Course code	Course Name	L-T-P-Credits	Year of Introduction
BM401	MEDICAL IMAGE PROCESSING	4-0-0-4	2016

Prerequisite: Nil

Course Objectives

- To provide an overview of the fundamentals behind image processing and analysis methods with an emphasis on biomedical applications.

Syllabus

Image perception, Image sampling and quantization, Two dimensional sampling. Image transforms - 2D DFT - cosine, sine, Hadamard, Haar, KL and slant transforms. Image enhancement - Point operations, Spatial operations, Frequency Domain methods. Image restoration-Inverse filtering, Wiener filtering. Image analysis- Spatial feature extraction - transform features, image segmentation. Fusion of multi-modal images for Hybrid Imaging, High-Resolution Fusion. Super resolution imaging.

Expected Outcome

The students will be able to

i. Understand the basic principles of Digital Image Processing applied to medical images
ii. Understand the different methods of image processing both in the time and transform domains.
iii. Identify the importance of medical hybrid imaging and its role in different medical applications

Text Books:

1. Jain Anil K: Fundamentals of Digital Image Processing-, Prentice Hall of India. 1989
2. Gonzalez Rafel C, Wintz Paul: Digital Image Processing, Addison Wesley.1993

Reference Books:

1. Medical Imaging Analysis- Atam P Dhawan, Wiley Inter science publication, 2003
2. Pratt William K: Digital Image Processing, John Wiley and Sons. 2001
3. Rosenfield Azriel, Kak Avinash C: Digital Picture Processing, Academic Press Inc.1991
4. Thomas M. Deserno Biomedical Image Processing Springer-Verlag Berlin Heidelberg 2011

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Image perception -MTF of the visual system -monochrome vision models - color vision model	5	15%
	Image sampling and quantization -Two dimensional sampling theory - Image quantization	5	
II	Image transforms -Two dimensional orthogonal and unitary transforms - properties of unitary transforms	4	15%
	2D DFT- cosine, sine, Hadamard, Haar , KL and slant transforms	6	

FIRST INTERNAL EXAM			
III	Image enhancement - Point operations - contrast stretching - clipping and thresholding - digital negative, intensity level slicing - bit extraction. Histogram modelling - histogram equalization -modification	5	**15%**
	Spatial operations - smoothing techniques. Magnification and interpolation. Frequency Domain methods - low pass filtering, high pass filtering, homomorphic filtering	5	
IV	Image restoration: Inverse filtering, Wiener filtering	4	**15%**
	Constrained Least Squares restoration, maximum entropy restoration, Geometric transformations	4	
SECOND INTERNAL EXAM			
V	Image analysis-Spatial feature extraction - transform features	5	**20%**
	Edge detection – boundary extraction, shape features, image segmentation.	5	
VI	Fusion of multi-modal images for Hybrid Imaging: Hybrid PET/CT Systems, PET/MRI Systems	4	**20%**
	Super resolution imaging- applications in quantitative Medical Image Analysis	4	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course code	Course Name	L-T-P-Credits	Year of Introduction
BM403	THERAPEUTIC EQUIPMENT	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To introduce the principles of various therapeutic, life-support and surgical equipment in clinical use.
- To familiarize with the design and system level analysis different therapeutic equipments
- To identify the applications and safety aspects of different equipments

Syllabus

Cardiac Pacemakers, Defibrillators, Ventilators, Surgical diathermy, Short wave and microwave diathermy, Lithotripsy, Endoscopy, Infusion pumps , Peristaltic pumps, Dialysis equipments, Heart lung machines, Anesthetic machines.

Expected Outcome

- Students will have acquired a thorough and comprehensive understanding of various therapeutic, life-support and surgical equipment in clinical use.

Reference Books:

1. Encyclopedia of Medical Devices and Instumentation, Wiley
2. R S Khandpur, Handbook of Bio medical Instrumentation , Tata McGraw Hill,2004Mushin, Automatic Ventilation of Lung , Black Well,1980
3. Bronzino, Hand book of Biomedical Engineering, IEEE press book
4. Webster J,' Medical Instrumentation-Application and Design', John Wiley
5. Joseph J. Carr, John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education (Singapore) Pvt. Ltd., 2001.
6. Geddes & Baker, Principles of Applied Biomedical Instrumentation Wiley, 1989.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Cardiac Pacemakers : Effects of electric field on cardiac muscles and laws of stimulation. Need for cardiac pacemaker.	1	15%
	External pacemakers – types - voltage pacemakers - current pacemakers - current limited voltage pacemakers. Internal pacemakers - basic requirement – types: fixed rate, demand pacemakers, R wave triggered, R wave blocked, Atrial triggered pacemakers. Programmable pacemakers - Functional block diagram and description.	3	
	Power sources - Mercury battery, biological power sources, Nuclear battery & lithium cells.	1	
	Heart lung machines - Principle of operation -Functional block diagram.	2	
II	Defibrillators - Need for a defibrillator- basic principle and comparison of output wave forms of different DC defibrillators - Defibrillator electrodes. DC defibrillator with synchronizer -	5	15%

	Functional block diagram. Automatic external defibrillators-Block diagram. Implantable defibrillators – components - block diagram - defibrillator analyzers.		
	RF ablation treatment for arrhythmia	1	
FIRST INTERNAL EXAM			
III	Ventilators: Physiological factors affecting Volume exchange – compliance - respiratory resistance. Functional specification: inspiratory phase – change over from inspiratory to expiratory phase - expiratory phase- change over from expiratory to inspiratory phase.	1	**15%**
	Inspiratory phase: Constant pressure generator -pneumatic characteristics - generated pressure, compliance and resistance of patient and ventilator. Comparative study of wave forms of pressure, volume & flow at very high and low generated pressure. Constant and non-constant flow generator, Non constant pressure generator. Mechanical forms of constant pressure and flow generator-weighted bag, pressure regulators, positive displacement pumps, injectors, blowers, and pressure transformers.	2	
	Change over from inspiratory to expiratory phase - time cycling, volume cycling, pressure cycling, and flow cycling.	2	
	Expiratory phase – Constant pressure-constant flow -non constant pressure and flow generators-waveforms produced by a constant ,negative pressure generator & constant flow generator-Patient cycling -Mixed cycling	1	
	Change over from expiratory phase to the inspiratory phase - time cycling, volume cycling, pressure cycling, and flow cycling.	1	
	Study of typical ventilator	1	
IV	Electrical stimulators, nerve and muscle stimulators - Stimulators for pain and relief- functional electrical stimulation- Ultrasonic stimulators.	2	
	Surgical diathermy -Principles and applications, Functional block diagram - monopolar & bipolar techniques, Electrodes and Safety aspects in electrosurgical units, electro surgical analyzers.	4	**15%**
	Principles of short wave and microwave diathermy.	1	
SECOND INTERNAL EXAM			
V	Lithotripsy – Basic principles, ESWL & ultrasonic lithotripters - applications.	3	**20%**
	Drug delivery devices - Infusion pumps - Functional block diagram.	2	
	Incubators & Dialysis equipments - Functional block diagram.	2	
VI	Endoscopy – Principles, types & applications. Block diagram of a fiber optic endoscope with integral TV cameras	3	**20%**
	Anesthetic machines: Need of anesthesia, gas used and their sources, gas blending and vaporizers, anesthesia delivery system, breathing circuits	4	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course code	Course Name	L-T-P-Credits	Year of Introduction
BM405	ARTIFICIAL NEURAL NETWORKS	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To understand the role of neural networks in engineering, artificial intelligence
- To provide knowledge of supervised and unsupervised learning in neural networks
- To provide knowledge of computation and dynamical systems using neural networks
- To provide hands-on experience in selected applications.

Syllabus

Introduction to neural networks: Biological neural networks, Perceptron, Feedback Networks, Feed Forward Networks, Counter Propagation Network, Adaptive Resonance Theory, Self-Organizing feature maps, Associative memory networks, Probabilistic neural networks.

Expected Outcome

The students will have

i. exposed to the concepts of feed forward feed back supervised unsupervised neural networks.
ii. acquired adequate knowledge on application of neural network to real time systems.

Text Books:

1. Laurene Fausett: *"Fundamentals of neural networks"*, Prentice Hall, New Jersey, 2007. ISBN 81-317-0053-4
2. James A. Freeman, David M. Skapure: Neural Networks Algorithms, Applications and Programming Techniques, Addison-Wesley, 2003 ISBN 81-7808-108-3.
3. Dr. S N Sivanandam: *"Introduction to neural networks using "MATLAB 6.0"*, Tata McGraw Hill New Delhi.,2012

Reference Books:

1. James A. Freeman, David M. Skapure: Neural Networks Algorithms, Applications and Programming Techniques, Addison-Wesley, 2003 ISBN 81-7808-108-3.
2. Kevin Gruney: "An Introduction to neural networks", CRC Press, 1997.
3. D. L.Hudson & M. E. Cohen: "*Neural Networks and Artificial Intelligence in Biomedical Engg.*", Prentice Hall Of India, New Delhi.,1999
4. James A. Anderson, "*An Introduction to Neural Networks", Prentice Hall of India, 1995.*
5. Simon Haykin: "*Neural Networks*", Pearson Education1 998.
6. Yegnanarayana: *Artificial Neural Networks*, Prentice Hall of India2004.
7. Jack M. Zureda, *Introduction to Artificial Neural Systems* West Publishing Company, *1992.*

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to neural networks. Artificial neural networks. Biological neural networks - Comparison, Basic building blocks of ANN. Activation functions.	2	15%

	McCulloch-Pitts Neuron Model, Hebb net. Learning Rules- Hebbian Learning Rules, Perceptron, Delta, Competitive,	3	
	Perceptron networks- single layer, multilayer –algorithm.	2	
II	Feedback Networks, Discrete Hopfield nets, Continuous Hopfield nets.	2	**15%**
	Feed Forward Networks: Back Propagation Networks, Learning Rule, Architecture, training algorithm. Problems	3	
	Counter Propagation Network: Full CPN, Forward only CPN, architecture, training phases	2	
FIRST INTERNAL EXAM			
III	Adaptive Resonance Theory, architecture, learning in ART. Problems on ART 1 and ART2	4	**15%**
III	Self Organizing feature maps: Kohonen SOM, Learning	3	**15%**
SECOND INTERNAL EXAM			
V	Hamming net. Associative memory networks Algorithms for pattern association Hetero associative networks, Auto associative memory networks Bidirectional associative memory networks Energy Function. Problems.	7	**20%**
VI	Probabilistic neural networks, Boltzmann machine, Cauchy machine, Support Vector Machine. Application of Neural networks (Assignments can be implementation of a network for an application in Biomedical field)	7	**20%**
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course code	Course Name	L-T-P-Credits	Year of Introduction
BM407	BIOPHOTONICS	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To understand the working principles of different lasers used in medicine.
- To learn the optical properties of tissue and the opto-thermal interaction of the tissue.
- To know the different applications of lasers in medical field.

Syllabus

Continuous and pulsed lasers used in medicine, Introduction to biophotonics, Optical properties of tissues, Light tissue interactions, Bioimaging, Introduction to Optical Coherence tomography. Biophotonic diagnosis & therapy.

Expected Outcome

At the end of the course, the student will be able to:

i. Understand the characteristics and properties of different lasers used in medicine.
ii. Learn the optical properties of tissues.
iii. Applications of various optical imaging and sensing techniques in biomedicine.

Text Books:

1. Paras N Prasad: Introduction to Biomedical Photonics, John Wiley.2003
2. Tuan Vo-Dinh: *Biomedical Photonics Handbook*, CRC Press, 2003.

Reference Books:

1. William T Silfwast: *Laser fundamentals*, Cambridge University Press, 1998.
2. Leon Goldman, *The Biomedical laser Technology and Clinical Applications* Springer-Verlag.
3. Leon Goldman, *Lasers in Medicine*, Springer-Verlag.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Principles of operation, characteristics & properties of continuous and pulsed lasers used in medicine - He-Ne, Nd-AG, Argon, CO2, free electron and semiconductor lasers	7	15%
II	Introduction to biophotonics – different applications. Optical properties of tissues: Introduction – fundamental optical properties – refraction, scattering, absorption – light transport in tissue – preliminaries to radiation transport.	4	15%
	Time resolved propagation of light pulses – tissue properties – refractive indices, scattering and absorption properties.	3	
	FIRST INTERNAL EXAM		
III	Light tissue interactions – light interactions with a strongly scattering tissue – continuous wave light, polarized light, short light pulses, diffused photon density waves	4	15%
	Molecular absorption of photon – De excitation pathways – Plasma formation	3	

III	Bioimaging – cellular, tissue imaging and in vivo imaging. Introduction to Optical Coherence tomography.	5	**15%**
SECOND INTERNAL EXAM			
V	Biophotonic diagnostics: Near IR spectroscopy for biological glucose analysis. Biosensors for medical applications - definition and classification - transduction system - optical detection.	4	**20%**
	Flow cytometry: basic operation, optical response - optical biosensors –principles, biorecognition, biological and clinical applications.	4	
VI	Biophotonic Therapy: Photodynamic therapy-basic principle, mechanism of photodynamic action, photosensitizers, applications .	4	**20%**
	Laser tissue welding - mechanism, applications, Photo thermal effects – tissue heating – effects of temperature on tissues – hyperthermia – laser induced interstitial thermotherapy (suggested as application) – tissue vaporization.	4	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course code	Course Name	L-T-P-Credits	Year of Introduction
BM409	MEDICAL IMAGING TECHNIQUES	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To expose imaging methods in medicine and biology.

Syllabus

Ultrasonic imaging, X-Ray computed tomography, Magnetic Resonance Imaging - Radio isotope imaging - SPECT & PET, Infrared Imaging.

Expected Outcome

At the end of the course the student will be able to

i. Learn the different methods and modalities used for medical imaging.
ii. Learn the preferred medical imaging methods for routine clinical applications
iii. Understand the engineering models used to describe and analyze medical images
iv. Apply these tools to different problems in medical imaging.
v. Implement methods to analyze medical images.

Text Books:

1. Webb, The Physics of Medical Imaging, IOP Publishing Ltd., 1988.
2. Peter Fish, The Physics of Diagnostic Ultrasound, John Wiley & sons, England, 1990.
3. A C Kak, Principle of Computed Tomography ,IEEE Press New York
4. HH Schild MRI made easy 2003 - Schering AG.

Reference Books:

1. Douglas A Christensen: Ultrasonic Bioinstrumentation, John Wiley, New York, 1988.
2. M N Rehani: Physics of Medical Imaging, Macmillian India Ltd., 1991.
3. D L Hykes, W R Hedrick & D E Starchman: Ultrasound Physics & Instrumentation, Churchill Livingstone, Melbourne, 1985.
4. Atam Dhavan, Medical Image Analysis,Wiley IEEE Press, 2003.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Basic physics of ultrasound – characteristic impedance, wavelength, frequency and velocity of propagation, Absorption, beam width, resolution. Generation and detection.	2	15%
	Ultra Sound In Medicine – Transducers – types, Block diagram of an ultrasound machine. Principles of image formation, capture and display - A-mode, B-mode and M-mode displays - applications.	3	
	Doppler Ultrasound and Colour flow mapping	1	
	Introduction to 3D and 4D ultrasound and its applications.	1	
II	X-Ray computed tomography - Principles of sectional imaging - generations - data acquisition system –components - image formation principles - conversion of x-ray data into scan image	3	15%
	Image reconstruction from projections CT reconstruction - Radon transform, inverse radon transform back projection operator-convolution back projection- parallel beam geometry-Fan beam geometry.	3	
	2D image reconstruction techniques - Iteration and Fourier methods.	2	
	Types of CT scanners – spiral CT, multi slice CT.	1	

FIRST INTERNAL EXAM			
III	Basic principles of magnetic resonance – magnetic moment, FID, excitation and emission - principles of image formation	2	**15%**
	Basic MRI technique:T1 weighted imaging,T2 weighted imaging, spin density weighted imaging ,Gradient echo imaging, Pulse sequences - spin echo, gradient echo imaging sequence.	4	
	MRI instrumentation – magnets – gradient system – RF coils- receiver system	1	
IV	Image acquisition and reconstruction techniques - MRI Fourier reconstruction.	2	**15%**
	Functional MRI - BOLD signal - clinical applications	1	
	Diffusion tensor imaging - principle and application.	1	
	Topics for seminar only: *Magnetic resonance elastography - Magnetic resonance angiography - Magnetic resonance spectroscopy - Magnetic resonance microscopy - Hybrid imaging – PET, MRI & EEG -MRI , applications - magnetic resonance perfusion weighted imaging*	3	
SECOND INTERNAL EXAM			
V	Emission Computed Tomography - Radio isotope imaging – Radio nuclides for imaging - Rectilinear & Linear scanners, PET & SPECT – principle – Gamma Camera.	6	**20%**
VI	Infrared Imaging - Physics of thermography – IR Detectors - photon & thermal detectors - thermal uncooled IR detectors: resistive micro bolometers, pyroelectric and ferroelectric detectors, thermoelectric detectors. Pyroelectric vidicon camera - camera characterization - thermographic image processing - clinical applications of thermography in rheumatology, neurology, oncology and physiotherapy.	6	**20%**
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course code	Course Name	L-T-P-Credits	Year of Introduction
BM411	MODELLING OF PHYSIOLOGICAL SYSTEMS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To appreciate the value and application of physiological models
- To understand the process of modeling dynamically varying physiological systems
- To understand methods and techniques to analyze and synthesize dynamic models
- To develop differential equations to describe the dynamic behavior of physiological systems.
- To solve and implement a modeling and design problem from inception to completion

Syllabus

Modeling concepts, Physiological Systems Models and the modeling process, Pharmaco-kinetic modeling, Neuron Models, Modeling of human thermal regulatory, respiratory & ultra filtration systems.

Expected Outcome

At the end of the course students will be able to

i. Solve mathematical models in physiological systems.
ii. Simulate system models and observe the dynamic variations of parameters.

Text Books:

1. David Cooney, *Advances in Bio medical Engineering*, Marcel Decker Publications, 1980
2. Arthur C Guyton, *Text Book of Medical physiology*, PRISM Books India, 2000
3. Peter Dayan, *Theoretical Neuroscience: Computational and Mathematical modeling of Neural systems* MIT Press

Reference Books:

1. Rushmer, *Medical Engineering*, Academic Press
2. Yukihito Nose: *The Artificial Kidney*, The C V Mosby Co., 1969.
3. Kennedy & Blackie, *Electromedcial Engineering*
4. Myers, *Engineering in Heart and Blood Vessels*, Wiley International
5. Ibrall & Guytion , *Regulations and Control in Physiological Systems* , Instruments Society USA
6. Brown & Gann, *Engineering in Physiology Vol 1 & Vol 2*
7. Michael C.K. Khoo, *Physiological Control System,* PHI, New Delhi, 2001.
8. Vasilis Z Marmarelis, *Nonlinear Dynamic Modeling of Physiological systems* IEEE Press series in Biomedical Engineering.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Modeling concepts: The techniques of mathematical modeling. Classification of models characteristics of models. Formulation of mathematical model. Physiological complexity and the need for models: Complexity	3	15%
	Different approaches of modeling physiological systems: Linear	3	

	Modeling - Distributed Modeling - Nonlinear Modeling - Time-varying Modeling - Mathematical approach		
	Pharmacokinetic modeling - compartmental models, blood-tissue models.	3	
II	Neuron Models: Electrical properties of Neurons, Single compartment models, voltage dependent conductances, Hodgkin Huxley model	3	**15%**
	Integrate fire neuron model, conductance based models, Cable equation, multi compartment models. Fitzhugh Nagumo models.	5	
FIRST INTERNAL EXAM			
III	Modeling of human thermal regulatory system: Parameters involved, control system model etc.	5	**15%**
IV	Biochemistry of digestion, Loss of heat to the environment, Heat transfer within the body, Models describing heat transfer between core and skin, heat distribution in extremities	6	**15%**
SECOND INTERNAL EXAM			
V	Modeling of Respiratory system: Human Lungs - Anatomy and physiology of the respiratory system -, oxygen and carbon dioxide transport in blood - Modeling oxygen uptake by RBC and pulmonary capillaries	7	**20%**
VI	Modeling of Ultra filtration system: Anatomy and physiology of kidneys - Transport through cells and tubules - passive diffusion - facilitated diffusion and active transports. Methods of waste removal - counter current method of urine formation in nephron - model of Henle's loop.	7	**20%**
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course code	Course Name	L-T-P-Credits	Year of Introduction
BM463	POWER ELECTRONICS & APPLICATIONS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To get a basic idea of the characteristics of modern power semiconductor devices used to perform the power conversions.
- To understand the fundamental principles and the operation, analysis, and design of various power converters
- 3. To familiarize recent applications of power electronics.

Syllabus

Impact of Power Electronics, SCR, TRIAC, Rectifiers, Commutation schemes, Chopper circuits, single phase inverters, speed control schemes for DC and Induction motor, Static switches, Solid state relays., Switching regulators, SMPS and UPS.

Expected Outcome

At the end of the course the student will be able to

i. Understand various power semiconductor devices and their application in control and conversion of electrical energy.
ii. Analyze and design solution to problems in wide spectrum of power engineering.

Reference Books:

1. Daniel. W. Hart, Power Electronics, Pearson Education
2. Dr. P. S. Bimbhra, Power Electronics, Khanna Publishers
3. M.D. Singh,K.B. Khanchandhani,PowerElectronics,TataMcgraw Hill.
4. Muhammad H. Rashid, Power Electronics Circuits, Devices and Applications, Pearson Education
5. Ned Mohan, Tore M. Undeland, Power electronics: converters, applications, and design, John Wiley & Sons.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to power electronics and its impact on modern industrial applications	1	20%
	Thyristors- Classification , SCR: Working principle, V – I, turn on, turn off and gate characteristics, ratings, Series and parallel operation of SCRs.	2	
	Trigger circuits- half- wave and full-wave operation, Thyristor protection - over current, over voltage, di/dt, dv/dt, gate protection.	3	
	TRIAC: characteristics, modes of operation.	2	
II	Single phase controlled rectifiers - half-wave, full-wave, half-controlled and fully controlled - typical waveforms with R, RL, RL with diode and RL with voltage source - voltage and current equation for half-wave controlled rectifier.	5	20%
	Three phase half-wave and full-wave controlled rectifier with R load, waveforms.	3	

FIRST INTERNAL EXAM			
III	DC motor speed control - various schemes - multiquardrant operation	3	15%
	Circuits for speed control of series, PM and separately excited motors	3	
IV	Commutation schemes - (different classes) waveforms	4	15%
	Chopper circuits using SCR/transistor -step up, step down, step up/down (detailed analysis not required)	2	
SECOND INTERNAL EXAM			
V	Single-phase invertors - series, parallel and bridge -PWM invertor – square wave and sin wave input	4	15%
	Induction Motor speed control - various schemes for electronic control.	3	
VI	Static switches: dc & ac (1φ and 3φ) switches, Solid state relays	2	15%
	Switching regulators - Basic concepts, analysis and design of Buck, Boost and Buck-Boost converters	3	
	SMPS - Configuration – Application. UPS - Configuration – Application. Batteries - charging circuit	2	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course code	Course Name	L-T-P-Credits	Year of Introduction
BM467	MEDICAL ROBOTICS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To understand the basics of robot kinematics
- To know basic concepts in kinematics, dynamics, and control relevant to medical robotics
- To develop the analytical and experimental skills necessary to design and implement robotic assistance for both minimally invasive surgery and image-guided interventions
- To understand professional and ethical responsibility

Syllabus

This course is designed for students to gain an understanding of fundamentals of and the state-of-the art in medical robotics. Through this course, students will learn the basic concepts, study fundamental techniques, and appreciate clinical level applications of popular medical robotic systems, from micro-scale in vivo devices to in vitro full-size surgical systems. Existing limitations and future perspectives will also be introduced and discussed.

Expected Outcome

At the end of the course the student will be able to

- Apply knowledge of mathematics, science, and engineering to design as well as to analyze and interpret data for meeting desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability.

Reference Books:

1. Achim Schweikard, Medical Robotics, Springer
2. John J. Craig, Introduction to Robotics: Mechanics and Control, Third Edition, Prentice-Hall (Pearson), 2005, ISBN: 0-13-123629-6.
3. P. Mikell, G. M. Weiss, R. N. Nagel, and N. G. Odraj, Industrial Robotics, McGraw-Hill

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Basic Concepts: Definition and origin of robotics	1	15%
	Different types of robotics, various generations of robots. Asimov's law s of robotics.	2	
	Degrees of freedom – dynamic stabilization of robots	4	
II	Review of Mathematical Preliminaries, Robot Forward Kinematics - Position, velocity, and acceleration analysis	4	15%
	Robot Inverse Kinematics, Manipulator Jacobian	3	
	FIRST INTERNAL EXAM		
III	Introduction to medical robotics -applications and paradigms	2	15%
	Robotic control and sensing systems, human-robot interaction,	5	

	Basic control concepts -impedance, admittance		
IV	Minimally Invasive Surgery (MIS), Human-machine interfaces, Robot design concepts, Video images in MIS, Augmented reality	4	**15%**
	Image-Guided Interventions, Robot compatibility with medical imagers(e.g., MRI, US, X-ray, CT), Image segmentation and modeling, Tracking devices, Surgical navigation, Calibration	3	
SECOND INTERNAL EXAM			
V	Case Studies: Cardiac, abdominal, and urologic procedures with tele-operated robots, Robotic catheters for heart electrophysiology	3	**20%**
	Orthopedic surgery with cooperative robots, Prostate interventions with manual "robots"	2	
	Mobile robots in the body, Instrument-tissue interaction modelling	2	
VI	Autonomous robotic surgery Other types of healthcare robots:	2	**20%**
	Physically assistive robotics, Socially assistive robotics, Rehabilitation robotics	3	
	Professional and medical ethics- robotics and artificial intelligence in human body	2	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course code	Course Name	L-T-P - Credits	Year of Introduction
**451	Seminar and Project Preliminary	0-1-4-2	2016
Prerequisite : Nil			

Course Objectives

- To develop skills in doing literature survey, technical presentation and report preparation.
- To enable project identification and execution of preliminary works on final semester project

Course Plan

Seminar: Each student shall identify a topic of current relevance in his/her branch of engineering, get approval of faculty concerned, collect sufficient literature on the topic, study it thoroughly, prepare own report and present in the class.

Project preliminary:

Identify suitable project relevant to the branch of study. Form project team (not exceeding four students). The students can do the project individually also. Identify a project supervisor. Present the project proposal before the assessment board (excluding the external expert) and get it approved by the board.

The preliminary work to be completed: (1) Literature survey (2) Formulation of objectives (3) Formulation of hypothesis/design/methodology (4) Formulation of work plan (5) Seeking funds (6) Preparation of preliminary report

Note: The same project should be continued in the eighth semester by the same project team.

Expected outcome .

The students will be able to

i. Analyse a current topic of professional interest and present it before an audience
ii. Identify an engineering problem, analyse it and propose a work plan to solve it.

Evaluation

Seminar : **50 marks**

(Distribution of marks for the seminar is as follows: i. Presentation : 40% ii. Ability to answer questions : 30% & iii. Report : 30%)

Project preliminary : **50 marks** (Progress evaluation by the supervisor : 40% and progress evaluation by the assessment board excluding external expert : 60%. Two progress evaluations, mid semester and end semester, are mandatory.)

Note: All evaluations are mandatory for course completion and for awarding the final grade.

Course code	Course Name	L-T-P-Credits	Year of Introduction
BM431	CLINICAL INSTRUMENTATION LAB	0-0-3-1	2016

Prerequisite: BM403 Therapeutic equipment

Course Objectives

- To acquaint with the operation and working principles of various biomedical instruments, surgical procedures and clinical instrumentation.

List of Exercises/ Experiments (Minimum 12 are mandatory)

1. Power amplifier circuit of Stylus movement
2. Chart Drive circuit.
3. QRS Detector circuit.
4. Automatic gain compensation circuit.
5. Time gain compensation circuit.
6. ESU waveform generator.
7. Study of IC 7107.
8. Study of various electrodes for data acquisition of Bio-signals
9. Study of multiparameter physiological recorders.
10. Spectrophotometer - Study, Standardization & Calibration.
11. Colorimeter - Study, Standardization & Calibration.
12. Flame photometer- Study, Standardization & Calibration.
13. ECG Machine – Study & Calibration.
14. Study of Electrosurgical unit
15. Study of ventilator & x-ray radiography system (Demo)
16. Study of ultrasound waves – Ultrasound transmitter & detector (Demo)
17. Circuit designing and PCB fabrication using simulation software
18. Study of Electrical safety analyzers

Equipments needed: Multimeters, function generators, CROs, power supplies, physiological recorders, ECG Machine, EEG machine, ESU unit, Ventilator unit, X-Ray equipment, Colorimeter, spectrophotometer, ultrasound transducers, Electrical safety analyzers.

Expected Outcome

At the end of the course the student will be able to

i. Identify and calibrate various clinical instruments
ii. Trouble shoot and service biomedical equipments for its improved working

Text Book:

1. R S Khandpur, Handbook of Biomedical Instrumentation by, 3rd Edition, McGraw Hill Publishers
2. Joseph J. Carr, John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education (Singapore) Pvt. Ltd., 2001.