Artificial Organs

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM108251BM

[Pre-Requisite- Nil]

Course Objectives

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

Course Content

Unit-1 Artificial Heart & Circulatory Assist Devices

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

Unit-2 Artificial Blood & Cochlear Implant

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.

Unit-3 Artificial Skin

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.

Unit-4 Artificial Pancreas & Artificial Lungs

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 & CO_2 transport; Coupling of oxygen & CO_2 exchange; Shear-Induced Transport Augmentation and Devices for Improved Gas Transport.

Course Materials

Required Text:

Textbooks

1. Bronzino, J. D. (2000). The Biomedical Engineering Handbook. Germany: CRC Press.
2. Artificial Organs. (2009). Netherlands: Springer London.

Optional Materials: Reference Books

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). Biomaterials Science: An Introduction to Materials in Medicine. Netherlands: Elsevier Science.

Embedded & Real Time System

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM108252BM

[Prerequisite - Nil]

Course Objectives

1. To introduce the basics of embedded systems.
2. To introduce the basics of general purpose processors.
3. To learn different communication interfaces.
4. To learn Embedded / RTOS concepts and different design technologies.

Course Content

Unit-1 Embedded Systems

Overview; Characteristics; Components; Categorization; Requirements; Design challenges; Processor technology; IC technology; Design Technology; Processors (RT- level): custom single purpose processor design, combinational logic, sequential logic.

Unit-2 General Purpose Processors

Introduction; Benefits; Basic architecture; Operations: Instruction execution, Pipelining; Programmer's view; development environment; Selecting a microprocessor.

Unit-3 Communication Interface

Need for communication interfaces, RS232/ RS432 / UART, RS422 / RS485, USB, Infrared, IEEE 1394 Firewire, Ethernet, IEEE 802.11 wireless LAN, Bluetooth.

Unit-4 Embedded / RTOS Concepts and Digital Technology

Architecture of the Kernel, Tasks and Task scheduler, Interrupt service routines, Semaphores, Mutex, Timers, Priority inversion problem. Logic synthesis, Behavioral synthesis, System synthesis, Hardware/Software co-design, Hardware/Software co-simulation, Reuse of intellectual property codes.

Course Materials

Required Text: Textbooks

1. Givargis, T., Vahid, F. (2003). Embedded System Design: A Unified Hardware/Software Introduction. United States: John Wiley & Sons, Incorporated.
2. Fan, X. (2015). Real-Time Embedded Systems: Design Principles and Engineering Practices. Netherlands: Elsevier Science.
3. Kamal, R. (2011). Embedded Systems: Architecture, Programming and Design. India: Tata McGraw Hill Education Private.

Optional Materials: Reference Books

1. Valvano, J. W. (2011). Embedded Microcomputer Systems: Real Time Interfacing. United States: Cengage Learning.
2. An Embedded Software Primer (With Cd). (1999). India: Pearson Education.
3. IEEE Embedded Systems Letters (ISSN-1943-0663) Journal, Elsevier.

Patient and Device Safety

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM108253BM

[Pre-Requisite- Nil]

Course Objectives

1. To provide a source of useful ideas, concepts, and techniques that could be selectively applied to reduce an intolerable rate of unacceptable errors, mistakes, goofs, or shortcomings in expected Medical Device performance.
2. To avoid patient injury, achieving efficacious treatment, and controlling health care costs.
3. Medical error has proved to be a difficult and recalcitrant phenomenon.

Course Content

Unit-1

Basics of Reliability

Reliability, Types of reliability, the concept of failure, Causes of failure, Types of Failures in Medical devices, Safety testing, Failure assessment and Documentation, Visual inspection: External & Internal visual inspection.

Unit-2

Measurement and Safety Parameters

Measurement, Safety parameters, Safety and risk management, Manufacturer's, and physician's responsibilities. Safe medical devices, operation – Medical Application safety. Environmental safety, Interference with the environment, Ecological safety.

Unit-3

Electrical Safety

Electrical Safety, Limitation of Voltages, Macroshock and Microshock, Earth and Protection, Leakage currents, Magnetic fields, and compatibility.

Unit-4

Regulations and Standards

Medical Standards and Regulations – Device classification – Registration and listing – Declaration of conformance to a recognized standard – Investigational Device Exemptions (IDEs) – Institutional Review Boards (IRBs) – IDE format – Good laboratory practices (GLPs) – Good manufacturing practices (GMPs) – Human factors – Design control – The Medical Devices Directives (MDD) – Definition, Process and choosing the appropriate directive – Active Implantable Medical Devices Directive (AIMDD) – In Vitro Diagnostic Medical Devices Directive (IVDMDD).

Course Materials

Required Text:

Textbooks

1. Murray, A., Jacobson, B. (2007). Medical Devices: Use and Safety. Ireland: Churchill Livingstone.
2. Fries, R. C., Richard, F. (2006). Reliable design of medical devices. United Kingdom: Taylor & Francis.

Materials: Reference Books

1. Leitgeb, N. (2010). Safety of Electromedical Devices: Law – Risks Opportunities. Austria: Springer.
2. Higson, G. (2001). Medical Device Safety: The Regulation of Medical Devices for Public Health and Safety. United Kingdom: CRC Press.

Bioinformatics

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM108261BM

[Prerequisite - NIL]

Course Objectives

1. To have understanding of gene sequences, sequence matching and other related methods
2. To understand mathematical optimization concepts related to Bioinformatics
3. To understand algorithms related to Bioinformatics

Course Content

Unit-1 Introduction

Phenotype, Central and Peripheral Dogmas, Systems Biology, Human Genome, Databases in Molecular Biology, Genetics Background, Maps and Tour Guides, DNA Sequencing, Next-Generation Sequencing, Ethical, Legal and Social Issues, Genomes, Transcriptomes and Proteomes, Genomes of Prokaryotes and Eukaryotes, Sequence Alignment, Phylogeny

Unit-2 Structural Bioinformatics

Principles of Protein Structure and Classification: Properties of Amino Acids and Peptide Bonds, Ramachandran Plot, Secondary Structures, Motifs and Folds, Protein Structure Visualization, Tools and Analysis of Protein Structures, Protein Structure Prediction and Modelling, Protein Databank, Concepts of B-factor and R-factor, Protein Structural Alignment and Superposition, Protein Fold Classification, CATH, SCOP and FSSP Databases

Unit-3 Algorithms in Bioinformatics

Algorithms and Complexity, Exhaustive Search, Greedy Algorithms, Dynamic Programming Algorithms, Randomized Algorithms, Graph Algorithms, Dot Plots, Measures of Sequence Similarity, Applications of Multiple Sequence Alignment to Database Searching, DNA Digital Data Storage

Unit-4 Machine Learning Approach for Bioinformatics

Machine-Learning Foundations: The Probabilistic Framework, Machine Learning Algorithms, Applications of Neural Networks in Bioinformatics, Hidden Markov Models, Stochastic Grammar and Linguistics

Course Materials

Required Text: Textbooks

1. Lesk, A. (2019). Introduction to Bioinformatics. United Kingdom: Oxford University Press.
2. Bach, F., Brunak, S., Baldi, P., Baldi, P. P. (2001). Bioinformatics. Cambridge: Bradford.

Optional Materials: Reference Books

1. Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis. Thailand: Cold Spring Harbor Laboratory Press.
2. Baxevanis, A. D., Ouellette, B. F. F. (2009). BIOINFORMATICS: A PRACTICAL GUIDE TO THE ANALYSIS OF GENES AND PROTEINS, 3RD ED. India: Wiley India Pvt. Limited.

BioMEMS

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM108262BM

[Pre-Requisite - Nil]

Course Objectives

1. To Make Students Understand The Basic Concepts Of MEMS.
2. To Create Problem Solving Ability Among Students For Developing Biological MEMS Design.
3. To Encourage Students For Designing Biomems Solutions For Existing Healthcare Solutions.
4. To Prepare Students For Entrepreneurship In Biomems Product And Services .

Course Content

Unit-1 Working Principles Of Microsystems

Microsensors: Acoustic, Biological, Chemical, Optical,Pressure, Thermal; Microactuations Using Thermal Force, Shape Memory Alloy, Piezoelectric Crystals, Electrostatic Forces; MEMS With Microactuators: Micrograppers, Micromotors, Microvalves, Micropumps; Microaccelerometer.

Unit-2 Engineering Mechanics For Microsystem Design

Static Bending Of Thin Plates: Bending Of Circular Plates-Rectangular Plates-Square Plates With Edge Fixed; Mechanical Vibrations: Resonant, Microaccelerometer, Design Theory Of Accelerometer, Resonant Microsensor; Thermomechanics: Thermal Effects On Mechanical Strength Of Materials, Creep Deformation, Thermal Stress; Fracture Mechanics:Stress Intensity Factors, Fracture Toughness, Interfacial Fracture Mechanics; Thin Film Mechanics .

Unit-3 Microsystems Design

Design Considerations: Constraint, Selection Of Materials, Manufacturing Processes, Signal Transduction, Electromechanical System; Process Design: Photolithography, Thin Film Fabrication, Geometry Shaping; Mechanical Designing:Thermomechanical Loading, Stress Analysis, Dynamic Analysis, Fracture Analysis.

Unit-4 Biomems Applications

Overall Market Of Micromachines, MEMS In Biotechnology Market, Micro-TAS And LOC In Sample Preparation For Molecular Diagnostics.

Course Materials

Required Text: Textbooks

1. Hsu, T. R. MEMS and Microsystems: Design and Manufacture. 2002. *McGrae Hill*.

Optional Materials: Reference Books

1. Madou, M. J. (2018). *Fundamentals of microfabrication and nanotechnology, three-volume set*. CRC Press.

Optical Fiber and Laser in Medicine

[8thSemester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM108263BM

[Pre-Requisite - Nil]

Course Objectives

1. To understand the LASER physics, Light and its working principle with different modes of operation.
2. To explain the construction, working principle of fibers and Light propagation through fibers.
3. To demonstrate the integration of biomedical sensor with optical fiber and thus its emerging various therapeutic, diagnostic as well as imaging application, its advantages and safety aspects.
4. Understanding the various applications for curing different diseases accurately by fiber optic laser system in an easy, fast and safe method of operation.

Course Content

Unit-1 Introduction and Applications of Lasers

Historical background. Medical Lasers: Introduction, Laser physics- fundamentals, principles, advances. Medical Laser system-fundamentals, principles. Laser safety-fundamentals, Laser assisted diagnosis and therapy fundamentals.

Unit-2 Laser Tissue Interaction

Laser interaction with tissue-principles; laser assisted diagnostic –principles, application of lasers in diagnosis and imaging-advances, laser surgery and therapy –principles-photothermal & photomechanical mechanism, thermal interaction between laser and tissue-advances.

Unit-3 Optical Fibers

Introduction, historical background, optical fiber fundamentals. Light transmission in optical fibers-principles, optical properties of optical fibers-advances, fabrication of optical fibers- principles, optical fibers for UV, visible, IR light-principles, power transmission through optical fibers-principles. Introduction, non-ordered fiber optic bundles for light guides-fundamental & principles, ordered fiberoptic bundles for imaging devices-fundamentals & principles, fiberscopes, and endoscopes-fundamentals fiber optic imaging systems-advances.

Unit-4 Endoscopy

Introduction endoscopic imaging systems-fundamental, principles, advances, endoscopic diagnostic –advances endoscopic therapy –fundamentals

Course Materials

Required Text: Textbooks

1. Katzir, A. (2012). Lasers and Optical Fibers in Medicine. United States: Elsevier Science.
2. Meardon, S. L. W. (1993). The Elements of Fiber Optics. United States: Regents/Prentice Hall.

Optional Materials: Reference Books

1. Advances in Optical Fiber Technology: Fundamental Optical Phenomena and Applications. (2015). Croatia: IntechOpen.
2. Sliney, D. H., Trokel, S. L. (2012). Medical Lasers and Their Safe Use. United States: Springer New York.
3. Hooper, B. A., Splinter, R. (2007). An Introduction to Biomedical Optics. United Kingdom: Taylor & Francis.
4. Lacy, E. A., Hoss, R. J. (1993). Fiber Optics. (n.p.): Pearson Education.
5. Crisp, J., Elliott, B. J. (2005). Introduction to Fiber Optics. Netherlands: Elsevier Science.

Biofluid Dynamics

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Open Elective	BM108341BM

[Pre-Requisite - Nil]

Course Objectives

1. To Make Students Understand The Basic Concepts Of Biofluid Dynamics.
2. To Create Problem Solving Ability Among Students For Biofluidic Problems.
3. To Encourage Students For Designing Computational Solution For Biofluid Domains In Physiological Events.
4. To Prepare Students For Advanced Biofluid Mechanics .

Course Content

Unit-1 Concepts Of Biofluid Dynamics

Transport Phenomena: Biofluid Compartment Models, Tissue Heat And Mass Transfer, Joint Lubrication, Cell Transport And Microvascular Beds Cardiovascular System : Cardiovascular Transport Dynamics, Heart, Blood Vessels.

Unit-2 Analyses Of Arterial Diseases

Vessel Occlusion: Artherosclerotic Plaque Formation, Intimal Hyperplasia Development, Thrombogenesis, Particle Hemodynamics; Aneurysm: Aortic Aneurysm, Stent Graft Implant, Stented AAA Model Analysis.

Unit-3 Biofluid Mechanics Of Organ Systems

Lung : Respiratory Tract Geometry, Pulmonary Disorder And Treatment Options; Kidney: Structure And Function, Fluid Flow And Mass Transfer In Artificial Kidney Model; Liver: Structure And Function, Fluid Flow And Mass Transfer In Liver Model.

Unit-4 Case Studies In Biofluid Dynamics

Nano Drug Delivery In Microchannels: Flow In Microchannels, Controlled Nanodrug Delivery In Microchannels; Particle Deposition And Targeting In Human Lung Airways: Nanoparticles And Microparticle Depositions In Human Upper Airway Model, Modeling Approach, Micro-Drug Aerosol Targeting In Lung Airways; Fluid Structure Interactions In Stented Aneurysms: Aneurysms And Their Possible Repairs, Stented Abdominal Aortic Aneurysm Model.

Course Materials

Required Text: Textbooks

1. Kleinstreuer, C. (2006). *Biofluid dynamics: Principles and selected applications*. CRC Press.

Optional Materials: Reference Books

1. Arindam Bit; (2020) Flow dynamics and tissue engineering of blood vesels; IOP Publisher.

Drug Delivery System

[8thSemester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Open Elective	BM108342BM

[Pre-Requisite- Nil]

Course Objectives

1. To understand the basics about Drug Delivery system.
2. To understand the various ways of drug delivery
3. To know about pharmacokinetics and pharmacodynamics.
4. To understand the various aspects of Matrix based drug delivery system.

Course Content

Unit-1

Drug Delivery System

Overview, dosage form-tablet, capsule, parenteral etc. classification of drug delivery system, chemically controlled system, diffusion-controlled system, controlled release mechanism-Membrane reservoir system, Matrix system, swelling controlled release system, biodegradable controlled release system.

Unit-2

Fundamental Aspects of Drug Delivery

Introduction of pharmacokinetics and pharmacodynamics, diffusive transport, diffusion in heterogeneous system, passage of drug through membrane drug release kinetics from different biopolymer matrices

Unit-3

Pharmacokinetics

Common routes of systemic drug administration, drug absorption, bioavailability, determinants of bioavailability disintegration, dissolution, drug distribution, drug elimination.

Unit-4

Matrix Based Drug Delivery System

Delivery materials, polymer-based matrices; hydrogels- drug carriers, transdermal and trans-mucosal drug delivery system, measuring in vitro diffusions, measuring controlled release kinetics, drug targeting approaches, biocompatibility aspects of matrices Immunity and immunological preparations: immunity, types, immunological preparations; bacterial vaccines, vaccines containing living viruses, vaccines containing toxoids Fundamentals of vaccine delivery.

Course Materials

Required Text: Textbooks

1. Drug Delivery: Fundamentals and Applications, Second Edition. (2016). United States: CRC Press.
2. Drug Delivery: Principles and Applications. (2016). Germany: Wiley.

Optional Materials: Reference Books and Links

1. Shargel, L., Yu, A. B. (2016). Applied Biopharmaceutics & Pharmacokinetics, Seventh Edition. Singapore: McGraw-Hill Education.
2. Basic Pharmacokinetics and Pharmacodynamics: An Integrated Textbook and Computer Simulations. (2016). United Kingdom: Wiley.

3D Printing Technology

[8th Semester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Open Elective	BM108351BM

[Pre-Requisite - Nil]

Course Objectives

1. To Make Students Understand The Basic Concepts Of 3D Printing Technology .
2. To Create Problem Solving Ability Among Students For Making Their Own 3D Printing Solutions.
3. To Encourage Students For Designing Novel 3D Printing Approaches For Different CAD Models.
4. To Prepare Students For Entrepreneurship In The Field Of 3D Printing Technology.

Course Content

Unit-1 Design Process Overview

Loading Fusion 360, The CAD Environment, Best Practices For Running CAD, Common CAD Files Types, CAD Libraries; A Short History Of Digital Manufacturing: Design For 3D Print, Fusion 360 Modeling, Sketching, Extruding, Collaborating On Files; Process Flow: Fusion 360 Sculpting, Moving Between Environments, Matching Imported Geometry.

Unit-2 3DP In Public Media 3

The 3DP Business Case: Working With Meshes, Scanning Tools, Editing Scanned Files, Fixing Scan Bugs; Printing In Plastic: Optimizing For Print, Printing @ Stanford Print, De-Bugging; Printing In Metal: Making Assemblies, Moving And Aligning, Parts Joints.

Unit-3 Bioprinting Approaches

Printing In Glass, Wood, Concrete & More: Prototype II, Fasteners, Finishes, Advanced Modeling Tools; Bioprinting: Working With Service Providers, Optimizing Files For Different Methods, Debugging Prints; Politics & Ethics: CAD Rendering, Mechanical Drawings, Photographing Parts.

Unit-4 Different 3D Printing Techniques

Stereolithography (SLA), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM), Digital Light Process (DLP), Multi Jet Fusion (MJF), Polyjet. Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM).

Course Materials

Required Text: Textbooks

1. Lipson, H., & Kurman, M. (2013). *Fabricated: The new world of 3D printing*. John Wiley & Sons.
2. France, A. K. (2013). *Make: 3D printing: the essential guide to 3D printers*. Maker Media, Inc..

Optional Materials: Reference Books

1. Rapid Prototyping Journal (ISSN 1355-2546)
2. International Journal of Rapid Manufacturing (ISSN 1757-8817)
3. Virtual and Physical Prototyping (ISSN 1745-2759)

Health Care Management

[8thSemester, Fourth Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Open Elective	BM108352BM

[Pre-Requisite- Nil]

Course Objectives

1. Learn concepts and theories in Health Care Management
2. Learn to understand perspectives and values of Health Care Management
3. Develop the basic management skills and ability to work productively with others
4. Develop skills in using materials tools and/or technology central to Health Care Management
5. Integrate health care management theory with real world situations

Course Content

Unit-1 An Overview of Healthcare Management, Leadership and Motivation

Introduction, Definition and Dimensions of health, Philosophy of Healthcare Management, History and Future of Healthcare Management, Management: Definition, Function, and Competencies, Role of Manager; Leadership vs Management, Leadership Styles, Ethical Responsibility, Motivation, Measuring Engagement, Organizational Behavior and Management Thinking – Four Key Features of Thinking, Socio-Emotional Intelligence, Strategic Planning – SWOT Analysis, Strategy Identification and Selection

Unit-2 Healthcare Marketing, Quality and Information Technology

Introduction and History of Healthcare Marketing, Strategic Process, Ethics and Social Responsibility; Quality in Healthcare, Patient-Centered Care, Common Elements of Quality and Improvement, Approaches and Tools for Quality Improvement, Health Information System, Healthcare Information Technology, Financial Management in Healthcare, Controlling Costs, Managing Budget.

Unit – 3 Strategic Management of Resources, Teamwork, Law and Ethics

Environmental Forces Affecting Human Resources Management, Workforce Planning/ Recruitment, Challenges of Teamwork in Healthcare Organization, Emotions and Teamwork, Organizational Learning, Role of Individuals and Communities in Addressing Health Disparities, Healthcare Law, Malpractices, Ethical Concepts, Rights and Responsibilities of Patient and Provider

Unit-4 Regulation, Compliance and Special Topics

Frauds and Abuse, Antitrust Issues, Emergency and Disaster Management, Innovations in Healthcare Management – Global Trends in Health System Innovation, Public Health Innovations, Leapfrog through mHealth, Initiatives by Indian Government, Bioterrorism and Violence in Health Care Settings, Medical Tourism, Consumer-Directed Health Care, Opportunities for Research on Emerging Issues, Case studies.

Course Materials

Required Text: Textbooks

1. Kite, B. J., Shanks, N. H., Buchbinder, S. B. (2019). Introduction to Health Care Management. United States: Jones & Bartlett Learning, LLC.
2. Singh, V.K., Lillrank, P., Innovations in Healthcare Management: Cost-Effective and Sustainable Solutions. (2015). United States: Taylor & Francis.

Optional Materials: Reference Books

1. Amelung, V. E. (2020). Healthcare Management: Managed Care Organisations and Instruments. Germany: Springer Berlin Heidelberg.
2. Dracopolou, S. (2006). Ethics and Values in Healthcare Management. United Kingdom: Taylor & Francis.