Microcontrollers

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM105111BM

[Prerequisite - BM104108BM (Microprocessor)]

Course Objectives

1. To learn the basics and the inbuilt hardware of microcontroller.
2. To learn 8051 microcontroller instruction and able to write and implement programs.
3. To learn and apply interfacing concepts for interfacing of the microcontroller with other devices.

Course Content

Unit-1 Introduction to Microcontroller 8051

Brief History, Classification of MCS-51family based on their features (8051, 8052, 8031, 8751, AT89C51), Pin configuration, Processor Architecture and Instruction Set: Registers of 8051, Inbuilt RAM, Register banks, stack, on-chip and external program code memory ROM, power reset and clocking circuits, I/O port structure, Addressing modes, Instruction set and programming.

Unit-2 Timer/Counter and Interrupts of 8051

Introduction, Registers, Different modes, Programming, Interrupt Vs Polling, Types of interrupts, Register used for interrupts initialization, Programming of external interrupts, Timer interrupts.

Unit-3 Asynchronous Serial Communication and Programming

Introduction to serial communication, Data Programming, RS232 standard, RS422 Standard, 1488 and 1489 standard, GPIB, Max 232/233 Driver, Serial communication programming.

Unit-4

Interfacing with 8051 and Advanced Microcontrollers

Interfacing and programming of: ADC & DAC, stepper motor , 4x4 keyboard matrix, LCD,Interfacing (only) of different types of Memory. Introduction to ARM and PIC microcontroller.

Course Materials

Required Text: Textbooks

1. Mazidi, M. A., Mazidi, J. G., & McKinlay, R. D. (2006). The 8051 microcontroller and embedded systems: using Assembly and C (Vol. 626). Pearson/Prentice Hall.
2. Predko, M. (1999). Programming and customizing the 8051 microcontroller. McGraw-Hill, Inc.
3. Vahid, F., & Givargis, T. D. (2001). Embedded system design: a unified hardware/software introduction. John Wiley & Sons.

Optional Materials: Reference Books

1. Ayala, K. J. (2010). The 8051 Microcontroller and Embedded Systems: Using Assembly and C. Cengage Learning.
2. Ayala, K. J. (1995). The 8051 microcontroller. Penram, India.

Medical Imaging

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM105112BM

[Pre-Requisite- Nil]

Course Objectives

1. To understand the Physics of medical imaging modalities
2. To understand Image Acquisition and related engineering
3. To learn about Radiation Biology and Safety

Course Content

Unit-1 Basic Concepts

Introduction to Medical Imaging; Radiation and the Atom, Important Discoveries in the History of Science, Interaction of Radiation with Matter, Image Quality, Medical Imaging Informatics.

Unit-2 Diagnostic Radiology

X-ray Production, Tubes, and Generators; Radiography; Breast Imaging: Mammography; Fluoroscopy; Computed Tomography; X-ray Dosimetry in Projection Imaging and Computed Tomography; Magnetic Resonance Basics: Magnetic Fields, Nuclear Magnetic Characteristics, Tissue Contrast, Image Acquisition; Magnetic Resonance Imaging: Advanced Image Acquisition Method; Ultrasound

Unit-3 Nuclear Medicine

Radioactivity and Nuclear Transformation; Radionuclide Production, Radiopharmaceuticals, and Internal Dosimetry; Radiation Detection and Measurement; Nuclear Imaging—The Gamma Camera; Nuclear Tomographic Imaging—Single Photon and Positron Emission Tomography (SPECT and PET)

Unit-4 Radiation Biology and Protection.

Radiation Biology - Determinants and Classification of the Biologic Response of Radiation, Interaction of Radiation with Cells and Tissue, Molecular and Cellular Response to Radiation; Radiation Protection - Sources of Exposure to Ionizing Radiation, Personnel Dosimetry, Radiation Detection Equipment in Radiation Safety, Structural Shielding of Imaging Facilities, Medical Emergencies Involving Ionizing Radiation, PACS

Course Materials

Required Text: Textbooks

1. Boone, J. M., Seibert, J. A., Bushberg, J. T., Leidholdt, J. (2020). The Essential Physics of Medical Imaging. Argentina: Wolters Kluwer Law & Business.
2. Iniewski, K. (2017). Medical Imaging: Technology and Applications. United States: CRC Press.

Optional Materials: Reference Books

1. Suetens, P. (2017). Fundamentals of Medical Imaging. United Kingdom: Cambridge University Press.
2. Hendee, W. R., Ritenour, E. R. (2003). Medical Imaging Physics. Germany: Wiley.

Biomedical Equipments

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM105113BM

[Prerequisite - Nil]

Course Objectives

1. To impart knowledge on various therapeutic equipment and their functions
2. Discuss and express the basic principle, working and design of various therapeutic equipment's
3. To acquaint the students with the different types of equipment used in medical field.
4. To describe the modes of operation and functioning of cardiac, respiratory and kidney devices.
5. To provide a comprehensive knowledge of the features of extracorporeal devices.

Course Content

Unit-1 Defibrillators & Concepts of Coronary Care

Basics, AC defibrillators, DC defibrillators, capacitance discharge and delay line capacitance discharge, defibrillator waveforms, electrodes used with defibrillators: types and their features, Cardioverters: working, principles. Systems Organization, critical physiological characters to be monitored, and layout and safety precautions.

Unit-2 Cardiac Pacemakers

Modes of operation (Asynchronous and Synchronous), External and Implantable; Block diagram and circuit diagram of a blocking oscillator asynchronous pacemaker. Implantable pacemakers: Technical and qualitative requirements of power supplies, transcutaneous RF powered Cardiac pacemaker systems, susceptibility of implantable pacemakers to electrical interference and remedial measures, Lead wires and electrodes used with pacemakers.

Unit-3 Respiratory System and Instrumentation

Mechanics of breathing, regulation of respiration, artificial respiration therapy, artificial mechanical ventilation. Basic principles of electromechanical, Pneumatic and electronic ventilators, Nebulizer, humidifiers and aspirators.
Anaesthesia Machine: General working principle, need of anasthesia and its delivery, Basics of Anaesthesia Machine and patient breathing circuit, Semiclosed Circle System and circle system.

Unit-4 Hemodialysis & Lithotripsy

Hemodialysis: Qualitative requirements, general scheme of operations, types of exchangers, block diagram electronic control & monitoring Systems.
Lithotripsy: Principles of Lithotripsy, the Stone Disease Problem, shock wave lithotripsy, mechanisms of stone fragmentation, Modern Lithotriptor Systems, Laser Lithotripsy.

Course Materials

Required Text: Textbooks

1. Webster, J. G., & Nimunkar, A. J. (2020). Medical Instrumentation: Application and Design (Fifth ed.). Wiley.
2. Khandpur, R. S. (2004). Biomedical Instrumentation: Technology and Applications. India: McGraw-Hill Education.
3. Geddes, L. A., Baker, L. E., Baker, L. E., Baker, L. E. (1989). Principles of Applied Biomedical Instrumentation. United Kingdom: Wiley.

Optional Materials: Reference Books

1. Webster, J. G. (2006). Encyclopedia of Medical Devices and Instrumentation. Wiley-Blackwell (an imprint of John Wiley & Sons Ltd.

PHYSIOLOGICAL SYSTEMS AND MODELLING

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM105211BM

[Prerequisite- Nil]

Course Objectives

1. To study system concept and different mathematical techniques applied in analyzing any given system.
2. To learn to do the analysis of given system in time domain and frequency domain.
3. To develop an understanding of the fundamental principles behind control of various biological systems.
4. To apply these analysis to study the biological systems.

Course Content

Unit-1

Mathematical Modelling

Mathematical Modelling: Generalized system properties, models with combination of system elements, Linear models of physiological systems, Conversions between electrical and mechanical analog, Distributed-Parameter versus Lumped-Parameter Models, Linear Systems and The Superposition Principle, Zero-Input and Zero-State Solutions of Odes, Laplace Transforms and Transfer Functions, the Impulse Response and Linear Convolution, State-Space Analysis.

Unit-2

Static Analysis

Static analysis of physiological systems: Open-loop versus closed-loop systems, Determination of the steady-state Operating point, Regulation of cardiac output, Regulation of glucose insulin, Chemical regulation of ventilation, Renal system.

Unit-3

Time-domain Analysis

Time-domain analysis of linear control systems: Linearized respiratory mechanics, Open-loop versus closed-loop transient responses: first-order model, second order model, Impulse responses, Step responses, Generalized. Second-Order Dynamics, Transient Response Descriptors. Frequency-domain analysis of linear control systems-steady-state responses to sinusoidal inputs, graphical representations of frequency response, frequency response of a model of circulatory control.

Unit-4

Stability Analysis

Stability analysis: Stability and transient response, Root locus plots, Routh–Hurwitz stability criterion, Nyquist criterion for stability, Relative stability, Stability analysis of the pupillary light reflex, Model of Cheyne–Stokes breathing. Basic problems in physiological system analysis, nonparametric and parametric Identification methods.

Course Materials Required Text: Textbooks

1. Nagrath, I. J., Gopal, M. (2008). Control Systems Engineering. India: Anshan.
2. Khoo., Khoo, M. C. K. (2000). Physiological Control Systems: Analysis, Simulation, and Estimation. United States: Wiley.
3. Edwards, A., Layton, A. T. (2014). Mathematical Modeling in Renal Physiology. Germany: Springer Berlin Heidelberg.

Optional Materials: Reference Books

1. Gopal, M. (2002). Control Systems: Principles and Design. India: McGraw-Hill Education (India) Pvt Limited.
2. Cobelli, C., Carson, E. (2019). Introduction to Modeling in Physiology and Medicine. United States: Elsevier Science.
3. Mathematical Modeling and Validation in Physiology: Applications to the Cardiovascular and Respiratory Systems. (2012). Germany: Springer Berlin Heidelberg.

Artificial Intelligence

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM105212BM

[Prerequisite - Nil]

Course Objectives

1. To provide a strong foundation of fundamental concepts in Artificial Intelligence
2. To provide a basic exposition to the goals and methods of Artificial Intelligence
3. Learn the methods of solving problems using Artificial Intelligence.
4. To enable the student to apply these techniques in applications.

Course Content

Unit-1 Introduction to Artificial Intelligence

Artificial Intelligence: Philosophy and other Foundations, Definition, Purpose, Significance, History, Scope, Advantages and Disadvantages; Intelligent Agents: Agents and Environments, Nature of Environments, Structure of agents; Problem solving: Problem Solving Agents, Searching for Solutions, Informed, Uninformed Search Strategies, Searching in Complex Environments Adversarial Search, Constraint Satisfaction Problems.

Unit-2 Knowledge, Reasoning, and Planning

A Knowledge-Based Agent, Logic - Propositional and First Order, Propositional Theorem Proving, Effective Propositional Model Checking, Agents Based on Propositional Logic; Syntax and Semantics of First-Order Logic, Using First-Order Logic, Knowledge Engineering in First-Order Logic; Inference in First-Order Logic - Forward and Backward Chaining; Knowledge Representation - Ontological Engineering; Automated Planning

Unit-3 Uncertain knowledge and reasoning

Quantifying Uncertainty - Acting under Uncertainty, Bayes' Rule and Its Use; Probabilistic Reasoning - Exact Inference in Bayesian Networks; Probabilistic Reasoning over Time - Hidden Markov Models, Kalman Filters; Probabilistic Programming - Relational Probability Models; Making Simple Decisions - The Basis of Utility Theory, Utility Functions, Decision Networks; Making Complex Decisions - Representing MDPs, Partially Observable MDPs; Multiagent Decision Making,

Unit-4 Machine Learning, Advance in Research and Applications.

Learning from Examples - Supervised, Unsupervised and Reinforcement Learning; Ensemble Learning; Learning Probabilistic Models; Deep Learning - Convolutional Networks; Generative Adversarial Network, AI in Healthcare; Ethics, and Safety of AI; The Future of AI - Artificial General Intelligence.

Course Materials

Required Text: Textbooks

1. Norvig, P., Russell, S. (2020). Artificial Intelligence: A Modern Approach. United Kingdom: Pearson
2. Rich, E. (2019). Artificial Intelligence 3E (Sie). India: Tata McGraw-Hill Publ.

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Optional Materials: Reference Books and Links

1. Dignum, V. (2020). Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way. Switzerland: Springer International Publishing
2. https://www.elementsofai.com/

Data Science in Healthcare

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM105213BM

[Pre-Requisite- Nil]

Course Objectives

1. To understand the basic concepts of Data Science
2. To understand Applications of Data Science in Healthcare

Course Content

Unit-1 Introduction

Introduction to Healthcare Data Analytics - Healthcare Data Sources and Basic Analytics, Advanced Data Analytics for Healthcare, Resources for Healthcare Data Analytics

Unit-2 Healthcare Data Sources and Basic Analytics

Electronic Health Records: A Survey, Components of EHR, Coding Systems, Benefits of EHR, Barriers to Adopting EHR, Challenges of Using EHR Data, Phenotyping Algorithms; Fundamentals of Biomedical Image Analysis; Mining of Sensor Data in Healthcare

Unit-3 Healthcare Data Analysis

Genomic Data Analysis for Personalized Medicine; Natural Language Processing and Data Mining for Clinical Text; Mining the Biomedical Literature; Social Media Analytics for Healthcare

Unit-4. Advanced Data Analytics for Healthcare

A Review of Clinical Prediction Models; Temporal Data Mining for Healthcare Data; Visual Analytics for Healthcare; Clinical Decision Support System, Fraud Detection in Healthcare

Course Materials

Required Text: Textbooks

1. Chandan K. Reddy, Charu C. Aggarwal, Healthcare Data Analytics. (2015). United States: CRC Press.
2. Data Science for Healthcare: Methodologies and Applications. (2019). Germany: Springer International Publishing.

Optional Materials: Reference Books

1. Ali-Hassan, H., El Morr, C. (2019). Analytics in Healthcare: A Practical Introduction. Germany: Springer International Publishing.
2. Harrison, E., Pius, R. (2020). R for Health Data Science. United States: CRC Press.

Analytical And Diagnostic Medical Equipment

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-0-0 (3)	Open Elective	BM105311BM

[Pre-Requisite - Nil]

Course Objectives

1. To Make Students Understand The Working Principles Of Analytical And Diagnostic Medical Equipments.
2. To Create Problem Solving Ability By Understanding The Concept Of Troubleshoot Raised In These Medical Equipment.
3. To Encourage Students For Designing Refined Principle For This Medical Equipment.
4. To Prepare Students For Advance Level Courses Device Development For Medical Equipment.

Course Content

Unit-1 Biochemistry Equipment

Clinical Equipments Principles Of Photometric Measurement, Optical Filters, Colorimeter, Spectrometer , Design Of Monochromators, Flame Photometer, Atomic Absorption Spectrophotometer, Automated Biochemical Analyzer-Auto Analyzer, Electromechanical Analyzer – Chromatographs, Microscopes, Scanning Electron Microscope, Transmission Electron Microscope, Centrifuge-Principles And Applications.

Unit-2 Hematological Equipment

Blood Gas Analyzers And Oximeters Blood Ph Measurement, Blood Pco2 Measurement, Blood Po2 Measurement, A Complete Blood Gas Analyzer, Fiber Optic Based Blood Gas Sensors, Oximetry, Principles Of Oximetric Measurements, Ear Oximeter, Pulse Oximeter, Intravascular Oximeter. Blood Cell Counters, Flow Cytometry, Coulter Counters, Automatic Recognition And Differential Counting Of Cells.

Unit-3 Blood Flow And Respiratory Measuring Equipment

Blood Flow Meters Electromagnetic Blood Flow Meter, Ultrasonic Blood Flow Meter-Transit Time And Doppler Blood Flow Meter, Cardiac Output Measurement-Dye Dilution Method And Impedance Technique. Pulmonary Function Analyzers Respiratory Volumes And Capacities, Compliance And Related Pressure, Pneumotachometer, Impedance Pneumograph / Plethysmograph, Apnea Detector

Unit-4 Endoscopic Apparatus

Endoscopy Basic Endoscopic Equipments, Fibre Optic Instruments And Video-Endoscopes, Accessories-Illumination, Instrument Tips, Instrument Channels, Tissue Sampling Devices, Suction Traps And Fluid-Flushing Devices, Various Endoscopic Applications. Maintenance And Storage

Course Materials

Required Text: Textbooks

1. Khandpur, R. S. (1987). *Handbook Of Biomedical Instrumentation*. Mcgraw-Hill Education.
2. Khandpur, R. S. (1989). *Handbook Of Analytical Instruments*. Mcgraw-Hill Education.
3. Griffiths, H. J. (1989). Encyclopedia Of Medical Devices And Instrumentation. *Radiology*, *170*(3), 1016-1016.
4. Aston, R. (1990). *PRINCIPLES OF BIOMEDICAL INSTRUMENTATION AND MEASUREMENT/RICHARS ASTON*.

Optional Materials: Reference Books

1. Bronzino, J. D. (2000). *Biomedical Engineering Handbook 2* (Vol. 2). Springer Science & Business Media.

Computational Biomechanics

[5th Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering [Pre-Requisite: Nil]	3-0-0, (3)	Open Elective	BM105312BM

Course Objectives

1. Understand how design considerations are done to simulate the biomechanical response of the human body.
2. Able to develop insight, skills and hands-on experience in computational modeling of diverse biomechanical systems and topics, spanning various scales from cellular to tissue and organ levels.
3. With practical use cases, it will provide knowledge of numerical methods, image analysis, and computational tools necessary to carry out end-to-end, subject-specific simulations in biomechanics, using open license software.

Course Content

Unit-1 Computational Biomechanics Overview

Biomechanics and its applications, Biomechanics of the musculoskeletal system: current knowledge, Rigid multi-body musculoskeletal modeling, Challenges and perspectives of musculoskeletal models. continuum modeling of musculoskeletal system: Introduction, hypothesis, kinematic balance and constitutive equations.

Unit-2 Modeling of Biomechanical Uncertainty

Introduction to biomechanical data and their uncertainties, uncertainties modeling and propagation, Monte Carlo simulation, physical law-based uncertainty propagation.

Unit-3 Modeling of Tissues of Musculoskeletal System

Human Gait modeling, Muscle Coordination of Walking and Running, nonlinear control theory to simulate the dynamics of human gait and optimization principles. Inverse and forward dynamics problems.

Unit-4 Time Dependent Adaptive Modeling

Bone adaption and remodeling formulation, tissue differentiation and osseointegration algorithms, biomechanical considerations, and procedural aspects. Design of computer-based experiments: comparative, parametric, and probabilistic models of musculoskeletal system. Performance assessment of computational models.

Course Materials

Required Text:

Textbooks

1. Belinha, J. (2014). Meshless Methods in Biomechanics: Bone Tissue Remodelling Analysis. Germany: Springer International Publishing.
2. Computational Biomechanics of the Musculoskeletal System. (2014). United States: CRC Press.

Optional Materials: Reference Books

1. Fung, Y. C. (2013). Biomechanics: Mechanical Properties of Living Tissues. United States: Springer New York.

Microprocessor and Microcontroller Laboratory

[5th Semester, Third Year]

Course Description Offered by Department	Credits	Status	Code
Biomedical Engineering	0-0-2, (1)	Core	BM105405BM

Course Content

Using 8085 instruction set:

Experiment 1	Program to move a data block with and without overlap.
Experiment 2	Program to perform addition, subtraction, multiplication, and division of two 8-bit numbers.
Experiment 3	Program to find the largest and smallest number in an array of data.
Experiment 4	Program to arrange an array of data in ascending and descending order.
Experiment 5	Program to convert given BCD number to its equivalent HEX number and vice versa.

Using 8051 instruction set:

Experiment 6	Program to add and subtract 16 bit number.
Experiment 7	Program to convert binary to(i) gray and (ii) BCD number
Experiment 8	Program to find even and odd numbers
Experiment 9	Program to find number of 1's and 0's in a given number
Experiment 10	Program to generate square wave of given frequency.

Biomedical Equipment Lab

[5rd Semester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	0-0-2, (1)	Core	BM105406BM

Course Content

Experiment 1	To Study The Operation And Troubleshooting Of Biochemistry Analyzer
Experiment 2	To Study The Operation And Troubleshooting Of Infusion Pump And Syringe Pump
Experiment 3	To Study The Operation And Troubleshooting Patient Monitoring System
Experiment 4	To Study The Operation And Troubleshooting Hemodialysis Unit
Experiment 5	To Design And Develop Pacemaker Amplifier On PCB Board
Experiment 6	To Design And Develop Defibrillator Discharge Circuit On PCB Board
Experiment 7	To Design And Develop Signal Conditioning Circuit For Optical Recording Of Biochemistry Analyzer
Experiment 8	To Simulate A Rate Responsive Pacemaker Design
Experiment 9	To Simulate The Working Of A Cardioverter