Signals and Systems

[3rd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM103101BM

[Pre-Requisite - Nil]

Course Objectives

1. To Make Students Understand the Representation and Properties of Continuous Time and Discrete Time Signals.
2. To Create Problem Solving Ability Among students for Analyzing Time and Frequency Domain Using Different Transforms.
3. To Encourage Students for Designing Filters for Signal Pre-processing.
4. To Prepare Students for Advance Level Courses in Control Systems and Biomedical Signal Processing.

Course Content

Unit-1 Introduction to Signals and Systems

Signals, Types of Signals, Properties of Signals; System & Basic System Properties; Various Operations on Signals, Singularity Functions; Sampling Theorem.

Unit-2 Transforms & Applications

Review of Continuous Fourier Transforms, Inverse Fourier Transform, Review of Laplace and inverse Laplace transform, Power Spectral Density, Correlation, Discrete Time Fourier Transform and Discrete Fourier Transform, Z-Transform, Region of convergence, Inverse Z-Transform. Transfer function, poles and zeroes. Introduction to Discrete and Continuous Time LTI Systems, Convolution Sum, Convolution Integral, Impulse Response, Step Response.

Unit-3 Design and Analysis of Passive Filters

Introduction to First and Higher Order Passive Filters; Realization of Various Filters (LP, HP, BP, BS, Notch, Inverted Notch); Transfer Function & Frequency Response; Magnitude and Delay Response; Various Biomedical Applications.

Unit-4 Random Signals & Random Process

Probability, Conditional Probability, Discrete and Continuous Random Variables, Probability Distribution Function, Cumulative Distribution Function, Probability Density Function, Joint Distribution Function and Density Function, Uniform and Gaussian Distribution, Stationary and Non-Stationary Random Process, Wide Sense Stationary Random Process, Ergodic Random Process.

Course Materials

Required Text: Textbooks

1. Oppenheim, A.V., Willsky, A.S. and Nawab, S.H., 2012. Signals and systems, PHI learning Pvt. Ltd.
2. Lathi, B.P., 1965. Signals, systems and communication. John Wiley & Sons Canada.
3. Kani, A.N., 2010. Signals & Systems. Tata McGraw-Hill Education.

Optional Materials: Reference Books

1. Hsu, H.P. and Hsu, H.P., 2014. Signals and systems. Mc Graw-Hill Education.
2. Haykin, S. and Van Veen, B., 2007. Signals and systems. John Wiley & Sons.
3. Rao, Ramakrishna P and Prakriya Shanka., 2013. Signals and systems. Mc Graw-Hill Education.

Analog Electronic Circuits

[3rd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM103102BM

[Pre-Requisite - Nil]

Course Objectives

1. To Introduce Different Methods used for Analyzing Transistor circuits at Low Frequency and High Frequency.
2. To Create Problem Solving Ability Among Students for Calculation of Parameters Such as Gain, Input and Output Impedances.
3. To Encourage Students to Understand and Apply Design Aspects of Oscillators and Power Amplifiers.
4. To Motivate Students to Design Operational Amplifier Circuits for Biomedical Applications.

Course Content

Unit-1 Transistor at Low Frequency

Transistor Hybrid Model, h-Parameters, Conversion Formulae, Analysis of Transistor Amplifier Circuit Using h-Parameter, Emitter Follower, Millers Theorem and Its Dual, Simplified h-parameter model, Common Emitter Amplifier With Emitter Resistance, High Input Resistance Transistor Circuits, Multistage amplifiers, lower and upper 3 dB frequency, effect of cascading on gain.

Unit-2 Transistor at High Frequency & Power Amplifiers

The Hybrid- π Common Emitter Transistor Model, the CE Short Circuit Current Gain, Current Gain with Resistive Load, Single Stage CE Transistor Amplifier Response, the Gain-Bandwidth Product, Emitter Follower at High Frequencies; Class A, Class B and Class AB amplifiers.

Unit-3 Feedback Amplifier and Oscillator

Feedback Concept, General Characteristics of Negative Feedback Amplifier, Voltage Series Feedback and Voltage Series Feedback Pair, Current Series Feedback, Voltage Shunt Feedback; Oscillators and its types.

Unit-4 Operational Amplifier

Differential Amplifier; Ideal Op-Amp Characteristics; Different Configurations (Inverting, Non-Inverting) and Functions (Adder, Subtractor, Integrator, Differentiator etc.), Requirements Specific to Biomedical Applications.

Course Materials

Required Text: Textbooks

1. Millman, J., Halkias C., Parikh C. D., 2010. Integrated electronics. McGraw-Hill Education.
2. Malvino, A.P., 1979. Electronic principles. McGraw-Hill.
3. Grob, B., 1984. Basic electronics. McGraw-Hill Companies.
4. Millman, J. and Grabel, A., 1987. Microelectronics. McGraw-Hill.

Optional Materials: Reference Books

1. Maini, A. K. and Agrawal, V., 2009. Electronic Devices and Circuits. John Wiley & Sons.
2. Bell, D.A., 2009. Fundamentals of electronic devices and circuits. Oxford University Press, Inc.
3. Sedra, A. S. and Smith, K. C., 1998. Microelectronic circuits. New York: Oxford University Press.

Biomedical Transducers and Sensors

[3rd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM103103BM

[Pre-Requisite - Nil]

Course Objectives

1. To Make Students Understand the Fundamental Knowledge of Transducers.
2. To Make Students Understand the Principle, Design and Working of Various Transducers.
3. To Develop Skills Among Students for Appropriate Selection of Transducer in Different Applications.
4. To Understand the Design of Typical Electronic Instrumentation for Biosensors and Important Concepts Such as Calibration and Reference.

Course Content

Unit-1 Introduction of Transducers

Basics of Various Biological Sensing Mechanisms in Human Body; Introduction to Transducers and Sensors, Classification, Principle of Transduction, Performance Characteristics of Transducers: Operating Range, Accuracy, Precision, Stability, Fatigue Etc.

Unit-2 Pressure, Displacement and Temperature Transducers

Resistive Strain Gauges, Strain Gauge, Strain Gauge Bridge. Piezoelectric Phenomena and Materials, Output Voltage Expression of Piezo Crystal, Equivalent Circuit of Piezoelectric Transducers and Dynamic Characteristics. Potentiometric Transducers, Capacitive, Inductive, LVDT Transducers-Principle, Equivalent Circuit, Linearity Issues, Capacitive Displacement Transducers, Digital Encoders. Thermo Resistive- Resistance Temperature Detectors (RTDS), Thermistor. Thermo Electric -Thermocouple, PN Junction Diode. Non-Contact Type Temperature.

Unit-3 Measurement of Biological Parameters

Units of Pressure, Requirement for Pressure Measurement, Physiological Ranges for Pressure Measurement, Reference Points for Pressure Measurement. Direct Pressure Measurement- Catheter and Diaphragm, Indirect Pressure Measurement –Measurement of Blood Pressure Using Sphygmomanometer, Detection of Korotkoff's Sound, Oscillometric Method. Indirect Measurement of Instantaneous Arterial Pressure. Electromagnetic Flow Meter and Ultrasound Flow Meter.

Unit-4 Chemical Biosensors

Chemical Transducers: Transducers for the Measurement of Ions and Dissolved Gases. Half-Cell Potential, Reference Electrodes - Hydrogen Electrodes - Silver-Silver Chloride Electrodes- Calomel Electrodes. Measurement of Ph- Glass Ph Electrodes. Measurement of pO2, Measurement of pCO2 -Catheter Tip Electrodes for the Measurement of pO2 and pCO2, Conductivity Measurement Transducer. Bio Sensors: Ion Exchange Membrane Electrodes- Oxygen Electrodes, CO2 Electrodes Enzyme Electrode - Construction – ISFET for Glucose, Urea Etc. Electrolytic Sensors - Optical Sensor - Fiber Optic Sensors. Microbial Sensor, Enzyme Immobilization of Chemical Analyses.

Course Materials

Required Text: Textbooks

1. Webster, J.G., 2009. Medical instrumentation application and design. John Wiley & Sons.
2. Togawa, T., Tamura, T. and Oberg, P.A., 1997. Biomedical transducers and instruments. CRC press.

Optional Materials: Reference Books

1. Geddes, L.A., 1968. Principles of applied biomedical instrumentation. John Wiley & Sons.
2. Cobbold, R., 1978. Transducers for Biomedical Measurements. Journal of Clinical Engineering, 3(3), p.306.
3. Norton, H.N., 1982. Biomedical sensors, fundamentals and applications. Noyes Publications.
4. Murthy, D.V.S., 2000. Transducers and Instrumentation. PHI, 1995 4. John P. Bentley, Principles of Measurement Systems.
5. Singh, S.K., 2003. Industrial Instrumentation & Control, 2e. Tata McGraw-Hill Education.

Network Analysis

[3rd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM103104BM

[Pre-Requisite - Nil]

Course Objectives

1. To Introduce Methods used for analyzing circuit using KCL, KVL and Network Theorems.
2. To Create Problem Solving Ability Among Students for Calculation of Network Parameters.
3. To Encourage Students to Understand and Apply Laplace Transform in circuits.
4. To Motivate Students to Design Electrical Network for Different Applications.

Course Content

Unit-1 Network Topology and Network Theorems

Introductory Concept of Network, Kirchhoff's Laws, Node and Mesh Analysis Methods, Graph of a Network, Concept of Tree and co-Tree, Twigs and Links, Incidence Matrix, Tie Set Matrix, Cut Set Matrix, Solution of Network by Using Network Equilibrium Equation; Series and Parallel Resonance, Frequency Response of Series and Parallel Circuits, Q-Factor, Bandwidth; Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Reciprocity Theorem, Superposition Theorem.

Unit-2 Transient Behavior & Initial Conditions in Networks

Behavior of Circuit Element Under Switching Condition and Their Representation, Evaluation of Initial and Final Conditions in RL and RC Circuits for AC&DC Excitation by Using General and Particular Solutions.

Unit-3 Application of Laplace Transform in Network Analysis

Introduction of Laplace Transform, Basic Theorems for the Laplace Transformation, Singularity Functions and Its Delayed Version, Inverse Laplace Transform by Using Partial Fraction Expansion, Evaluation of Initial and Final Conditions in RL, RC& RLC Circuits for AC&DC Excitation by Using Laplace Transformation Technique.

Unit-4 Network Function & Two Port Network

Driving Point Admittance Function & Transfer Function, Pole- Zero Concepts of the Network Function; Open Circuit Impedance Parameters, Short Circuit Admittance Parameters, Transmission Parameters, Hybrid Parameters, Calculation of These Parameters for Two Port Networks.

Course Materials

Required Text: Textbooks

1. Van Valkenburg, M.E., 1964. Network analysis (Vol. 3). Prentice-Hall.
2. Kuo, F., 2006. Network analysis and synthesis. John Wiley & Sons.
3. Edminister, J.A., 1965. Schaum's outline of theory and problems of electric circuits.

Optional Materials: Reference Books

1. Hayt, W.H., Kemmerly, J.E. and Durbin, S.M., 1986. Engineering circuit analysis. New York, McGraw-Hill.
2. Temes, G.C. and LaPatra, J.W., 1977. Introduction to circuit synthesis and design. McGraw-Hill.
3. Ghosh, S.P. and Chakraborty, A.K., 2010. Network analysis and synthesis. Tata McGraw Hill.

Anatomy and Physiology

[3rd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM103105BM

[Pre-Requisite - Nil]

Course Objectives

1. To Introduce the Basic Human Anatomy and Physiology to Students.
2. To Explain the Interrelationships Among Molecular, Cellular, Tissue and Organ Functions in Each System.
3. To Correlate Organ Systems to Understand the Interdependency & Interactions Among Them.
4. To Appreciate the Working Principle Behind Organ Systems.

Course Content

Unit-1 Human Physiology

Introduction to the Human Body, Levels of Structural Organization, Basic Life Processes of the Human Body, Cell and Its Organelles, Tissue Level of Organization, Types of Tissues- Epithelial, Connective, Muscular and Nervous Tissue. Types, Function and Properties of Muscular Tissue, Types of Muscle Tissue, Skeletal Muscle- Contraction and Relaxation of Skeletal Muscle.

Unit-2 Nervous System

Structure and Function of Nervous System, Subdivision of Nervous System, Histology of Nervous System- Neurons and Myelination, Organization of Nervous System – Central and Peripheral Nervous System, Electrical Signal in Neurons, Synapse and Neurotransmitters, Signal Transmission. Brain –Organization, Protection and Blood Supply, Cerebrospinal Fluid, Autonomic Nervous System.

Unit-3 Cardiovascular System

Anatomy of Heart, Heart Valve and Circulation of Blood, Properties of Cardiac Muscles, Conduction System, Cardiac Cycle, Heart Sounds, Cardiac Output, Regulation of Heart Rate, Blood Pressure and Its Regulation. Electrocardiogram. Structure and Function of Blood Vessels-Artery, Vein and Capillaries, Capillary Exchange, Factors Affecting Blood Flow, Development of Blood Vessels.

Unit-4 Respiratory, Renal System and Blood Cells

Respiratory System Anatomy, Pulmonary Ventilation, Lung Volume and Capacities, Exchange and Transport of O2 and Co2, Control of Respiration. Anatomy and Physiology of Kidney, Nephron, Formation and Dilute and Concentrated Urine; Function and Properties of Blood, Formation of Formed Blood Cells- Red Blood Cell, White Blood Cell, Platelets, Formation and Life Span of RBC's, Types and Functions of WBC's, Blood Coagulation and Blood Grouping.

Course Materials

Required Text: Textbooks

1. Tortora, G.J. and Derrickson, B.H., 2008. Principles of anatomy and physiology. John Wiley & Sons.
2. Guyton, A.C. and Hall, J.E., 2006. Textbook of medical physiology, Saunders.

Optional Materials: Reference Books

1. Sembulingam, K. and Sembulingam, P., 2012. Essentials of medical physiology. JP Medical Ltd.
2. Saladin Kenneth S., 2014. Anatomy & Physiology: The Unity of Form and Function. McGraw-Hill Education

Mathematics-III

[3rd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Mathematics	4-0-0, (4)	EPR	BM103001MA

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

Course Objectives

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

1. Introduce the Fourier Series and Fourier Transform
2. Introduce the concepts of Laplace Transform and its application in solution of differential equations and improper integral
3. Able to form and solve the partial differential equation using different analytical techniques with application in solution of wave and Laplace equations
4. Introduce to Z –Transform with application in solution of difference equations.

Course Content

Unit-1 **FOURIER SERIES AND FOURIER TRANSFORM**

Expansion of function as Fourier series, Functions having points of discontinuity, Change of interval, Even & Odd functions, Half-range series, Harmonic analysis, Fourier Transformation, Inverse transformation, Finite cosine and sine transform.

Unit-2 **LAPLACE TRANSFORM**

Definition, Transform of elementary functions, Properties of Laplace transform, Transform of derivatives and integrals, Multiplication by t^n , Division by t, Evaluation of Integrals, Periodic functions, Inverse Laplace transform, Convolution theorem, Application of Laplace transform to find the solutions of ordinary differential equations.

Unit-3 **PARTIAL DIFFERENTIAL EQUATION**

Formation, Solutions by direct integration method, Linear equations of first order, Homogeneous linear equations with constant coefficients, Non-homogeneous linear equations, Method of separation of variables with applications in finding the solution of wave, heat and Laplace equations.

Unit-4 **GROUP THEORY**

Definition and examples, Permutation group, Cyclic group, Subgroup, Cosets, Langrange's theorem, Homomorphism and Isomorphism of groups, Normal subgroup, Quotient group, Fundamental theorems of homomorphism.

Course Materials

Required Text: Text books

1. Higher Engineering Mathematics by B. S. Grewal - Khanna Publishers.
2. Advanced Engineering Mathematics by Erwin Kreyszig - John Wiley & Sons.
3. Contemporary Abstract Algebra by Joseph A. Gallian, Narosa Publishing House.

Optional Materials: Reference Books

1. Advanced Engg. Mathematics by R. K. Jain and S. R. K. Iyengar–Narosa Publishing House.
2. Higher Engineering Mathematics by B. V. Ramana, McGraw Hill.

Biomedical Electronics Laboratory

[3rd Semester, Second Year]

Course Description			
Offered by Department	Credits	Status	Code
Biomedical Engineering	0-0-2, (2)	Core	BM103401BM

Course Content

Experiment 1	Verification of Thevenin's theorem in A.C. circuits.
Experiment 2	Verification of Maximum Power Transfer theorem in A.C. circuits.
Experiment 3	To draw the characteristics of CE configuration of a transistor amplifier.
Experiment 4	To draw the characteristics of CB configuration of a transistor amplifier.
Experiment 5	To draw the characteristics of CC configuration of a transistor amplifier.
Experiment 6	To design a half wave rectifier and to determine its efficiency and ripple factor.
Experiment 7	To draw the characteristics of a Zener diode and to find cut-in voltage, reverse resistance, static resistance and dynamic resistance.
Experiment 8	To study Strain gauge working as displacement sensor.
Experiment 9	To study LVDT as displacement transducer and observe displacement versus output voltage characteristics.

Anatomy & Physiology Laboratory

[3rd Semester, Second Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	0-0-2, (2)	Core	BM103402BM

Course Content

Experiment 1	Anatomical Planes and Regions
Experiment 2	The Skeleton System – Axial System
Experiment 3	The Skeleton System – Appendicular System
Experiment 4	Determination of Bleeding Time
Experiment 5	Determination of Clotting Time
Experiment 6	Detection of Blood Group
Experiment 7	R.B.C. Counting
Experiment 8	Total W.B.C. Counting
Experiment 9	Detection of Hemoglobin
Experiment 10	Preparation of Blood Film & Staining
Experiment 11	Measurement of Blood Pressure