD or similar software)
2. Study of CMOS Inverter characteristics (Using ORCAD or similar software)
3. Basic Logic gates (using VHDL)
4. Binary to gray and Gray to Binary code conversion(using VHDL)
5. Binary to Excess-3 code conversion(using VHDL)
6. Implementation of 4:1/8:1 Mux(using VHDL)
7. Implementation of 3:8 Deoder(using VHDL)
8. Implementation of one bit Half Adder a Full adder (using VHDL)
9. Implementation of 4 bit full adder using half adder as component(using VHDL)
10. Implementation of JK flip flop(using VHDL)

Text books:

1. Introduction to VLSI design, E. D. Fabricus, McGraw Hill Publications, first edition, 1990
2. Basic VLSI Design D.A. Pucknell and Eshraghian,
3. Digital Design Principles and Practises John F Wakerly,
4. CMOS Digital Integrated Circuits, Kang , Tata McGraw Hill Publications

Reference Books:

1. VHDL Programming by Examples Douglas Perry, , Tata McGraw Hill Publications, 2002
2. Principles of CMOS VLSI Design : ASystems Perspective Neil H.E. Weste, Kamran Eshraghian second edition, Addison Wesley Publications, 1993
3. Digital Integrated Circuits: A Desiqn Perspective, Rabaey Jan M., Chandrakasan Anantha, Nikolic Borivoje, second edition, 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 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
BEBM705	Networking and Information System in Medicine (abbreviated as NISM)	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.					
BEBM705	Networking and Information Systems in Medicine	20	20	20	80	25	-	25	150

Course Objectives	Build an understanding of fundamental component of computer Networking Understand the functioning and configuration of various networking devices and components. Understand a concept about network security. Understand the healthcare IT infrastructure and also the prevalent standards in healthcare informatics.
Course Outcomes	The students will be able to design and configure basic computer network. The students will be able to design understand the IT information component of healthcare infrastructure.

Module	Contents	Time
	Networking Technology	
1.	LAN, MAN, WAN, Performance of network/device parameters Ethernet Technology: Ethernet types, Types of cables and connectors, Crossover and straight through cables, Colour coding of cables OSI Model, TCP/IP, Addressing types (IP, MAC & Port)	08
2.	IP V4 addressing, Subnetting, Supernetting, IP V6, Detailed working of networking equipment: HUB, Switch, Router, Modem, Bridge; Packet switching, Circuit switching.	08
3.	Basic Security Concepts Security Mechanism and security services, Authentication, Authorization, Confidentiality, Integrity, Symmetric and Asymmetric Key cryptography, RSA algorithm	06
	Information Systems in Medicine	
4.	PACS Components, Generic workflow, PACS architectures stand-alone, client-server, and Web-based, PACS and Teleradiology, Enterprise PACS and ePR System with Image Distribution	10
5.	Introduction to RIS and HIS, HIS/RIS/PACS integration, PIR, Storage Area Network, Network Attached storage, RAID, PACS Server & Archive and operating systems	08

6.	Introduction to Healthcare informatics standard HL7 and DICOM, IHE, IHE Domains, Legal issues in PACS, HIPAA.	08

List of Experiments:

1. Study of various networking cables, demonstration of crimping of cables and configuring networking parameters for computer.
2. Tutorial on IP addressing.
3. Introduction and basic commands used in various network simulation software.
4. Internetwork Communcation through Router and Switch, See the Mac Table of each switch and Routing table of Router
5. Static routing configuration.
6. Generating the HL7 message format.

Text books:

1. PACS and Imaging Informatics by Huang, Second Edition, Wiley and Blackwell
2. PACS Guide to Digital Revolution by Keith J. Dreyer (Springer)
3. Data Communication and Networking by Behrouz A. Forouzan McGrow Hill
4. Computer Networks by A.S. Tanenbaum, Pearson Education

Reference Books:

1. Governance of Picture Archiving and Communications Systems by Carrison K.S. Tong (Medical Information Science Reference)
2. Practical Imaging Informatics, By Barton F. Branstetter, Springer
3. PACS fundamentals- By Herman Oosterwijk
4. Cryptography and Network Security By William Stalling, Pearsons

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.
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Term Work:
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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
BEBM706	Project Stage - I	-	6	-	-	3	-	3

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
BEBM706	Project Stage - I	-	-	-	-	25	-	25	50

Project Guidelines

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

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