SMTB5101	ADVANCE MATHEMATICS (Common to all M.E Branches and M.Tech Medical Instrumentation)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVE

- The ability to identify, reflect upon, evaluate and apply different types of information and knowledge to form independent judgments.

UNIT 1 MATRIX THEORY 9 Hrs.

QR decomposition – Eigen values using shifted QR algorithm – Singular Value Decomposition – Pseudo inverse – Least square approximations

UNIT 2 CALCULUS OF VARIATIONS 9 Hrs.

Concept of Functionals – Euler's equation – functional dependent on first and higher order derivatives – Functionals on several dependent variables – Iso-perimetric problems – Variational problems with moving boundaries

UNIT 3 TRANSFORM METHODS 9 Hrs.

Laplace transform methods for one dimensional wave equation – Displacements in a string – Longitudinal vibration of a elastic bar – Fourier transform methods for one dimensional heat conduction problems in infinite and semi infinite rod.

UNIT 4 ELLIPTIC EQUATIONS 9 Hrs.

Laplace equation – Properties of harmonic functions – Fourier transform methods for Laplace equations – Solution for Poisson equation by Fourier transforms method.

UNIT 5 LINEAR AND NON-LINEAR PROGRAMMING 9 Hrs.

S Simplex Algorithm – Two Phase and Big M techniques – Duality theory – Dual Simplex method – Non Linear Programming – Constrained extrenal problems – Lagranges multiplier method – Kuhn – Tucker conditions and solutions.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Defining the concepts of Matrix theory.
CO2 - Learning the concepts of calculus of variations and its applications.
CO3 - Understanding the concept of transform methods and elliptic equations.
CO4 - Evaluation of one dimensional heat conduction problems using transform methods
CO5 - Applying various techniques for solving linear programming problems.
CO6 - Produce the solution for non-linear programming problems.

TEXT BOOK / REFERENCE BOOK

1. Richard Bronson, Schaum's Outline Matrix Operations, McGraw-Hill, 2011.
2. Venkataraman M K, Higher Engineering Mathematics, National Pub. Co, 2003.
3. Elsgolts, L., Differential Equations and Calculus of Variations University Press of the Pacific,2003.
4. I.N., Elements of Partial differential equations, Dover Publications, 2006.
5. SankaraRao, K., Introduction to partial differential equations. Prentice Hall of India, 2011.
6. Taha H A, "Operations research - An introduction, McMilan Publishing co, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB5101	INTRODUCTION TO ANATOMY AND PHYSIOLOGY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To impart knowledge on basic structural and functional elements of human body.
- To impart knowledge on Organs and structures involving in system formation and functions

UNIT 1 CARDIOVASCULAR AND SPECIAL SENSES 9 Hrs.

Structure of Heart, Cardiac Cycle, ECG, Arterial Blood Pressure, Structure of Eye and Ear, Photochemistry of vision and accomodation, Mechanism of Hearing, Sensation of Taste and Sensation of Smell.

UNIT 2 GASTROINTESTINAL AND RESPIRATORY 9 Hrs..

Structure of gastrointestinal system, Mouth, Stomach, Saliva, Gastric juice, pancreatic juice, Liver. Mechanism of breathing, Lung volumes and capacities, Oxygen and Carbon dioxide transport, Pulmonary function tests,

UNIT 3 ENDOCRINE AND NEURAL 9 Hrs..

Endocrine glands Hypothalamus and Pituitary gland, Thyroid gland, Endocrine function of Pancreas, Adrenal glands Structure of kidney, Nephron, Physiology of Urine formation, renal function tests,Cystometerogram, Skin structure and function

UNIT 4 NERVOUS SYSTEM 9 Hrs..

Neuron, Synapse, Neurotransmitters, Reflex activity, Spinal cord, EEG, Physiology of Pain, Physiology of Sleep, Epilepsy, Cerebrospinal fluid (CSF)

UNIT 5 REPRODUCTIVE SYSTEM 9 Hrs..

Male Reproductive System, Female Reproductive System, Menstrual cycle, Ovulation, Menopause, Placenta, Fertility control

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course the student will be able to

CO1 - Recall the basic elements of human body.
CO2 - Compare the major bones and their processes as they relate to each region of the body
CO3 - Recognize the major organs and vessels of the cardiovascular system.
CO4 - Interpret the major organs and components of the respiratory system.
CO5 - Describe the basic components and functions of urinary and special sensing systems.
CO6 - Demonstrate the structure and functions of nervous systems.

TEXT BOOK / REFERENCE BOOK

1. Ross and Wilson, Anatomy and Physiology in Health and Illness, Churchill Livingstone, 12th Edition 2019
2. Gerard. J. Tortora Principles of Human Anatomy and physiology, Harper Collins College Publishers, 9th Edition 2015
3. Arthur C. Guyton & John E. Hall, Text Book of Medical Physiology, W.B. Saunders Company, London, 12th Edition 2015
4. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Oxford University Press, USA, 2018
5. William F.Ganong, ―Review of Medical Physiology, 22nd Edition, McGraw Hill, New Delhi,2017

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB5102	BIOSENSING TECHNOLOGIES	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- Covers biosensor approaches including electrochemistry, fluorescence, acoustics, and optics; aspects of selective surface chemistry including methods for biomolecule attachment to transducer surfaces.

UNIT 1 INTRODUCTION 9 Hrs.

Introduction to biosensors Biosensor classification, Main elements in biosensors, General Configuration and functional description of measuring instruments-Characteristics of instrument-Static characteristics - Dynamic characteristic, Error in the measurements. Overview of Biosensors, Fundamental elements of biosensor devices, advantages and limitations.

UNIT 2 PHYSICAL&CHEMICALSENSORS 9 Hrs.

Sensors for physical measurands: pressure, acceleration, flow, volume, temperature and biopotentials. Sensors for measurement of chemicals, ion selective electrodes, ISFETS; Amperometric sensors, Clark Electrode; Biosensors, Catalytic biosensors, Immunosensors. Smart sensors: Introduction -Primary sensors, Converters, Compensation, Recent trends in sensor technology, Basics of detection methods: Fluorescence Spectroscopy, UV-Vis Absorption and Emission.

UNIT 3 TRANSDUCERS 9 Hrs.

Classification of transducers-Resistive, Capacitive, Inductive, Potentiometers, Temperature Compensation, Resistance Hygrometer, Linear variable differential transformer, Capacitive displacement transducers, Equibar differential pressure transducer , Photoelectric, piezoelectric and mechanoelectronics, Principle of fiber optic cable, fiber optic sensors, Photo acoustic sensors.

UNIT 4 ELECTRODES & AMPLIFIERS 9 Hrs.

Half cell potential, Reference electrodes, polarization effects, Polarisable and non-polarisable electrodes, Micro electrodes, Equivalent Circuits, Liquid and solid ion exchange membrane electrode, Enzyme electrode Signal Conditioning circuits-Characteristics of Amplifiers, Differential Amplifiers, Filters, A/D Converters.

UNIT 5 NONELECTRICALPARAMETERMEASUREMENTS 9 Hrs.

Measurements of Respiration Rate, Temperature, Pulse rate, Blood pressure Measurements- Direct, Indirect, Blood flow Measurements–Invitro, Invivo, Gas flow measurements.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course the student will be able to

CO1 - Apply principles and concepts of biology and engineering to design biosensors

CO2 - Apply principles and concepts of electronics and electrochemistry to design electrochemical biosensors.

CO3 - Recognize different types of transducers, and their application in biosensor design

CO4 - Apply principles and concepts of sensing and engineering to (i) design biosensors for detection of markers in biofluids, and (ii) be able to evaluate quality of biosensors

CO5 - Apply engineering tools to evaluate parameters needed for point-of-care health screening and mobile-health, and design of appropriate point-of-care diagnostic devices

CO6 - Work in a team to design biosensors and identify applications

TEXT BOOK / REFERENCE BOOK

1. Richard S.C. Cobbold: Transducers for Biomedical Measurements: Principles and Applications, John Wiley & Sons 2012.
2. A.P.F. Turner, I.Karube & G.S.Wilson: Biosensors: Fundamentals & Applications, Oxford University Press, Oxford,2007. 3.RanganC.S.,SarmaG.R.,and,Instrumentation devices and system, Second Edition,Tata McGraw Hill Publishing Company Limited,NewDelhi,2016.
4. John G.Webster, Medical Instrumentation, Application and Design,3rdEdition,JohnWilleyandSons,2017.
5. Jacob Kline, Handbook of BioMedical Engineering, Academic press Inc.,Sandiego,2016.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB5103	ADVANCED BIOMEDICAL INSTRUMENTATION	L	T	P	EL	Credits	Total Marks
		3	0	0	2	3	100

COURSE OBJECTIVE

- To provide the student with an advanced understanding of biomedical instrumentation, from signal acquisition through to process control.
- To understand the principles and working of therapeutic and surgical equipments.
- To enrich students' knowledge with ultrasonic applications and neonatal equipments.
- To learn about the safety measures while working on medical equipments.

UNIT 1 BIOSIGNAL MEASUREMENTS 9 Hrs.

Sources of biomedical signals, Basic medical instrumentation system, Need for bio-amplifier - differential bio-amplifier, Impedance matching circuit, isolation amplifiers, Electrodes for ECG, EEG, EMG, ECG, EEG, EMG - Lead systems and recording methods. Electrooculography (EOG), Electroretinography (ERG).

UNIT 2 CARDIAC AND RESPIRATORY CARE UNIT 9 Hrs.

Cardiac Pacemakers-different types and their comparison, batteries for pacemakers, Defibrillators-Need, DC Defibrillator, Implantable defibrillators, Heart lung machine -Different types of Oxygenators, Pumps, Monitoring Process, Hemodialyser- Principle of Hemodialysis, Membranes, Dialyasate, Wearable Artificial Kidney, Regulation of Breathing - Humidifier, Nebulizer – Ventilators - different types.

UNIT 3 RADIOLOGICAL, SURGICAL SCOPY AND DIATHERMY EQUIPMENT 9 Hrs.

Digital radiography, Mammography, Angiography, Endoscopy, Laparoscopy Bronchoscopy, Gastroscopy, Physiological effects of HF radiation, Depth of Penetration, Short wave, Ultrasonic and microwave diathermy, Surgical diathermy, Galvanic, Faradic Stimulators, Interferential therapy, Cryosurgery.

UNIT 4 ULTRASONIC AND NEONATAL INSTRUMENTS 9 Hrs.

Basic principles of Echo technique, display techniques A, B, M modes, Echo cardiograms, Echo encephalogram, Ultrasonic applied as diagnostic tool in ophthalmology, obstetrics and gynaecology. Infusion Pumps. Baby incubator, Phototherapy, Radiant warmer - Working principle, block diagram, description, and function of basic blocks, Foetal Monitoring System.

UNIT 5 SPECIAL MEDICAL INSTRUMENT AND SAFETY MEASUREMENTS 9 Hrs.

Principles and operations of thermographic Equipment, applications of thermography. Lithotripters-Principles and operations of Lithotripter system, Ophthalmic equipment- slit Lamp, Keratometer, Tonometer, Retinal response Plotter, Electric shock hazards – Gross shock, Effects on human body, Micro and macro electric shock, Leakage current and types, Safety techniques, Testing of Biomedical Equipment.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Describe and emphasize particular components of the cardiac and respiratory care units and assistive devices

CO2 - Design amplifier and Isolation circuits for any bio signals

CO3 - Familiarize with radiological and surgical instruments in hospital

CO4 - Solve design related problems in diathermy and various scopes

CO5 - Design ultrasound and neonatal equipment

CO6 - Analyze the principles of special equipment and safety measures in various equipment

TEXT BOOK / REFERENCE BOOK

1. John G. Webster, Amit J. Nimunkar, Medical Instrumentation application and design – 5th Edition, (An Indian Adaptation), Wiley India, 2021.
2. R. AnandaNatarajan, Biomedical Instrumentation and Measurements, 2nd Edition, PHI, 2016.
3. Leslie Cromwell, ―Biomedical Instrumentation and measurement, Prentice Hall of India, New Delhi, 2nd edition, 2015.
4. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd edition, 2014.
5. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", edition, 2015. Pearson education, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

S1SB9101	RESEARCH METHODOLOGY & IPR	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To understand the concepts of research.
- To provide an insight into the techniques of research. To learn the requisites of writing a research report.
- To impart knowledge on formulation of research problem, research methodology, ethics involved in doing research and importance of IPR protection

UNIT 1 RESEARCH PREPARATION AND PLANNING 9 Hrs.

Objectives of research – Understanding research and its goals, Critical thinking, Techniques for generating research topics. Topic selection and justification. Techniques involved in designing a questionnaire – Methods of scientific enquiry – Formulation of hypotheses and testing of the same – Development of a research proposal

UNIT 2 RESEARCH RESOURCES 9 Hrs.

Sources of information. Literature search. World Wide Web, Online data bases – search tools. Citation in dices – Principles underlying impact factor – Literature review – Case studies, review articles and Meta analysis – Role of the librarian. Ethical and moral issues in Research, Plagiarism, tools to avoid plagiarism

UNIT 3 ACADEMIC WRITING AND PRESENTATION 9 Hrs.

Proposal submission for funding agencies, Elements of Style. Organization of proposals, Basic knowledge of funding agencies, Research report writing, Communication skills, Tailoring the presentation to the target audience – Oral presentations, Poster preparations, Submission of research articles for Publication in Reputed journal, Thesis writing and Research report writing. Elements of excellent presentation: preparation, visual and delivery, oral communication skills and oral defense.

UNIT 4 DATA COLLECTION, ANALYSIS AND INFERENCE 9 Hrs.

Basic statistical distributions and their applications.Sample size determination and sampling techniques.Large sample tests and small sample tests.

UNIT 5 INTELLECTUAL PROPERTY RIGHTS 9 Hrs.

Nature of Intellectual Property: Patents, Designs, Trade Mark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting under PCT.Scope of Patent Rights.Licensing and transfer of technology.Patent information and databases.Geographical Indications. New Developments in IPR: Administration of Patent System.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, the student will be able to

CO1 - Understand the important basics of research and Intellectual Property Rights.
CO2 - Write research problem formulations through various methods of literature survey.
CO3 - Analyze research related information and Follow research ethics
CO4 - Correlate the results of any research article with other published results. Write a review article in the field of engineering.
CO5- Differentiate patents, copyrights, trademark and designs.
CO6 - Apply the process for IPR protection.

TEXT BOOK / REFERENCE BOOK

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.
5. James C. Van Horne, Standford University, Financial Management and Policy, Prentice Hall,
6. James R. McGuigan, R. Charles Moyer, Frederick H. deB. Harris, Managerial economics – applications, strategy and Tactics, Cengage learning,
7. Philip Kotler, Marketing management Pearson Education, India
8. Modern Production / Operations Management, Elwood S. Buffa & RakeshSarin, Wiley India
9. Ronald R. Sims, Organizational success through effective human resources Management, Quorum books, London
10. Ganesan R, Research Methodology for Engineers, MJP Publishers, Chennai. 2011

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB6101	BIOMEDICAL INSTRUMENTATION LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVE

- To provide the student with an advanced understanding of biomedical instrumentation, from signal acquisition to measuring and processing.
- To understand the fundamental principles and working of biomedical instruments.
- To learn about applying MATLAB in signal simulation.

COURSE CONTENTS

1. Analysis of ECG using BIOPAC system
2. Heart rate variability extraction and analysis from ECG
3. Phonocardiography- Assessment of heart sounds
4. Simulation of heart abnormalities and verification using a cardiac pacemaker.
5. Heart Lung Machine- Working
6. Haemodialysis- Working
7. Study of Short-wave Diathermy.
8. Testing of Surgical Diathermy
9. Medical telemetry system with receiver and transmitter.
10. Design and testing of instrumentation amplifier for ECG acquisition.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Illustrate various diagnostic and therapeutic techniques
CO2 - Evaluate the working of medical instruments.
CO3 - Analyze the different bio signals using suitable tools
CO4 - Apply safe handling of equipment in hospitals.
CO5 - Acquire skills to operate medical equipment.
CO6 - Design cost effective and simple biomedical instruments.

SBMB5201	BIOSIGNAL SIGNAL PROCESSING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To presents the application of the main signal processing tools to the analysis of biomedical signals
- To illustrated with examples of the application in the analysis of the electrocardiogram (ECG), electroencephalogram (EEG), evoked potentials (EP), heart rate variability (HRV) and other signals
- To study various techniques for noise cancellation of Biosignals

UNIT 1 INTRODUCTIONTOBIOMEDICAL SIGNALS 9 Hrs.

Bioelectric signals-Action potential, Electro-neurogram, Electro-oculogram,Electro-encephalogram, Evoked potential, Electro-cardiogram, Electro-gastrogram, bio-impedance signals-course objectives of biomedical signal analysis, difficulties inbiomedical signal analysis.

UNIT 2 REAL TIME TRANSFORMS 9 Hrs..

Convolution–LinearConvolution,CircularConvolution,Correlation–Auto Correlation, Cross Correlation, DFT and FFT–DIT & DIF Algorithms, Real Time Transforms: Discrete Cosine Transform, Walsh Transform, Hadamard Transform and Wavelet Transform.

UNIT 3 FILTERING 9 Hrs..

Time domain filtering–Synchronous averaging, Moving average filters, Frequency domain filters–Design of Butterworth filters-optimal filtering, Adaptive noise cancellation-LMS and RLS algorithms in adaptive filtering – Application of these techniques in removal of artifacts in bio-signals.

UNIT 4 EVENTDETECTION 9 Hrs..

Detection of events and waves – Derivative based operators in QRS detection – Pan Tompkins algorithm – Correlation analysis- ACF and CCF in rhythm analysis – Cross - spectral techniques - Murmur detection - Homomorphic filtering –Matchedfilters–Waveletdetection–Spikeandwavedetection-Extraction of vocaltract response and other applications.

UNIT 5 CANCELLATION OF NOISE IN BIO SIGNALS 9 Hrs..

Adaptive noise cancellation-LMS and RLS algorithms in adaptive filtering – Application: Motion Artifacts in ECG, Powerline Interference in ECG, Maternal Interference in ECG.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course the student will be able to

CO1 - Understand the sources and characteristics of biomedical signals
CO2 - Obtain the frequency and time-frequency components of the signals using transforms
CO3 - Analyse various filtering techniques for biomedical signals
CO4 - Determine the events that occur in biopotential signals
CO5 - Perform noise cancellation in biosignals
CO6 - Model and Develop a system for bio signal analysis

TEXT BOOK / REFERENCE BOOK

1. Rangaraj M.Rangayyan, 'Biomedical Signal Analysis - A case study approach', Wiley-Interscience / IEEE Press, 2015.
2. Willis J.Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2006.
3. Dr.P.Ramesh Babu, Digital Signal Processing Scitech Publications, 4th Edition 2010 4.
4. D.C.Reddy, Biomedical Signal Processing–Principles and Techniques, TMH, New Delhi, 2005
5. Avtar Singh and S. Srinivasan, Digital Signal Processing, Thomson Publishing 2004, Singapore.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

S44BPB21	INDUSTRY VERSION 5.0	L	T	P	EL	Credits	Total Marks
		2	0	2	0	3	100

COURSE OBJECTIVE

- To have an in-depth knowledge of advancements in Industries
- To differentiate Industry version 4.0 and version 5.0.
- To acquire knowledge on Internet of Medical things and its security threats and challenges

UNITB 1 INTRODUCTION TO INDUSTRY 5.0 9 Hrs.

Industry 4.0- difference between industry 4.0 and industry 5.0, Society 5.0, Human Centric Approach, Advantages of Industry 5.0, Implementation of Industry 5.0.-Challenges-Human Centric solution

UNIT 2 FEATURES OF INDUSTRY 5.0 9 Hrs.

Smart additive manufacturing- Predictive maintenance- Hyper customization- Cyber Physical Cognitive systems- Supply chain management-Collaborative Robots-6G communication-Big data Analytics

UNIT 3 INDUSTRY 5.0 IN BIOMEDICINE 9 Hrs.

Smart hospitals- Smart Sensors- 4D CT and MRI scans-Holography in medicine-AI in medicine-Robotic Surgery-Smart materials and 4D printing

UNIT 4 INTERNET OF MEDICAL THINGS 9 Hrs.

Introduction and system architecture: Introduction, IoMT Devices-On-Body Devices, In Home Devices, Community Devices, In-Clinic Devices, In Hospital Devices, IoMT System Architecture-Data Collection Layer, Data Management Layer, Medical Server Layer.

UNIT 5 INTERNET OF MEDICAL THINGS SECURITY 9 Hrs.

Threats, Security Challenges and Potential Solutions: IoMT Attack Types, Challenges in IoMT Security Schemes, Current Security Plans for IoMT, Potential Solutions for Security Vulnerabilities.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course the students will be able to

CO1 - Differentiate Industry 4.0 and Industry 5.0
CO2 - Evaluate features of Industry 5.0
CO3 - Analyse Industry 5.0 in biomedical field.
CO4 - Analyse the aspects of Internet of Medical things
CO5 - Examine the security challenges and threats in Internet of medical things
CO6 - Explore avenues of IoMT in Industry 5.0

TEXT BOOK / REFERENCE BOOK

1. Veneri, Giacomo, and Antonio Capasso- Hands-on Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0, 1stEd.,Packt Publishing Ltd, 2018.
2. D. Jude Hemanth and J. Anitha George A. Tsihrintzis- Internet of Medical Things Remote Healthcare Systems and Applications, Springer, 2021
3. UthayanElangovan, Industry 5.0: The Future of the Industrial Economy,2021
4. Srivastava J, Routray S, Ahmad S, Waris MM. Internet of Medical Things (IoMT)-Based Smart Healthcare System: Trends and Progress. ComputIntellNeurosci. 2022

S44BLH21	EMBEDDED SYSTEM DESIGN AND CIRCUITS	L	T	P	EL	Credits	Total Marks
		3	0	2	0	4	100

COURSE OBJECTIVE

- To study the ARM processor and ARM instruction sets.
- To understand RTOS concepts and Embedded networking concepts.
- To understand basic ARM interfacing.

UNIT 1 INTRODUCTION TO EMBEDDED SYSTEMS 9 Hrs.

Definition of embedded system, Embedded systems Vs General computing systems, History of embedded systems and classification, Major application areas of embedded systems, purpose of embedded systems, characteristics and quality attributes of embedded systems.

UNIT 2 ARM INSTRUCTION 9 Hrs.

ARM Architecture ARM Design Philosophy, Registers, Program Status Register Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions. Thumb Instruction Set : Register Usage, Other Branch Instructions, Data Processing Instructions,SingleRegisterandMultiRegisterLoad-StoreInstructions,Stack,SoftwareInterrupt Instructions.

UNIT 3 REALTIMEOPERATINGSYSTEM 9 Hrs.

Real time operating systems (RTOS)–real time kernel–OStasks–task states–task scheduling–interrupt processing–clocking communication and synchronization–control blocks–memory requirements and control–kernel services.

UNIT 4 EMBEDDED NETWORKS 9 Hrs.

Embedded Networks-Distributed Embedded Architecture, Networks for embedded systems–I2C, CAN Bus, Ethernet, Internet, Network–Based design–Communication Analysis, system performance Analysis, Hardware platform design, Allocation and scheduling.

UNIT 5 SYSTEM DESIGN 9 Hrs.

Switches and LED interfacing-LCD Display interfacing - Analog sensors interfacing for digital data conversion- Access control using analog keypad, Design Example: Elevator Controller.

PRACTICE EXERCISES 15 Hrs.

1. Basic inverting adder, non-inverting adder, unity follower.
2. Highpass, lowpass and band pass filter design.
3. Comparator and waveform generator.
4. Half and full adder.
5. Half and full subtractor.
6. Study of basic flipflops.
7. Study of registers and counters.
8. Interfacing stepper motor and temperature sensor.

Max. 60 Hrs.

C**OURSE OUTCOMES**

On completion of the course, students will be able to

CO1 - Discuss and design embedded systems.
CO2 - Identify the significance of Real Time Operating Systems.
CO3 - The types of memory and interfacing to external hardware.
CO4 - Describe embedded firmware design approaches.
CO5 - Analyse the issues for development of task communication techniques and device drivers.
CO6 - Identify the use of system design that can be used for specific medical application

TEXT BOOK / REFERENCE BOOK

1. Felipe Neves Hands-on Embedded systems Design, 2019.
2. Jonathan W.Valvano, Embedded Microcomputer Systems: Real Time Interfacing, Cengage Learning, 2019.
3. Wayne Wolf, Computersas Components: Principles of Embedded Computing System Design, Morgan Kaufman Publishers, 2008.
4. Hands-on Embedded systems Design, 2019.

SBMB5301	ADVANCED REHABILITATION ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	0	2	3	100

COURSE OBJECTIVE

- To incorporate the principles and ethics of rehabilitation while designing a device
- To discriminate between an orthotic and prosthetic device and design the same
- To integrate the concepts learnt through the course to develop devices that will support in significant fields of rehabilitation

UNIT 1 INTRODUCTION 9 Hrs.

Introduction to Rehabilitation Engineering, Principles involved in rehabilitation engineering. Steps in patient management, Epidemiology of Rehabilitation, Preventive Rehabilitation, Diagnosis of Disability and Functional Diagnosis, Tele-rehabilitation, Vocational Rehabilitation, Paediatric Rehabilitation, Policy and regulations in rehabilitation engineering, Ethical Issues in rehabilitation engineering

UNIT 2 VIRTUAL REALITY REHABILITATION AND REHABILITATION TEAM 9 Hrs.

Virtual reality-based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation. Rehabilitation Team: The Role of Physiatrist, Occupational Therapist, Physical Therapist, Prosthetics- Orthotics, Rehabilitation nurse& Biomedical engineer. Burn injury rehabilitation.

UNIT 3 ORTHOTICS AND PROSTHETICS 9 Hrs.

Orthotics, classification of orthotics, general principles of orthotics, biomechanics of orthotics, material design consideration in orthotics, different types of orthotics–spinal, cervical, thoracic tlso and lso. Automated Technological tools in rehabilitation-Fundamentals, FES systems-restoration of hand functions, restoration of standing & walking,hybrid assistive systems. Active prostheses-active above knee prostheses, myoelectric hand and arm prostheses.

UNIT 4 NEURO PROSTHETICS 9 Hrs.

Sensory prosthetics-Visual Prosthetics-Bionic eye -auditory prosthetics-cochlear implant- Auditory brain stem implant- bionic ear- spinal cord stimulator- Motor prosthetics- bladder control implant-sacral anterior root stimulator-Brain computer interface, Cognitive technologies

UNIT 5 COMMUNICATION SYSTEMS AND MOBILITY AIDS 9 Hrs.

Communication systems: AAC in the 21st century, Hand Talk Device, types of visual aids, IOT assisted blind canes- Features, hearing aids, writing aids. Electronic Assitive Technology - (EAT), Mobility Aids: Walking frames, Parallelbars, Rollators, Quadripods, Tripods & walking sticks, Crutches, EMG based & Solar Powered Wheelchairs, Specialized wheelchairs. Smart sensors for activity recognition- Wearable sensors, Smart phones, Machine learning.

Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Apply the principle involved in rehabilitation engineering following ethics and policies.
CO2 - Create a rehabilitation team to aid a patient and support in recovery through virtual reality.
CO3 - Develop skills to design an orthotic and prosthetic device.
CO4 - Designneuro -prosthetic devices for relevant patients based on their disability.
CO5 - Analyze the available aids in hearing, visual and mobility communications.
CO6 - Assess the state of the art in rehabilitation engineering both in the clinical practice and in research

TEXT BOOK / REFERENCE BOOK

1. Roshani Raut, Intelligent Systems for Rehabilitation Engineering, Wiley Publications, 2022
2. Alex Mihailidis, Rehabilitation Engineering- Principles and Practices, CRC Press, 2023.
3. Dr.S. Sunder, Rehabilitation Medicine, Jaypee Medical Publications,2016.
4. Kondraske, G.V, Rehabilitation Engineering, CRC Press, 2016

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB5302	ADVANCED MEDICAL IMAGE PROCESSING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To provide students an overview of the computational and mathematical methods in medical image processing.
- To study the current methods used to enhance and extract useful information from medical image
- To have knowledge about variety of radiological diagnostics methods for image acquisition

UNIT 1 IMAGE FUNDAMENTALS AND PREPROCESSING 9 Hrs.

Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization – two-dimensional sampling theory, Image quantization, Image transforms–2D-DFT, Image enhancement–point operation, Histogram modeling, spatial operations.

UNIT 2 BASICS OF MEDICAL IMAGE SOURCES 9 Hrs..

Medical images obtained with ionizing radiation: Medical imaging modalities, Images from x-rays, Images from γ-rays, Dose and risk. Medical images obtained with non-ionizing radiation: Ultrasound imaging, Magnetic resonance imaging ,Picture archiving and communication systems(PACS).

UNIT 3 MEDICAL IMAGE ANALYSIS AND CLASSIFICATION 9 Hrs..

Image segmentation- pixel based, edge based, region-based segmentation. Feature extraction and representation - Statistical, Shape, Texture, Feature and image classification –Wavelet transform.

UNIT 4 IMAGE REPRESENTATION, RECONSTRUCTION, RECOGNITION 9 Hrs..

Representation–Chain Code–Polygonal approximation, signature, boundary segments–Boundary descriptors–Shape number–Fourier Descriptor, moments-Regional Descriptors–Topological feature, Texture–Pattern and Pattern classes–Projection geometry-Fourier Slice theorem-Back Projection-Algebraic reconstruction, Recognition based on matching.

UNIT 5 INTELLIGENT TECHNIQUES INIMAGING PROCESSING 9 Hrs..

SVM, The Unsupervised Clustering Algorithm, Bayes Classifier, Support Vector Machine, Neural Networks, deep learning for image processing. Application on AI in medical Imaging.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course the student will be able to

CO1 - Describe the digital image fundamentals and the effect of image enhancement techniques on images.
CO2 - To analyze the medical images obtained with ionizing radiation and non-ionizing radiation.
CO3 - Evaluate the image segmentation procedures and the various feature extraction techniques for image analysis.
CO4 - Compute features useful for image representation and recognition.
CO5 - Develop image classification model using Intelligent techniques.
CO6 - Predict the qualitative performance of advanced imaging techniques.

TEXT BOOK / REFERENCE BOOK

1. Atam P. Dhawan, Medical Image Analysis, Wiley Interscience Publication, NJ, USA2003.
2. Geoff Dougherty, Digital Image Processing for Medical Applications, Cambridge University Press, 2009.
3. R.C. Gonzalezand R.E.Woods, DigitalImage Processing, Fourth Edition, Pearson Education, 2018.
4. Anil.K. Jain, Fundamentals of Digital Image Processing, Pearsoneducation, Indian Reprint 2017.
5. Malay K. Pakhira, Digital Image Processing and Pattern Recognition, First Edition, PHI Learning Pvt. Ltd, 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB6301	ADVANCED MEDICAL SIGNAL & IMAGE PROCESSING LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVE

- To provide the student with an advanced understanding of signal processing tool.
- To impart hands on knowledge on various signal processing techniques.
- To apply MATLAB / LabVIEW for Biosignal for biomedical signal applications.

SUGGESTEDLISTOFEXPERIMENT

1. DFT and FFT computation.
2. IIR filters design-digital Butterworth filter.
3. IIR filters design-digital Chebyshev filter.
4. FIR filter design using windowing techniques.
5. Adaptive filter design.
6. Analysis of PPG signals.
7. Detection of QRS complex in ECG.
8. Analysis of EMG.
9. Analysis of heart rate variability.
10. Analysis of respiratory signal.
11. Spectral analysis of EEG signals.
12. Implementation of bio signal analysis using LabVIEW.
13. Biomedical Signal Compression

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Demonstrate Fourier transformations on a given data.
CO2 - Design IIR and FIR filters for the given specification.
CO3 - Assess the characteristics of given ECG signal.
CO4 - Examine the given EMG signal for specific analysis.
CO5 - Show the reason for changes in respiratory signal.
CO6 - Demonstrate the usage of software tools for Biosignal analysis.

SBMB7001	BIOMATERIALS AND ARTIFICIAL ORGANS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To provide a general understanding of the multidisciplinary field of biomaterials.
- To provide an understanding of material bulk and surface properties, degradation processes, various biological responses to the materials.
- The general concepts of artificial organs learned in this course will further extend the understanding about the interactions of material and biological systems

UNIT 1 INTRODUCTION TO BIOMATERIALS 9 Hrs.

Overview of Biomaterials, mechanical properties, surface chemistry of materials, surface modification, Corrosion of metallic implants, Tissue Reaction, Bio Compatibility. metallic biomaterials, Ceramic biomaterials, Polymeric biomaterials, Composite biomaterials.

UNIT 2 TISSUE REPLACEMENTS 9 Hrs.

Hard tissue replacements – Wires, pins and Screws, Joint replacements – Upper extremity and Lower extremity, Soft tissue replacements – sutures, Tapes, Staples, Adhesives, Normal Wound healing process.

UNIT 3 OPTHALMIC AND ORAL IMPLANTS 9 Hrs.

Contact lenses, Optical implants, Eye Shields, Artificial tears, Dental materials, types and designs, Oral implants, use of collagen in dentistry and maxillofacial implants.

UNIT 4 BLOOD INTERFACING IMPLANTS 9 Hrs.

Artificial blood, Neural and neuro muscular implants, Cardiac Implants, heart valve implants, heart and lung assist devices, artificial heart, cardiac pacemakers, Cardiac defibrillators, artificial kidney, Dialysis system.

UNIT 5 STERILIZATION OF IMPLANT 9 Hrs.

Sterilization techniques: Process and mechanism of action of steam sterilization, radiation sterilization, electron beam sterilization, ethylene oxide, chlorine dioxide and plasma gas sterilization, filter sterilization.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand the basic principles in material science and their contribution towards Biomedical engineering
CO2 - Analyze different types of materials and apply in designing a device.
CO3 - Select the materials for designing an implant in tissue replacement.
CO4 - Acquire knowledge about different types of artificial organs and their implantation.
CO5 - Identify significant gap required to overcome challenges and further developments.
CO6 - Implement the artificial organs to replace malfunctioning of natural organs.

TEXT BOOK / REFERENCE BOOK

1. JD Bronzino, Biomedical Engineering hand book, CRC Press/IEEE Press, Volume 2, 2nd Edition, 2000.
2. Sujata V Bhat, Biomaterials – Narosa Publishing House Pvt. Ltd., 2nd Edition, 2009.
3. Larry L. Hench and Julian R.Jones, Biomaterials, Artificial organs and Tissue Engineering, 2005.
4. Anne Booth Sterilization of Medical DevicesPublisher CRC Press 2008

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SBMB7002	HOSPITAL HEALTH SYSTEMS AND MANAGEMENT	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- Learn the procedures in maintenance of equipments.
- Apply the design principles in engineering systems.

UNIT 1 PRINCIPLES OF HOSPITAL MANAGEMENT 9 Hrs.

Importance of management and Hospital, Management control systems. Forecasting techniques decision- making process, Hospital Administration.

UNIT 2 EVOLUTION OF HOSPITAL 9 Hrs.

Outpatient Department, Inpatient Service, Operation Theatre Complex, Delivery Suite, Pharmacy, Laboratory services, Radiological Department, Central Sterile supply department, and Medical records department, Material management, Hospital dietary services, Ambulance services, Medico-legal sciences.

UNIT 3 HEALTH SYSTEM 9 Hrs.

Quality management in hospitals, health financial system, Joint commission and accreditation of Hospitals, NABH and NABL standards, FDA.

UNIT 4 HOSPITAL PLANNING 9 Hrs.

Technical consideration, size & kind of hospitals, principles of planning, selection, site of orientation, equipment plan, communication and information system, Power supply, Air-conditioning, Water supply, elevators.

UNIT 5 NATIONAL HEALTH POLICY 9 Hrs.

Need for evaluating a health policy, Health organization in state, Health education, health insurance, health legislation.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Identify the principle of organizational structures and regulatory services.
CO2 - Classify the types of codes followed and applications.
CO3 - Modify the design to develop support systems.
CO4 - Infer the most challenges in environment and market trends.
CO5 - Evaluate the systems based on the safety criteria to environment.
CO6 - Create the methodology for new equipments to user needs.

TEXT BOOK / REFERENCE BOOK

1. Sharma D K, R.C. Goyal, “Hospital administration and human Resource Management in Hospital”, Prentice Hall of India, New Delhi, 2017 .
2. Hokey Min, “Healthcare Supply Chain Management: Basic Concepts and principles”, Business expert press, New York, 2014.
3. Syed Amin Tabish “Hospital and Health services Administration Principles and Practices” Oxford Press, New Delhi, 2016.
4. M. A. George, The Hospital Administrator, Jaypee Publications, 2015.
5. Sanskriti Sharma, Essentials for Hospital Support Services and Physical infrastructure, Publications 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB7003	FIBER OPTICS & LASER FOR BIOMEDICAL APPLICATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To comprehend the optical properties of tissues.
- To understand the components that are utilised to design a fiber optic set up.
- To acquire knowledge on applications of lasers in diagnosis in the medical field and the science of holography in laser imaging.

UNIT 1 INTRODUCTION 9 Hrs.

Principles of light propagation through a fiber–Total internal reflection, Numerical aperture, Angle ofAcceptance, fibre material-construction details of optical fiber-types of fibers – Absorption losses – Scattering losses – Dispersion, optical sensors based on polarization, magnetic sensors, medical applications of fiber optic sensors in measuring temperature, pressure, flow and chemical activities.

UNIT 2 OPTICAL SOURCES, DETECTORS, FIBER COUPLERS & CONNECTORS 9 Hrs.

Optical Sources and Detectors: Introduction, LED's, LASER diodes, Photodetectors–PIN photodiode, avalanche photo diode. Fiber Couplers and Connectors: Introduction, fiber alignment and joint loss, fiber splices, fiber connectors and fiber couplers-T-coupler, star coupler.

UNIT 3 LASER CHARACTERISTICS & LASER IN BIOLOGY 9 Hrs.

Laser Characteristics: Single frequency operation, coherence of laser, spatial distribution, intensity of laser emission, polarization of laser emission, measurement of pulsed laser energy. Laser In Biology: Optical properties of tissue, Pathology of laser reaction in skin, thermal effects, laser irradiation, non-thermal reactions of laser energy in tissue.

UNIT 4 LASER AND MEDICAL DIAGNOSIS 9 Hrs.

Wood's lamp, Imaging techniques - Optical coherence tomography, Elastography, Fluorescence Imaging, Raman Imaging, FLIM, FRAP, NIRS-Application, X-Ray Diagnostic Techniques, Speckle Correlometry.

UNIT 5 HOLOGRAM AND MEDICAL APPLICATIONS 9 Hrs.

Holography – Basic principle - Methods – Holographic interferometry and application, Holography for non- destructive testing – Holographic components – Medical applications of lasers- Dermatology, dentistry, ophthalmology.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Interpret the propagation of light through tissues.
CO2 - Categorize the elements of a fibre optic system.
CO3 - Generalize the applications of lasers in biology.
CO4 - Acquire knowledge about different techniques utilizing laser to diagnose diseases.
CO5 - Explore the utilization of holography in the medical field.
CO6 - Identify the use of Lasers that can be used for specific medical application.

TEXT BOOK / REFERENCE BOOK

1. G.Keiser, Optical Fiber Communication, McGraw-Hill,2017.
2. M.Arumugam, Optical Fiber Communication and Sensors, Anuradha Agencies, 2016.
3. Leon Goldman, The Biomedical laser Technology and Clinical Applications, Springer-Verlag, 2011.
4. Paras N. Prasad, "Introduction to Biophotonics, A.Wiley and Sons,2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB7004	E-HEALTH AND TELEMEDICINE	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To introduce the concepts of eHealth.
- To assess the advantages of eHealth care.
- To design and develop applications for eHealth care.
- To explore the advancements of Telemedicine technology.

UNIT 1 INTRODUCTION TO eHEALTH CARE 9 Hrs.

Overview and introduction to eHealth and flow of health information- International regulations in eHealth-Advantages, Challenges and future of eHealth.

UNIT 2 MEDICAL DATA ANALYTICS AND WEARABLE DEVICES 9 Hrs.

Health care data and Electronic Health Records (EHR) systems- Medical data bases –Wearable Devices-Data collection from wearable devices-Clinical use of personal health data-big data in the field of Medicine.

UNIT 3 DIGITAL HEALTH 9 Hrs.

Introduction to health care digital transformation- Digital health: Tools, Strategies of digital health-Technologies in digital health-Implementation of Digital health- Advantages and challenges of Digital health.

UNIT 4 APPLICATION DEVELOPMENT FOR e HEALTH 9 Hrs.

Introduction to Android, Creating Android Activities, Android User interface design, Access Wi-fi and Bluetooth with mobile applications-Web based App for e-health applications.

UNIT 5 TELEMEDICINE 9 Hrs.

Usage scenarios and operation modes- Telemedicine systems technologies- Standards and best-practices - Telemedicine in developed and developing countries - Telemedicine generations in India Telemedicine for management of Cancer, Stroke cardiology and Diabetes.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Acquire knowledge on basics of e-health care and its regulations.
CO2 - Explore medical data analytics and records.
CO3 - Apply digital transformation in the field of medicine.
CO4 - Apply Android Application development and its accessing tools for eHealth care.
CO5 - Evaluate the development of telemedicine in India and abroad.
CO6 - Develop an android App for telemedicine application.

TEXT BOOK / REFERENCE BOOK

1. Shortliffe, Edward H and Cimino James J. Biomedical Informatics, Computer Applications in Health Care and Biomedicine, Springer-Verlag London 2014.
2. ICMR- National Centre for Disease Informatics and Research. Framework for Telemedicine use in Management of Cancer, Diabetes, Cardiovascular Disease and Stroke in India. Bengaluru: ICMR-National Centre for Disease Informatics and Research; 2021.
3. Lavis, JN (ed). Ontario's Health System: Key Insights for Engaged Citizens, Professionals and Policymakers. 2016.
4. Hoyt RE, Yoshihashi A, Bailey N. Health informatics: Practical guide for healthcare and information technology professionals. Lulu Press. 2014 Seventh edition.
5. Gaddi A, Capello F, Manca M. eHealth, Care and Quality of Life. 2014 electronic library holding in the Health Science Library.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB7005	HOSPITAL EQUIPMENT MAINTENANCE & SAFETY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To Focus on the acquisition of skills necessary to perform inspection, installation, preventative maintenance and troubleshooting of Basic Clinical Equipment
- To facilitate the related medical device/ electronic systems, including appropriate documentation for all service activities and training the hospital staff.

UNIT 1 EQUIPMENT MANAGEMENT 9 Hrs..

Organizing the maintenance operation, biomedical equipment procurement procedure, proper selection, compatibility, testing and installation, purchase and contract procedure, trained medical staff, on proper use of equipment and operating instructions. Maintenance job planning, preventive maintenance, maintenance budgeting, contract maintenance.

UNIT 2 LOGISTIC SUPPORT & RELIABILITY 9 Hrs..

Maintenance equipment and Tools, failure analysis, spare parts and maintenance materials. Reliability fundamentals.

UNIT 3 CLINICAL ENGINEERING 9 Hrs..

Role to be performed in Hospital, Manpower & Market, Professional Registration, Maintenance of Hospital support system, surveillance network, electric power management, Medical gas production, waste disposal, inventory control. Case study: RF ID tag for inventory.

UNIT 4 HOSPITAL SAFETY 9 Hrs..

Radiation safety, Operations of safety devices, Hazardous effects of radiation, radiation measurements, ICRP regulations for radiation safety.

UNIT 5 ELECTRICAL & FIRE SAFETY 9 Hrs..

Sources of shocks, macro & micro shocks, monitoring and interrupting the Operation from leakage current- Elements of basic fire aid, causes of fire & fire protection Case study: Safety awareness.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Facilitate Biomedical Instrumentation Services for basic clinical equipment.
CO2 - understands the strategy of medical equipment maintenance and various options for medical equipment maintenance in the hospital.
CO3 - Demonstrate good communication, communicate accurately and appropriately in the role of Medical Equipment Technician.
CO4 - Deliver and set-up medical equipment.
CO5 - Calibrate and help in equipment maintenance.
CO6 - Maintain a safe, healthy, and secure working environment.

TEXT BOOK / REFERENCE BOOK

1. Maintenance and repair of laboratory diagnostic imaging and hospital equipment, WHO 2010 (revised) Antony Kelly, Maintenance Planning & Control Butterworth, London, 2004.
2. Hokey Min, "Healthcare Supply Chain Management: Basic Concepts and principles", Business expert press, New York, 2014.
3. Syed Amin Tabish "Hospital and Health services Administration Principles and Practices" Oxford Press, New Delhi, 2016.
4. M. A. George, The Hospital Administrator, Jaypee Publications, 2015.
5. Sanskriti Sharma, Essentials for Hospital Support Services and Physical infrastructure, Publications 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB7006	MEMS AND NANOTECHNOLOGY IN HEALTH CARE	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To understand Various MEMS fabrication techniques.
- Application of MEMS in different field of medicine.
- To know the underlying concept in engineering and implement in nano centric applications.

UNIT 1 MEMS & FABRICATION 9 Hrs.

MEMS and Microsystems, Materials for MEMS-Active Substrate Materials Silicon and Its Compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz Polymers Lithography Etching and Its Types, Wafer Bonding, Micromachining –Bulk, Surface Micromachining, LIGA Process.

UNIT 2 MICROFLUIDIC SYSTEMS 9 Hrs.

Fluid Dynamics, Continuity, Momentum Equation, Equation of Motion Laminar air Flow In- Circular, Circular Conducts, Flow in Micro conducts in Sub micro meterand Nanoscale. Microscale Fluid Expression for Liquid Flow In A Channel, Fluid Methods Actuation, Dielectrophoresis, Microfluid Dispenser, Microneedle, Micropump, Continuous flow System, Micro mixers.

UNIT 3 APPLICATIONS OF MEMS IN MEDICINE 9 Hrs.

CADfor MEMS Biological MEMS Materials Polymers Based Gas Sensor Microbial Analysis Systems Detection and Measurement Methods Microsystems Approaches To PCR, DNA Sensor Drug Delivery Types of Reservoirs CARDIOMEMS Case Study Design of Sensor in Health Care Introduction To 3D Printing.

UNIT 4 OVERVIEW OF NANOPARTICLES 9 Hrs.

Nanotechnology from medical perceptive Different Types of Nano biomaterials And Nanostructure Interactions Synthesis and Characterization of Smart Nano materials Surface Modification Biofunctionalization of Nano materials.

UNIT 5 NANOTECHNOLOGY IN HEALTH CARE 9 Hrs.

Nano shells, Nanopores, Carbon Nanotubes, Synthesis and Monitoring of Antigen Antibody Reactions. Nanowires, Quantum Dots and Biomedical Applications Nanorobots in Surgery Nano oncology Nano neurology, Nano cardiology, Nanoorthopedies and Nano Ophthalmology.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand the Mems Fabrication Processes and Characterization of Various Mems Materials
CO2 - Applying the Concepts to The Design of Different Types of Microsystems.
CO3 - Design the Procedure Adopted for Mems Device Towards Health Care Applications.
CO4 - Interpret the Latest Scientific Development and Discoveries in The Field of Nanomedicine.
CO5 - Examine the New Findings and Implement the Perspective in The Field of Nanoscience.
CO6 - Create New Approaches in Nanotechnology That Can Be Used in Biomedical Therapies.

TEXT BOOK / REFERENCE BOOK

1. Nano: The Essentials: T. Pradeep. McGraw – Hill education, First edition, 2017.
2. CarolaLeuschaer, Nanofabrication towards Biomedical Applications, Techniques, Tools, Applications and Impact.2005, Wiley –VCH.
3. Kewal K. Jain, The Handbook of Nanomedicine. Humana Press, (2008).
4. Wanjun Wang, Stephen A.Soper, Bio MEMs: Technologies and applications, CRC Press, New York, 2007.
5. Marc J. Madou, Fundamentals of micro fabrication: the science of miniaturization, CRC Press, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB7007	COMPUTERS IN MEDICINE	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To infer the use of computer and related technologies in medicine.
- To understand the standards, compression and communication methods in medical field.
- To justify the applications of computers and health informatics in the medical field.

UNIT 1 HEALTH INFORMATICS AND MEDICAL STANDARDS 9 Hrs.

Introduction, Needs of computers in medicine, Historical highlights and Evolution, Hospital Information System, its characteristics and functional online and offline modules, e-health services, Medical Standards–HL7– DICOM–PACS, Medical data formats–Bioethics.

UNIT 2 MEDICAL INFORMATICS 9 Hrs.

Definitions and its six levels of interfacing, Biometrics, Telemedicine – Technologies and applications, Evidence Based Medicine, Virtual Reality and Multimedia applications in Medicine– Virtual Hospital.

UNIT 3 ELECTRONIC MEDICAL RECORDS (EMR) 9 Hrs.

Medical Data and patient records, Terminologies, Clinical Coding systems, Information Exchange Standards, Usability i\Issues, User Interface, Evaluation, Integrated Multimedia Patient Record. Case study.

UNIT 4 MEDICAL DATA COMPRESSION, STORAGE AND RETRIEVAL 9 Hrs.

Introduction, Picture Compression, Compression in the DICOM Standard, Data Compression for Dynamic Functional Images, Content- Based Medical Image Retrieval: Image Retrieval by Physical Visual Features, Geometric Spatial Filters, Combination of Semantic and Visual Features and Physiologically functional features.

UNIT 5 DATA COMMUNICATION, NETWORK INFRASTRUCTURE AND SECURITY 9 Hrs.

Transmission and Communication Technologies, The Internet and World Wide Web, Wireless an Mobile Technologies in M-Health, Sensor Networks for Health Monitoring, Applications of Wireless Technologies in Telemedicine, Overview of Cryptographic system, Digital Watermarking, Medical Image Watermarking, Computer aided diagnosis.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Infer the medical standards for hospital information system and the procedure for bioethics.
CO2 - Choose the use of Virtual Reality and Multimedia in medicine.
CO3 - Assess the role of electronic medical records in medicine.
CO4 - Formulate data compression, storage, retrieval techniques.
CO5 - Develop Transmission and Communication Technologies for Health Monitoring.
CO6 - Recommend the use of computers in the medicinal and healthcare field.

TEXT BOOK / REFERENCE BOOK

1. Ramachandra Lele, Computers in Medicine Progress in Medical Informatics, Tata McGraw Hill,2015.
2. Mohan Bansal MS, Medical Informatics, Tata McGraw Hill, 2015.
3. David Dagan Feng, Biomedical information technology, Academic Press,2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB7008	ROBOTICS AND ITS MEDICAL APPLICATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To outline the role of robotics in medicine.
- To understand the numerous applications of robots in the medical industry.
- To apply the knowledge to design robots for medical applications.

UNIT 1 INTRODUCTION TO ROBOTICS 9 Hrs.

Classification of robots, basic robot components, manipulator end effectors, controller, accuracy precision and repeatability. Robotic vision system, Position, velocity and acceleration sensors, proximity and range sensors, touch and slip sensors, tactile sensors and force and torque sensors.

UNIT 2 SURGICAL ROBOTS 9 Hrs.

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynaecologic Surgery, General Surgery and Nanorobotics. Case Study.

UNIT 3 ASSISTIVE AND REHABILITATION ROBOTS 9 Hrs.

Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication.Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb.Case Study.

UNIT 4 WEARABLE ROBOTS 9 Hrs.

Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication – case study.

UNIT 5 ROBOT DESIGN AND ARTIFICIAL INTELLIGENCE 9 Hrs.

Characterization of gestures to the design of robots- Design methodologies- Technological choices - Security.Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents, Ethics and risks of artificial intelligence in robotics.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Identify the components and sensors in a robot.
CO2 - Evaluate the applications of surgical robotics.
CO3 - Examine the concepts in Rehabilitation of limbs and brain machine interface.
CO4 - Categorize the types of assistive robots aiding in wearable technology.
CO5 - Discuss on how to design a robot and role of AI in medical robotics.
CO6 - Analyze the design characteristics, methodology and technological choices for medical robots.

TEXT BOOK / REFERENCE BOOK

1. J J Craig, “Introduction to Robotics: Mechanics and Control”, Prentice Hall, 2014.
2. Daniel Faust, “Medical Robots”, Rosen Publishers, 2016.
3. JocelyneTroccaz, “Medical Robotics”, Wiley, 2013.
4. Paula Gomes, "Medical robotics- Minimally Invasive surgery", Woodhead, 2015.
5. Francis.X.Govers, “Artificial Intelligence for Robotics”, Packt Publishing, 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SBMB7009	ARTIFICIAL INTELLIGENCE FOR HEALTHCARE	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To develop fundamental knowledge in the area of artificial intelligence and to establish useful applications for it.
- To organise and model a complex issue as a state space, then use intelligent search. techniques to identify the most effective solutions.
- To design and create methods for making decisions in challenging, unpredictable situations.

UNIT 1 INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND PROBLEM-SOLVING AGENT 9 Hrs.

Introduction–Definition – Future of Artificial Intelligence – Characteristics of Intelligent Agents–Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

UNIT 2 INFORMED SEARCH ALGORITHMS 9 Hrs.

Informed Search - Introduction to Heuristics – Greedy Breadth First Search, A* - Local Search Optimization Algorithms - Hill Climbing, Simulated Annealing.

UNIT 3 OPTIMAL SEARCH ALGORITHMS 9 Hrs.

Global optimization algorithms - Genetic Algorithms, Particle Swarm Optimization Algorithm, Ant Colony Optimization, Gravitational Search Algorithm - Games – Optimal Decisions in Games - Minimax Algorithm, Alpha-Beta Pruning Algorithm.

UNIT 4 KNOWLEDGE REPRESENTATION AND REASONING 9 Hrs.

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation – Ontological Engineering-Categories and Objects – Events – Mental Events and Mental Objects – Reasoning Systems for Categories – Reasoning with Default Information.

UNIT 5 DECISION THEORY AND PLANNING 9 Hrs.

Basics of utility theory, decision theory, sequential decision problems, decision networks, elementary game theory, Planning: planning as search, partial order planning, construction and use of planning graph.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Demonstrate fundamental understanding of the evaluation of Artificial Intelligence (AI) and its foundations.

CO2 - Elucidate the basic knowledge representation, problem solving, and learning methods of Artificial Intelligence.

CO3 - Apply basic principles of AI in solutions that require problem solving through Optimal Search Algorithms.

CO4 - Demonstrate working knowledge of reasoning in the presence of uncertain information and show how search algorithms are essential for problem-solving.

CO5 - Illustrate the importance of artificial intelligence and planning in solving real world problems

CO6 - Design applications for healthcare that use Artificial Intelligence.

TEXT BOOK / REFERENCE BOOK

1. Russell S and Norvig P, Artificial Intelligence – A Modern Approach, 3rd Edition, Prentice Hall, 2015.
2. Elaine Rich, Kevin Knight, Shivashankar B Nair., “Artificial Intelligence”, 3rd Edition, McGraw Hill Education, 2017.
3. Wolfgang Ertel,” Introduction to Artificial Intelligence”, Second Edition, Springer, 2017.
4. Stephen Lucci and Danny Kopec,” Artificial Intelligence in the 21st Century, Second Edition, Mercury Learning and Information, 2015.
5. David L. Poole and Alan K. Mackworth, “Artificial Intelligence: Foundations of Computational Agents”, Second Edition, Cambridge University Press, 2017.
6. SarojKaushik, “Logic & Prolog Programming”, New Age International, Ist edition, 2002.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB7010	3D PRINTING TECHNOLOGY AND ITS BIOMEDICAL APPLICATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To provides opportunities for training and research in all aspects of 3D printing.
- To educate the students in the development of high quality of printing technology to provide a satisfactory environment to the manufacturing sector.
- To implement 3 D printing in health care industry for future betterment to the society.

UNIT 1 DIGITAL MANUFACTURING FOR 3D PRINTNG 9 Hrs.

Introduction- Definition of 3D Printing, Terminologies, Types additive manufacturing operations- Stereolithography (SLA), Digital Light Processing (DLP), Fused Deposition Modeling (FDM), Selective laser sintering (SLS), Selective Laser Melting (SLM), Electron Beam Melting (EBM), Details of Laminated Object Manufacturing (LOM); Granular Materials Binding, 3D innovative printers and application.

UNIT 2 DIGITAL DESIGN FOR 3D PRINTING 9 Hrs..

Transferring prototyping to 3D printing, STL file for 3D printing, Rapid prototyping, Classification of 3D printing technologies, Design criteria, Design consideration, Types of fast filament fusion support, Top-Down support structures, designing for selective Laser Sintering, Designing for material Jetting, OBJ-VRML files, CAD-STL files, Rules for STL format.

UNIT 3 3D PRINTING 9 Hrs..

Introduction, Development of physical goods, Nomenclature; milestones of 3D systems, Nontraditional manufacturing innovative technique, shorter lead time and design freedom, 3D printing possibilities, the digital model, CAD software- 3D scanners process, 3D printing pen, 3D printing geometry restrictions, STL file, Professional and home 3D printers, 3D printers improvements, Phases of rapid prototyping to home fabrication.

UNIT 4 ADDITIVE MANUFACTURING 9 Hrs..

Limited prototyping, Hazards of printing materials, 3D printing state and federal laws, Steps towards AM cyber security, 3D printing in forensic science, ethics and legality of 3D printing, Intricacy of 3D printing, Impact of 3D printing, 3D printing impact on global manufacturing, Revolutionizing mass manufacturing, Advance perception of additive manufacturing.

UNIT 5 3D PRINTING IN HEALTH CARE 9 Hrs..

Bone reconstructive surgery, living tissues- Bioprinting 2D and 3D tissues Bioink components, Hydrogels for Bioprinting; Implants of printed organs- Human Ear, Kidneys artificial liver, Bioprinting skin, Bioprinting nerves, 3D printed ovaries, obstacles to bio printing organs, 3D Bio-Printing, 3D Printing for implant and medical device- Hearing Aid, sensor arm, Knee replacement, Aorta, dental implants, obstacles to bioprinting organs, 3D print future medical implants.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understands the basic principles of 3D printing.
CO2 - Outline the problem encountered during design for 3D printing.
CO3 - Recognize the importance and future scope of 3D printing and evolving.
CO4 - Demonstrate the types of additive manufacturing in 3D printing technology.
CO5 - Application of 3D printing in health care system.
CO6 - Identify the importance of 3D printing in health care systems.

TEXT BOOK / REFERENCE BOOK

1. Sabrie Soloman,3D printing and design, Khanna Book Publishing Co., (P) Ltd., 2020.
2. Ad van Wijk and Iris van Wijk, 3D Printing with Biomaterials Towards a Sustainable and Circular Economy, Published by IOS Press, under the imprint Delft University Press. 2020.
3. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2nd Edition. 2015.
4. Andreas Gebhadt, Julia Kessler and Laura Thurn, 3D Printing Understanding Additive Manufacturing, Second Edition, Science Direct, 2019.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB7011	DEEP LEARNING FOR BIOMEDICAL APPLICATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To gain knowledge on the concepts of deep learning.
- To provide insight into recent CNN architectures and deep models.
- To enable the students to know deep learning techniques to support real-time applications.

UNIT 1 FOUNDATION OF NEURAL NETWORKS AND DEEP LEARNING 9 Hrs.

Neural Networks-Training neural networks, Activation Functions, Loss functions, Hyperparameters, Fundamentals of Deep Networks-Defining Deep Learning, Common Architectural Principles of Deep Networks, Parameters, Layers, Activation Functions, Loss Functions, Optimization Algorithms, Hyperparameters.

UNIT 2 CONVOLUTION NEURAL NETWORKS 9 Hrs.

Architectural Overview – Input Layers, Convolutional Layers, Pooling Layers, Fully Connected Layers – Filters – Parameter sharing – Regularization, Popular CNN Architectures: ResNet, AlexNet.

UNIT 3 RECURRENT AND RECURSIVE NETS - SEQUENCE MODELLING 9 Hrs.

Recurrent Neural Networks, Bidirectional RNNs, Encoder-decoder sequence to sequence architectures - BPTT for training RNN, Long Short-Term Memory Networks.

UNIT 4 AUTO ENCODERS AND DEEP GENERATIVE MODELS 9 Hrs.

.Under complete Autoencoders – Regularized Autoencoders – stochastic Encoders and Decoders – Contractive Encoders. Deep Belief networks – Boltzmann Machines – Deep Boltzmann Machine - Generative Adversial Networks.

UNIT 5 RECENT TRENDS IN DEEP LEARNING 9 Hrs.

Recent Models of Deep Learning, Genomics, Predictive Medicine, Clinical Imaging, Lip Reading, Visual Reasoning.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Ability to differentiate the concept of machine learning with deep learning techniques.
CO2 - understand and visualize Convolutional Neural Network for real-world applications.
CO3 - demonstrate the use of Recurrent Neural Networks and Transformer based for time series. prediction .
CO4 - Illustrate auto encoder and deep generative models to solve problems with high dimensional data.
CO5 - design and develop an application-specific deep learning model.
CO6 - Analyse the latest trends in deep learning.

TEXT BOOK / REFERENCE BOOK

1. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
2. Wei Di, AnuraghBharadwaj, “Deep Learning Essentials”, Jianing Wei, Packt Publishers, 2018.
3. Nikhil Buduma, Nicholas, “Fundamentals of Deep Learning”, O Reilly Media, 2017.
4. Ian Goodfellow, YoshuaBengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.
5. SurajSawant. “Deep Learning”, IGI Global, 2018.
6. Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” Apress, 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SBMB7012	ENTREPRENEURSHIP IN HEALTHCARE MANAGEMENT	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To gain the knowledge necessary to launch a biomedical start-up.
- To implement the concepts into practice and copyright the Inventions.
- To understand the significance of sales and marketing.

UNIT 1 BIOMEDICAL SECTOR 9 Hrs.

Challenges & Opportunities – Medical Technology – Pharmaceutical Industry – Innovations in Medical Technology - Development and Growth of Pacemaker Industry – Impact of MedTech innovations on Healthcare – Three Development Phases of Entrepreneurship.

UNIT 2 EVALUATING AND STARTING THE VENTURE 9 Hrs.

Evaluating the Entrepreneurship: Entrepreneur Team – Nature – Practising Entrepreneurship – Development of Wearable & Wireless Devices, Evaluating the Invention – Robotics & Artificial Intelligence – Medical Imaging, Forming the Company: Organizational Structure – Capitals required for the Company's Operation – Company Registration – Share Distribution – Exit Strategy, Patenting the Invention: US Patent –Trademark Office – Importance of Patenting – Process of Patenting, Safety & Effectiveness of Medical Devices.

UNIT 3 ESTABLISHING THE ENTERPRISE 9 Hrs.

Financing & Accounting: Account Management – Budgeting – Financial Projections, Negotiating Process, Manufacturing the Product: Procurement & Outsourcing – Current Good Management Practice (cGMP) – Accountability – Risk Management – Lifecycle Management for Maximum Value.

UNIT 4 BUSINESS MARKETING AND GLOBALIZATION 9 Hrs.

Marketing & Sales: Know the Customers – Market Characteristics of Medical Devices – Customer Relationship Management (CRM) – Marketing Ethics and Legal Compliance, Expanding & Globalizing the Business: World Prevalence of Diseases – Healthcare in UK/Germany/France/Italy – Healthcare Systems and Biomedical Industry in China – Global Markets of Medical Devices – Challenges of Global Marketing.

UNIT 5 INSTANCES OF APPLICATIONS IN BIOMEDICAL AREAS 9 Hrs.

Covid-19 Pandemic Assistive Devices - Inventions in various fields of Biomedical Engineering – Devices Developed.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - To study the Technologies in Medical Industry.
CO2 - To understand the concepts of Entrepreneurship.
CO3 - To analyse the need in building an organisation, patenting.
CO4 - To understand the Financial Management and Product Manufacturing.
CO5 - To familiarise Marketing and Business Globalization.
CO6 - To apply the concepts of Biomedical Engineering for inventions and device development.

TEXT BOOK / REFERENCE BOOK

1. Jen-shih Lee, “Being A Biomedical Entrepreneur - Growth of The Biomedical Industry”, World Scientific Publication Co. Pvt. Ltd., 2019.
2. Jen-shih Lee, “Biomedical Engineering Entrepreneurship”, World Scientific Publication Co. Pvt. Ltd., 2016.
3. RiadhHabash, “Green Engineering: Innovation, Entrepreneurship and Design”, CRC Press, Taylor & Francis Group, 2017.
4. Michael Friebe, Novel Innovation Design for the Future of Health Entrepreneurial Concepts for Patient Empowerment and Health Democratization, Springer International Publishing, 2022.
5. Shreefal S. Mehta, Commercializing Successful Biomedical Technologies, Cambridge University Press, 2022.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 6 Questions of 5 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit with internal choice, each carrying 14 marks **70 Marks**

SBMB7013	GENETIC ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To understand the concepts, introduction of genetic engineering.
- To identify the tools such as restriction enzymes, ligases, polymerases, vectors, their types, sources and their roles in genetic engineering.
- To learn about cloning and expression of gene and how it functions and to develop transgenic animals.

UNIT 1 GENETIC ENGINEERING BASIC 9 Hrs.

Introduction, Overview and scope of genetic engineering, Tools of Genetic engineering- Enzymes, Foreign DNA, Cloning Vector, Genomic library, cDNA library, RFLPs, RAPD.

UNIT 2 ENZYMES IN GENETIC ENGINEERING 9 Hrs.

Restriction Endonucleases, Types, Nomenclature, Target site- Blunt ends, Sticky end. Ligase Enzymes, sources of ligase enzymes, Activity of ligase enzymes and applications, DNA polymerase enzymes, types, sources and applications.

UNIT 3 CLONING AND EXPRESSION OF GENES 9 Hrs.

Overview of Restriction and Modification system.Cloning vehicles: Plasmids – Host range, Copy number control, Compatibility.λ phage – Insertional and replacement vectors. Single strand DNA vector – M13 Phage.Cosmids, Phasmids, Shuttle vector, Multiple cloning site. Virus vector for animal cells.

UNIT 4 DNA SEQUENCING AND BLOTTING TECHNIQUES 9 Hrs.

Chemical and Enzymatic methods, Pyrosequencing, Automated sequencing, Genome sequencing methods – top -down approach, bottom- up approach, Next generation gene sequencing. Blotting techniques: Southern and Northern, Hybridization, Polymerase Chain Reaction (PCR): Principle and applications. Different types of PCR.

UNIT 5 TRANSGENIC ANIMALS 9 Hrs.

Introduction of foreign genes into animal cells – Importance, DNA Microinjection, Retroviral vectors, Transfection of Embryonic stem cells, recombination. Methods for Creating Transgenic Animals-Physical Transfection, Chemical Transfection, Viral Vectors-Retrovirus-Mediated Gene Transfer, Transgenic animals- Transgenic Cow, Transgenic Sheep, Transgenic Mice. Applications of transgenic animals. Issues in Genetic Engineering, Bio and Environmental safety of transgenic products.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understanding the principles and tools of genetic engineering.
CO2 - Demonstrate the role of various enzymes used in genetic engineering and gene manipulation.
CO3 - Learning the process of gene cloning procedure and gene expression.
CO4 - Identify the gene sequencing technique and demonstrate the blotting methods.
CO5 - Understanding the procedure to develop transgenic animals and their importance.
CO6 - Outline the problem encountered during gene manipulation and environmental safety of transgenic products.

TEXT BOOK / REFERENCE BOOK

1. Primrose S.B., Twyman R.H., and Old R.W. “Principles of Gene Manipulation.” 7th Edition.Blackwell Science/Oxford, 2006.
2. Glick B.R. and Pasternak J.J. “Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3 rd Edition. ASM Press, 2003.
3. Bernard R. Glick, Cheryl L. Patten, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 6th Edition. ISBN: 978-1-683-67366-8 ASM Press, 2022.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 6 Questions of 5 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit with internal choice, each carrying 14 marks **70 Marks**

SBMB7014	HUMAN RESOURCE MANAGEMENT IN HOSPITALS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- This subject acquaints the students with major functions of HRM aligned with the business strategy.
- The subject encompasses the concept of best fit employee, training & executive development.
- Sustaining employee interest and performance appraisal.

UNIT 1 PERSPECTIVES OF HUMAN RESOURCE MANAGEMENT 9 Hrs.

Evolution of Human resource Management, objectives of HRM, Human resource policies, Need for HRM in Health care organization, computer applications in Human resource management.

UNIT 2 CONCEPT OF EMPLOYEE 9 Hrs.

Organizational Job design, description analysis job rotation, job evaluation. Man power planning. Importance of Human resource planning. Forecasting of Human resource requirement-selection procedure test, validation interview recruitment, medical examination.

UNIT 3 HOSPITAL MANAGEMENT 9 Hrs.

Management of Hospital organization, Nursing sector, medical sector, central services. Technical department.Definition and practice of management by objectives. Human relation in hospital. Importance of team work, legal aspect in hospital management.

UNIT 4 TRAINING& PERFORMANCE APPRAISAL 9 Hrs.

Types of Training methods and their benefits, importance of performance appraisal. Methods of performance evaluation, Traditional method, modern method, feedback, promotion, demotion, transfer implications of job change.

UNIT 5 SUSTAINING EMPLOYEE INTERNET 9 Hrs.

Wage and salary administration concept of incentives and its operational implications. Participative decision making, concept of collective bargaining compensation plans Reward motivation Theories of motivation, Grievance and redressed methods.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand the Scope and Significance of Human Resource Management.
CO2 - Analyse the Concepts of Recruitment and Selection Procedure.
CO3 - Apprehend the Organisation and Management in Hospitals.
CO4 - Examine the Process of Training and Career Development.
CO5 - Design the Methods of Appraisal System.
CO6 - Create the Employee Conflicts and Administrative System.

TEXT BOOK / REFERENCE BOOK

1. R.C.Goyal, Human Resource Management in Hospitals, Prentice Hall of India,5th Edition 2009.
2. Mamoria C.B. and MamoriaS.Personnel Management, Himalaya Publishing Company, 2011.
3. Decenzo and Robbins, Human Resource Management, Wiley & Sons, Singapore, 11th edition 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 6 Questions of 5 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit with internal choice, each carrying 14 marks **70 Marks**

SBMB7015	WEARABLE SYSTEMS FOR HEALTHCARE	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To impart the importance of smart sensors, sensor interface standards for wearable device applications.
- Identify the need for development of wearable devices and its implications on various sectors.
- Comprehend the design and development of various wearable bioelectrode and physiological activity monitoring devices for use in healthcare applications.

UNIT 1 SENSORS FOR WEARABLE SYSTEMS 9 Hrs.

Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Radiant thermal sensor, Wearable motion sensors, Wearable biochemical Sensors, Wearable gas sensors.

UNIT 2 SIGNAL PROCESSING AND ENERGY HARVESTING 9 Hrs.

Wearability issues -physical shape and placement of sensor, technical challenges – sensor design, signal acquisition, light weight signal processing, Rejection of irrelevant information, Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests.

UNIT 3 SCOPE OF WEARABLE DEVICES 9 Hrs.

Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Wearables: Challenges and Opportunities, Future and Research Roadmap.

UNIT 4 WIRELESS SYSTEMS AND IOT 9 Hrs.

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, IoT- Definition and characteristics of IoT, Physical design of IoT, IoT functional blocks, IoT levels, IoT design methodology.

UNIT 5 APPLICATIONS OF WEARABLE DEVICES 9 Hrs.

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Elderly patients, arthritic patients, Multi parameter monitoring, Gait analysis, Sports Medicine, Smart Fabrics.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Discuss and analyse the usage of various biochemical and gas sensors as wearable devices.
CO2 - Identify the technical challenges for signal processing and Energy Harvesting.
CO3 - Describe the scope of the wearable devices and its design constraints for measuring physical and biological signals.
CO4 - Design and develop various wearable device for detection of physiological body signals, blood pressure and body temperature for use in healthcare applications.
CO5 - Acquaint the usage of wearable devices as assistive devices, diagnostic devices and other modern applications.
CO6 - Able to design and perform experiments on the sensors and develop the projects based on the customer needs.

TEXT BOOK / REFERENCE BOOK

1. John G. Webster, Amit J. Nimunkar, Medical Instrumentation application and design – 5th Edition, (An Indian Adaptation), Wiley India, 2021.
2. R. AnandaNatarajan, Biomedical Instrumentation and Measurements, 2nd Edition, PHI, 2016.
3. Leslie Cromwell, ―Biomedical Instrumentation and measurement, Prentice Hall of India, New Delhi, 2nd edition, 2015.
4. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd edition, 2014.
5. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, edition, 2015. Pearson education, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 6 Questions of 5 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit with internal choice, each carrying 14 marks **70 Marks**

SBMB7016	MEDICAL ETHICS AND REGULATORY AFFAIRS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- Students will be able to know about the legal and ethical principles.
- To apply these principles in health care settings & gain knowledge about the medical standards that to be followed in hospitals.

UNIT 1 INTRODUCTION TO MEDICAL ETHICS 9 Hrs.

Definition of Medical Ethics, Scope of Ethics In Medicine, American Medical Association Code of Ethics, CMA Code of Ethics Fundamental Responsibilities. The Doctor and Patient, Doctor and Safety, Professional Independence.

UNIT 2 ETHICAL THEORIES MORAL PRINCIPLES 9 Hrs.

Theories-Deontology and Utilitarianism Casuist Theory Virtue Theory, The Right Theory, Ethical Issues in Biomedical Research, Bioethical Issues in Human Genetics and Reproductive Medicine.

UNIT 3 MEDICAL EQUIPMENTS SAFETY STANDARDS 9 Hrs.

General Requirements for Basic Safety and Essential Performance of Medical Equipments.Iec60601 Standard Indian and International Standards Base Standard General Requirement of Electrical Medical Devices. Collateral Standards Particular Types of Medical Device.

UNIT 4 MEDICAL DEVICE AND INVITRO DIAGNOSTIC 9 Hrs.

.Introduction And Types of Devices Including Combination Devices. Medical Devices Rules 2017.Implication on Medical Device, Classification of Medical Devices. Labelling of Medical Devices and Invitro Diagnostic.

UNIT 5 STANDARDS OF MEDICAL DEVICE, QUALITY ASSURANCE AND TESTING 9 Hrs.

Regulatory Requirements of Biocompatibility of Medical Devices and ISO 10993 Clinical Investigation of Medical Devices, Regulation of Investigational Medical Devices.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Understand the Social Responsibility in Health Care Systems.
CO2 - Analyse the Role of Biomedical Engineers to Know the Importance.
CO3 - Comphrend the Medical Equipment Safety Standards to Medical Device Maintenance.
CO4 - Examine the Types of Medical Devices and Their Invitro Diagnostic Methods.
CO5 - Interpret the Quality Assurance and Testing Procedure for Standard Medical Devices.
CO6 - Create A Protocol for Regulatory Requirement of Biocompatibility on Medical Devices.

TEXT BOOK / REFERENCE BOOK

1. Johnna Fisher, Biomedical Ethics: A Canadian Focus., Oxford University Press Canada, 2009.
2. Robert M Veatch, The Basics of Bio Ethics, 3 Rd Edition. Routledge, 2011.
3. Joint Commission Accreditation Standards for Hospitals, 6th Edition 2018.
4. Medical Devices Rules 2017, Related Guidance Documents.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 6 Questions of 5 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit with internal choice, each carrying 14 marks **70 Marks**

SBMA7017	DESIGN THINKING AND DEVICE DEVELOPMENT	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To understand the process of design thinking and device development.
- To identify and analyze societal issues and provide solution to real time problems.

UNIT 1 INTRODUCTION AND COGITATION 9 Hrs.

Introduction to design thinking- Johari Window – Persona - DCAFE and VAL. – Theory of prioritization – Brain storming - 25 brainstorming techniques Case Study - Identification of Real-World Problems using brain storming and assigning priorities. Discussion on case study. Activities: Formation of team – Brain storming – Case study.

UNIT 2 DESIGN THINKING PROCESS 9 Hrs.

Elements of great design - Human element of design thinking – Lateral thinking – HOTS – Out of box thinking Case study - Problem Identification – Identification of a specific Real Word Problem after brain storming. – Team Presentation on identified problem. Activities: Specific Problem selection to proceed with the work – Team presentation on identified problems and various possible solutions.

UNIT 3 DEVICE DEVELOPMENT 9 Hrs.

Design Evaluation and Demand forecasting, Processes of Device Development-Generic Product development Process, Concept development process, Customer need Process- Concept Generation-Concept selection-Tools used for Device development.

UNIT 4 ENGINEERING DESIGN PHASE 1 9 Hrs.

Identification of stake holders – Roles and responsibilities – Conduct of surveys and interviews for addressing Real World Problems – Literature Surveys - Data collection.
Surveys: Stake holder Survey – Literature Survey – Presentation on Stake holder's survey and Literature survey. (3 non-contact hours). Activities: SWOT Analysis – Finalize the identified problem.

UNIT 5 ENGINEERING DESIGN - PHASE 2 9 Hrs.

Difference between Creativity and Innovation – Examples of innovation – Overcoming obstacles – Decision making on implementation of identified problem – Identifying evaluation criteria - Functional decomposition.
Documentation: Functional decomposition diagram, Decision on implementation, Evaluation criteria.
ENGINEERING DESIGN - PHASE 3 Brain storming alternate solutions- Developing proof of concept Project: Poster presentation and Proof of concept display.Activities: Development of POC.

Max. Max. 45 Hrs..

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Comprehend the various types of thinking skills.
CO2 - Explain the innovative and creative ideas.
CO3 - Understand the concepts of device development.
CO4 - Analyze a suitable solution for socially relevant issues.
CO5 - Develop working structure and, concepts for the identified problem.
CO6 - Design solutions for Real World Problem.

TEXT BOOK / REFERENCE BOOK

1. How to have Creative Ideas, Edward debone, Vermilon publication, UK, 2007.
2. The Art of Innovation, Tom Kelley & Jonathan Littman, Profile Books Ltd, UK, 2008.
3. G.Pahl and W.Beitz (Translated by Ken Wallace et al.,) „Engineering Design: A Systematic Approach, Second Edition, Springer, 2005.
4. George E. Dieter and Linda C. Schmidt, “Engineering Design”, Fourth Edition, McGraw Hill Higher Education, 2009.
5. Product Design and Development, MIT open course ware, Springer 2018.
6. Foundation Skills in Integrated Product Development, NASSCOM, Edition 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 6 Questions of 5 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit with internal choice, each carrying 14 marks	**70 Marks**