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Item No. 4.57

UNIVERSITY OF MUMBAI

Revised Syllabus for the

TE Biomedical Engineering
(Third Year - Semester V and VI)

(As per Choice Based Credit and Grading System with effect from the academic year 2018–2019

Scheme for Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC601	Biomedical Monitoring Equipment	04	----	----	04	----	----	04
BMC602	Microprocessors and Microcontrollers	04	----	----	04	----	----	04
BMC603	Digital Image Processing	04	----	----	04	----	----	04
BMC604	Medical Imaging-I	04	----	----	04	----	----	04
BMDLO602X	Department Level Optional Course – II	04	----	----	04	----	----	04
BML601	Biomedical Monitoring Equipment	----	02	----	----	01	----	01
BML602	Microprocessors and Microcontrollers	----	02	----	----	01	----	01
BML603	Digital Image Processing	----	02	----	----	01	----	01
BML604	Medical Imaging-I	----	02	----	----	01	----	01
BMDLL602X	Department Level Optional Course Laboratory – II	----	02	----	----	01	----	01
Total		20	10	----	20	05	----	25

Examination Scheme for Semester VI

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC601	Biomedical Monitoring Equipment	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC602	Microprocessors and Microcontrollers	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC603	Digital Image Processing	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC604	Medical Imaging-I	80	32	20	8	---	---	---	---	---	---	---	---	100
BMDLO 602X	Department Level Optional Course – II	80	32	20	8	---	---	---	---	---	---	---	---	100
BML601	Biomedical Monitoring Equipment	---	---	---	---	25	10	---	---	---	---	25	10	50
BML602	Microprocessors and Microcontrollers	---	---	---	---	25	10	---	---	---	---	25	10	50
BML603	Digital Image Processing	---	----	---	---	25	10	---	---	---	---	25	10	50
BML604	Medical Imaging-I	---	---	---	---	25	10	---	---	25	10	---	---	50
BMDLL 602X	Department Level Optional Course Laboratory – II	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		400	160	100	40	125	50	---	---	50	20	75	30	750

Department Level Optional Courses

Course Code	Department level Optional Course - I
BMDLO5011	Healthcare Database Management
BMDLO5012	Biostatistics
BMDLO5013	Rehabilitation Engineering

Course Code	Department level Optional Course - II
BMDLO6021	Healthcare Software
BMDLO6022	Lasers and Fibre Optics
BMDLO6023	Biological Modelling and Simulation

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC601	Biomedical Monitoring Equipment (Abbreviated as BME)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC601	Biomedical Monitoring Equipment (BME)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC601	Biomedical Monitoring Equipment	04
Course Objective	• To understand the basic principles and working of patient monitoring system. • To develop skills enabling Biomedical Engineers to serve the health care industry • To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.	
Course Outcome	Learner will be able to: • Provide a better understanding about various bioelectrical signal recorders and patient safety • Demonstrate the principles of electronics used in designing various biomedical monitoring equipment. • Understand the basic princples and working of audiometry equipments and hearing aids • Provide a better understanding about foetal and neonatal monitoring systems. • Acquire the ability to explain the various blood flow and cardiac output meauremnet devices. • Acquire in-depth knowledge about different streams in Biomedical Engineering with greater emphasis on health care Equipment and the advanced technologies such as Telemetry and Telemedicine.	

Module	Contents	Hours
1	**Bioelectrical signals and recorders** ECG, EMG and EEG signals, LEAD configurations, 10-20 electrode system Measuring techniques for EOG, ERG and Phonocardiography, **Patient Safety:** Electric Shock Hazards, Leakage currents, safety codes for electro-medical equipment.	**10**
2	**Arrhythmia and Patient monitoring:** Cardiac Arrhythmias, waveforms and interpretation from them. Stress test measurement. Ambulatory monitoring instruments-Holter monitor. Measurement of Heart Rate, Pulse rate, Blood pressure, Temperature and Respiration rate, Apnoea Detector. Electrical Safety in Biophysical Measurements. Heart rate variability measurement and applications. **Point of care devices and their design considerations for homecare devices:** glucometer, lung function test.	**16**
3	**Audiometers and hearing aid** Basic audiometer, Pure tone and Speech audiometer, evoked response Audiometry, Conventional and Digital Hearing Aids, Cochlear Implants.	**04**
4	**Foetal and Neonatal Monitoring System:** Cardiotocograph, Methods of monitoring of Foetal Heart rate, Monitoring of labour activity, Incubator and Infant warmer, Non-stress test monitoring.	**05**
5	**Blood flow and Cardiac output** Electromagnetic, Ultrasonic, NMR and Laser Doppler flowmetry, Indicator Dilution, Dye Dilution and Thermal Dilution Techniques.	**05**
6	**Bio-Telemetry and Telemedicine** General Telemetry System, Single channel and Multi-channel, Landline and Radio-frequency Telemetry, Telemedicine, its essential parameters and delivery modes and its Applications.	**08**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text books:

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements : Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

Reference books:

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
1. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
2. Various Instruments Manuals.
3. Various internet websites.

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC602	Microprocessors and Microcontrollers (Abbreviated as MPMC)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC602	Micro-processors and Micro-controllers (MPMC)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC602	Microprocessors and Microcontrollers	04
Course Objective	• To create a strong foundation by studying the basics of Microprocessors and Microcontroller interfacing to various peripherals which will lead to a well-designed Microprocessor/ Microcontroller System.	
Course Outcome	Learner will be able to: • Understand the basic of Microprocessor and Microcontroller based systems and their architecture. • Understand 8086 microprocessor along with its architecture and memory organization. • Understand peripheral controller ICs used in interfacing. • Understand 8051 Microcontroller architecture, memory organization, Interrupt structure, Port structure, Timers/Counters • Understand assembly language and C compilers used to program 8051 • Design simple interfaces for keyboard LCD, ADC/DAC and Stepper motors	

Module	Contents	Hours
1.	**Introduction to Microprocessor** Introduction to Microprocessor and Microcontroller, Microcomputer based system elements, Generalized block diagram of Microprocessor, RISC & CISC CPU Architectures, Harvard & Von-Neumann CPU architecture, Microprocessor Programming languages, Microcomputer System software, Evolution of Microprocessor ,machine cycle, T states and concepts of read write cycles.	**04**
2.	**Architecture of Intel 8086 Microprocessor** Major features of 8086 processor, 8086/88, CPU Architecture and the pipelined operation, Programmer's Model and Memory Segmentation	**04**
3.	**Peripheral Controllers for 8086 family and System Design:** Functional Block Diagram and description, Control Word Formats, Operating Modes and Applications of the Peripheral Controller namely 8255-PPI, , 8259- PIC and 8237-DMAC, 8279- Display and Keyboard driver, Interfacing of the above Peripheral Controllers. Keyboard and Display Interface.	**08**
4.	**MCS-51 Microcontroller** 8051 architecture ; its variants and comparision, comparision of microprocessor and microcontrollers, CPU timing and machine cycle, memory organisation, SFR's, integrated prepherials such as timers/counters, serial ports, parallel I/O ports, interrupt structure, memory interfacing power saving and power down modes.	**10**
5.	**8051programming** Assembly language programming process, programming tools, addressing modes, instruction set and Programming practice using assembly and C compilers	**12**
6.	**Microcontroller design and interfacing case studies** Interfacing with external memories, Interfacing with 8255, Interfacing with 7 segment display, Interfacing with keyboard, interfacing with LCD, Interfacing with ADC, DAC and Sensors, Interfacing with stepper motor Interfacing with PC using RS232	**10**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. "8086/8088 family: "Design, Programming an Interfacing", John Uffenbeck: Prentice Hall, 2nd Edition
2. Microcomputer systems 8086/8088 family, Architecture, Programming and Design - Yu-Cheng Liu & Glenn A Gibson, 2nd Edition- July 2003, Prentice Hall of India.
3. "Advanced Microprocessor and Peripherals – Architecture, Programming and Interfacing", A.K.Ray & K.M Bhurchandi, Tata Mc Graw Hill , 2006.
4. The 8051 microcontrollers-Kenneth J Ayala

5. The 8051 Microcontroller and Embedded Systems Muhammad A Mazidi, , Pearson Education
6. Using MCS-51 Microcontroller Han-Way Huang,.
7. 8051 microcontroller hardware, software applications.V Udayashankara, M S Mallikarjunaswamy

Reference Books:

1. "Microprocessors and Interfacing : Programming and Hardware", Douglas V.Hall, second edition , Tata Mc Graw Hill ,2006.
2. " IBM PC Assembly language and programming"Peter Abel, , fifth edition
3. "Pentium Processor System Architecture", Don Anderson, Tom Shanley: MindShare Inc., 2nd Edition.
4. Embedded System Design: A unified Hardware/Software Introduction Frank Vahid,Toney Givargis- John Wiley publication
5. "Microprocessors and Interfacing : Programming and Hardware", Douglas V.Hall, second edition , Tata Mc Graw Hill ,2006.
6. " IBM PC Assembly language and programming"Peter Abel, , fifth edition
7. "Pentium Processor System Architecture", Don Anderson, Tom Shanley: MindShare Inc., 2nd Edition.
8. Embedded System Design: A unified Hardware/Software Introduction Frank Vahid,Toney Givargis- John Wiley publication.

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC603	Digital Image Processing (Abbreviated as DIP)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC603	Digital Image Processing (DIP)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC603	Digital Image Processing	04
Course Objective	• To introduce the learners the basic theory of digital image processing. • To expose learners to various available techniques and possibilities of this field. • To understand the basic image enhancement, transforms, segmentation, compression, morphology, representation, description techniques & algorithms. • To prepare learners to formulate solutions to general image processing problems. • To develop hands-on experience in using computers to process images. • To familiarize with MATLAB / C/ Labview / similar software for processing digital images.	
Course Outcome	Learner will be able to: • Acquire the fundamental concepts of a digital image processing system such as image acquisition, enhancement, segmentation, transforms, compression, morphology, representation and description. • Analyze images in the spatial domain. • Analyze images in the frequency domain through the Fourier transform. • Design and implement with MATLAB/C/Labview algorithms for digital image processing operations such as point processing, histogram processing, spatial and frequency domain filtering, denoising, transforms, compression, and morphological processing**.**	

Module	Detailed Contents	Hours
1.	**Basics of Image Processing**: Image acquisition, Processing, Communication, Display; Electromagnetic spectrum; Elements of visual perception - Structure of the human eye, Image formation in the eye, Brightness adaptation and discrimination, Image formation model, 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 2D-DFT, Low pass, High pass, Noise removal, Homomorphic filters,	**12**
3.	**Image Segmentation**: Basic relationships between pixels - Neighbours, Adjacency, Connectivity, Regions, Boundaries, Distance measures; Detection of discontinuities, Point, Line, Edge detection, Edge linking, Hough transform, Thresholding-based segmentation, Region-based segmentation.	**08**
4.	**Image Transforms**: DFT, FFT, DCT, DST, Hadamard, Walsh, Haar, Slant, K-L Transforms, Basis functions and basis images	**08**
5.	**Image Compression**: Fundamentals of image compression models, Lossless compression - RLE, Huffman, LZW, Arithmetic coding techniques. Lossy compression - IGS coding, Predictive coding, Transform coding, JPEG, JPEG 2000.	**08**
6.	**Morphology, Representation and Description**: Dilation, Erosion, Open, Close, Hit-or-miss, Boundary extraction, Region filling, Thinning and thickening; Chain Codes, Polygonal approximations, Signatures; Fourier descriptors, Moments.	**07**

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:
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-Prentice Hall India.

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

Theory Examination:
1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC604	Medical Imaging - I (Abbreviated as MI - I)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC604	Medical Imaging - I (MI - I)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC604	Medical Imaging - I	04
Course Objective	• To familiarize the learners with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities. • To keep the learners abreast with the technological developments in the field of Medical Imaging	
Course Outcome	Learner will be able to: • Understand X ray imaging along with X ray tube construction, X ray generators and the total radiographic system. • Understand Fluoroscopic Imaging and Digital Subtraction Angiography. • Distinguish between CR and DR. Understand Mammography. • Understand the technique of Computed tomography, the CT scanner configuration, reconstruction techniques and clinical applications. • Apply the knowledge of CT and learn advancements in CT. • Understand the applications of X-rays in the field of Radiotherapy.	

Module	Detailed Contents	Hours
1.	**X- ray Imaging**: Properties of X rays, production of X rays, X ray interaction with matter, Attenuation Total radiographic System: X –ray tubes, Rating of X ray tubes, X –ray generators, Filters, Grids, Beam Restrictors, Control Panel, X ray Film	14
2.	**Fluoroscopic Imaging** and X ray Image Intensifier, Digital subtraction Angiography	05
3.	**Computed Radiography and Digital Radiography** **Mammography**	04

4.	**Principle of Computed tomography** Scanner configurations/generations, CT system: Scanning unit(gantry), detectors, CT Number ,Data Acquisition System, Spiral CT: technology and applications, Reconstruction Techniques:- Radon Transform, Iterative, Filtered back projection, Fourier reconstruction, CT artefacts, Clinical applications of CT	**14**
5.	**Advancements in CT** Multi-detector computed tomography (MDCT), Flat panel detectors CT-Angiography, Contrast agents in CT	**05**
6.	**Linear Accelerators:** Production and transport of the RF wave, Major components of linear accelerator, Clinical Applications.	**06**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Christensen's Physics of Diagnostic Radiology
2. Medical Imaging Physics William .R.Hendee
3. Practical Radiotherapy: Physics and equipment: Pam Cherry, Angela Duxbury

Reference Books:

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

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 6021	Department Level Optional Course- II Healthcare Software (Abbreviated as HCS)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BMDLO 6021	Department Level Optional Course - II Healthcare Software (HCS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO6021	Healthcare Software	04
Course Objective	• To setup programming environment for ASP.NET programs • To develop modular applications using object oriented methodologies • To configure ASP.NET application and creating applications using standard .NET controls • To develop data driven web application • To connect different data sources and manage them • To maintain session and controls related information in multi-user web applications	
Course Outcome	Learner will be able to: • Understanding of Microsoft .NET Framework and ASP.NET page structure • Designing of windows applications using C#.NET • Designing of web applications using ASP.NET controls • Creating database driven ASP.NET web applications using SQL Server • Debugging and deploying ASP.NET web applications.	

Module	Contents	Hours
1	**Introduction to .NET Programming:** • .Net Concepts: Framework, Common Language Runtime, Base Class Library, Common Type System (CTS), Assemblies, Namespaces. • Programming with C#: Variables, Comments, Constants, Keywords, Data Types, Control Statements, Conditional Statements, Switch Statement, Loops, Jump, Statements, Goto, break, Continue, Return, Arrays. • Exception handling in C# • Object Oriented Programming (OOP): Class, Object, Encapsulation, Inheritance, Polymorphism, Constructors.	12
2	**Developing Windows Forms Applications:** • Standard Controls - Windows Application: Labels, Textboxes, Rich Text Box, Button, Check Box, Radio Button, Combo Box, Picture Box, List Box, Image List, List View, Tab Control, Menu Strip, Data Grid View, Date Picker • Event Handlers: Creating Event Handlers, Default Event Handlers, Associating Event Handlers at Run Time.	06
3	**Developing Web Applications using ASP.NET and C#** • Introduction to ASP.Net: From ASP to ASP.NET, ASP.NET Features, Web Forms Life Cycle, Request/Response Programming. • Web Applications Using Visual Studio: Using Visual Web Developer, Using Components, Using the Global.asax file. • State Management: Session State, Application State, Cookies. • Server Control: HTML Server Controls, Web Forms Server Controls, Rich Controls, Validation Controls. • Themes • Configuration: Using the machine. config file, Using the web. config file, Globalization and Localization.	12
4	• **Data access and manipulation with ADO.NET using SQL Server** Introduction to ADO.NET, Data Providers in .NET, Connected and Disconnected architecture, ADO.NET Architecture, Command Object, Data Adapter and Data Set, Data Tables and Data Views, Updating the Dataset.	10
5	**Security, Deployment, & Introduction to advanced concepts** • Security: Authentication, Authorization, Impersonation, Code Access Security • Deployment.	04
6	**Introduction to advanced concepts of .Net framework:** Windows Presentation Foundation (WPF), Windows Communication Foundation (WCF), Windows Workflow Foundation (WWF), Windows Card Space (WCS).	04

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:
Text Books:
1. ASP.NET 3.5 Unleashed (Sams) - Stephen Walther
2. Microsoft ASP.NET Step by Step (Microsoft Press) - G. Andrew Duthrie

Reference Books:
1. Designing Microsoft ASP.NET Applications (Microsoft Press) - Jonathon Goodyear, Brian Peek, Brad Fox
2. Deploying and Managing Microsoft .NET Web Farms (Sams) - Barry Bloom

Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 6022	Department Level Optional Course- II Lasers and Fibre Optics (Abbreviated as LFO)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract.	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BMDLO 6022	Department Level Optional Course - II Lasers and Fibre Optics (LFO)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO6012	Lasers and Fiber Optics	04
Course Objective	• To understand the fundamentals in Laser and Fiber Optics. • To understand the applications of Laser and Fiber optics in health sector.	
Course Outcome	Learner will be able to: • Understand the fundamentals and clinical applications of Laser and Fiber Optics. • Correlate the knowledge of medicine and engineering for the wellness of human being. • Understand the safety aspects while dealing with Laser and Fiber Optic Units.	

Module	Contents	Hours
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 equipment, 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, In vivo 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**

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

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.BensonJr, Mosby Pub
5. Laser Fundamentals-William T.Silfvast, Cambridge University Press
6.Lasers in Medicine, Volume-1,Hans K. Koebner, John Wiley & Sons

Theory Examination:

3. Question paper will comprise of 6 questions, each carrying 20 marks.
4. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLO 6023	Department Level Optional Course- II Biological Modelling and Simulation (Abbreviated as BMS)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMDLO 6023	Department Level Optional Course - II Biological Modelling and Simulation (BMS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMDLO6023	Biological Modelling and Simulation	04
Course Objective	• To provide in-depth knowledge of modelling of physiological systems. • To understand basic concepts of modeling for designing biological model.	
Course Outcome	Learner will be able to: • Explain the concepts, usage and process of physiological modelling • Apply basic biophysical laws for calculation of membrane potential under different equilibrium conditions and develop simulation programs for understanding neuronal functions • Understand the function of complex closed loop systems like temperature control using modelling. • Understand the function of neuromuscular system with the help of various models. • Understand the function of open loop system like eye movement system and differentiate open loop and closed loop system • Understand the usage of, and the assumptions behind biological models (immune response, drug delivery and insulin glucose feedback) in the working life.	

Module	Detailed Contents	Hours
1.	**Physiological Modelling**: Steps in Modelling, Purpose of Modelling, lumped parameter models, distributed parameter models, compartmental modelling, modelling of circulatory system and respiratory system.	**07**
2.	**Model of Neurons:** Biophysics tools, Equilibrium in a one ion system, Donnan Equilibrium, Space-Charge Neutrality, Membrane with no-zero permeability, GHK equation, Active Transport (Pump), Action Potential, Electrical Equivalent model of a biological membrane, The H-H model, The iron-wire model, Channel Characteristics, Simulation of action potential, voltage propagation in a passive axon (cable equation).	**14**
3.	**Neuromuscular System:** modelling of skeletal muscle, mono and polysynaptic reflexes, stretch reflex, reciprocal innervations, two control mechanism, Golgi tendon, experimental validation, Parkinson's syndrome.	**06**
4.	**Eye Movement Model:** Eye movements, quantitative eye movement models, techniques for validating models, validation of other physiological systems	**12**
5.	**Thermoregulatory systems:** Thermoregulatory mechanisms, model of thermoregulatory system, controller model, validation and application.	**03**
6.	**Modelling of other physiological systems.** **Modelling the Immune response:** Behavior of the immune system, linearized model of the immune response. **Modelling of Drug delivery systems.** **Modelling of Insulin Glucose feedback system** and Pulsatile Insulin secretion.	**06**

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Books Recommended:

Text Books:

1. Bioengineering, Biomedical, Medical and Clinical Engg.: A.Teri Bahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey

Reference Books:

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML601	Biomedical Monitoring Equipment (BME)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML601	Biomedical Monitoring Equipment (BME)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML601	Biomedical Monitoring Equipment	01
Course Objective	• To understand the basic principles and working of patient monitoring system. • To develop skills enabling Biomedical Engineers to serve the health care industry • To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems.	
Course Outcome	Learner will be able to: • Design and Implement filters for filtering of noise from signals. • Design and Implement Instrumentation amplifier to amplify low amplitude signals. • Design and Implment a regulated power supply. • Design and Implement Pulse Width Modulator. • Undesrtand the working of ECG machine by recording ECG. • Provide a better understanding about foetal monitoring systems. • Test the hearing ability by use of an audiometry.	

Syllabus: Same as that of BMC601 Biomedical Monitoring Equipment(BME).

List of Laboratory Experiments: (Any Seven)

1. Design of Instrumentation amplifier.
2. Implementation of notch filter.
3. Implementation of Bandpass filter
4. Design and implementation of regulated power supply.

5. Design and implementation of Pulse width modulator.
6. Demonstration of ECG machine / monitor.
7. Demonstration of foetal monitor.
8. Demonstration of Blood flow measurement.
9. Testing of hearing ability using Audiometer.
10. Industry / Hospital visit may to be conducted.

Any other experiment based on syllabus which will help learner to understand topic/concept.

Group Presentations on the latest technology in hospitals based on the topics covered in the syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 5 Marks
Presentation : 5 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text books:

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements : Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)

Reference books:

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various internet websites

Practical and Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML602	Microprocessors and Microcontrollers (MPMC)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML602	Microprocessors and Microcontrollers (MPMC)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML602	Microprocessors and Microcontrollers	01
Course Objective	• To apply the theoretical concepts of Microcontroller to design practical circuits. • To learn circuit simulation and software simulations and then convert into a working model.	
Course Outcome	Learner will be able to: • Execute the program using microprocessor and microcontroller kits. • Execute assembly and C language programs using simulator. • Apply the knowledge of programming to implement a mini project.	

Syllabus: Same as that of BMC602 Microprocessors and Microcontrollers (MPMC).

List of Laboratory Experiments: (Any four and mini project)

1. To study 8031\8086 kit.
2. To perform experiment on data transfer.
3. To study arithmetic operations.
4. To perform experiment on logical instructions.
5. To perform experiment on Timers\Counters.
6. To study and perform experiment on Square wave generation.
7. To implement LCD interfacing.
8. Mini Project.

Any other experiment based on syllabus which will help students to understand topic/concept

Term Work:

Term work shall consist of minimum 7 experiments. Every year at least 3 experiments should be changed from previous year experiments

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments and Journal) : 10 Marks

Mini Project (Implementation and Report) : 10 Marks

Attendance : 5 Marks

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

Books Recommended:

Text Books:

2. "8086/8088 family: "Design, Programming an Interfacing", John Uffenbeck: Prentice Hall, 2nd Edition
3. Microcomputer systems 8086/8088 family, Architecture, Programming and Design - Yu-Cheng Liu & Glenn A Gibson, 2nd Edition- July 2003, Prentice Hall of India.
4. "Advanced Microprocessor and Peripherals – Architecture, Programming and Interfacing", A.K.Ray & K.M Bhurchandi, Tata Mc Graw Hill , 2006.
5. The 8051 microcontrollers-Kenneth J Ayala
6. The 8051 Microcontroller and Embedded Systems Muhammad A Mazidi, , Pearson Education
7. Using MCS-51 Microcontroller Han-Way Huang,.
8. 8051 microcontroller hardware, software applications.V Udayashankara, M S Mallikarjunaswamy

Reference Books:

1. "Microprocessors and Interfacing : Programming and Hardware", Douglas V.Hall, second edition , Tata Mc Graw Hill ,2006.
2. " IBM PC Assembly language and programming"Peter Abel, , fifth edition
3. "Pentium Processor System Architecture", Don Anderson, Tom Shanley: MindShare Inc., 2nd Edition.
4. Embedded System Design: A unified Hardware/Software Introduction Frank Vahid,Toney Givargis- John Wiley publication
5. "Microprocessors and Interfacing : Programming and Hardware", Douglas V.Hall, second edition , Tata Mc Graw Hill ,2006.
6. " IBM PC Assembly language and programming"Peter Abel, , fifth edition
7. "Pentium Processor System Architecture", Don Anderson, Tom Shanley: MindShare Inc., 2nd Edition.
8. Embedded System Design: A unified Hardware/Software Introduction Frank Vahid,Toney Givargis- John Wiley publication.

Practical and Oral examination will be based on mini project.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML603	Digital Image Processing (DIP)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML603	Digital Image Processing (DIP)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML603	Digital Image Processing	01
Course Objective	• To introduce the learners the basic theory of digital image processing. • To expose learners to various available techniques and possibilities of this field. • To understand the basic image enhancement, transforms, segmentation, compression, morphology, representation, description techniques & algorithms. • To prepare learners to formulate solutions to general image processing problems. • To develop hands-on experience in using computers to process images. • To familiarize with MATLAB / C/ Labview/ similar software for processing digital images.	
Course Outcome	Learner will be able to: • Acquire the fundamental concepts of a digital image processing system such as image acquisition, enhancement, segmentation, transforms, compression, morphology, representation and description. • Analyze images in the spatial domain. • Analyze images in the frequency domain through the Fourier transform. • Design and implement with MATLAB/C/Labview algorithms for digital image processing operations such as point processing, histogram processing, spatial and frequency domain filtering, denoising, transforms, compression, and morphological processing**.**	

Syllabus: Same as that of BMC603 Digital Image Processing (DIP).

List of Laboratory Experiments (Any Seven)

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

Any other experiment based on syllabus which will help students to understand topic/concept

Term Work:

Term work shall consist of minimum 7 experiments. Every year at least 3 experiments should be changed from previous year experiments

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 Marks

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

Books Recommended:

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-Prentice Hall India.

Reference Books:

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

Practical and Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML604	Medical Imaging - I (MI – I)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML604	Medical Imaging - I (MI – I)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML604	Medical Imaging – I	01
Course Objective	• To familiarize the learners with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities. • To keep the learners abreast with the technological developments in the field of Medical Imaging.	
Course Outcome	Learner will be able to: • Understand X ray imaging along with X ray tube construction, X ray generators and the total radiographic system. • Understand Fluoroscopic Imaging and Digital Subtraction Angiography • Distinguish between CR and DR. Understand Mammography. • Understand the technique of Computed tomography, the CT scanner configuration, reconstruction techniques and clinical applications. • Apply the knowledge of CT and learn advancements in CT.	

Syllabus: Same as that of BMC604 Medical Imaging – I (MI - I).

List of Laboratory Experiments (Any Seven)

1. Study of X ray tube
2. Study of X ray Tube housing
3. To compare technical specifications of different X ray machines
4. To compare technical specifications of different CT Scanners
5. To generate Sinogram of the image
6. To perform CT windowing on an Image

7. To perform back projection on an Image
8. To generate pseudo colour image
9. To study Fluoroscopy Machine
10. Hospital Visit may be conducted to Radiology Department
11. Presentation on the given topic
12. To generate Research article on the advanced topic
13. Demonstrations/Experts talk

Any other experiment based on syllabus which will help students to understand topic/concept.

Group Presentations on the latest technology in hospitals based on the topics covered in the syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Christensen's Physics of Diagnostic Radiology
2. Medical Imaging Physics William .R.Hendee
3. Practical Radiotherapy: Physics and equipment: Pam Cherry, Angela Duxbury

Reference Books:

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

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credits assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 6021	Department Level Optional Course – II Healthcare Software (HCS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 6021	Department Level Optional Course – II Healthcare Software (HCS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL6021	Healthcare Software	01
Course Objective	• To setup programming environment for ASP.NET programs • To develop modular applications using object oriented methodologies • To configure ASP.NET application and creating applications using standard .NET controls • To develop data driven web application • To connect different data sources and manage them • To maintain session and controls related information in multi-user web applications	
Course Outcome	Learner will be able to: • Understanding of Microsoft .NET Framework and ASP.NET page structure • Designing of windows applications using C#.NET • Designing of web applications using ASP.NET controls • Creating database driven ASP.NET web applications using SQL Server • Debugging and deploying ASP.NET web applications	

Syllabus: Same as that of BMDLO6021 Healthcare Software (HCS).

List of Laboratory Experiments (Any Seven)

1. Develop an ASP.NET application to show all page events along with their order of execution.
2. Develop an ASP.NET application to demonstrate the use of standard ASP.NET controls (TextBox, CheckBox, RadioButton, Button, Image, ImageButton, etc).
3. Develop an ASP.NET application to demonstrate the use of rich ASP.NET controls (use the FileUpload control).
4. Develop an application to demonstrate the use of validation controls in ASP.NET (RequiredFieldValidator, RangeValidator, CompareValidator and RegularExpressionValidator).
5. Develop an ASP.NET web application to demonstrate page themes and master page.
6. Develop an ASP.NET web application to demonstrate session management across application.
7. Develop an ASP.NET web application with Databound controls (List, Tabular, and Hierarchical).
8. Develop an ASP.NET web application to demonstrate use of SQLDataSource control.
9. Develop an ASP.NET web application to demonstrate use of XMLDataSource control.
10. Develop any database driven web application using SQL Server (experiment should demonstrate creation, updating and deletion of records from the database).

Any other experiment based on syllabus which will help students to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 10 Marks

Laboratory work (Journal) : 10 Marks

Attendance : 5 Marks

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

Books Recommended:

Text Books:

1. ASP.NET 3.5 Unleashed (Sams) - Stephen Walther
2. Microsoft ASP.NET Step by Step (Microsoft Press) - G. Andrew Duthrie

Reference Books:

1. Designing Microsoft ASP.NET Applications (Microsoft Press) - Jonathon Goodyear, Brian Peek, Brad Fox
2. Deploying and Managing Microsoft .NET Web Farms (Sams) - Barry Bloom

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credits assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 6022	Department Level Optional Course – II Lasers and Fiber optics (LFO)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 6022	Department Level Optional Course – II Lasers and Fiber optics (LFO)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL6022	Lasers and Fiber Optics	01
Course Objective	• To understand the fundamentals in Laser and Fiber Optics. • To understand the applications of Laser and Fiber optics in health sector.	
Course Outcome	Learner will be able to: • Understand the fundamentals and clinical applications of Laser and Fiber Optics. • Correlate the knowledge of medicine and engineering for the wellness of human being. • Understand the safety aspects while dealing with Laser and Fiber Optic Units.	

Syllabus: Same as that of BMDLO6022 Lasers and Fibre Optics(LFO).

Laboratory work:

1. Demonstrations in hospital / Industry.
2. Discussion on research articles and recent developments in the field of medicine.
3. Group ppresentations on the latest technology in hospitals based on the topics covered in the syllabus.
4. 5 Assignments based on the entire syllabus.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work : 10 Marks
Laboratory work (Documentation) : 5 Marks
Presentation : 5 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

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.BensonJr, Mosby Pub
5. Laser Fundamentals-William T.Silfvast, Cambridge University Press
6.Lasers in Medicine, Volume-1,Hans K. Koebner, John Wiley & Sons

Oral examination will be based on entire syllabus

Course Code	Course Name	Teaching scheme			Credits assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMDLL 6023	Department Level Optional Course – II Biological Modelling and Simulation (BMS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BMDLL 6023	Department Level Optional Course – II Biological Modelling and Simulation (BMS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BMDLL6023	Biological Modelling and Simulation	01
Course Objective	• To understand basic approach of modeling for designing biological model. • To simulate physiological processes for better understanding. • To develop competency in terms of logical thinking, programming and application skills • To train and motivate students for pursuing higher education and research for developing cutting edge technologies.	
Course Outcome	Learner will be able to: • Apply concept of physiological modelling to model thermometer system. • Virtually understand biophysical laws for calculation of membrane potential under different equilibrium conditions and develop simulation programs for understanding neuronal functions. • Simulate mathematical model for the eye movement • Electrically simulate model of thermoregulatory system • Understand the usage of, and the assumptions behind biological models	

	(immune response, drug delivery and insulin glucose feedback) in the working life.

Syllabus: Same as that of BMDLO6023 Biological Modelling and Simulation (BMS).

List of Laboratory Experiments (Any Seven)

1. Simulations thermometer system using MATLAB
2. Simulation of Nernst/Goldman Equation using MATLAB
3. Simulation of eye movement using MATLAB
4. Simulation using HHSim **(Two practicals)**
5. Simulation using Neurons in Action **(Two practicals)**
6. Developing a model of a neuron using NEURON
7. Electrical simulation of thermoregulatory model

Any other experiment / assignment / presentation based on syllabus which will help students to understand topic/concept.

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 Marks
The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

Text Books:

1. Bioengineering, Biomedical, Medical and Clinical Engg.: A.Teri Bahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey

Reference Books:

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

Oral examination will be based on suggested practical list and entire syllabus