UNIVERSITY OF MUMBAI

Bachelor of Biomedical Engineering

Third Year and Final Year Engineering

Sem. V, VI, VII & VIII

Revised course (Rev- 2012)

From Academic Year 2012 -13

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 learner'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 learner-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 learner'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 student 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 students to demonstrate an ability to identify, formulate and solve electrical based issues.
- To prepare students to demonstrate an ability in the area of design, control, analyse and interpret the electrical and electronics systems.
- To prepare students for successful career in industry, research and development.
- To develop the ability among students for supervisory control and data acquisition for power system application.
- To provide opportunity for students 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.

Chairman,
Board of Studies in Electrical Engineering,
University of Mumbai

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**

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
	TOTAL	**16**	**16**	**2**	**16**	**8**	**2**	**26**

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				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		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
TOTAL				**80**	**320**	**150**		**200**	**750**

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 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**

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	8

	defibrillator and defibrillator analyzer.	
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	08

	Network, Network Attached storage, RAID, PACS Server & Archive and operating systems	
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.
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
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.

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
	TOTAL	**16**	**16**	**2**	**16**	**8**	**2**	**26**

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				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		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
TOTAL				**80**	**320**	**150**		**200**	**750**

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
BEBM801	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.					
BEBM801	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 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.	**Basics of Nuclear Physics**: Radioactivity, Radioactive Decay Law, Radioactive Decay Processes, Units of Radioactivity Measurement, Successive Decay Equations. Statistics of Counting, Interaction of Radiation with Matter **Production of Radionuclide:** Methods of radionuclide production: Nuclear Reactor, Medical Cyclotron & Radionuclide Generators Spectra of commonly used radio nuclides e.g. I-131, Tc-99m, Cr-51, Cs-137. Problems in radiation measurements.	10
2.	**Radiopharmaceuticals:** Ideal Radiopharmaceutical, Methods of Radiolabeling **Internal Radiation Dosimetry:** Absorbed Dose Calculations to Target & Non-Target Tissues, MIRD Methodology **Radiation Safety:** Natural & Artificial Radiation Exposure, External & Internal Radiation Hazard, Methods of Minimizing External Exposure, Methods of Preventing Internal Exposure, Evaluation of External & Internal Hazard, Biological Effects of Radiation, Radioactive Waste Management, Ethics in Nuclear medicine.	08
3.	**Detectors in Nuclear Medicine & Counting and Measuring System:**	10

	Gas filled Detectors, Scintillation Detectors and Solid State Detectors, Scintillation Counting System, Gamma Ray Spectrometry, Radionuclide Dose Calibrator, Properties of Detectors. **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	09
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.	08
6.	**Radionuclide Therapy** Choice of a Radionuclide in Therapeutic Nuclear Medicine Treatment of Benign & Malignant Diseases Palliative & Curative Procedures:	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.	**BASICS OF MINIATURIZATION & MATERIALS** Dimensional effect on engineering systems Clean room classification Scaling Laws in Miniaturization MEMS & Micro system products Substrates and Wafers Properties of Silicon Compounds SiO2, Si3N4, Polysilicon, Amorphous silicon Polymers: Dielectric polymers, Conducting polymers, and piezoelectric polymers	08
2.	**MEMS FABRICATION PROCESSES** 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

	like optical grating structure, SiO_2 cantilever , SiN_x 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	08
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	08
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	04
6.	**MICROSYSTEM PACKAGING** Importance of packaging Packaging materials Packaging techniques Wafer bonding	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_2 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:

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, 0. 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 FranssilaJohn Wiley & Sons Ltd, ISBN 0-470-85106-6
7. "Microelectromechanical Systems", Nicolae Lobontiu, Ephrahim Garcia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-387-23037-8
8. "BIOMEDICAL NANOTECHNOLOGY", Neelina H. MalschCRC 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
BEBM803	Hospital Management (abbreviated as HM)	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.					
BEBM803	Hospital Management	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.	**Process of management:** 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.	**Organization of the hospital & Hospital Planning:** 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.	**Planning for Clinical and Supportive Services :** 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.	**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	11
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	04
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	03

Text books:

1. Hospital Management by Dr. Pradyna Pai
2. Hospital Planning, Designing and Management: Kunders 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	Elective: Lasers and Fiber Optics (abbreviated as LFO)	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	Lasers and Fiber Optics	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.	**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** 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.	**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

4.	**Optic Fibers Fundamentals** 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.	**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	06
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	06

Text books:

1. Lasers and Optical Fibers in Medicine – AbrahimCatzir 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
BEBM804	Elective: Robotics in Medicine (abbreviated as RIM)	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	Robotics in Medicine	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, Shane 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
BEBM804	Elective: Health Care Informatics (abbreviated as HCI)	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	Health Care Informatics	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.	**Healthcare Interoperability** Introduction: Standards In Healthcare System, Categorizing Standards, Standard Development, Various Healthcare Informatics Standards	04
2.	**XML** 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.	**Health Level 7** 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.	**DICOM standard** 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.	**DICOM Communications** 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.	**DICOM Associations** Association Establishment, Transfer Syntax, Application Context, Presentation Context, User Information, Protocol Data Unit (PDU) **DICOM Media: Files, Folders, and DICOMDIRs** 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
BEBM804	Elective: Rehabilitation Engineering (abbreviated as RE)	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	Rehabilitation Engineering	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.	**Introduction and socio-legal aspects of Rehabilitation Engineering:** Medical Rehabilitation, Epidemiology of Rehabilitation, preventive Rehabilitation, Impairment Disability and Handicap. Delivery of Rehabilitation Care: The team-Medical, Paramedical , Socio-vocational	06
2.	**Orthotics, Amputation, and Prosthetics, Activities of Daily Living (ADL):** 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.	**Mechanical principles of Kinematics and Kinetics:** 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.	**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	08
5.	**Common deformities and role of surgery in rehabilitation engineering.** Types of deformities, Management of 1st and 2nd degree deformities. Common deformities of lower limb. Treatment for partial foot deformities. Deformities of the foot. Arm deformities. Torticollis	05
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	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

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 students 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 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
BEBM805	Project Stage - II	-	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.					
BEBM706	Project Stage - II	-	-	-	-	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.