National Institute of Technology Raipur													
Course of Study and Scheme of Examination							B. Tech. 4th Semester				Branch:	
S. No.	Subject Code	Subject Name	Periods per Week			TA	Examination Scheme				Total Marks	Credits
			L	T	P		MSE/MTR		ESE/ESVE			
							Theory	Prac.	Theory	Prac.		
1	BM104106BM	Biomedical Signal Processing	3	1	0	20	30		50		100	4
2	BM104107BM	Digital Electronics	3	1	0	20	30		50		100	4
3	BM104108BM	Microprocessor	3	1	0	20	30		50		100	4
4	BM104109BM	Biomedical Instrumentation and Measurement	3	1	0	20	30		50		100	4
5	BM104110BM	Biomechanics	3	1	0	20	30		50		100	4
6	BM104004MA	Mathematics IV (Numerical Methods in Biomedical Engineering)	4	0	0	20	30		50		100	4
7	BM104403BM	Biomedical Signal Processing Lab	0	0	2	40		20		40	100	1
8	BM104404BM	Biomedical Instrumentation and Measurement Lab	0	0	2	40		20		40	100	1
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Biomedical Signal Processing

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM104106BM

[Pre-Requisite - Nil]

Course Objectives

1. To Make Students Understand the Sources, Types & Characteristics of Different Noises and Artifacts Present in Biomedical Signals.
2. To Make Students Able to Design Time Domain and Frequency Domain Filters for Noise and Artifact Removal from Biomedical signals.
3. To Make Students Able to Understand and Apply Various Methods for Analyzing Biomedical Signal Characteristics.
4. To Motivate Students to Explore Alternative Techniques of Analyzing Biomedical Signals in Time and Frequency Domain.

Course Content

Unit-1 Introduction to Biomedical Signals

Action Potential and Its Generation, Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event-Related Potentials (ERPS), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis.

Unit-2 Removal of Noise and Artifacts from Biomedical Signal

Random and Structured Noise, Physiological Interference, Stationary and Nonstationary Processes, Noises and Artifacts Present in ECG, Time and Frequency Domain Filtering.

Unit-3 EEG Signal Processing and Event Detection in Biomedical Signals

EEG Signal and Its Characteristics, EEG Analysis, Linear Prediction Theory, Autoregressive Method, Sleep EEG, Application of Adaptive Filter for Noise Cancellation in ECG and EEG Signals; Detection of P, Q, R, S and T Waves in ECG, EEG Rhythms, Waves and Transients, Detection of Waves and Transients, Correlation Analysis Ad Coherence Analysis of EEG Channels.

Unit-4 Analysis of Nonstationary Signals

Heart Sounds and Murmurs, Characterization of Nonstationary Signals and Dynamic Systems, Short-Time Fourier Transform, Considerations in Short-Time Analysis and Adaptive Segmentation.

Course Materials

Required Text: Textbooks

1. Rangayyan, R.M., 2015. Biomedical signal analysis (Vol. 33). John Wiley & Sons.
2. Reddy, D.C., 2005. Biomedical signal processing: principles and techniques. McGraw-Hill

Optional Materials: Reference Books

1. Tompkins, W.J., 1993. Biomedical digital signal processing. Editorial Prentice Hall.
2. Sörnmo, L. and Laguna, P., 2005. Bioelectrical signal processing in cardiac and neurological applications (Vol. 8). Academic Press.

Digital Electronics

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM104107BM

[Pre-Requisite - Nil]

Course Objectives

1. To Introduce Methods Used for Minimization Techniques for Analyzing Digital Circuits.
2. To Create Problem Solving Ability Among Students for Designing Combinational Circuits and Sequential Circuits.
3. To Encourage Students to Understand and Design Registers and Counters.
4. To Motivate Students to Design Digital Circuits for Biomedical Applications

Course Content

Unit-1 Number System, Codes & Logic Gates

Number-Base Conversion, Binary Codes, Decimal Codes, Error Detecting Code, Reflected Code, Alpha-Numeric Codes, NOT, OR, and, NOR, NAND, Ex-OR, Ex-NOR Gates, Fundamental Laws of Boolean Algebra and Their Application in Simplification of Boolean Functions, Realization of Boolean Functions Using Gates, Universal Properties of NAND and NOR Gates.

Unit-2 Minimization Techniques and Combinational Circuits

Expansion of a Boolean Expression to SOP & POS Forms, Two, Three & Four Variable K-Map, Concept of Don't Care Terms; Half Adder, Full Adder, Half Subtractor, Full Subtractor, Parallel Binary Adder, Look Ahead Carry Adder, Serial Adder, BCD Adder, Code Converter, Magnitude Comparator, Decoder, Encoder, Multiplexer, Demultiplexer, Parity Generator & Checker, Diode Based Rom, Pal, PLA & PLD.

Unit-3 Sequential Circuits, Shift Register & Counters

Flip Flops & Timing Circuit, S-R Latch; D Latch; J-K Flip-Flop; T-Flip Flop, S-R Flip Flop, D-Flip Flop, Edge-Triggered Flip Flop, Master - Slave Flip-Flop, Direct Preset and Clear Inputs, PIPO, SIPO, PISO, SISO, Bi-Directional Shift Registers, Universal Shift Register, Asynchronous Counter, Synchronous Counter, Up Counter, Down Counter, Ring Counter, Johnson Counter, Twisted Ring Counter, Effect of Propagation Delay.

Unit-4 Digital Logic Families

Introduction, Simple Diode Gating and Transistor Inverter, Basic Concepts of RTL, DTL, TTL, IIL, and ECL Mos. Logic: CMOS Logic, Comparison Between Various Logic Families.

Course Materials

Required Text: Textbooks

1. Kumar, A.A., 2014. Fundamentals of digital circuits. PHI Learning Pvt. Ltd.
2. Taub, H. and Schilling, D.L., 1977. Digital integrated electronics. McGraw-Hill.
3. Maini, A.K., 2007. Digital Electronics: Principles and Integrated circuits. John Wiley & Sons.

Optional Materials: Reference Books

1. Jain, R.P. and Floyd, T.L., 2009. Digital fundamentals, Dorling Kindersley Pvt Ltd.
2. Malvino, A.P. and Leach, D.P., 1986. Digital principles and applications. McGraw-Hill.
3. Mandal S. K., 2017. Digital Electronics: Principles and Applications. McGraw-Hill.

Microprocessor

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM104108BM

[Pre-Requisite - Nil]

Course Objectives

1. To Make Students Understand the Architecture of 8085 Microprocessor and Various Peripheral Interfacing Devices.
2. To Develop Programming Skills of Assembly Language of 8085.
3. To Create Microprocessor Based System Design Ability Among Students for Interfacing I/O and Memory Devices.
4. To Motivate Students to Apply Fundamental Concepts Gained for Understanding Advanced Microprocessors.

Course Content

Unit-1 Microprocessor Architecture

Introduction to Microprocessor, Architecture of 8085, Pin Configuration and Function, Internal Register and Flag Register, Generation of Control Signals, Bus Timings, Demultiplexing of Address/Data Bus, Fetch Cycle, Execute Cycle, Instruction Cycle, Instruction Timing and Operation Status, Timing Diagram.

Unit-2 Instruction Set and Programming With 8085

Instruction for Data Transfer, Arithmetic & Logical Operations, Branching Operation, Machine Cycle Concept, Addressing Modes, Instruction Formats, Stacks, Subroutine and Related Instructions, Elementary Concepts of Assemblers, Assembler Directives, Looping and Counting, Software Counters With Time Delay, Simple Program Using Instruction Set of 8085, Debugging, Programs Involving Subroutines, Programs for Code Conversion, Program for Addition, Subtraction, Programs for Multiplication and Division of Unsigned Binary Numbers.

Unit-3 Interrupts and Interfacing

8085 Interrupts H/W, S/W Interrupts, Maskable / Non Maskable Interrupts, Vectored / Non-Vectored Interrupts, 8085 Interrupts Structure, Interrupt Priorities. RIM and SIM Instruction, Pending Interrupts, Use of Interrupt and Handshaking Signals in Interfacing, Application of Interrupts and Illustrative Programs; Memory Interfacing With 8085, Absolute & Partial Decoding, I/O Mapped I/O, Memory Mapped I/O, Architecture & Interfacing of 8255, 8155/8156. 8355/8755, 8253/8254 With 8085, Direct Memory Access.

Unit-4 Advanced Microprocessor and Programmable Devices

Architecture & Pin Diagram of 8085, Comparison of 8085 & 8086, Instruction Format & Addressing Modes of 8086. Architecture of 80386 & Pentium-4 Microprocessors; Arduino, Raspberry Pi, Introduction to Quantum Processors.

Course Materials

Required Text: Textbooks

1. Gaonkar, R.S. Microprocessor Architecture, Programming and Application. Wiley Eastern.
2. Liu, Y.C. and Gibson, G.A., 1986. Microcomputer systems: the 8086/8088 family: architecture, programming, and design. Prentice-Hall.
3. Hall, D.V., 1986. Microprocessors and interfacing: programming and hardware. McGraw-Hill.
4. Sanjay, K. Bose. Digital System – From Gates to Microprocessor. New Age International.

Optional Materials: Reference Books

1. Srinath, N.K., 2005. 8085 Microprocessor: Programming and Interfacing. PHI Learning Pvt. Ltd.
2. Malvino, A.P. and Brown, J.A., 1992. Digital computer electronics. Glencoe.
3. Quazzaman, M.R., 2003. Microprocessors Theory and Applications: Intel and Motorola. Prentice Hall of India.
4. Singh, B., 0000 to 8085 Introduction to Microprocessor for Engineering & Scientists.

Biomedical Instrumentation & Measurements

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM104109BM

[Pre-Requisite - Nil]

Course Objectives

1. To Familiarize Students with Basic Approach to Instruments Design.
2. To Understand the Functional Elements of Biomedical Instrumentation/ Measurements.
3. To Enable the Students to Understand the Working of Biomedical Instruments and follow the Safety Regulations Required in Design.
4. To Motivate Students to Explore Other Biomedical Instruments used in Hospitals.

Course Content

Unit-1 Introduction to Biomedical Instruments

Evolution of Modern Health Care System; What Is Biomedical Engineering; Component and Scope of Biomedical Engineering; Roles Played by Biomedical Engineers; Recent Advancement in Biomedical Engineering; Fundamentals of Interdisciplinary Engineering Domains.

Unit-2 Bio-Potential Amplifiers and Cardiovascular Measurements

Simple Differential Bio-Potential Amplifiers, Instrumentation Amplifiers, Frequency Ranges of Various Bio-Potential Signals, Bio-Potential Amplifier With DC Rejection, AC-Coupled Instrumentation Bio-Potential, Bootstrapped AC-Coupled Bio-Potential Amplifier, Design of Active Filters; Electrocardiogram- Amplifiers, Leads, Recording Principles; Blood Pressure- Direct Measurements, Indirect Pressure Measurement and Its Types.

Unit-3 Indicating and Recording Instruments

Introduction; 7-Segment, Dot Matrix, Led and LCD Display Devices, CRO/DSO. Galvanometric & Potentiometric Recorders, Thermal, Inkjet, Laser Recorders, Digital Recorders & Data Storage, Basic Features of a Patient Monitor.

Unit-4 Electrical Hazards and Safety

Proper Design of Power Subsystems in Medical Electronics: Transient Voltage Protection, Electromagnetic Interference, Overvoltage Protection, And Overload Protection. Safety Codes, Standard Micro and Macro Shock and Its Physiological Effects, Leakage Currents and Protections by Use of Isolation Amplifiers, Isolation Transformer, Equipotential Grounding and Earth Free Monitoring, Design of Safe Medical Device Prototypes. Special Safety Requirement for Interventional Systems & Defibrillator Compatibility. Importance of Dedicated Earthing for Medical Systems.

Course Materials

Required Text: Textbooks

1. Malvino, A. and Bates, D., 2006. Electronic Principles with Simulation CD. McGraw-Hill, Inc.
2. Doebelin, E.O. and Manik, D.N., 2007. Measurement systems: application and design. Tata McGraw-Hill Education.
3. Nakra, B.C. and Chaudhry, K.K., 2003. Instrumentation, measurement and analysis. Tata McGraw-Hill Education.

Optional Materials: Reference Books

1. Dewhurst, D.J., 2014. An Introduction to Biomedical Instrumentation: Pergamon International Library of Science, Technology, Engineering and Social Studies. Elsevier.
2. Khandpur, R.S., 1994. Handbook of biomedical instrumentation. Tata McGraw-Hill Education.

Biomechanics

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM104110BM

[Pre-Requisite - Nil]

Course Objectives

1. To Make Students Aware of the Biomechanical Aspects of Human Body
2. To Create Problem Solving Ability Among Students Related to Biomechanics
3. To Encourage Students for Correlating the Mechanical Aspects of Various Assistive Devices with the Biomechanics of Respective Organs
4. To Motivate Students Towards Development of Medical Devices Based on Biomechanical Principles.

Course Content

Unit-1 Biofluid 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.

Unit-2 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.

Unit-3 Soft Tissue Mechanics

Pseudoelasticity; Non-Linear Stress-Strain Relationship; Viscoelasticity; Structure Function and Mechanical Properties of Skin; Ligaments and Tendons.

Unit-4 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.

Course Materials

Required Text: Textbooks

1. Fung, Y.C., 2013. Biomechanics: mechanical properties of living tissues. Springer Science & Business Media.
2. Hall, S.J. and Lysell, D., 1995. Basic biomechanics (Vol. 2). St. Louis: Mosby.
3. Knudson, D., 2007. Fundamentals of biomechanics. Springer Science & Business Media.

Optional Materials: Reference Books

1. Peterson, D.R. and Bronzino, J.D. eds., 2014. Biomechanics: principles and practices. CRC Press.
2. Zamir, M., 2006. The physics of coronary blood flow. Springer Science & Business Media.

Mathematics-IV

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Mathematics	4-0-0, (4)	EPR	BM104001MA

[Pre-requisites: Mathematics-I, Mathematics-II]

Course Objectives

To enable the students to apply the knowledge of Mathematics in various fields:

1. Introduce the method to solve the algebraic and transcendental equations and its application.
2. Introduce the method to solve the simultaneous algebraic equations and its application.
3. Introduce the method to solve the problems related to data appear equal or unequal intervals.
4. Able to solve the ordinary differential equations using different numerical techniques.
5. Introduce to knowledge of curve fitting method for the given data.

Course Content

Unit-1 **Numerical Solutions of Linear equations and Non-Liner Equations**

Simultaneous algebraic equations by Gauss elimination method**,** Gauss-Jordan method**,** Crout's triangularization method**,** Iterative approach for solution of linear systems – Jacobi method**,** Gauss-Seidel method**,** Errors in numerical computation, Methods of Solving Problem by bisection method**,** Regula Falsi method**,** Newton-Raphson method**,** secant method**.**

Unit-2 **Interpolation with Equal and Unequal Intervals**

Finite difference, Newton's Forward and Backward interpolation formula, Central interpolation, Stirling's Interpolation, Bessel's method, Lagrange's method and Newton's Divided difference interpolation.

Unit-3 **Numerical Differentiation, Integration & Curve fitting**

Numerical differentiation, Numerical integration-Newton-Cote's quadrature method, Trapezoidal Rule, Simpson's Rules, Weddle's Rule, Principal of least squares, Curve Fitting of linear & non-linear, Exponential, Logarithmic curves.

Unit-4 **Numerical Solution of Ordinary Differential Equations**

Picard's method, Taylor's series method, Euler's method, Euler's modified method, Runge-Kutta fourth order method, Predictor-corrector method, Adams-Bashforth method, Milne's method to solve ODE.

Course Materials

Required Text: Text books

1. Dunn S., Constantinides A. & Moghe P., Numerical Methods in Biomedical Engineerin, Academic Press
2. B. S. Grewal, Numerical Method in Engineering and Science, Khanna Publisher.
3. Sastry, S. S., Introductory Methods of Numerical Analysis, PHI

Optional Materials: Reference Books

1. Burden, Richard L., Fairs & J. Douglas Fairs, Numerical Analysis. Thomson Asia. PTE
2. Gourdin A. & Boumahrat M., Applied Numerical Method, PHI.
3. Rajasekaran, S., Numerical Method in Science& Engineering, A Practical Approach, S. Chand
4. Jain M. K., Iyengar S.R. K. & Jain, R. K., Numerical Methods for Scientific & Engineering. Computation, New-Age International Publication

Biomedical Signal Processing Laboratory

[4th Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	0-0-2, (2)	Core	BM104403BM

Course Content

Experiment 1	Acquire and Obtain the Limb Lead ECG Signal and Display
Experiment 2	Design a Notch Filter of 50 Hz to Remove the Power Line Interference in Acquired ECG Signal
Experiment 3	Design a Low Pass Filter of Defined Cut-Off Frequency to Remove the High Frequency Noises in Acquired ECG Signal
Experiment 4	Design a High Pass Filter of Defined Cut-Off Frequency to Remove the Low Frequency Noises in Acquired ECG Signal
Experiment 5	Compare Different Types of FIR Filter for LPF of ECG Signal
Experiment 6	Compare Different Types of IIR Filter for LPF of ECG Signal
Experiment 7	To Perform a Spectral Analysis of ECG Signal
Experiment 8	Detection of R Peak and R-R Interval from Acquired ECG Signal
Experiment 9	Acquire and Obtain the 20-20 Lead ECG Signal and Display
Experiment 10	To Perform a Spectral Analysis of ECG Signal

Biomedical Instrumentation & Measurements Laboratory

[4th Semester, Second Year]

Course Description Offered by Department	Credits	Status	Code
Biomedical Engineering	0-0-2, (2)	Core	BM104404BM

Course Content

Experiment 1	Study the Working of CRO and Function Generator
Experiment 2	Design and Demonstrate to Measure the CMRR and Input Impedance of Simple Differential Biopotential Amplifier. Compare the Characteristics of Various Op Amps (741/ TI-082/LLF-356)
Experiment 3	Design a Basic Instrumentation Amplifier on Breadboard and Test the Unit
Experiment 4	Compare the CMRR of Instrumentation Amplifier with Differential Amplifier
Experiment 5	Design of 4-Lead ECG Amplifier with Pacemaker Pulse Detection and Artifacts Rejection
Experiment 6	Design a Notch Filter in Breadboard to Remove 50 Hz Noise from Acquired ECG Signal
Experiment 7	Study the Various Types of Earthing for Electrical Systems, Practice of Earthing and Measurement of Earth Resistance of Campus Premises