E.G.S. PILLAY ENGINEERING COLLEGE

(Autonomous)

NAGAPATTINAM – 611002

(Affiliated to Anna University, Chennai | Accredited by NAAC with 'A++' Grade|Accredited by NBA T1(B.E. – CSE, CIVIL, ECE, EEE, MECH& B.Tech – IT) |

Approved by AICTE, New Delhi)

B.E. - Biomedical Engineering R- 2023

THIRD YEAR

CURRICULUM AND SYLLABUS FOR FIFTH SEMESTER

COURSE CODE	COURSENAME	CATEGORY	L	T	P	C	MAX.MARKS		
							CA	ES	TOTAL
THEORY COURSES									
2302BM501	Diagnostic and Therapeutic Equipment II	PCC	3	0	0	3	40	60	100
2302BM502	Fundamental of Rehabilitation Healthcare Analytics	PCC	3	0	0	3	40	60	100
2302BM503	Bio Signal Processing	PCC	3	1	0	4	40	60	100
	Elective I	PEC	3	0	0	3	40	60	100
	Elective II	PEC	3	0	0	3	40	60	100
	Open Elective I	OEC	3	0	0	3	40	60	100
PRACTICALCOURSES									
2302BM551	Biomechanics Laboratory	PCC	0	0	2	1	60	40	100
2302BM552	Biomedical Digital Signal Processing Laboratory	PCC	0	0	2	1	60	40	100
	Professional Development Course-1	EEC	0	0	2	1	100	--	100
TOTAL			**18**	**1**	**06**	**22**	**460**	**440**	**900**

L–Lecture|T–Tutorial|P–Practical|C–Credit|CA–ContinuousAssessment|ES–EndSemest

2302BM501 DIAGNOSTIC AND THERAPEUTIC EQUIPMENT – II

L	T	P	C
3	0	0	3

PREREQUISITE:

1. Diagnostic and therapeutic equipment-1
2. Biomedical instrumentation

COURSE OBJECTIVES:

1. Understand the ICU devices , principles of Telemetry, Diathermy and Ultrasonic equipments
2. Explain extracorporeal devices used in critical care.
3. Discuss the importance of patient safety against electrical hazard.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Discuss the various equipment used in ICU and applications of telemetry.
CO2: Explain the types of diathermy and its applications.
CO3: Express the basics of ultrasound and its application in medicine
CO4: Discuss the various extracorporeal and special diagnostic devices used in hospitals
CO5: Outline the importance of patient safety against electrical hazard

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	1	-	-	1	1	-	2	-
CO2	3	2	1	-	-	-	-	1	-	-	1	1	-	2	-
CO3	3	2	1	-	-	-	-	1	-	-	1	1	-	2	-
CO4	3	2	1	-	-	-	-	1	-	-	1	1	-	2	-
CO5	3	2	1	-	-	-	-	1	-	-	1	1	-	2	-

COURSE CONTENTS:

MODULE I PATIENT MONITORING AND BIOTELEMETRY **9 Hours**

Patient monitoring systems, ICU/CCU Equipments, bed side monitors, Infusion pumps, Central consoling controls. Biotelemetry: Radio Telemetry (single &multi-channel), Portable and Landline Telemetry unit.

MODULE II DIATHERMY **9 Hours**

Diathermy: Short wave diathermy, ultrasonic diathermy, Microwave diathermy- working Principle, operation, applications. Electro surgery machine - Current waveforms, Tissue Responses, Electro surgical current level, Hazards and safety procedures.

MODULE III ULTRASONIC EQUIPMENTS **9 Hours**

Diagnosis: Tissue Reaction, Basic principles of Echo technique, display techniques A, B and M mode, B Scan, Application of ultrasound as diagnostic tool – Echocardiogram, Echoencephalogram, abdomen, obstetrics and gynecology, ophthalmology.

MODULE IV EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES **9 Hours**

Need for heart lung machine, functioning of bubble, disc type and membrane type oxygenators, finger pump, roller pump, electronic monitoring of functional parameters. Hemo-Dialyser unit, Lithotripsy, Principles of Cryogenic technique and application, Endoscopy, Laproscopy, Otoscopes.

MODULE V PATIENT SAFETY IN ELECTRICAL HAZARD **9 Hours**

Physiological effects of electricity – important susceptibility parameters – Macro shock – Micro shock hazards – Patient's electrical environment – Isolated Power system – Conductive surfaces – Electrical safety codes and standards – IEC 60601-1 2005 standard, Basic Approaches to Protection against shock, Protection equipment design, Electrical safety analyzer

TOTAL: 45 HOURS

REFERENCES:

1.Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice hall of India, New Delhi, 2015.

2. Richard Aston "Principles of Biomedical Instrumentation and Measurement", Merril Publishing Company, 1990

3. L.A Geddas and L.E.Baker "Principles of Applied Biomedical Instrumentation" 2004.

4. Myer Kutz "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill Publisher, 2003.

5. Khandpur R.S, "Handbook of Biomedical Instrumentation", 3rdedition,Tata McGraw-Hill, New Delhi, 2014.

2302BM502 FUNDAMENTAL OF REHABILITATION HEALTHCARE ANALYTICS

L	T	P	C
3	0	0	3

PREREQUISITE:

1. Human anatomy and physiology

COURSE OBJECTIVES:

1. Understand the fundamentals of data mining techniques in healthcare.
2. Understand the healthcare data analytics approaches used.
3. Analyze the effective information retrieval from healthcare data using data analytics approaches.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Understand the fundamental concepts of healthcare data analytics.
CO2: Analyze the effectiveness of data mining in clinical and non-clinical applications.
CO3: Categorize the approaches to retrieve data from social media.
CO4: Analyze the process of advanced healthcare data analytics.
CO5: Analyze the information present based on visual characteristics of an expert system.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	1	1	-	-	-	1	1	1	1	-
CO2	3	2	1	-	-	1	1	-	-	-	1	1	1	1	-
CO3	3	2	1	-	-	1	1	-	-	-	1	1	1	1	-
CO4	3	2	1	-	-	1	1	-	-	-	1	1	1	1	-
CO5	3	2	1	-	-	1	1	-	-	-	1	1	1	1	-

COURSE CONTENTS:

MODULE I INTRODUCTIONTOHEALTHCAREDATAANALYTICS 9 Hours

Introduction, Healthcare data sources and basic analytics, Advanced data analytics for healthcare, Applications and practical systems for healthcare, resources for healthcare data analytics- Healthcare data sources and Basic analytics: Electronic Health Records (EHR), Components of EHR, Coding systems, Benefits of EHR, Barriers to Adopting EHR, Challenges using EHR data.

MODULE II MINING OF SENSOR DATA AND DATA MINING 9 Hours

Introduction, Scopes and Challenges in mining sensor data, Challenges in Healthcare data analytics, sensor data mining applications, Nonclinical Health care applications, Introduction to data mining, Natural language processing, Mining information from clinical text and current methodologies, Informatics for integrating Biology, Challenges of processing clinical reports, Clinical applications.

MODULE III SOCIALMEDIAANALYTICS 9 Hours

Introduction, Social media analysis for detection and tracking of infectious disease outbreaks: Outbreak detection, Analyzing and tracking outbreaks, syndromic surveillance systems based on social media, Social medical analysis for public health research: Topic models for analyzing health-related contents, detecting reports of adverse medical events and drug reactions, characterizing life style and well-being, analysis of

social media use in healthcare.

MODULE IV ADVANCED DATA ANALYTICS FOR HEALTH CARE 9 Hours

Introduction- Basic statistical prediction models: Linear regression, generalized additive model, Logistic regression: Multi class, polytomous and ordered Logistic regression, Bayesian models, Markov Random Fields, Alternative clinical prediction models: Decision trees, ANN, cost sensitive learning, Advanced prediction models, survival models, Evaluation and validation.

MODULE V VISUAL ANALYTICS AND INFORMATION RETRIEVAL FOR HEALTHCARE 9 Hours

Introduction, Medical data visualization, Visual analytics in Healthcare, Introduction to information retrieval, Knowledge based information in healthcare and biomedicine, content of knowledge- based information resources, indexing, retrieval: Exact match and partial match retrieval, Evaluation: system-oriented evaluation, user oriented evaluation, Introduction to clinical decision support system

TOTAL: 45 HOURS

REFERENCES:

1. TinglongDai,SridharTayur, Hand book of Healthcare Analytics,Wiley,2018.
2. HuiYang,EvaK,Lee, Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.

2302BM503 **BIO SIGNAL PROCESSING** **L T P C**
3 1 0 4

PREREQUISITE:

1. Probability and statistics.
2. Signals and system.

COURSE OBJECTIVES:

1. To learn discrete Fourier transform, properties and its computation.
2. To know the characteristics of IIR filter and to learn the design of IIR filters for filtering undesired signals.
3. Understand the sources, characteristics and conversion process of biomedical signals.
4. Learn the basics of signal averaging and data compression techniques.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Design the discrete Fourier transform, properties and its computation.
CO2: Design the different types of analog and digital IIR filters.
CO3: Design the FIR filter based on the given specifications.
CO4: Discuss about the nature of biomedical signals.
CO5: Discuss time domain and frequency domain filters to remove noise and artifacts from biomedical signals.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	-	-	-	2	-	1	2	1	-	2
CO2	3	3	2	2	-	-	-	-	2	-	1	2	1	-	2
CO3	3	3	3	3	3	-	-	-	2	-	1	2	1	-	2
CO4	3	3	3	-	-	-	-	-	2	-	1	2	1	-	2
CO5	3	3	2	-	-	-	-	-	2	-	1	2	1	-	2

COURSE CONTENTS:

MODULE I DISCRETE FOURIER TRANSFORM AND COMPUTATION **12 Hours**

Discrete Fourier Transform –properties, magnitude and phase representation – Computation of DFT using FFT algorithm – DIT &DIF using radix 2 FFT – Butterfly structure.

MODULE II INFINITE IMPULSE RESPONSE FILTER **12 Hours**

Analog Filter design – Butterworth filter – Chebyshev filter – Design of IIR filters from analog filters – Impulse Invariance – Bilinear Transformation – IIR realizations – Direct Form, Cascade Form and Parallel Form.

MODULE III FINITE IMPULSE RESPONSE FILTER **12 Hours**

FIR Design – FIR design by windows – Rectangular window – Hamming window – Hanning window – Triangular window – Blackman window – Kaiser window – FIR design by frequency sampling method

MODULE IV INTRODUCTION TO BIOMEDICAL SIGNALS **12 Hours**

Nature of Biomedical Signals, Objectives and difficulties in Biomedical analysis. Electrocardiography: ECG leads systems, ECG signal characteristics. Signal Conversion**:** Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits.

MODULE V SIGNAL AVERAGING **12 Hours**

Basics of signal averaging, signal averaging as a digital filter, signal averaging as a typical average, software for signal averaging, limitations of signal averaging. Adaptive Noise Cancelling: Principle noise canceller model, 60-Hz adaptive cancelling using a sine wave model, other applications of adaptive filtering.

Total:60Hours

REFERENCES:

1. SalivahananS ,Vallavaraj A., Gnanapriya C, Digital Signal Processing, Tata McGraw- Hill, New Delhi, 2008.
2. Biomedical Signal Analysis-Rangaraj M. Rangayyan, John Wiley & Sons 2022.
3. Advanced Bio signal Processing- Amine NaitAli 2020.
4. 'Biomedical Signal Processing' A Modern Approach – Ganesh R.Naik and Wellington Pinheiro dos santos 2024.
5. Bio signal and Medical image processing – Third Edition – John L Semmlow 2014.

2303BM001 **BIOMATERIALS** **L T P C**
3 0 0 3

PREREQUISITE:

1. Human Anatomy and Physiology.
2. Biosciences in Medical Engineering.

COURSE OBJECTIVES:

1. To learn about different types of biomaterials.
2. To understand different metals, ceramics ,Polymer and its characteristics as biomaterials
3. To understand the Biomedical application of different textile structures.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Understand the structure of bio-materials and its bio-compatibility.
CO2: Apply appropriate implant materials in medical field based on their properties
CO3: Analyze polymeric materials and its combinations that could be used as a tissue replacement .
CO4: Analyse soft and hard tissue replacement implants in biomedical applications.
CO5: Apply material properties of biopolymers suitable for implantable, non, implantable and drug delivery textiles

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	1	1	-	-	-	1	1	1	-	1
CO2	3	2	1	-	-	1	1	-	-	-	1	1	1	-	1
CO3	3	2	1	-	-	1	1	-	-	-	1	1	1	-	1
CO4	3	2	1	-	-	1	1	-	-	-	1	1	1	-	1
CO5	3	2	1	-	-	1	1	-	-	-	1	1	1	-	1

COURSE CONTENTS:

MODULE I STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY **9 Hours**

Definition and classification of bio-materials, mechanical properties, viscoelasticity, wound healing process, body response to implants, blood compatibility, HLA compatibility.

MODULE II IMPLANT MATERIALS **9 Hours**

Metallic implant materials, stainless steels, Ti-based alloys, ceramic implant materials, aluminium oxides, hydroxyapatite, glass ceramics, carbons. Polymerization, polyamides, Acrylic polymers, Hydrogels, rubbers, high strength, thermoplastics, medical applications.

MODULE III BIOPOLYMERS **9 Hours**

Biopolymers: classification and their properties, requirements, and applications, testing methods; In vitro tests, direct contact, agar diffusion & elution methods, in vivo assessment of tissue compatibility. Collagen and elastin. Materials for ophthalmology: contact lens, Intra ocular lens. Membranes for plasma separation and blood oxygenation.

MODULE IV TISSUE REPLACEMENT IMPLANTS **9 Hours**

Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair. Soft tissue replacements, types of transplant by stem cell, sutures, surgical tapes, Tissue adhesive/glue. Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, point replacements.

MODULE V IMPLANTABLES, NON, IMPLANTABLES AND DRUG DELIVERY 9 Hours

Bandages, types, properties and applications; compression garments, types, properties and applications; sutures: types and properties; implantable textiles: hernia mesh , vascular prostheses , stents; Extra corporeal materials: Cartilage nerves , liver ligaments, kidney, tendons, cornea; Drug delivery textiles: classification , mechanism various fabrication methods , characterization , applications.

TOTAL: 45 HOURS

REFERENCES:

1. Park Joseph D.Bronzino, Biomaterials-Principles and Applications, CRC press,2003.
2. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, ―Introduction to Biomedical Engineering‖, Elsevier, 2005.
3. Sreeram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, Biomaterials: A Nano Approach‖, CRC Press, 2010
4.Joon B. Park., and Joseph D. Bronzino., Biomaterials , Principles and Applications , CRC Press, Boca Raton London, New York, Washington, D.C. 2002.

2303BM002 FOUNDATION SKILLS IN INTEGRATED PRODUCT

L	T	P	C
3	0	0	3

PREREQUISITE:

1. Human physiology and anatomy.
2. Biomechanics.

COURSE OBJECTIVES:

1. To understand the global trends of product development and methodologies of various types of new product.
2. To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and
3. To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL support activities for engineering customer.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Define, formulate and analyze a problem.
CO2: Solve specific problems independently or as part of a team.
CO3: Gain knowledge of the Innovation & Product Development process in the Business Context .
CO4: Work independently as well as in teams.
CO5: Manage a project from start to finish.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	1	1	1	-	-	1	1	1	-	1
CO2	3	2	1	-	-	1	1	1	-	-	1	1	1	-	1
CO3	3	2	1	-	-	1	1	1	-	-	1	1	1	-	1
CO4	3	2	1	-	-	1	1	1	-	-	1	1	1	-	1
CO5	3	2	1	-	-	1	1	1	-	-	1	1	1	-	1

COURSE CONTENTS:

MODULE I FUNDAMENTALS OF PRODUCT DEVELOPMENT **9 Hours**

Global Trends Analysis and Product decision – Social Trends – Technical Trends-Economic Trends – Environmental Trends – Political/Policy Trends – Introduction to Product Development Methodologies and Management – Overview of Products and Services – Types of Product Development – Overview of Product Development methodologies – Product Life Cycle – Product Development Planning and Management.

MODULE II REQUIREMENTS AND SYSTEM DESIGN **9 Hours**

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modelling - Introduction to System Modelling - System Optimization - System Specification - Sub-System Design - Interface Design.

MODULE III DESIGN AND TESTING **9 Hours**

Conceptualization – Industrial Design and User Interface Design – Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines – Concept Screening and Evaluation – Detailed Design – Component Design and Verification -Mechanical, Electronics and Software Subsystems –

High Level Design/Low Level Design of S/W Program – Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping – Introduction to Rapid Prototyping and Rapid Manufacturing – System Integration, Testing, Certification and Documentation

MODULE IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9 Hours

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

MODULE V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9 Hours

The Industry – Engineering Services Industry – Product Development in Industry versus Academia -The IPD Essentials – Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems – Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs – Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL: 45 HOURS

REFERENCES:

1. Hiriyappa B, "Corporate Strategy – Managing the Business", Author House, 2013.
2. Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, "Enterprise Resource Planning -Concepts", Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013.

2303BM003 **CLINICAL ENGINEERING**

L	T	P	C
3	0	0	3

PREREQUISITE:

1. Human physiology and anatomy.
2. Biomechanics.
3. Biochemistry.
4. Hospital training.

COURSE OBJECTIVES:

1.Understanding of the clinical engineering profession, qualifications, roles, activities, and expectations.
2.Enhance the students to practice medical equipment work as a team to address problems and errors in medical devices.
3.Design better .medical devices and explore the Health Technology Management systems .

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: State the role of clinical engineers and discuss the basic concepts of medical and healthcare technology
CO2: Give the program and framework to recognize the errors of medical equipment.
CO3: State the issues or errors in patient safety and formulate patient safety package system
CO4: Define the problem precisely and examine the possible issues using program indicators
CO5: Demonstrate computer-based equipment with automated system by using CPOE method.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	1	1	-	-	-	1	1	1	-	1
CO2	3	2	1	1	-	1	1	-	-	-	1	1	1	-	1
CO3	3	2	1	1	-	1	1	-	-	-	1	1	1	-	1
CO4	3	2	1	1	-	1	1	-	-	-	1	1	1	-	1
CO5	3	2	1	1	-	1	1	-	-	-	1	1	1	-	1

COURSE CONTENTS:

MODULE I INTRODUCTION TO CLINICAL ENGINEERING **9 Hours**

Clinical engineering: Definition, Evolution, Role, Responsibilities, Functional status, History of clinical engineering and Technology in Health Care System, Enhancing patient safety.

MODULE II MEDICAL TECHNOLOGY MANAGEMENT PRACTICES **9 Hours**

Strategic Medical Technology Planning, Scope, Clinical necessity operational support, strategic planning process ,Technology assessment: Technology audit, Budget strategies, Prerequisite for medical technology assessment, Management Practice for Medical Equipment, Device evaluation, Risk reduction, Asset management, ESHTA.

MODULE III ESSENTIAL HEALTH CARE TECHNOLOGY PACKAGE (EHTP) **9 Hours**

Introduction – Health care technology management – Package development: Methodology, Logical framework, Implementation, Information promotion and dissemination – EHTP Justification – EHTP matrix –EHTP advantages – Impact Analysis.

MODULE IV CLINICAL ENGINEERING PROGRAM INDICATOR **9 Hours**

Clinical engineering: Program Services, Program database, Clinical Engineering Program management, Program indicator, managing clinical engineering performance using program indicators, Indicator management process.

MODULE V ADVANCED TECHNOLOGY FOR PATIENT SAFETY **9 Hours**

Factors Contributing to Medical Errors: Heath Care Reimbursement, Health Care Failure Mode and Effect Analysis (HFMEA), Patient Safety Best Practices Model: Bar coding, Computerized Physician Order Entry(CPOE), and Clinical data repositories,Process analysis, Methodology. Computerized medical equipment management systems

TOTAL: 45 HOURS

REFERENCES:

1. A Handbook for Clinical and Biomedical Engineers, Second Edition of Clinical Engineering.
2.AzzamTaktak, Paul S. Ganney, ... Richard G. Axell, Academic press, 2020.
3. Clinical Engineering Handbook, 2nd edition, James Eric Myers, Biomed InstrumTechnol (2020) https://doi.org/10.2345/0899-8205-54.3.230.
4. Clinical Engineering A Handbook for Clinical and Biomedical Engineers 1st Edition - November 12, 2013 Editors: AzzamTaktak, Paul Ganney, David Long.

2303BM004 **BIOMECHANICS** **L T P C**
3 0 0 3

PREREQUISITE:

1. Solid state physics.
2. Human physiology and anatomy.

COURSE OBJECTIVES:

1. Understand the basic principle of mechanics needed for biomedical engineers.
2. Discuss the bio-fluid mechanics of human anatomy, the mechanics of tissues, muscles and bones.
3. Illustrate the Skeletal joints of human and Design of a Computer work station

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Understand the principles of mechanics.
CO2: Outline the principles of bio fluid dynamics.
CO3: Explain the fundamentals of bio-solid mechanics.
CO4: Interpret the knowledge of joint mechanics.
CO5: Give Examples of computational mathematical modeling applied in biomechanics.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	1	1	-	-	-	1	1	-	1	1
CO2	3	2	1	1	-	1	1	-	-	-	1	1	-	1	1
CO3	3	2	1	1	-	1	1	-	-	-	1	1	-	1	1
CO4	3	3	1	1	-	1	1	-	-	-	1	1	-	1	1
CO5	3	2	1	1	-	1	1	-	-	-	1	1	-	1	1

COURSE CONTENTS:

MODULE I INTRODUCTION TO MECHANICS **9 Hours**

Bio-fluid Mechanics Newton's Law; Stress, Strain, Elasticity; Hooke's Law; Viscosity; Newtonian Fluid; Non- Newtonian Fluid; Viscoelastic Fluids; Velocity and Pressure of Blood Flow; Resistance Against Flow.

MODULE II BIOFLUID MECHANICS **9 Hours**

Cardiovascular and Respiratory Mechanics Mechanical Properties of Blood Vessels: Arteries, Arterioles, Capillaries and Veins; Function of Cardiac Chambers & Valves; Mechanics of Angiography and Angioplasty; Stent Deployment & Prosthetic Replacement of Cardiac Valves; Alveoli Mechanics; Interaction of Blood and Lung; Breathing Mechanism; Airway Resistance; Working Dynamics of Spirometer; Ventilators

MODULE III BIOSOLID MECHANICS **9 Hours**

Soft Tissue Mechanics Pseudoelasticity; Non-Linear Stress-Strain Relationship; Visco elasticity; Structure Function and Mechanical Properties of Skin; Ligaments and Tendons.

MODULE IV BIOMECHANICS OF JOINTS **9 Hours**

Orthopedic Mechanics Mechanical Properties of Cartilage; Stress-Strain Analysis; Mechanical Properties of Bones and Implants; Design Consideration of Stress Shielding; Kinetics and Kinematics of Joints; Lubrication of Joints; Foot Mechanics.

MODULE V MODELINGANDERGONOMICS **9 Hours**

Introduction to Finite Element Analysis, finite element analysis of lumbar spine ; Ergonomics–Musculo skeletal disorders, Ergonomic principles contributing to good work place design

TOTAL: 45 HOURS

REFERENCES:

1. *Krishna B.Chandran, AjitP.Yoganathan and Stanley E. Rittgers Bio-fluid Mechanics: The Human Circulation‖, Taylor and Francis,2007.*
2. *Sheraz S. Malik and Shahbaz S. Malik, ―Orthopaedic Biomechanics Made Easy‖, Cambridge University Press,2015*
3. *Jay D.Humphrey, Sherry De Lange, An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, Springer Science Business Media,2004.*

2303BM005 **SPEECH & AUDIO SIGNAL PROCESSING** **L T P C**
3 0 0 3

PREREQUISITE:

1. Human physiology and anatomy.
2. Signals and systems.
3. Bio signal processing.

COURSE OBJECTIVES:

1.Understand basics of Anatomy & physiology of speech production and audio perception mechanism
2.Implement different methods of processing speech and audio signals using time & transform domain techniques
3.Discuss the methods of parametric representation of speech signals and speech coding

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Familiarize the basic speech production and audio perception mechanism.
CO2: Implement different methods of processing speech and audio signals using time & transform domain techniques.
CO3: Analyse the methods of parametric representation of speech signals.
CO4: Apply the concepts of speech coding .
CO5: Apply various speech and audio signal processing techniques in biomedical applications.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	1	1	-	-	-	1	1	1	1	-
CO2	3	2	1	-	-	1	1	-	-	-	1	1	1	1	-
CO3	3	2	1	-	-	1	1	-	-	-	1	1	1	1	-
CO4	3	3	1	-	-	1	1	-	-	-	1	1	1	1	-
CO5	3	2	1	-	-	1	1	-	-	-	1	1	1	1	-

COURSE CONTENTS:

MODULE I INTRODUCTIONTOSPEECH PRODUCTION **9 Hours**

Anatomy & physiology of speech production. Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Articulation, Voicing, Articulatory model. Acoustic Phonetics – acoustics of speech production; Acoustic theory of speech production-Excitation,Vocal tract model, Formant structure, Pitch.

MODULE II AUDIO PERCEPTION **9 Hours**

Basic anatomy of hearing System. Psycho-acoustic analysis: Sound pressure level & loudness, Auditory Filter Banks, Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking. Speech perception: Vowel Perception.

MODULE III TIME AND FREQUENCY DOMAIN METHODS FOR SPEECH AND AUDIO PROCESSING SPEECH ANALYSIS **9 Hours**

Short-Time Speech Analysis, Time domain analysis- Short time energy, short time average magnitude, short time zero crossing rate, short time ACF. Frequency domain analysis- Filter Banks, STFT, Spectrogram,

Formant Estimation & Analysis, Cepstral Analysis-MFCC

MODULE IV PARAMETRIC REPRESENTATION OF SPEECH **9 Hours**

AR Model, ARMA model. LPC Analysis- LPC model, Auto correlation method, Covariance method. Levinson-Durbin Algorithm, Sinusoidal Model, HMM. Applications of LPC parameters as pitch detection and formant analysis

MODULE V SPEECH CODING **9 Hours**

Phase Vocoder, LPC, Sub-band coding, Adaptive Transform Coding, Harmonic Coding, Vector Quantization based Coders, CELP. Biomedical applications of speech signal processing: - Detection of neurodegenerative diseases, emotion recognition, Speaker Verification.

TOTAL: 45 HOURS

REFERENCES:

1. Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, 2nd Edition, 1999; ISBN: 0780334493.

2.Donald G. Childers, Speech Processing and Synthesis Toolboxes, John Wiley & Sons, September 1999; ISBN: 0471349593

3.Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall,1st Edition, 1994 ISBN-10 – 0130151572

2303BM006 **MEDICALOPTICS**

L	T	P	C
3	0	0	3

PREREQUISITE:

1. Human physiology and anatomy.
2. Signals and systems.
3. Bio signal processing.
4. Medical image processing.

COURSE OBJECTIVES:

1. To Discuss the optical properties of the tissues and the interactions of light with tissues.
2.To understand the instrumentation and components in Medical Optics, Medical Lasers and their applications
3.To explain the optical diagnostic applications and therapeutic techniques

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Demonstrate knowledge of the fundamentals of optical properties of tissues.
CO2: Analyze the components of instrumentation in Medical Photonics and Configurations.
CO3: Describe surgical applications of lasers.
CO4: Describe photonics and its diagnostic applications.
CO5: Investigate emerging techniques in medical optics.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	1	1	-	-	-	1	1	1	1	-
CO2	3	2	1	1	-	1	1	-	-	-	1	1	1	1	-
CO3	3	2	1	1	-	1	1	-	-	-	1	1	1	1	-
CO4	3	3	1	1	-	1	1	-	-	-	1	1	1	1	-
CO5	3	2	1	1	-	1	1	-	-	-	1	1	1	1	-

COURSE CONTENTS:

MODULE I OPTICAL PROPERTIES OF THE TISSUES **9 Hours**

Refraction, Scattering, absorption, light transport inside the tissue, tissue properties, Light interaction with tissues, opto thermal interaction, fluorescence, speckles.

MODULE II INSTRUMENTATIONIN PHOTONICS **9 Hours**

Instrumentation for absorption, scattering and emission measurements, excitation light sources–high pressure arc lamp, solid state LEDs, Lasers, optical filters, polarizer, solidstate detectors, time resolved and phase resolved detectors.

MODULE III APPLICATIONS OF LASERS **9 Hours**

Lasers in ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology, Tissue welding and Soldering.

MODULE IV OPTICAL TOMOGRAPHY **9 Hours**

Optical coherence tomography, Elastrography, Doppler optical coherence tomography, Application towards clinical imaging.

MODULE V SPECIAL OPTICAL TECHNIQUES **9 Hours**

Near field imaging of biological structures, invitroclinical diagnostic, fluorescent spectroscopy, photodynamic therapy.

TOTAL: 45 HOURS

REFERENCES:

1.MarkolfH.Niemz,—Laser-Tissue Interaction Fundamentals and Applications‖,Springer,2007.

2.G.David Baxter—Therapeutic Lasers Theory and practice, Churchill Livingstone publications Edition 2001.

3. Leon Goldman, M.D.,&R.JamesRockwell,Jr.,—Lasers in Medicine‖, Gordon and Breach, Science Publishers Inc., 1975.

2303BM007 **ARTIFICIAL ORGANS AND IMPLANTS** **L T P C**
3 0 0 3

PREREQUISITE:

1. Rehabilation engineering.

COURSE OBJECTIVES:

1.To have an overview of artificial organs and transplants
2.To describe the principles of implant design and various organs replacement concept
3.To study about physical parameters for concept design of artificial organs and the concept of biocompatibility

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Learner will be able to understand the principles and biology underlying the design of implants and artificial organs.
CO2: Able to understand the principles of implant design with a case study
CO3: Will be familiar about various organs replacement concept
CO4: Knowledge about physical parameters for concept design of artificial organs
CO5: Able to understand the concept of biocompatibility and the methods of biomaterial testing

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	1	-	-	1	1	1	1	-
CO2	3	2	1	-	-	-	-	1	-	-	1	1	1	1	-
CO3	3	2	1	-	-	-	-	1	-	-	1	1	1	1	-
CO4	3	3	1	-	-	-	-	1	-	-	1	1	1	1	-
CO5	3	2	1	-	-	-	-	1	-	-	1	1	1	1	-

COURSE CONTENTS:

MODULE I ARTIFICIAL HEART & CIRCULATORY ASSIST DEVICES **9 Hours**

Engineering Design of artificial Heart & Circulatory Assist Devices; Detailed Design to execute the plant; Heart Assist Technology; Blood Pumps; Prosthetic Heart Valves.

MODULE II ARTIFICIAL BLOOD & COCHLEAR IMPLANT **9 Hours**

Blood components & characteristics; Oxygen carrying plasma expanders; Blood substitutes; Crystalloid & colloidal solutions as volume expanders; Artificial oxygen carriers; Fluorocarbons ; Hemoglobin based artificial blood. Cochlear Implant: Introduction; candidates for implant; the auditory system; the auditory periphery; theory of operation; evaluation of cochlear prosthesis; benefits & risks of implantation; the cost of implantation; the future of cochlear prosthesis.

MODULE III ARTIFICIAL SKIN **9 Hours**

Structure & functions of skin; Characteristics & clinical use of skin substitutes; Two conceptual stages in the treatment of massive skin loss; Skin substitutes: characteristics & uses, types of skin substitutes

MODULE IV ARTIFICIAL PANCREAS & ARTIFICIAL LUNGS **9 Hours**

Parenteral Structure & function of Pancreas; Endocrine pancreas & insulin secretion; Diabetes; Insulin therapy; Insulin administration systems; Insulin production systems. Artificial Lungs: Gas exchange systems; Cardiopulmonary Bypass; Oxygen & CO2 transport; Coupling of oxygen & CO2 exchange;

Shear-Induced Transport Augmentation and Devices for Improved Gas Transport.

MODULE V BIOMATERIAL TESTING AND ARTIFICIAL ORGANS IMPLANTS 9 Hours

Testing of biomaterials: In-vitro, in-vivo preclinical tests - biocompatibility - methods for improvement, surface modification of materials - implant retrieval and evaluation. Artificial Heart, eye and ear implants, artificial pancreas, ophthalmic implantation, dental implantation, insulin administration devices, extracorporeal artificial organs, neural prostheses.

TOTAL: 45 HOURS

REFERENCES:

1. Miller, G. E. (2006). Artificial Organs. United States: Morgan & Claypool Publishers.
2. Schoen, F. J., Ratner, B. D., Hoffman, A. S., Lemons, J. E. (2004).
3. Biomaterials Science: An Introduction to Materials in Medicine. Netherlands: Elsevier.
4. Artificial Organs. (2009). Netherlands: Springer London.

2303BM008 **MEDICAL DEVICE DESIGN**

L	T	P	C
3	0	0	3

PREREQUISITE:

1. Biomedical instrumentation
2. Biosensors and measurements.

COURSE OBJECTIVES:

1.To know about the Medical product design and development

2.Patient safety and regulatory aspects followed in hospitals

3.Professional ethics to be followed by Biomedical Engineers

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Implement Good Design Practice in medical product design.
CO2: Apply appropriate methodologies for Product development.
CO3: Analyse important regulatory schemes to be followed in medical device design.
CO4: Apply testing, validation and market analysis for developed product.
CO5: Analyse challenges in converting innovation into product in Healthcare sector.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	-	-	-	-	1	1	1	1	-
CO2	3	2	1	1	1	-	-	-	-	-	1	1	1	1	-
CO3	3	2	1	1	1	-	-	-	-	-	1	1	1	1	-
CO4	3	3	1	1	1	-	-	-	-	-	1	1	1	1	-
CO5	3	2	1	1	1	-	-	-	-	-	1	1	1	1	-

COURSE CONTENTS:

MODULE I INTRODUCTION TO MEDICAL PRODUCT DESIGN **9 Hours**

Design and Product Life Cycle, Design Process, Understanding the innovation cycle, Good Design Practice. Understanding, Screening Needs, Technical Requirements, Concept Generation, Innovation Survey Questionnaire, Morphological Matrix, QFD, Concept Analysis and validation, Concept Modeling, Concept Screening & Validation.

MODULE II PRODUCT DEVELOPMENT **9 Hours**

Breakthrough Products, Platform Products, Front End of Innovations, Fuzzy Front End, Generic Product Development Process, Variants of Development Processes, Good Documentation Practice, and Prototyping Specifications, Prototyping, Medical Device standards, Quality management systems(ISO 13485), Medical Device Classification, Design of Clinical Trials.

MODULE III REGULATORY SCHEMES **9 Hours**

DesignControl&RegulatoryRequirements,DocumentationinMedicalDevices,Regulatorypathways, Biomedical Evaluation of Medical Devices, ISO Medical Devices, Applications of Risk Management to Medical Devices (ISO 14971), Electrical Safety Standard, IEC60601-1, IEC60601-2, IEC60601-6, Protection of Electrical and Electronic Parts, Assemblies and Equipments (ESD S20.20-2014).

MODULE IV SCALABLE PRODUCT DEVELOPMENT **9 Hours**

Design for manufacturing, Design for assembly, Design for Serviceability, Design for usability, Medical Device Verification & Validation, Product Testing & Regulatory compliance, Clinical trial & validation, Device Certification.

MODULE V PRACTICAL CHALLENGES ON MEDICAL DEVICE DEVELOPMENT 9 Hours

Product life cycle, Challenges in Practicing International Regulatory Requirements, Risk Management: Integration of Risk Management into the supporting QMS, Use of Codes to Identify Medical Devices, Application of Risk Management throughout product life cycle.

TOTAL: 45 HOURS

REFERENCES:

1.JohnG.Webster,Medical Instrumentation: Application and Design,5th Edition, June 2020

2.Peter J. Ogrodnik, Medical Device Design: Innovation from Concept to Market, Academic Press is an imprint of Elsevier, 1st edition 2013

3.PaulH.King,RichardC.Fries,Arthur T.Johnson, Design of Biomedical Devices and Systems, CRC Press, Tailor and Francis Group, 3rd Edition, 2015

2303BM009 HOSPITAL PLANNING AND MANAGEMENT

L	T	P	C
3	0	0	3

PREREQUISITE:

1. Human physiology and anatomy.
2. Clinical engineering.
2. Hospital training.

COURSE OBJECTIVES:

1. To understand the fundamentals of hospital administration and management.
2. To explore various information management systems and relative supportive services.
3. To learn the quality and safety aspects in hospitals.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Analyze the challenges in hospital administration with appropriate hospital management system.
CO2: Analyze the functions and characteristics of human resource management in hospitals.
CO3: Implement the various marketing research techniques and its challenges involved in Hospital system management.
CO4: Outline the quality and safety aspects to be maintained in the Hospital environment.
CO5: Structure the Information system to be implemented in the Hospital environment.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	2	-	1	-	-	1	1	1	-	-	-
CO2	3	-	1	-	2	-	1	-	-	1	1	1	-	-	-
CO3	2	2	2	-	2	2	1	-	-	1	1	1	-	-	2
CO4	2	2	2	-	2	3	1	-	-	1	1	1	-	-	2
CO5	2	3	1	-	2	-	1	-	-	1	1	1	-	-	3

COURSE CONTENTS:

MODULE I HOSPITAL MANAGEMENT **9 Hours**

Nature and Scope of a hospital, History of Indian Hospitals, Distinction between Hospital and Industry, Challenges in Hospital Administration, Hospital Planning- Equipment Planning- Functional Planning- Current issues in Hospital Management- Telemedicine- Biomedical Waste Management.

MODULE II HUMAN RESOURCE MANAGEMENT IN HOSPITAL **9 Hours**

Human Resource Management- Principles, Characteristics, Functions, Significance and Importance Profile of HRD Manager, Good HR Practices, Causes for Poor Human Resource Management, Tools of HRD, Human Resources Inventory- Manpower Planning, Recruitment, Selection, Induction, Training Guidelines, Promotion, Termination and Communication

MODULE III HOSPITAL DATA MANAGEMENT **9 Hours**

Managing A Service Organization- Hospital Service Delivery- Quality Control- Six Sigma, NABH. Hospital Queuing Systems- Simple Queuing Systems, Interdependent Queuing Systems- Hospital Management Functions- Operation Management, Finance and Cost Management, Materials Management- Case Studies.

MODULE IV QUALITY AND SAFETY ASPECTS IN HOSPITAL **9 Hours**

Quality system- Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000-9004- Features of ISO 9001- ISO 14000- Environment Management

Systems, NABA, JCI, NABL. Security- Loss Prevention- Fire Safety- Alarm System Safety Rules. Health Insurance & Managing Health Care- Medical Audit- Hazard and Safety in a Hospital Setup.

MODULE V HOSPITAL INFORMATION SYSTEMS **9 Hours**

Management Decisions and Related Information Requirement- Clinical Information Systems Administrative Information Systems- Support Service Technical Information Systems- Medical Transcription, Medical Records Department- Central Sterilization and Supply Department- Pharmacy Food Services- Laundry Services.

TOTAL: 45 HOURS

REFERENCES:

1. R.C.Goyal, Hospital Administration and Human Resource Management, PHI-Fourth Edition, 2006.
2. G.D.Kunders, Hospitals Facilities Planning and Management- TMH, New Delhi- Fifth Reprint 2007.
3. Ramani KV, Hospital Management- Text and Cases, Pearson education, New Delhi, 2012.
4. Malhotra A K, Hospital Management- An Evaluation, Global India Publications, New Delhi, 2009.
5. Norman Metzger, Handbook of Health Care Human Resources Management, 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.
6. Blane, David, Brunner, Health and social organization: Towards a Health Policy for the 21st Century, Eric Calrendon Press 2002

2303BM010 REHABILITATION ENGINEERING

L	T	P	C
3	0	0	3

PREREQUISITE:

1. Human physiology and anatomy.
2. Biomechanics
3. Clinical engineering
2. Hospital training.

COURSE OBJECTIVES:

1. The course is designed to provide a brief and basic knowledge to understand musculoskeletal, neuromuscular, sensory disorders, prosthetics and orthotics and their applications.
2. To know the basic concept so that the students can implement their knowledge for higher studies in developing innovative and effective rehabilitation and assistive technologies.
3. ToDiscuss visual augmentationand advanced applications in rehabilitation engineering.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Study basics of Rehabilitation Engineering.
CO2: Learn the Orthotics & Ortho prosthetics.
CO3: Gain knowledge of the Wheeled Mobility.
CO4: Understand sensory augmentation and substitution.
CO5: Study recent developments in the field of rehabilitation engineering.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	-	-	-	-	1	1	1	-	-
CO2	1	2	2	-	-	-	-	-	-	-	1	1	1	-	-
CO3	1	2	2	1	-	-	-	-	-	-	1	1	1	-	-
CO4	1	2	2	1	-	-	-	-	-	-	1	1	1	-	-
CO5	1	1	-	-	-	-	-	-	-	-	1	1	1	-	-

COURSE CONTENTS:

MODULE I INTRODUCTION TO REHABILITATION 9 Hours

Introduction Concepts and principles of rehabilitation engineering, Ergonomics - Positioning anatomical site, simplicity and intuitive operation, adaptability and flexibility, mental and chronological age appropriateness. Knowledge of disability act 1995 for physically disabled, visually impaired, hearing impaired and others. Rehabilitation Team.

MODULE II ORTHOTICS & ORTHOPROSTHETICS 9 Hours

Orthopedic prosthetics and orthotics in Rehabilitation Fundamentals, Applications: Computer Aides Engineering in customized component design. Intelligent prosthetic knee and hand. A self-aligning orthotic knee joint. FES System: Restoration of hand function; restoration of standing and walking. Hybrid Assistive systems (HAS) Active prostheses. Active Above knee Prosthesis. Myoelectric hand and arm prostheses. Orthotics - FO, AFO, TLSO, LSO.

MODULE III WHEELED MOBILITY **9 Hours**

History and Categories of Wheelchairs. Wheelchair Structure and Component Design. Ergonomics of wheel chair propulsion. Power Wheelchair Electrical System. Personal transportation. Tricycles.

MODULE IV SENSORY AUGMENTATION AND SUBSTITUTION **9 Hours**

Visual System: Visual augmentation. Tactual vision substitution. Auditory vision substitution: Auditory System: Auditory augmentation. Cochlear implantation. Visual auditory substitution. Tactual auditory substitution. Tactual system: Tactual augmentation. Tactual substitution. Alternative and Augmentative communication, User Interface: Outputs: Acceleration Techniques.

MODULE V ADVANCED APPLICATIONS IN REHABILITATION ENGINEERING **9 Hours**

Interfaces in Compensation for visual perception. Improvement of orientation and mobility. Computer - assisted lip reading. Brain - computer interface. Electronic Travel Applications (ETA) : Path Sounder, Laser Cane, Ultrasonic Torch, Sonic Guide, Light Probes, Nottingham Obstacle Sensor, Electro-cortical Prosthesis,. Polarized Ultrasonic Travel Aid.

TOTAL: 45 HOURS

REFERENCES:

1. Bronzino, Biomedical Engineering, Hand Book IEEE Press Volume 1.
2. Robinson C. J, Rehabilitation Engineering, CRC Press. 1995.
3. Ballabio E. et al, Rehabilitation Technology, IOS Press. 1993.
4. Handbook of Physical Medicine & Rehabilitation, W.B.Saunders Publication, 2003.
5. Hanfredclynes, Biomedical Engineering System, McGraw Hill, 1999.

2303BM011 **BIOMETRICS** **L T P C**
3 0 0 3

PREREQUISITE:

1. Image processing

COURSE OBJECTIVES:

1.To understand the general principles of design of biometric systems and the underlying trade-offs.
2. To understand the technologies of fingerprint identification technology.
3. To explain face recognition representations and determination.
4. To Discuss speech recognition and evaluations.
5. To recognize multi biometrics and design aspects.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to
CO1: Demonstrate knowledge engineering principles underlying biometric systems.
CO2: Analyze design basic biometric system applications.
CO3: Explain face recognition representations and determination.
CO4: Discuss speech recognition and evaluations.
CO5: Recognize multi biometrics and design aspects.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	1	1	-	-	-	1	2	-	1	1
CO2	3	2	1	1	-	1	1	-	-	-	1	2	-	1	1
CO3	3	2	1	1	-	1	1	-	-	-	1	2	-	1	1
CO4	3	3	1	1	-	1	1	-	-	-	1	2	-	1	1
CO5	3	2	1	1	-	1	1	-	-	-	1	2	-	1	1

COURSE CONTENTS:

MODULE I INTRODUCTION TO BIOMETRICS **9 Hours**

Introduction and back ground – biometric technologies – passive biometrics – active biometrics - Biometrics Vs traditional techniques – Benefits of biometrics - Operation of a biometric system– Key biometric processes: verification, identification and biometric matching – Performance measures in biometric systems: FAR, FRR, FTE rate, FTA rate and rate- Need for strong authentication – Protecting privacy and biometrics and policy – Biometric applications

MODULE II FINGERPRINT IDENTIFICATION TECHNOLOGY **9 Hours**

Fingerprint Patterns, Fingerprint Features, Fingerprint Image, width between two ridges - Fingerprint Image Processing - Minutiae Determination - Fingerprint Matching: Fingerprint Classification, Matching policies.

MODULE III FACE RECOGNITION **9 Hours**

Introduction, components, Facial Scan Technologies, Face Detection, Face Recognition, Representation and Classification, Kernel- based Methods and 3D Models, Learning the Face Spare, Facial Scan Strengths and Weaknesses, Methods for assessing progress in Face Recognition.

MODULE IV VOICE SCAN **9 Hours**

Introduction, Components, Features and Models, Addition Method for managing Variability, Measuring Performance, Alternative Approaches, Voice Scan Strengths and Weaknesses, NIST Speaker Recognition Evaluation Program, Biometric System Integration

MODULE V FUSION IN BIOMETRICS **9 Hours**

Introduction to Multibiometric - Information Fusion in Biometrics - Issues in Designing a Multi-biometric System - Sources of Multiple Evidence - Levels of Fusion in Biometrics - Sensor level, Feature level, Rank level, Decision level fusion - Score level Fusion. Examples – bio potential and gait based biometric systems.

TOTAL: 45 HOURS

REFERENCES:

1.James Wayman, Anil Jain, DavideMaltoni, Dario Maio, ―Biometric Systems, Technology Design and Performance Evaluation‖, Springer, 2005.
2. David D. Zhang, ―Automated Biometrics: Technologies and Systems‖, Kluwer Academic Publishers, New Delhi, 2000.
3. Paul Reid, ―Biometrics for Network Security‖, Pearson Education, 2004.
4. Nalini K Ratha, Ruud Bolle, ―Automatic fingerprint Recognition System‖, Springer, 2003.
5.L C Jain, I Hayashi, S B Lee, U Halici, ―Intelligent Biometric Techniques in Fingerprint and Face Recognition‖ CRC Press, 1999.

2303BM012 **WEARABLE DEVICES** **L T P C**
3 0 0 3

PREREQUISITE:

1. Biosensors and measurements

COURSE OBJECTIVES:

1. To understanding the technology behind wearable devices, including sensors, connectivity, and data processing.
2. To Understand how wearable devices collect, transmit, and analyze data, including issues related to data privacy and security.
3. To Analyze various applications of wearable devices across different sectors, such as healthcare, fitness, and industrial uses.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Describe different sensors used in physiological system measurement.
CO2: Understand the bio signal acquisition methods and signal processing methods for human systems.
CO3: Analyze the usage of optimized energy techniques for wearable devices.
CO4: Evaluate the wireless Tele health technology for applications.
CO5: Executing the specified wearable systems for respective physiological systems.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	-	1	-	-	1	2	3	1	-
CO2	3	2	1	1	1	-	-	1	-	-	1	2	3	1	-
CO3	3	2	1	1	1	-	-	1	-	-	1	2	3	1	-
CO4	3	2	1	1	1	-	-	1	-	-	1	2	3	1	-
CO5	3	2	1	1	1	-	-	1	-	-	1	2	3	1	-

COURSE CONTENTS:

MODULE I SENSORS **9 Hours**

Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS –Based Biosensors, E-Textiles, Bio compatibility.

MODULE II SIGNAL PROCESSING **9 Hours**

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, rejection of irrelevant information, datamining.

MODULE III ENERGY HARVESTING FOR WEARABLE DEVICES **9 Hours**

Solar cell, vibration based thermal based human body as a heat source for power generation, hybrid thermoelectric photovoltaic energy harvests, and thermopiles.

MODULE IV WIRELESS HEALTH SYSTEMS **9 Hours**

Need for wireless monitoring, Definition of Body area network and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication techniques.

MODULE V APPLICATIONS OF WEARABLE SYSTEMS **9 Hours**

Medical diagnostics, Medical monitoring-patients with chronic disease, Multi parameter monitoring, Neural recording, Gait analysis, Sports medicine, Smart fabrics.

TOTAL: 45 HOURS

REFERENCES:

1. Hang,Yuan-Ting, "wearable medical sensors andsystems",Springer-2013.
2. Guang-ZhongYang(Ed.), "Body Sensor Networks, "Springer,2006.
3. Mehmet R. Yuce, Jamil Y. Khan,"Wireless Body Area Networks Technology, Implementation and Applications " , Pan Stanford Publishing Pvt. Ltd, Singapore,2012.
4.Andreas Lymberis, Danilo de Rossi ,'Wearable eHealth systems for Personalised Health Management - State of the art and future challenges ' IOS press, The Netherlands,2004.

		L	T	P	C
2303BM013	**OCCUPATIONAL SAFETY AND HEALTH IN PUBLIC HEALTH EMERGENCIES WEARABLE DEVICES**	**3**	**0**	**0**	**3**

PREREQUISITE:

1. Clinical engineering.
2. Hospital training and management.

COURSE OBJECTIVES:

1.To know about occupational safety and health (OSH)

2.Discuss about risks faced by emergency responders during disease outbreaks and other emergencies

3.To create awareness on necessary strategies for managing OSH in emergency Situations

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Practice the occupational safety measures by the scientific knowledge to overcome the risks faced by emergency responders.
CO2: Apply appropriate strategies and tools in occupational safety and healthcare.
CO3: Analyze common risks for safety and health in emergencies.
CO4: Adapt appropriate occupational safety practices in chemical accidents.
CO5: Guide Occupational safety measures in radiation incidents.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	-	-	-	1	-	-	1	2	-	1	-
CO2	3	2	2	2	-	-	-	1	-	-	1	2	-	1	-
CO3	3	2	2	2	-	-	-	1	-	-	1	2	-	1	-
CO4	3	2	2	2	-	-	-	1	-	-	1	2	-	1	-
CO5	3	2	2	2	-	-	-	1	-	-	1	2	-	1	-

COURSE CONTENTS:

MODULE I MANAGEMENT ASPECTS **9 Hours**

Management system approach to occupational safety and health hazards and risks – rights, duties and responsibilitiesofemployersandworkersduringoutbreaksandemergencies –Emergency responders health monitoring and surveillance.

MODULE II STRATEGIES AND TOOLS **9 Hours**

International Health Regulations, 2005 – Incident command system for managing outbreaks and emergencies–Occupational safety and health controls–Strategies for infection prevention and control

MODULE III COMMON RISKS FOR SAFETY AND HEALTH IN EMERGENCIES **9 Hours**

Vector-borne diseases, water and food-borne diseases,Vaccine-preventable diseases–Heatstress- Slips, trips and falls - Road traffic injuries – Ergonomic hazards - Violence – Psychological stress during outbreaks and injuries.

MODULE IV OCCUPATIONAL SAFETY AND HEALTH IN CHEMICAL INCIDENTS **9 Hours**

Emergencies caused by chemical incidents – Occupational safety and health hazards and risks of chemicals–Personal Protective Equipment –Decontamination of emergency response personal – Medical surveillance of emergency responders

MODULE V OCCUPATIONAL SAFETY AND HEALTH IN RADIATION INCIDENTS **9 Hours**

Sources and scenarios of radiation incidents–Guidance for protection of emergency responders-Occupational health surveillance of persons occupationally exposed to radiation in emergencies

TOTAL: 45 HOURS

REFERENCES:

1. *Emergency responder health monitoring and surveillance. National Response Team technical assistance document. Atlanta (GA): National Institute for Occupational Safety and Health; 2012.*

2.Emergency response framework(ERF).Geneva: World Health Organization;2013

3. Guidelines on occupational safety and health management systems, second edition. Geneva: International Labour Organization; 2009.

4. OSH management system: a tool for continual improvement. Geneva: International Labour Organization; 2011

5. OECD Environmental Outlook to 2050: the consequences of inaction. Paris: Organization for Economic Co-operation and Development; 2012.

2302BM551 **BIOMECHANICS LABORATORY** **L T P C**
0 0 2 1

PREREQUISITE:

1. Human anatomyand physiology.

COURSE OBJECTIVES:

1. To study the mechanics involved with various physiological systems.
2. To gain knowledge in deriving the mathematical models related to blood vessels.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to
CO1: Understand the basics of MATLAB for Mechanics
CO2: Simulate and Understand the mechanics of bones
CO3: Simulate and Understand the mechanics of Soft Tissues
CO4: Simulate and Understand the mechanics of Joints
CO5: Simulate FEA models

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	-	-	-	1	1	1	1	-
CO2	3	2	1	1	1	1	1	-	-	-	1	1	1	1	-
CO3	3	2	1	1	1	1	1	-	-	-	1	1	1	1	-
CO4	3	2	1	1	1	1	1	-	-	-	1	1	1	1	-
CO5	3	2	1	1	1	1	1	-	-	-	1	1	1	1	-

LIST OF EXPERIMENTS:

1. Simulation of Musculoskeletal Anatomy
2. Simulation of Basics Statics
3. Simulation of Joint Mechanics
4. Calculation of Stress strain curve for the bone under tension and compression.
5. Calculation of the Average CT Number (HU)
6. Calculation of Bone Multidimensional Interpolation using RBAS method
7. Simulation of Mechanical Testing of the Femur
8. Simulation of Crack Growth of the Cortical Bone

TOTAL: 30 HOURS

REFERENCES:

1. *K.Nandakumar, R.Anandaraj, "Power Electronics and Drives Laboratory Manual", 2018.*
2. *G.K Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosa Book Distributors,2013.*
3. *R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", 1st Edition, Pearson Education,2015.*
4. *Bimal K. Bose, "Modern Power Electronics and AC Drives", 1st Edition, Pearson Education,2015.*
5. *https://nptel.ac.in/courses/108/104/108104140/*
6. *https://in.mathworks.com/matlabcentral/fileexchange?q=electrical+drives.*

7. *https://ied-nitk.vlabs.ac.in/*
8. *https://em-coep.vlabs.ac.in/List%20of%20experiments.html*.

2302BM552 **BIOMEDICAL SIGNAL PROCESSING** **L T P C**
0 0 2 1

PREREQUISITE:

1.Probability and Stochastic Processes
2.Biomedical Signals and system

COURSE OBJECTIVES:

1. To study the mechanics involved with various physiological systems.
2. To gain knowledge in deriving the mathematical models related to blood vessels.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1: Design of digital filter and Generation of various signals, Analysis of signal and system properties.
CO2: Computation of circular and linear convolution.
CO3: Determine the frequency transformation and Analysis of sampling rate.
CO4: Design of digital filters.
CO5: Analyze the power spectral density of the system.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	-	-	-	1	1	1	1	2
CO2	3	2	1	1	1	1	1	-	-	-	1	1	1	1	2
CO3	3	2	1	1	1	1	1	-	-	-	1	1	1	1	2
CO4	3	2	1	1	1	1	1	-	-	-	1	1	1	1	2
CO5	3	2	1	1	1	1	1	-	-	-	1	1	1	1	2

LIST OF EXPERIMENTS:

1.Simulation and verify generation of signals
2. Simulate and verify, Properties of Discrete time Systems-Linearity, stability, causality &Time variance.
3. Simulate and verify, Sampling of an audio signal with different sampling rate and reconstruct the sampled signal.
4.Compute and verify DFT of a signal using basic equation and FFT & power spectrum estimation using DFT
5. Design and Simulation of IIR filters.
6. Design and Simulation of FIR filters.
7.Simulate and verify ,Multirate signal processing-Down sampling , Up sampling , Decimation and Interpolation.
8.Simulate and verify ,Arithmetic operations in DSPs.

TOTAL: 30 HOURS

REFERENCES:

1.J.G. Proakis and D.G. Manolakis, „Digital Signal Processing Principles, Algorithms and Applications",

Pearson Education, New Delhi, PHI. 2003.
2. S.K. Mitra, „Digital Signal Processing – A Computer Based Approach", McGraw Hill Edu, 2013.