**کسب کمال کن که عزیز جهان شوی**

**Balochistan University of Engineering & Technology**

**Khuzdar**

**Department of Biomedical Engineering**



**BOS APPROVED CURRICULUM for**

**Bachelor in biomedical engineering**

**2022**

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# COURSE DISTRIBUTION

## Distribution of course ratio domain-wise under OBE system

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Domain** | **Knowledge Area** | **PEC/HEC Recommended** | | **Institute's Program Breakup** | |
|  |  | **Total** | **Overall** | **Total** | **Overall** |
| **Subjects** | **%** | **Subjects** | **%** |
| **Non-Engineering** | Humanities | 4 | **30 - 35** | 4 | **31.80** |
| Management Sciences | 3 | 3 |
| Natural Sciences | 7 | 7 |
| **Sub Total** | **14** | **14** |
| **Engineering** | Computing | 4 | **65 - 70** | 4 | **68.20** |
| Engineering Foundation | 6 | 6 |
| Major Based Core (Breadth) | 6 | 6 |
| Major Based Core (Depth) | 5 | 5 |
| Inter-Disciplinary Engineering Breadth (Electives) | 7 | 7 |
| Senior Design Project | 2 | 2 |
| Industrial Training (Summer) | 0 | 0 |
| **Sub Total** | **30** | **30** |
| **Total** | | **44** | **100** | **44** | **100** |

**Note**:

**Total credit Hours 138**

\*Biomedical Engineering Core (Breadth)

\*\*Biomedical Engineering (Depth)/ Technical Elective

## 

## Scheme of studies for Bachelor’s (4 Years) in Biomedical Engineering

| **Semester – I** | | | | | | | | | | |  | **Semester – II** | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Code** | | **Course** | | | | **Cr. Hr.** | | | | **S. No.** | **Code** | **Course** | | | | **Cr. Hr.** | | |
| 1 | NS-122 | | Applied Physics | | | | 2 | | + | 1 | 1 | HS-105 | Pakistan Studies | | | | 2 | + | 0 |
| 2 | CS-113 | | Introduction to Computing | | | | 2 | | + | 1 | 2 | NS-116 | Calculus & Analytical Geometry | | | | 3 | + | 0 |
| 3 | EE-120 | | Basic Electrical Engineering | | | | 3 | | + | 1 | 3 | BME-123 | Physiology I | | | | 2 | + | 1 |
| 4 | BMF-114 | | Basic Mathematics | | | | 4 | | + | 0 | 4 | EE-121 | Circuit Analysis | | | | 3 | + | 1 |
| BMF-114 | | Basic Biology | | | | 4 | | + | 0 | 5 | CS-125 | Object Oriented Programming | | | | 2 | + | 1 |
| 5 | BME-115 | | Introduction to Biomedical Engineering | | | | 1 | | + | 0 | 6 | BME-126 | Human Anatomy | | | | 2 | + | 1 |
| 6 | HS-117 | | Islamic Studies | | | | 2 | | + | 0 |  |  |  | | | |  |  |  |
| HS-116 | | Ethical Behavior | | | | 2 | | + | 0 |  |  |  | | | |  |  |  |
| **Sub Total =** | | | | | | | 14 | | + | 3 | **Sub Total =** | | | | | | **14** | **+** | **4** |
| **Total =** | | | | | | | **17** | | | | **Total =** | | | | | | **18** | | |
|  | | | | | | | | | | |  |  |  |  | | | |  |  |  |
| **Semester – III** | | | | | | | | | | |  | **Semester – IV** | | | | | | | | |
| **S. No.** | | **Code** | | **Course** | | | | **Cr. Hr.** | | | **S. No.** | **Code** | **Course** | | | **Cr. Hr.** | | | |
| **1** | | NS-211 | | Complex Variable & Transformation | | | | 3 | + | 0 | 1 | BME-241 | Biomedical Electronics | | | 3 | | + | 1 |
| **2** | | BME-232 | | Physiology II | | | | 2 | + | 1 | 2 | CS-219 | Digital Logic Design | | | 3 | | + | 1 |
| **3** | | BME-233 | | Biochemistry | | | | 2 | + | 1 | 3 | NS-223 | Linear Algebra & Differential Equation | | | 3 | | + | 0 |
| **4** | | EL-103 | | Basic Electronics | | | | 3 | + | 1 | 4 | NS-312 | Probability and Statistics | | | 3 | | + | 0 |
| **5** | | EE-315 | | Computer Aided Engineering Drawing | | | | 0 | + | 1 | 5 | EE-224 | Signals & Systems | | | 3 | | + | 1 |
| **6** | | HS-119 | | Communication Skills | | | | 2 | + | 0 |  |  |  | | |  | |  |  |
| Sub Total = | | | | | | | | 12 | + | 4 | Sub Total = | | | | | **15** | | **+** | **3** |
| **Total =** | | | | | | | | **16** | | | **Total =** | | | | | **18** | | | |
|  | | | | | | | |  | | |  |  | | | | |  | | | |
| **Semester – V** | | | | | | | | | | |  | **Semester – VI** | | | | | | | | |
| **S. No.** | **Code** | | | **Course** | | **Cr. Hr.** | | | | | **S. No.** | **Code** | **Course** | | **Cr. Hr.** | | | | |
| **1** | BME-351 | | | Biomedical Instrumentation 1 | | 3 | | | + | 1 | **1** | BME-361 | Biomedical Instrumentation II | | 3 | | | + | 1 |
| **2** | BME-244 | | | Biomechanics | | 3 | | | + | 1 | **2** | BM-362 | Elective I | | 3 | | | + | 0 |
| **3** | NS-313 | | | Numerical Methods | | 3 | | | + | 0 | **3** | BME-363 | Biomedical Control Systems | | 3 | | | + | 1 |
| **4** | EE-314 | | | Microprocessor & Interfacing | | 2 | | | + | 1 | **4** | CS-324 | Modeling & Simulation | | 2 | | | + | 1 |
| **5** | BME-355 | | | Biomedical Signal Processing | | 3 | | | + | 1 | **5** | BME-365 | Biomaterials | | 3 | | | + | 1 |
| **Sub Total =** | | | | | | **14** | | | **+** | **3** | **Sub Total =** | | | | **14** | | | **+** | **4** |
| **Total =** | | | | | | **18** | | | | | **Total =** | | | | **18** | | | | |
|  | |  | |  | |  | | |  |  |  |  |  |  | |  | | |  |  |
| **Semester – VII** | | | | | | | | | | |  | **Semester – VIII** | | | | | | | | |
| **S. No.** | | **Code** | | **Course** | **Cr. Hr.** | | | | | | **S. No.** | **Code** | | **Course** | **Cr. Hr.** | | | | |
| **1** | | MS-411 | | Engineering Management | 3 | | | | + | 0 | **1** | BM-481 | | Elective IV | 3 | | | + | 0 |
| **2** | | BME-472 | | Medical Imaging | 2 | | | | + | 1 | 2 | MS-422 | | Professional Practices & Ethics | 3 | | | + | 0 |
| **3** | | BME-473 | | Elective II | 3 | | | | + | 0 | **3** | BM-483 | | Elective V | 3 | | | + | 0 |
| **4** | | BM-474 | | Elective III | 3 | | | | + | 0 | **4** | BMP-474 | | Biomedical Engineering Project (Phase II) | 0 | | | + | 3 |
| **5** | | HS-415 | | Technical Report Writing | 3 | | | | + | 0 | 5 | MS-304 | | Entrepreneurship | 3 | | | + | 0 |
| **6** | | BMP-474 | | Biomedical Engineering Project (Phase I) | 0 | | | | + | 3 |  |  | |  |  | | |  |  |
| **Sub Total =** | | | | | **14** | | | | **+** | **4** | **Sub Total =** | | | | **12** | | | **+** | **3** |
| **Total =** | | | | | **18** | | | | | | **Total =** | | | | **15** | | | | |

**Total Credit Hours =138**

## OBE Based Syllabus/Course Contents Biomedical Engineering

| **1st Semester** |
| --- |

| Applied Physics | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **32** | Theory | | | **2** |
| Practical | | **48** | Practical | | | **1** |
| **Total** | | **80** | **Total** | | | **3** |
| **Objective: - Course Learning Outcomes: -**  After completion of this course, the student should be able to:   | **CLO** | **Description** | **Mapping with PLOs** | **Taxonomy level** | **PL0** | | --- | --- | --- | --- | --- | |  | | **Illustrate** the electromagnetic phenomena and fields mathematically. | | --- | | Cognitive | 2 | 1 | |  | | **Interpre**t basic electric circuits used in science and engineering. | | --- | | Cognitive | 3 | 1 | |  | **Examine** the mechanical phenomena including straight line motion and simple harmonic motion along with their mathematical models. | Cognitive | 2 | 1 | | **4** | **Carryout** experiments in laboratory in order to interpret experimental data and observe its conformance with achieved results of circuits. | Psychomotor | 3 | 2 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | 1 | Engineering Knowledge |  | 7 | Environment and Sustainability |  | | 2 | Problem Analysis |  | 8 | Ethics |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork |  | | 4 | Investigation |  | 10 | Communication |  | | 5 | Modern Tool Usage |  | 11 | Project Management |  | | 6 | The Engineer and Society |  | 12 | Lifelong Learning |  |   **Course outline:**  1**. Properties of Matter**  a. Elasticity and modulus of Elasticity b. Experimental determination of young’s modulus c. Bending of beams d. Cantilever.  2. Fluids a. Steady and turbulent flow b. Bernoulli’s theorem, Viscosity c. determination of Coefficient of viscosity by Poiseuille’s method d. Surface tension e. Surface energy f. Angle of contact g. Determination of surface tension by rise in a capillary tube.  **3. Heat & Thermodynamics**  a. Heat, Temperature, and Theories of heat b. Adiabatic and isothermal processes c. The four laws of thermodynamics d. Thermodynamic functions e. Efficiency of Heat Engines f. Carnot’s Cycle g. Entropy h. Reversible Process and cycles i. Thermodynamic equilibrium j. Introduction to Heat transfer Mechanisms.  **4. Optics**  a. Waves and Oscillations b. Simple Harmonic Motion c. types of wave motion d. Optics of light e. Interference f. Diffraction g. Polarization h. Double refraction i. Dispersion j. Types and uses of Deviation Lasers | | | | | | | | | | | |
| **5. Electricity and Magnetism**  a. Electric charges b. Electric field c. Electric potential d. Coulomb’s law e. Gauss’s law f. Capacitors and dielectrics g. Electric current h. Ohm’s Law i. Magnetic properties of matter 26 j. Magnetic field k. Magnetic force on current l. Ampere’s law, Faraday’s law, and Lenz’s law  **6. Sound**  a. Hearing and Echolocation b. Ultrasound  **Practical:**  1. Study of Hooke's Law  2. Measuring stress, strain and Young’s Modulus of different materials  3. Study of Surface Tension and Viscosity of liquids  4. Study of Boiling points of liquids  5. Study of Gas laws  6. Venturi effect of liquids in motion  7. Heat transfer and entropy  8. Study of light, Color addition, Reflection and Prism  9. Measurement of Snell’s Law  10. Convex and Concave Lens  11. Study of reversibility and Dispersion of Light  12. Focal point and Magnification of Thin lens  13. Focal point and Magnification of Concave Mirror  14. Telescope and Microscope  15. Calculation of speed of Sound  16. Project : Construction of Telescope./Microscope  **Recommended books:**  Text and Reference Books:   1. David Halliday, Robert Resnick and Jearl Walker, WIE Fundamentals of Physics, 7th ed. 2005, 2. John Wiley & Sons, ISBN:0471465097 2. Arthur Beiser, “ Schaum’s Outline of Applied Physics, 4th ed. 2004, 3. McGraw-Hill, ISBN:0071426116 3. Hobbie, Russell, Intermediate physics for medicine and biology-4th edition, 200 | | | | | | | | | | | |
| Introduction to Computing | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** | Theory | | | **03** |
| Practical | | **48** | Practical | | | **01** |
| **Total** | | **96** | **Total** | | | **04** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| 1 | **Identify** the components of a computer system, demonstrate basic proficiency in computer and commonly used computer applications | | | | | | Cognitive | C3 | | 1 | |
| 2 | **Explain** the fundamentals of operating systems, databases, computer networks and the internet. | | | | | | Cognitive | C2 | | 1 | |
| 3 | **Ability** to write, debug and execute programs in C language. | | | | | | Cognitive | C3 | | 1 | |
|  |  | | | | | |  |  | |  | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | | **√** | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Team Work: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
|  | | | | | | | | | | | |
| **Course outline:**  Course Outline:  1. **Introduction**  a. Applications of Computers  b. Classification of Computers  c. Advantages and Disadvantages of Computers.  d. Basic Components of a Computing Machine.  e. Input and Output Devices  f. Mass Storage Devices g. Ports, Buses and Expansion slots.  h. Computer Networking Environment  2. **Data Storage** a. Data organization. b. Data representation in Computers. c. Physical and Logical Storage. d. Magnetic Storage Devices viz. RAM, ROM, Secondary Storage, Cache. e. Optical Storage Devices.  3. **Data Processing** a. Data Structures. b. Flow Charts. c. Process Flow Diagrams  4. **System and Application Programming** a. Basics of Operating Systems. b. Desktop and Network Operating Systems, Application softwares.  5. **Computer Programming**. a. Introduction to High Level and Low-Level Programming Languages. b. Process of Compilation and Interpretation. c. Data Types and Declaration. d. Header file and Linkage. e. Preprocessor Directives. f. Variables and Constants. g. Basic library functions. h. Input and Output Statements. i. Termination, Remarks. j. Control structures k. Repetition and loops. l. Arrays and String Operations  **Lab Work**  . Working with Windows 8/10 and DOS.  2. Basic Computer Hardware Awareness and Troubleshooting  3. To begin Programming in C++.  4. Preparing your PC for C++.  5. Understanding C++  6. Making small programs, do compilation, execution and debugging of  programs.  7. Implementation of simple control structures.  8. Using Loops  9. Implementation of functions  10. Using user input and presenting output.  11. Arrays, multidimensional arrays  12. Working with strings, string functions.  **15. Open Ended Lab I6. Open Ended Lab II** | | | | | | | | | | | |
| **Recommended Books**   1. Brian Williams and Stacey Sawyer, “Using Information Technology”, McGraw- Hill, ISBN: 0072260718, (Latest Edition). 2. Introduction to Computing Systems from Bits and Gates to C and Beyond, Patt and Patel, McGrawHill   Lab handouts – miscellaneous | | | | | | | | | | | |
| Basic Electrical Engineering | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** | Theory | | | **03** |
| Practical | | **48** | Practical | | | **01** |
| **Total** | | **96** | **Total** | | | **04** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | **Define** fundamentals of basic electrical engineering circuits, laws of current and voltage. | | | | | | Cognitive | C1 | | 1 | |
| **2** | **Apply** network theorems on various resistive circuits and solve the RC circuits, RL circuits, RLC circuits and transient analysis of RL and RLC circuits to find their response under DC conditions. | | | | | | Cognitive | C3 | | 2 | |
| **3** | **Reproduce** basic circuits in the laboratory to validate the laws and theories of circuit analysis. | | | | | | Psychomotor | P3 | | 5 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course content**  a. Fundamentals of Electric Circuits: Charge, Current, Voltage and Power, Voltage and Current Sources. Ohm’s Law.  b. Voltage and Current Laws: Nodes, Paths, Loops and Branches, Kirchhoff’s Current Law, Kirchhoff’s Voltage Laws, the single Loop Circuits, the single node-pair circuits, series and parallel connected independent sources, resistors in series and parallel, voltage and current division.  c. Basic Nodal and Mesh Analysis: Multi-Nodal Analysis, the super node, Mesh Analysis, the super mesh Circuit.  d. Analysis Techniques: Linearity and Superposition, Source Transformations, The venin and Norton Equivalent Circuits, Maximum Power Transfer, Delta-Wye Conversion  e. Capacitors and Inductors: Capacitors, Inductor, Inductance and Capacitance Combination  f. Basic RL and RC Circuits: The Source-Free RL Circuit, Properties of the Exponential Response, the Source-Free RC Circuits, the Unit-Steps Function. Driven RL Circuits, Natural and Forced Response, Driven RL Circuits.  g. The RLC Circuit: The Source-Free Parallel Circuit, the overdamped parallel RLC Circuits, Critical Damping, the under damped Parallel RLC Circuit, the Source-Free Series RLC Circuit, the complete response of the RLC Circuit, the Lossless LC Circuit.  **Practical:**  1. To get familiar with the usage of dual power supply and multimeter.  2. To study the resistor color code and measure the value of given resistors by the resistor color code chart and also study about the potentiometer.  3. To study the properties of series circuits and also find the calculated value and measured values of the given resistors.  4. To study the properties of parallel circuits and also find the calculated value and measured values of the given resistors.  5. To solve the given combination (series-parallel) circuit and find the values given in the observation table.  6. To study the properties of combination (series-parallel) circuits and also solving the given circuits.  7. To study the properties of combination (series-parallel) circuits and also solving the given circuits.  8. To analyze the given circuit using superposition theorem and find out the value of voltage and current across Resistor.  9. To solve the given circuit using the superposition theorem and find out the voltage and current.  10. To verify Norton’s Theorem and the theory of source Transformation.  11. To study the characteristics of the transformer.  12. To perform open circuit and short circuit testing of a transformer  **Textbooks**  a. Basic Engineering Circuit Analysis, by David Irwin, Wiley.  b. Principles of Electric Circuits, by Floyd.  c. Electrical Circuit Analysis, by William H. Hayat, Mac-Hill.  d. Electric Circuits, by Theodore F. Bogart, Jr.  e. Fundamentals of Electric Circuits by Charles k. Alexander. | | | | | | | | | | | |
| Basic Mathematics  | Contact Hours | |  | Credit Hours: | | | --- | --- | --- | --- | --- | | Theory | 64 | Theory | 4 | | Practical | 0 | Practical | 0 | | Total | 64 | Total | 4 |   **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to   | S # | CLO | Domain | Taxonomy  level | PLO | | --- | --- | --- | --- | --- | | 1. | **Define** the several areas of mathematics | Cognitive | 1 | 1 | | 2. | **Understand** to articulate the difference between inductive and deductive reasoning and identify the process of mathematical problem solving using a variety of techniques | Cognitive | 2 | 1 | | 3 | **Compute** the process of mathematical problem using a variety of techniques | Cognitive | 3 | 1 | | 4 | **Solve** different mathematical problems | Cognitive | 3 | 2 |   The course is designed so that students will achieve the following PLOs   | **1** | Engineering Knowledge: |  | **7** | Environment and Sustainability: |  | | --- | --- | --- | --- | --- | --- | | **2** | Problem Analysis: |  | **8** | Ethics: |  | | **3** | Design/Development of Solutions: |  | **9** | Individual and Teamwork: |  | | **4** | Investigation: |  | **10** | Communication: |  | | **5** | Modern Tool Usage: |  | **11** | Project Management: |  | | **6** | The Engineer and Society: |  | **12** | Lifelong Learning: |  | | | | | | | | | | | | |
| **Course outline:**  1. Algebra a. Complex Numbers b. Properties of complex numbers of c. Conjugates and modulus d. Geometrical representation of complex numbers a+ ib.  2. Quadratic Equations a. Roots of a quadratic equation (real, distinct, equal and imaginary roots) b. Formation of quadratic equation when the roots are given  3. Cube Root of Unity a. Properties of cube root of unity; ω, ω2 , 1+ ω + ω2 = 0, etc.  4. Matrices a. Properties, sum, difference and multiplication of matrices b. Cramer’s rule c. Solution of linear equations of three unknowns  5. Determinants a. Properties: addition, subtraction and multiplication of determinants b. Sequence and series c. Arithmetic progression d. Standard forms of an A. P. e. Arithmetic means f. Geometric progression g. Standard forms of a G. P., 33 h. Sum of Infinite geometric series i. Geometric means j. Harmonic progression k. Harmonic means l. Relation between H.M., A.M. and G.M.  6. Binomial Expansion a. Expansion of type (a+b)n for positive integer of 'n' b. Use of the general term and determine the middle term or terms of the expansion.  7. Partial Fractions a. Resolve into partial fractions b. Proper and improper fraction  8. Functions: a. One-one function b. Onto function c. Even function d. odd function e. Exponential function f. Trigonometric function g. Logarithmic function  9. Circular Measure a. Understand the definition of radians and use the relationship between radians and degrees.  10. Trigonometric Functions a. Basic functions e.g., sine, cosine, tangent etc. relation between them b. Trigonometric identities, sum and difference formulae, multiple angle formulae c. Express type {a(sinθ) + b(cosθ)} into Rsin(θ +- φ) etc. d. Inverse functions  11. Differential Calculus a. Limits: Basic concepts b. Limit of form {(sin θ)/ θ} = I; when θ tends to zero. c. Exponent functions and type ax etc.  12. Differentiation a. Differentiation of χn product and quotient formula b. Trigonometric, exponents and logarithmic functions c. Differentiation of implicit function, parametric function d. Higher order Derivatives e. Applications of differentiations f. Minima and maxima g. Tangent and normal velocity and acceleration h. Rate of reaction  13. Integral Calculus a. Basic Integration b. Integrals of sum of powers of 'χ' c. Trigonometric, exponential and logarithmic functions d. Integration by parts: e.g., χsinχ, χeχ and logχ etc. e. Substitution method  14. Coordinate Geometry a. Lines b. Find length, mid-point, gradient of line segment, given the coordinates of endpoints c. Different forms of equation of a line  **Recommended Books:**  FSC Math Part I /II | | | | | | | | | | | |
| Basic Biology | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **64** | Theory | | | **4** |
| Practical | |  | Practical | | | **0** |
| **Total** | | **64** | **Total** | | | **4** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | **Acquire** the understanding of biology of human body | | | | | | Cognitive | C2 | | **1** | |
| **2** | **Differentiate** the role of biological molecules under normal and diseased conditions | | | | | | Cognitive | C3 | | **4** | |
| **3** | **Apply** the knowledge of the human genome to identify its role in human diversity. | | | | | | Cognitive | C4 | | **4** | |
| **4** | **Exploit** knowledge of biology to explain healthcare challenges/problems | | | | | | Cognitive | C5 | | **3** | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | | **√** | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | | **√** | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | | **√** | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course outline:**  1. **Cell Structure and Function**  Techniques used in Cell Biology, Cell Wall and Plasma Membrane – The Boundary Wall, Cytoplasm and Organelles, Prokaryotic and Eukaryotic Cells  **2. Biological Molecules**  Biological Molecules in Protoplasm, Importance of Water (Importance in Protoplasm and in Environment), Carbohydrates, Proteins, Lipids, Nucleic Acids, Conjugated Molecules (Glycolipids, Glycoproteins, Lipoproteins and Nucleoproteins)  **3. Enzymes**  Structure of Enzymes, Mechanism of Enzyme Action, Factors affecting the Rate of Enzymatic Action (Temperature, pH, Enzyme Concentration and Substrate Concentration), Enzyme Inhibition (Competitive and Noncompetitive Inhibitors), Classification of Enzymes  **4. Bioenergetics**  Aerobic and Anaerobic respiration, Mechanism of Respiration, Synthesis of ATP – Chemiosmosis and Substrate-level Phosphorylation  **5. Biodiversity**  Acellular life, Prokaryotes, Diversity among animals, Digestion, Circulation, Immunity, Respiration, Homeostasis, Support and movement, Nervous coordination, Chemical coordination  **6. Continuity in Life**  Reproduction, Development and aging, Inheritance, Chromosome and DNA, Evolution  **7. Application of Biology**  Gene Cloning (Recombinant DNA Technology and Polymerase Chain Reaction), DNA Sequencing, DNA Analysis, Genome Maps, Tissue culture, Transgenic bacteria, plants and animals, Biotechnology and healthcare, Scope and importance of biotechnology, Vaccination and integrated disease management, Animal husbandry, Latest techniques applied to enhance crop and fruit yields, home gardening, Role of microbes in human welfare  **Teaching Methodology**  Lecturing  Written Assignments  Report Writing  **Assessment**   1. Sessional (20%) 2. Quiz (12%) 3. Assignment (8%) 4. Midterm (30%) 5. Final Term (50%)   **Reference Books**   1. AQA A-Level Biology, Pauline Lowrie, Mark Smith 2. Human Biology by Sylvia S. Mader | | | | | | | | | | | |
| Introduction to Biomedical Engineering | | | | | | | | | | | |
| **Code: -**  **Contact Hours: Credit Hours:**  **Theory** = 16 **Theory** = **1**  **Practical** = 0 **Practical** = **0**  **Total** = 16 **Total** = **1**  **Course Objective:**  This course will provide exposure to engineering problems associated with living systems and health care. Examples will be used to illustrate how basic concepts and tools of science & technology can be brought to provide solutions to healthcare professionals and improve the quality of life of people with disabilities. The course will focus on: Rehabilitation engineering, clinical engineering, biomechanics, biomaterials and tissue engineering, bio-signal and image processing, neural engineering and will introduce the basic life sciences and engineering concepts associated with these topics.   | CLOs | Description | Domain | Taxonomy Level | Mapping with PLO | | --- | --- | --- | --- | --- | | 01 | **Acquire** the basic knowledge of Biomedical engineering | Cognitive | 2 | 1 | | 02 | **Describe** the applications of Biomedical Engineering with Examples | Cognitive | 2 | 1 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering knowledge: |  | 7 | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis: |  | 8 | Ethics |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork |  | | 4 | Investigation: |  | 10 | Communication: |  | | 5 | Modern Tool Usage: |  | 11 | Project Management |  | | 6 | The Engineer and Society: |  | 12 | Lifelong Learning |  |   **Recommended Books:**   1. Introduction to Biomedical Engineering, 4th Edition, John Enderle 2. Biomedical Engineering Handbook Volume I & II, J. D. Bronzino | | | | | | | | | | | |
| Islamic Studies | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **32** | Theory | | | **02** |
| Practical | | **0** | Practical | | | **0** |
| **Total** | | **32** | **Total** | | | **02** |
| **Course Description:**  The Islam is a religion of peace and harmony for all humans based on knowledge and guidance in the Holy Quran. The basic teachings of Islam are comprehensive, practicable and universal. Therefore, this course briefly presents the vision of life and applied aspects of ethical system.  **Area Scope:**   * To enhance understanding of Islamic Culture and Civilization * To understand values and social system in Islam * To improve students’ ethical and professional skill and critical thinking   **After completion of the course, the students will be able**   | CLOs | Description | Domain | Taxonomy level | PLO | | --- | --- | --- | --- | --- | | 01 | To understand the basic concept of Islamic culture, Social System of Islam, Professional Ethics and Morality and Selected Verses of Surah Al-Inam, Surah Al-Hujrat, Surah Al-Ihzab, Surah Al-Hashar, Surah Al-Saf, Surah al-Furqan, Surah Al-Mumanoon, Surah Al-Baqara. | Cognitive | C2 | 8 | | 2 | I**nvestigate** the current social, professional & ethical issues in the light of Islamic teachings |  | A2 | 6 | | 02 | **Share** the concept of Islam and Science, Islam – Religion of Peace and Harmony | Cognitive | A3 | 12 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering Knowledge: |  | 7 | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis: |  | 8 | Ethics | **√** | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork |  | | 4 | Investigation: |  | 10 | Communication: |  | | 5 | Modern Tool Usage: |  | 11 | Project Management |  | | 6 | The Engineer and Society: |  | 12 | Lifelong Learning | **√** |   **Course Outline:**   1. **Islam – Religion of Peace and Harmony**  * Basic Concepts – Islam, Quran and Hadith * Faith and Religious Life   o Selected Verses of Surah Al-Baqara Related to Faith (Verse No-284-286)  o Selected Verses of Surah Al-Mumanoon Related to Characteristics of Faithful (Verse No-1-11)  **2. Islamic Culture and Civilization**   * Basic Concepts and of Characteristics of Islamic Culture and Civilization, Economic System of Islam Principles, Riba, Trade and Commerce , Acceptance of Other Religions – Interfaith Harmony, Foreign Policy | | | | | | | | | | | |
| **3-Social System of Islam**   * Basic Concepts of Social System in Islam * Elements of Family and their Rights - Parents, Women, Husband & Wife, Children * Inheritance – Rights and Laws * Social Rights – Neighbors, Relatives and Society * Equality and Brotherhood * Selected Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77) * Concept of Welfare State – Period of Khilafat-e-Rashida   **4-Professional Ethics and Morality**   * Basic Concepts - Islam and Ethics * Selected Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154) * Profession and Professionalism in Islam * Characteristics of a Professional * Truthfulness, Honesty, Sincerity, Patience, Gratitude, Meditation and Research * Role for Human Safety and Environment * Time Management * Prophet Muhammad (PBUH) – Role Model * Selected Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No1-18) * Selected Versus of Surah Al-Ihzab Related to Adab Al-Nabi (Verse No. 6, 21, 40, 56, 57, 58)   **5-Islam and Science**   * Islam and Science * Role of Muslims in Science and Education * Critical Thinking and Innovation * Selected Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment * Selected Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No1,14)   **Note:**  All topics should be taught/covered in the light of relevant Verses from Holy Quran and hadiths.  **Teaching Methodology (Proposed as applicable):**  Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to egg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing 85  **Assessment:**  Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term Suggested Books:  · Al-Qur’ān القرآن) selected text).  · Sayyid TāhirRasūlQādriقرآن دروس 52(Karachi: Islamic Research Academy, 7th ed., 2017).  · Sayyid Hasan-uddin Ahmad, قرآنی تعلیمات 2-vols., (Karachi: Jasarat Publications, 1998).  · Muhammad Shafī‘,القرآن معارف) Karachi: Dar-ul-Isha’at, 2000). | | | | | | | | | | | |
| **2nd Semester** | | | | | | | | | | | |
| Pakistan Study | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **32** | Theory | | | **2** |
| Practical | | **0** | Practical | | | **0** |
| **Total** | | **32** | **Total** | | | **2** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | To explore colonial and postcolonial history of Pakistan | | | | | | Cognitive | C-2 | | 6 | |
| **2** | To impart knowledge of foreign policy of Pakistan and current affairs | | | | | | Cognitive | C-1 | | 7 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | | **√** | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | | **√** | **12** | Lifelong Learning: | | |  | | |
| **Introduction/Objectives**   * Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan. * Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.   **Course Outline**  **1-Historical Perspective**   * Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah. * Factors leading to Muslim separatism * People and Land * Indus Civilization * Muslim adventnnnn * Location and geo-physical features. | | | | | | | | | | | |
| 2. **Government and Politics in Pakistan**  Political and constitutional phases: 1947-58 ,1958-71 ,1971-77 ,1977-88 ,1988-99 ,1999 onward  3. **Contemporary Pakistan**   * Economic institutions and issues * Society and social structure * . Ethnicity * Foreign policy of Pakistan and challenges * Futuristic outlook of Pakistan  1. Population Dynamics of Pakistan   Books Recommended  1. Burki, Shahid Javed. State & Society in Pakistan, The Macmillan Press Ltd 1980.  2. Akbar, S. Zaidi. Issue in Pakistan’s Economy. Karachi: Oxford University Press, 2000.  3. S.M. Burke and Lawrence Ziring. Pakistan’s Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.  4. Mehmood, Safdar. Pakistan Political Roots &Development.Lahore, 1994.  5. Wilcox, Wayne.The Emergence of Bangladesh., Washington: American Enterprise, Institute of Public Policy Research, 1972.  6. Mehmood, Safdar. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-eIslamia, Club Road, nd.  7. Amin, Tahir. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.  8. Ziring, Lawrence. Enigma of Political Development. Kent England: WmDawson& sons Ltd, 1980. | | | | | | | | | | | |
| Calculus & Analytical Geometry | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** | Theory | | | **3** |
| Practical | | **0** | Practical | | | **0** |
| **Total** | | **48** | **Total** | | | **3** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | Domain | **Taxonomy Level** | | **PLO** | |
| **1** | **Define** the basic concept of complex number ; function and derivatives | | | | | | Cognitive domain | C-1 | | 1 | |
| **2** | **Use** of the Analytical Geometry and Integral Calculus in multiple dimensions to solve different engineering problems | | | | | | Cognitive domain | C-3 | | 2 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | | **√** | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | | **√** | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Outline:**  **∙ Analytical Geometry:**   * Review of vectors, scalars and vector products. * Three-dimensional coordinate system and equation of straight line and plane 63   + - * **Functions Limit and Continuity:** * Review of functions and graphs, * Limits & Continuity, * Techniques of Finding Limits, * Discontinuity, * Limits of Sine and Cosine and Exponential Functions   + - * **Differentiation:** * Introduction to Derivatives * Examples of Derivatives * Derivative as Rate of Change * Derivative’s Rules * Implicit Differentiation * Higher order derivatives * Leibnitz Theorem   + - * **Applications of Derivatives:** * Applications of Derivatives * Monotonic functions * Optimization problems * First and second derivative tests * Point of inflection g. Concavity * Curvature * Indeterminate Forms and L’ Hospital rule * Differentials   + - * **Integration:** * Integrals and Properties of Integrals * Techniques of Integration * Integration by Parts * Definite Integrals | | | | | | | | | | | |
| * Integration of Trigonometric * Exponential and Inverse Functions * Integration by Partial Fractions * Reduction Rules   + - * **Applications of Integration:** * Applications of Integration * Area under the curve * Area between curves * Solids of Revolution * Volume of Solids of revolution by disk 64 * washer, Cylindrical shell & Cross Section Methods * Center of Pressure and Depth of Center of Pressure * Center of mass * Arc length   + - * **Improper Integrals:** * Improper Integrals * Integrals and Singularities * Convergence of improper integrals   + - * **Infinite Sequence and Series:** * Sequence and Infinite Series * Convergence and Divergence of sequences and series * Positive Term Series * Integral Test * Basic Comparison Test * Limit Comparison Test * Ratio and Root tests * Alternating series * Absolute and Conditional Convergence   + - * **Power and Taylor Series:** * Power series * Maclaurin and Taylor Series and its Applications * **Teaching Methodology (Proposed as applicable):** * Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing * **Assessment:** * Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term   **Suggested Books:** Thomas' Calculus by George B. Thomas, Jr., Maurice D. Weir, Joel R. Hass, Pearson, USA. Calculus: Early Transcendental by James Stewart. Brooks/Cole USA. | | | | | | | | | | | |
| Physiology I | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **32** | Theory | | | **02** |
| Practical | | **48** | Practical | | | **01** |
| **Total** | | **80** | **Total** | | | **03** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| | **Sr. No.** | **CLOS** | **Domain** | **Domain’s Level** | **PLO** |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 1 | **State** the fundamental concepts and methods of life or physical science. | Cognitive | C1 | 1 |  |  |  |  | | 2 | **Explain** the physiological principles of cells and tissue, and muscular, skeletal, immune, and nervous systems | Cognitive | C2 | 1 |  |  |  |  | | 3 | **Use** various tools to determine chemical composition of blood to discuss the function of various organs of human being | Psychomotor | P3 | 5 |  |  |  |  |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | | **√** | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | | **√** | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course Outline:**  **1. Introduction**  a. The Cell and General Physiology  b. Functional organization of human body and control of the internal environment  c. Cell and its function, protein synthesis and cell reproduction  d. Metabolism of carbohydrates and formation of ATP e. Lipid and Protein Metabolism, transport through Cell membrane  **2. Human physiology** from a system's viewpoint  a. Quantitative issues at the organ and whole-body levels of Cardiovascular  b. Respiratory c. Renal d. Digestive systems  3**. Nerve and Muscle** a. Membrane potential b. Action potential c. Excitation and Rhythmicity d. Contraction of Skeletal and cardiac muscles, sliding filament Mechanism, Heart as a pump  **4. Sensory Systems** a. Sensory Receptors b. Classification and basic mechanism of action  a. Mechanoreceptive sensations, pain, thermal and visceral pain, headache 6. Special Senses a. Eye, receptor function of the retina, Neurophysiology of Vision, the Chemical Sense-taste and smell  **Class Attendance:** Minimum 75% class attendance is mandatory to appear in the examinations.  5. S**omatic Sensations**  Distribution of marks:  Quizzes 05%  Assignment 05%  Midterm exams 20%  Final exams 50 %  Lab Work 20 %  **List of Practical’s**  1. Use of stethoscope & measurement of human arterial blood pressure & pulse  2. Determination of Red Blood Cells per cmm of human Blood  3. Determination of White Cells per cmm of human blood  4. Determination of hemoglobin percentage in human blood  5. Physiochemical & microscope analysis of human urine sample (Renal System)  6. a) Demonstration of the use of ECG, b) Test of hearing  7. Determination of visual acuity of a human subject by using Snellen’s eye chart  8. Determination of bleeding time in human body  9. Determination of the coagulation time in human body  10. a) To record normal respiration & effect of System exercise on it using spirometer. b) To record normal respiration & effect of exercise on it using power lab. c) Introduction the organization & classification of neurons using neurolab System  11. a) To record normal respiration & effect of exercise on it using spirometer b) To record normal respiration & effect of exercise on it using power lab By HoD | DEPT. OF BIOMEDICAL ENG., BUETK c) Introduction the organization & classification of neurons using neurolab  12. To demonstrate the differential count of leukocytes in human blood Sample  13. To observe the shape of RBC in normal saline stem | | | | | | | | | | | |
| 14. Open ended labs I  15. Open Ended lab II  **Recommended Books:**   1. John E. Hall, Guyton and Hall Textbook of Medical Physiology, 13th Edition, ISBN: 9781455770052 2. Kim E. Barrett, Susan M. Barman, Scott Boitano and Heddwen Brooks, Ganong's Review of Medical Physiology, 25th Edition, ISBN: 9780071825108 | | | | | | | | | | | |
| Circuit Analysis | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** | Theory | | | **3** |
| Practical | | **48** | Practical | | | **1** |
| **Total** | | **96** | **Total** | | | **4** |
| **Course Learning Outcomes: -** After completion of the course, the students will be able to   | Sr.no | CLO | Domain | Taxonomy level | PLO Mapping | | --- | --- | --- | --- | --- | |  | **Discuss** knowledge related to basic concepts, laws and theorems used for circuit analysis | Cognitive | C2 | 1 | |  | **Solve** the circuits using basic concepts, laws and theorems | Cognitive | C3 | 2 | |  | **Conduct**experimentsto interpret experimental data and observe its conformance with analyzed results of circuits. | Psychomotor | P4 | 5 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering Knowledge: |  | 7 | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis: |  | 8 | Ethics: |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork |  | | 4 | Investigation: |  | 10 | Communication: |  | | 5 | Modern Tool Usage: |  | 11 | Project Management |  | | 6 | The Engineer and Society: |  | 12 | Lifelong Learning |  |   **Course outline:** | | | | | | | | | | | |
| Electric quantities, electric signals, electric circuits, Kirchhoff's laws, circuit elements. Resistance, series parallel combination, voltage and current dividers, resistive bridges and ladders, practical sources and loading, instrumentation and measurement. Nodal analysis, loop analysis, linearity and superposition, source transformation, one ports, circuit theorems, power calculations. Dependent sources, circuit analysis with dependent sources, ideal transformer, amplifiers. The operational amplifier, basic op-amp configurations, ideal op-amp circuit analysis, summing and difference amplifiers, amplifier types. Capacitance, inductance, natural response of RC and RL circuits. Response to DC forcing function. Transient response of first order circuits, step, pulse and pulse train responses, first order op-amp circuits. Transient response and step response of second order circuits. AC fundamentals; RMS or effective, average and maximum values of current & voltage for sinusoidal signal wave forms, introduction to phasor representation of alternating voltage and current, single phase circuit analysis, star-delta transformation for DC and AC circuits.  **List of Practical:**  1. To determine the voltage of series circuit  2. To determine the voltage of a parallel circuit.  3. To determine the current through mesh analysis  4. To determine the voltage across nodes through nodal analysis of the circuit  5. To determine the voltage across nodes through nodal analysis of the circuit  6. To determine the voltage across Resistor in the circuit.  7. To study the filter circuit and response  8. To study the response of an RC circuit when applied with a sudden dc voltage source.  9. To study the response of a Driven RC circuit when applied with a sudden dc voltage source.  10. To Study the response of Parallel Resonant Circuit  11. To study the response of Series Resonant Circuit  12. To study source free RLC circuit and determine its response mathematically and graphically  13. To determine the transient analysis and plot transient analysis of RL circuit using PSpise/Multisim  14. To determine the transient analysis and plot transient analysis of RLC circuits using PSpise/Multisim.  **Recommended Books:**   1. Electric Circuits Fundamentals, S. Franco, Oxford University Press, (Latest edition). 2. The Analysis and Design of Linear Circuits by R E Thomas, A J Rosa and G J Toussaint, John Wiley, 6th Edition, 2009 3. Fundamentals of Electric Circuits by C Alexander and M Sadiku, McGraw Hill, 4th Edition, 2008 4. Basic Engineering Circuit Analysis by J D Irwin and R M Nelms, Wiley, 9th Edition, 2008   Engineering Circuit Analysis by W Hayt, J Kemmerly and S Durbin, McGraw Hill, 7th Edition, 2007 | | | | | | | | | | | |
| Object Oriented Programming | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **32** | Theory | | | **2** |
| Practical | | **48** | Practical | | | **1** |
| **Total** | | **80** | **Total** | | | **3** |
| Course Objectives: This is an introductory course on object-oriented programming,which is designed to develop understanding of fundamental concepts of object-oriented programming. The course covers a number of basic and advanced object-oriented concepts including classes, objects, inheritance, polymorphic, composition, encapsulation, templates etc. The course aims to illustrate the object-oriented concepts and develop solutions using C++ and a little bit of JAVA language, their design principles and tools.  [CS-1201 Object Oriented Programming | Department of Software Engineering (ajku.edu.pk)](http://se.ajku.edu.pk/courses/cs-1201-object-oriented-programming/)  **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | Acquire knowledge of underlying concepts of object-oriented paradigm. | | | | | | Cognitive | C3 | | 1 | |
| **2** | Develop an understanding of object-oriented design artifacts and their mapping to object-oriented programming. | | | | | | Cognitive | C2 | | 1 | |
| **3** | Design and implement object-oriented solutions for small systems involving single/multiple objects. | | | | | | Psychomotor | P3 | | **3** | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| Contents (Catalog Description)Introduction to OOP Introduction to OOP, Object oriented programming vs. procedural programming, advantages of object-oriented programming. Introduction to C++ and Java OOP in Java, basic intro to loop and conditional statements in JAVA, arrays, Array List / Vectors Introduction to Classes Classes: data members and member functions. Member access, constructors and destructors, static data members, scope resolution operator. Memory allocated for objects. Operator Overloading Unary, binary, comparison, Arithmetic assignment operator overloading, Data conversion Inheritance Inheritance, base and derived classes, casting base class to derived class, public, protected, friendly and private inheritance, overriding member functions. Composition Complex classes composed of objects of other classes. Polymorphism Overridden functions, abstract base class, and this pointer. Object Oriented Design Class Diagram, Forward Engineering of class diagram to code, Reverse Engineering of code to class diagram. Exception Handling Exception handling, Error handling, try/catch/finally blocks, throwing an exception, re-throwing and exception. File Handling Streams, Stream objects, Character and binary I/O, Object I/O, readers and writers, I/O with Multiple Objects, Position and offset. Templates Simple Function templates, function templates with multiple arguments, class templates. | | | | | | | | | | | |
| **List of Practical:**  1. Revision of Loops.  2. Algorithm design based on loops and arrays.  3. Developing small programs using functions.  4. Experimenting operator overloading feature.  5. Developing classes and creating instances of Objects.  6. Developing Inherited classes  7. Designing user defined classes.  8. Experimenting OOP features such as Encapsulation  9. Experimenting OOP features such as Abstraction  10. Experimenting OOP features such as Polymorphism  11. Experimenting OOP features such as Handling runtime errors using Exceptions  12. Experimenting OOP features such as Directives 13. Revision of OOP feature  14. Open ended lab I  15.Open ended lab II Recommended Textbooks 1-Robert Lafore, Object-Oriented Programming in C++,Third Edition, The Waite’s Group.  2-Deitel and Deitel, Java How to Program, 9th Edition,Prentice Hall, 2012  Reference Books   1. Greg Perry and Marcus Johnson, Turbo C++ by Example,Prentice Hall 2. Stanley B. Lippman, C++ Primer, 2nd edition. 3. Java Class Libraries Unleashed, SAMS Publishing. | | | | | | | | | | | |
| Human Anatomy | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **32** | Theory | | | **2** |
| Practical | | **48** | Practical | | | **1** |
| **Total** | | **80** | **Total** | | | **03** |
| **Course Learning Outcome:**  Upon successful completion of the course, students will be able to:   | **S #** | **CLO, Course Learning Outcome** | **Domain** | **Level** | **PLO** | | --- | --- | --- | --- | --- | | 1 | **Understand** the principle structures of major human organs and systems. | Cognitive | C2 | 1 | | 2 | **Understand** and describe the neuromuscular coordination using anatomic structures. | Cognitive | C2 | 1 | | 3 | **Identify** the consequences of deformities in the principle structures of upper and lower extremities. | Cognitive | C4 | 4 | | 4 | **Differentiate** types of joints and variations in its movement planes. | Cognitive | C2 | 1 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering Knowledge: |  | 7 | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis: |  | 8 | Ethics: |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork |  | | 4 | Investigation: |  | 10 | Communication: |  | | 5 | Modern Tool Usage: |  | 11 | Project Management |  | | 6 | The Engineer and Society: |  | 12 | Lifelong Learning |  |   **1. Introduction**  a Anatomy and its branches b. Anatomical positions c. Planes d. Topography  **2. Cell Anatomy**  a. Overview of Cellular Anatomy.  **3. Extremities (Upper and lower)**  a. Bones b. Muscles c. Ligaments d. Tendons  e. Bursae f. Reticulae g. Capsules h. Arteries i. Veins j. Lymphatic system  **4. Vertebral Anatomy**  a. Vertebrae  b. Pelvic girdle  c. Spinal cord  d. Nervous system  **5. Thorax-Thoracic Viscera**  a. Surface anatomy b. Bones surface musculature c. Lungs d. Heart  **6. Abdomen**  a. Organs location b. Structures c. Relations and function | | | | | | | | | | | |
| **7. Head & Neck**  a. Bones b. Muscles c. Cranial nerves  **Practical:**  1. Demonstration of Human Skeleton in general.  22.Demonstration of basic structures in Human Anatomy (Skin, Muscles &  Other Structures).  3. Demonstration of Anatomical planes & positions.  4. Demonstration of Movements &Motional Terms.  5. Demonstration & Study of Scapula & Clavicle.  6. Demonstration & Study of Humerus bone.  7. Demonstration of Ulna and Radius.  8. Demonstration of wrist & hand bones.  9. Demonstration of Pelvic bone.  10. Study and demonstration of Femur bone.  11. Study and demonstration of Tibia & Fibula.  12. Demonstration of Foot bones.  13. Demonstration of skull.  14. Demonstration & study of different parts of Vertebral column.  15. Study and Demonstration of different Models.  16. Audio & Visual Demonstration of Human Anatomy.  **Teaching Methodology**   * Lecturing * Written Assignments * Report Writing   **Assessment**   * **Theory (100%)**  1. Sessional (20%) 2. Quiz (12%) 3. Assignment (8%) 4. Midterm (30%) 5. Final Term (50%)  * **Laboratory (100%)**   **Reference Books**   1. PRINCIPLES OF HUMAN ANATOMY, FOURTEENTH EMEA EDITION 2. B.D. CHAURASIA'S HUMAN ANATOMY: REGIONAL AND APPLIED DISSECTION AND CLINICAL VOLUME 1: UPPER LIMB AND THORAX WITH CD, 7e (pb) 2017 3. Human Anatomy Standalone book 8e (hb) 2014 4. HUMAN ANATOMY & PHYSIOLOGY 10ED(HB)2015 5. GUYTON AND HALL TEXTBOOK OF MEDICAL PHYSIOLOGY 14e (pb) 2020 | | | | | | | | | | | |
| **3rd Semester** | | | | | | | | | | | |
| Complex Variable and Transformation | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** | Theory | | | **03** |
| Practical | | **0** | Practical | | | **0** |
| **Total** | | **48** | **Total** | | | **03** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | **Define** the complex number system, complex functions and integrals of complex functions | | | | | | Cognitive | C1 | | 1 | |
| **2** | **Explain** the concept of limit, continuity, differentiability of complex valued functions | | | | | | Cognitive | C2 | | 1 | |
| **3** | **Apply** the results/theorems in complex analysis to complex valued functions | | | | | | Cognitive | C3 | | 2 | |
| **4** | **Explain** the concept of integral transforms, e.g., Laplace, Fourier transforms and the related inverse transforms by using the following Partial fractions method, Tables, Convolution theorems and apply this transformation for engineering problems | | | | | | Cognitive | C3 | | 2 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| COURSE CONTENTS   1. **Introductory Concepts**    * Introduction to Complex Number System    * Argand diagram    * De Moivre’s theorem and its Application Problem Solving Techniques  * **Analyticity of Functions**   + Complex and Analytical Functions,   + Harmonic Function, Cauchy-Riemann Equations.   + Cauchy’s theorem and Cauchy’s Line Integral * **Singularities**   + Singularities, Poles, Residues, Contour Integration * **Laplace transform**   + Laplace transform definition,   + Laplace transforms of elementary functions   + Properties of Laplace transform, Periodic functions and their Laplace transforms,   + Inverse Laplace transform and its properties,   + Convolution theorem,   + Inverse Laplace transform by integral and partial fraction methods,   + Heaviside expansion formula,   + Solutions of ordinary differential equations by Laplace transform, | | | | | | | | | | | |
| * + Applications of Laplace transforms * **Fourier series and Transform**   + Fourier theorem and coefficients in Fourier series,   + Even and odd functions,   + Complex form of Fourier series,   + Fourier transform definition,   + Fourier transforms of simple functions,   + Magnitude and phase spectra,   + Fourier transform theorems,   + Inverse Fourier transform * **Solution of Differential Equations**   + Series solution of differential equations,   + Validity of series solution, Ordinary point,   + Singular point, Forbenius method,   Indicial equation, Bessel’s differential equation, its solution of first kind and recurrence formulae, | | | | | | | | | | | |
| Physiology II | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **32** | Theory | | | **02** |
| Practical | | **16** | Practical | | | **01** |
| **Total** | | **48** | **Total** | | | **03** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to:   | **Sr. No.** | **CLOS** | **Domain** | **Taxonomy Level** | **PLO** | | --- | --- | --- | --- | --- | |  | **Acquire** the knowledge about nervous system, Motor functions and endocrinology | Cognitive | C1 | 1 | |  | **Demonstrat**e neuromuscular coordination system and its implication in normal and abnormal reflexes | Cognitive | C3 | 4 | |  | **Explain** the structural and functional relationship of nervous, endocrine, reproductive, and lymphatic systems | Cognitive | C2 | 1 | |  | **Recognize** the physiological principles of nervous, reproductive, endocrine and lymphatic systems۔ | Psychomotor | P3 | 1 | |  | **Identify** and use the tools of a scientific discipline to carry out collaborative laboratory investigation۔ | Psychomotor | P4 | 1 | | | | | | | | | | | | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Nervous System**  a. Organization of Nervous System  b. Basic functions of synapses  c. Neuronal Mechanism and circuits for processing information  **2. Motor Functions**  a. Spinal cord and the cord reflexes  b. The cerebral cortex and intellectual functions of the Brain  c. Motor function of the Brain stem  d. Vestibular control of postural reflexes  e. Cerebrum and basal ganglia  f. Reticular  **3. Somatic Sensations**  a. Mechanoreceptive sensations  b. Pain  c. Thermal and visceral pain  d. Headache  **4. Behavioral functions of the Brain**  a. Limbic System  b. Role of the Hypothalamus  c. Control of the vegetative functions of the body  d. The Autonomic nervous system  e. The Adrenal Medulla  f. Electrical Activity from Brain  **5. Endocrinology and Reproduction**  a. Introduction to Endocrinology and the pituitary Hormones.  b. Hormonal functions in male and female  **Practical**  1. Study of kymograph  2. Recording of simple muscle twitch in Gastrocnemius sciatic nerve preparation  3. Recording of the effect of two successive stimuli on the nerve muscle preparation  4. Recording of the effect of continuous stimuli (fatigue) in a nerve muscle  preparation  5. To demonstrate phenomenon of tentanisation  6. Effect of temperature on the simple muscle twitch  7. Demonstrate the superficial reflexes on a given subject  8. Demonstrate the deep reflexes on a given subject  9. To observe the receptor adaptation associated with Pacinian Corpuscle and other receptors in a computer simulated program | | | | | | | | | | | |
| 10. To illustrate the principle of phase locking in auditory fibers by using the  compute simulated program  11. Determination of visual field in human subject.  12. Observe and study the spectrum and waveforms of different vowels sound and their relationship with the configuration of the vocal tract  13. Study the movement in basilar membrane during the passage of sound waves of different frequencies, on a simulated mode  14. (a) To calculate nerve conduction velocity from twitch records obtained  by using a nerve-muscle preparation using Kymograph.  (b) To calculate nerve conduction velocity from twitch records obtained by  to Physiological Systems (Biosystems &Bio robotics)  using a nerve-muscle preparation using powerlab. To locate the  gustoreceptors in the human  15. Demonstration of the recording of an (extracellular) action potential  from frog sciatic nerve (monophasic & biphasic) on oscillograph /  oscilloscope  16. Study of reflex movements in spine of frog; Effect of acid treatment,  Effect Effects of electric shock  17. Open Ended Lab 1  **Teaching Methodology**   * Lecturing * Written Assignments * Report Writing   **Assessment**   * **Theory (100%)**  1. Sessional (20%) 2. Quiz (12%) 3. Assignment (8%) 4. Midterm (30%) 5. Final Term (50%)  * **Laboratory (100%)**   **Reference Books**   1. John E. Hall, Guyton and Hall Textbook of Medical Physiology, 13th Edition, ISBN: 9781455770052. 2. Arthur B. Ritter, Physiology for Engineers: A Systems Approach, 2017, ISBN: 9781498734561.   Physiology for Engineers: Applying Engineering Methods | | | | | | | | | | | |
| Biochemistry | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **32** | Theory | | | **02** |
| Practical | | **48** | Practical | | | **01** |
| **Total** | | **80** | **Total** | | | **03** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to:   | Sr.No | CLO | Domain | Taxonomy level | PLO | | --- | --- | --- | --- | --- | |  | Provide an introduction with the basic concepts of biochemistry | Cognitive | C1 | 1 | |  | Comprehend structural properties of globular proteins and co-relate them to the loading and unloading of oxygen in myoglobin or hemoglobin. | Cognitive | C2 | 1 | |  | Comprehend and analyze the metabolism of  carbohydrates, Lipids and enzyme. | Cognitive | C2 | 1 | |  | Interpret and analyze structural properties of  DNA, its synthesis and factors involved in its mutation | Cognitive | C5 | 1 | |  | Use modern chemical analytical Tools for quantitative analysis of Biomolecules | Psychomotor | P4 | 5 | | | | | | | | | | | | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | | **✔** | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course outline:**  Introduction to Biochemistry: Colloidal state, buffer, pH, significance of pH, Henderson equation, surface tension, viscosity, osmosis, diffusion, concept of chromatographic techniques (TLC, paper chromatography, GLC column chromatography etc.) carbohydrates, amino acids, nucleic acids, proteins, vitamins, enzymes, hormones & signaling agents, Metabolism of Carbohydrates, Lipids and Proteins: carbohydrate derivatives, optical activity, polarimetry, glycogenesis, gluconeogenesis, glycolysis, tricarboxylic acid cycle, hexose monophosphate shunt. Effects of hormones on carbohydrate metabolism. Chemistry and Metabolism of Lipids and proteins.  **Recommended Books:**   1. Introduction to General, organic and biochemistry, 7th edition, by Bettelheim, Brown, March. 2. Biochemistry, 4th edition, by Lippincott’s   **Class Attendance:** Minimum 75% class attendance is mandatory to appear in the examinations.   * **Theory (100%)**  1. Sessional (20%) 2. Quiz (12%) 3. Assignment (8%) 4. Midterm (30%) 5. Final Term (50%) | | | | | | | | | | | |
| **List of Practical**   1. How to prepare the Solution in Lab 2. Determination of pH-by-pH meter and Litmus paper 3. Demonstration the action of buffer 4. To determine the principle application of Henderson- Haselbash's equation 5. Tests for proteins 6. Examination of Egg white By HoD | DEPT. OF BIOMEDICAL ENG., BUETK 7. Color reactions for proteins 8. Isolation of Casein from milk 9. Tests on carbohydrates 10. Measurement of Blood Glucose level with help of spectrophotometer 11. Oral Glucose Tolerance Test (OGTT) 12. Tests of Lipid profile by chemical analyzer   Separation of Amino Acids by chromatographic methods   1. **Open ended Lab 1,2** | | | | | | | | | | | |
| Basic Electronics | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** | Theory | | | **03** |
| Practical | | **48** | Practical | | | **01** |
| **Total** | | **96** | **Total** | | | **04** |
| **Course Learning Outcome:**  Upon successful completion of the course, students will be able to:   | S # | CLO, Course Learning Outcome | Domain | Taxonomy level | PLO | | --- | --- | --- | --- | --- | | 1. | **Explain** the basics, working and characteristics of Semiconductor material and diodes. | Cognitive | C2 | 1 | | 2. | **Analyze** the working and behavior of transistors and their types and be able to understand different transistor applications | Cognitive | C4 | 2 | |  | **Reproduce** basic electronic circuits on board using discrete components i.e., resistors, diodes and transistors, and develop projects using discrete components and/or circuit simulation platforms. | Psychomotor | P3 | 5 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering Knowledge: |  | 7 | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis: |  | 8 | Ethics: |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork |  | | 4 | Investigation: |  | 10 | Communication: |  | | 5 | Modern Tool Usage: |  | 11 | Project Management |  | | 6 | The Engineer and Society: |  | 12 | Lifelong Learning |  |   **Course Contents**  Introduction to electronics:  1. Diodes:pn junction diode, forward and reverse characteristics of a diode, ideal diode, practical diode, equivalent circuit of a diode, current equation of a diode, diode as a switch. 2. Types of diodes:  Schottky diode, Zener diode, tunnel diode, varactor diode, LED, laser diode.3. Applications of diode:  Half-and full-wave rectifiers, clipper and clamper circuits, voltage multipliers.4. Bipolar junction transistor:  Operation, npn andpnp transistors, unbiased transistors, DC biasing of a transistor, static characteristics, DC circuit analysis, load line, operating point and bias stabilization, Transistor as an amplifier.5. Transistor biasing configurations: Common emitter, common base, common collector. Field-effect transistor. 6. FET biasing techniques: Common drain, common source and common gate, fixed bias and self-bias configurations, voltage divider biasing, universal JFET bias curve, darlington pair.7. MOSFET: Introduction, Enhancement mode, depletion mode MOSFET | | | | | | | | | | | |
| **List of Practical:**  1 To observe the working of diodes with forward and reverse bias.  2. Plot the diode characteristic curve.  3. Calculate the bulk resistance of the diode and observe its effect in the diode approximations.  4. To observe the working of a half wave rectifier.  5. To observe the working of full wave rectifier  6. To observe the working of Bridge wave rectifiers.  7. To observe the working of Zener Diode  8. To analyze the working of Clamper Circuit.  9. To analyze the working of Clipper Circuit.  10. To determine the output voltage for half wave voltage doubler.  11. To determine the output voltage for full wave voltage doubler.  12. To determine the output voltage for Zener limiting circuit  13. Checking and Troubleshooting the NPN and PNP Transistor using a Multimeter.  14. To use the transistor in switching mode.  15. Demonstrate the operation and determine the biasing parameter of Base Bias Circuit.  16. Demonstrate the operation and determine the biasing parameter of Voltage Divider Bias Circuit.  **Recommended Books:**  Electronic Devices and Circuit Theory, Robert Boylestad and Louis Nashelsky, Prentice Hall, Latest Edition.  Introductory Basic Electronics: Electron Flow Version, Robert Paynter, Prentice Hall, Latest Edition.  Principles of Electronic Mehta, Latest Edition.  The Art of Electronics, Paul Horowitz and Winfield Hill, Latest Edition. | | | | | | | | | | | |
| Computer Aided Engineering Drawing | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **0** | Theory | | | **0** |
| Practical | | **48** | Practical | | | **1** |
| **Total** | | **48** | **Total** | | | **1** |
| **Course Learning Outcomes: -** After completion of this course, the student should be able to   | **Sr.no** | **CLO** | **Domain** | **Taxonomy Level** | **PLO** | | --- | --- | --- | --- | --- | | **2** | **Draw** basic drawing objects | Psychomotor | P1 | 5 | | **3** | **Interpre**t basic engineering drawing | Cognitive | C3 | 1 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | **1** | Engineering Knowledge: |  | **7** | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | **2** | Problem Analysis: |  | **8** | Ethics: |  | | **3** | Design/Development of Solutions |  | **9** | Individual and Teamwork |  | | **4** | Investigation: |  | **10** | Communication: |  | | **5** | Modern Tool Usage: |  | **11** | Project Management |  | | **6** | The Engineer and Society: |  | **12** | Lifelong Learning |  |   **Course outline:**  **1. Introduction**  a. Introduction to Engineering Drawing  b. Use of drawing instruments and materials.  c. Basic Tools- classification and brief description  d. Lines, Types of lines, configuration of lines and their application, Selection of line thickness  **2. Engineering Geometry**  a. Geometric construction  b. Coordinate systems  c. Basic entities  d. Drawing simple geometric objects  e. Introduction to different types of scales. | | | | | | | | | | | |
| **3. Modeling Fundamentals**  a. Introduction to solid modeling  **4. Multiview and Visualization**  a. Projection theory  b. Projection of principal views from 3D models  c. Orthographic projections d. Isometric drawings e. Section views  5. **Dimensioning and plotting**. Dimensioning b. Plotting and printing  **Recommended Books:**   1. Shawna Lockhart, “Tutorial Guide to AutoCAD”, Prentice Hall, Latest Edition.   First Year Engineering Drawing, A.C Parkinson, Latest Edition | | | | | | | | | | | |
| Communications Skills | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **32** | Theory | | | **02** |
| Practical | | **0** | Practical | | | **00** |
| **Total** | | **32** | **Total** | | | **02** |
| **SUGGESTED COURSE LEARNING OUTCOMES:** Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | **Define** and **comprehend** complex English language texts. | | | | | | Cognitive | C1 | | 10 | |
| **2** | **Discuss** different topics by acquiring four skills specifically (Reading, Writing, Listening & speaking) | | | | | | Cognitive | C2 | | 10 | |
| **3** | **Conform** the importance of communication and presentation skills for becoming an affective engineer | | | | | | Affective | A2 | | 10 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | | **√** | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **COURSE OUTLINE**  **Business Writing**   * Seven Cs of Communication * Business Writing Styles * Business Memos * Business Emails * Tenders and Quotations * Billing and Invoicing * Common Writing Errors * Useful Vocabulary and Phrases * Personal Documents   **Oral Communication**   * Verbal and non-verbal communication * Conducting meetings * Small group communication * Taking minutes.   **Presentation skills**   * Presentation strategies * Defining the objective, scope and audience of the presentation * Material gathering and material organization strategies * Time management * Opening and Concluding * Use of audio-visual aids * Delivery and presentation.   **Activities Involved**   * Interactive session of the students for communication skills followed by assessment with defined rubrics.   **Recommended Books**   * Practical English Grammar by A. J. Thomson and A. V. Martinet. Fourth edition. Oxford University Press. ISBN 978-0-19-431342-1. * Practical English Grammar Exercises 1 by A. J. Thomson and A. V. Martinet. Third edition. Oxford University Press. ISBN 978-0-19-431349-0. * A Practical Guide to Business Writing: Writing in English for Non-Native Speakers by Khaled Mohamed Al Maskari. Wiley. ISBN 978 1 118 41079 0 * Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 4354057 * The blue book of Grammar and Punctuation by Jane Straus, 11th Edition, 2014, John Willey, ISBN 978-11187855608   Directions: Use this rubric to evaluate a student’s communicative competencies. Assign a percentile score to each student for each section. Then, add all the student’s percentile scores for each section and divide by the number of students to determine the sample mean for each section. Lower percentile scores suggest areas where students can use improvement. | | | | | | | | | | | |
| |  | Qualities of Student Communicative Competence and Related Percentile Score | | | Students Score | | --- | --- | --- | --- | --- | | Competency  Students will be able to |  |  |  |  | | Excellent | Average | Poor | | 80-100 % | 50-79 % | 0-49 % | | Understand and clearly state the purpose and thesis of their speech | The purpose and thesis of the communicative competency and presentations are clearly understood and serve to focus the speech. | The purpose and thesis of the communicative competency and presentations are clearly understood, but the presentation strayed from its central point. | The purpose and thesis of the communicative competency and presentations are not clearly stated but were implicit. |  | | Analyze particular audiences and select an appropriate ethical communication strategy | The speaker clearly understood his or her audience and spoke appropriately and ethically with the audience in mind. | The speaker had a general understanding of the audience but missed key opportunities to communicate effectively with the audience. | The speaker had a general understanding of the audience but did not present information effectively with the audience. |  | | Identify access, select, evaluate, and site supporting information for a speech | An appropriate amount of high-quality supporting material was used for the presentation and clearly cited. | An appropriate amount of high-quality supporting material was used, but it was of medium quality and not always cited. | Little supporting material was used from low quality sources, and it was not cited appropriately. |  | | Present a clearly organized set of ideas | The communicative competence and presentation of ideas had a clear and deliberately organizational structure. | The communicative competence and presentation of ideas were organized, but the speaker sometimes strayed from the organization. | The communicative competence and presentation of ideas had easily identifiable main points but lacked internal structure. |  | | | | | | | | | | | | |
| **4th Semester** | | | | | | | | | | | |
| Biomedical Electronics | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** | Theory | | | **03** |
| Practical | | **48** | Practical | | | **01** |
| **Total** | | **96** | **Total** | | | **04** |
| **Course Objective:**  The subject provides basic concepts of amplifier, power amplifier, operational amplifier and instrumentation amplifier, to be able to use OP-AMP as pre-amplifier, power amplifier, oscillator, filter, to perform mathematical operations on signals using OP-AMP, and to design various timing circuits using OP-AMP  **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to:   | **S. No** | **CLO** | **Domain** | **Taxonomy level** | **PLO** | | --- | --- | --- | --- | --- | | **CLO-1** | **Interpret** single and multistage amplifiers at low and high frequencies. | Cognitive | 2 | 1 | | **CLO-2** | **Analyze** various biomedical electronic circuits using operational amplifiers | Cognitive | 4 | 2 | | **CLO-3** | **Analyze** circuits for how to cascade low-pass and high-pass filters to make a band-pass filter. | Cognitive | 4 | 3 | | **CLO-4** | **Design** data acquisition and signal conditioning circuits for biomedical applications. | Cognitive | 5 | 3 | | **CLO-5** | **Design,** Construct and Analyze various amplifiers and filters using operational amplifiers (OP-AMPs) | Psychomotor | 4 | 3 | | **CLO-6** | **Demonstrate** experiments on various amplifiers to acquire biopotential signal | Psychomotor | 4 | 5 |   **The CLO will map with following PLO**   | **1** | Engineering Knowledge: |  | **7** | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | **2** | Problem Analysis: |  | **8** | Ethics: |  | | **3** | Design/Development of Solutions |  | **9** | Individual and Teamwork |  | | **4** | Investigation: |  | **10** | Communication: |  | | **5** | Modern Tool Usage: |  | **11** | Project Management |  | | **6** | The Engineer and Society: |  | **12** | Lifelong Learning |  |   **Course Content ,** Amplifier Characteristics: Input and output impedance, Real and Apparent gain, Amplifier loading, Impedance matching of amplifiers. Power Supplies: Regulated and switched mode power supplies. Power Amplifiers: Classes of Power amplifiers. Oscillators: Hartley oscillators, Colpitt oscillators, RC phase shift oscillators, Wein-Bridge oscillators, Crystal oscillators based on BJT and FET. Differential Amplifiers: Darlington transistor circuit, properties of differential amplifier stage, circuits of differential amplifiers using BJTs and FETs. Operational Amplifiers: Analysis of Operational Amplifiers: Analysis of OP-AMP action, OP-AMP specifications: interpreting OP-AMP data sheet, offset voltage and current, temperature rating, output swing, CMRR, slew rate, Applications: Inverting amplifiers, non-inverting amplifiers, voltage follower, summing amplifiers, instrumentation amplifiers, integrator, differentiator, nonlinear amplifiers. Frequency response of OP-AMPs, A/D and D/A converters, power control using Op-Amp, Op-Amp based timing circuits. | | | | | | | | | | | |
| **Practical**   1. Design and Analyze OP-AMP Based Inverting Amplifier 2. Design and Analyze OP-AMP Based Non-Inverting Amplifier 3. Design and analyze the characteristics of Summing Amplifier 4. To study Characteristics of Differential Amplifier 5. To determine common mode rejection ratio (CMMR) 6. Design and Analyze OP-AMP Based Integrator 7. Design and Analyze OP-AMP Based Differentiator 8. Design and Analyze Instrumentation Amplifier 9. Designing an ECG Amplifier. 10. To Analyze Analog to Digital Converter 11. To Analyze Digital to Analog Converter 12. Designing and analyzing frequency response of Active Low Pass Filter 13. Designing and analyzing frequency response of Active High Pass Filter 14. Designing and analyzing frequency response of Active Band Pass Filter 15. Designing and analyzing frequency response of Active Band Stop Filter 16. Complex Engineering Problem: ECG/EMG/ EOG/PPG Amplifier and filters  * **Complex Engineering Problem**   **Recommended Books:**   1. Cirovic, M. M., “Basic Electronic Devices, Circuits and Systems”. 2. Howard M. Berlin, Fundamental of Operational Amplifiers & Linear Integrated Circuits *“Electronic Devices: Conventional Current Version” Thomas L. Floyd*   **Class Attendance:** Minimum 75% class attendance is mandatory to appear in the examinations.   | **Distribution of Theory Marks:** |  | | --- | --- | | Quizzes | 05% | | Assignment | 05% | | Midterm Examinations | 20% | | Final Examination | 50% | | Lab Work | 20% | | **Total** | **100 %** | | | | | | | | | | | | |
| Digital Logic Design | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** | Theory | | | **03** |
| Practical | | **48** | Practical | | | **01** |
| **Total** | | **96** | **Total** | | | **04** |
| **SUGGESTED COURSE LEARNING OUTCOMES**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | **PERFORM** gate level minimization using K-map and combinational logic by employing analysis and design procedure. | | | | | | Cognitive | 3 | | 1 | |
| **2** | **DERIVE** equations from the truth / state table in order to design synchronous sequential logic which includes latches, flip-flops and state reduction. | | | | | | Cognitive | 3 | | 1 | |
| **3** | **DESIGN** a valid ALU using Verilog language and Xilinx ISE platform. | | | | | | Cognitive | 5 | | 3 | |
| **4** | **Recognize** different types of digital integrated circuits (ICs) | | | | | | Psychomotor | 1 | | 1 | |
| **5** | **Arrange** discrete components for different types of combinational and sequential logic circuits | | | | | | Psychomotor | 2 | | 2 | |
| **6** | **Construct** different types of combinational and sequential logic circuit | | | | | | Psychomotor | 5 | | 3 | |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | | **√** | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course outline:**  Number systems, Boolean Algebra, Combinational Logic, Sequential Logic, Tri-state logic, Counters, Shift Registers, Computer Buses, Memory, Storage, Adders, Multiplexers, ALU, Microcode based control, Hardwired Control of ALU.  **Project Based Learning**  **List of Practical :**  1. Digital Logic Gates  2. Simplification of Boolean Functions  3. Combinational Circuits  4. Code Converters  5. Design with Multiplexers  6. Adders and Subtractors  7. Flip Flops  8. Sequential Circuits  9. Counters  10. Shift Registers  11. Serial Addition  12. Memory Unit  13. Clock Pulse Generator  14. Parallel Adder  15. Binary Multiplier  16. Asynchronous Sequential Circuits ,  17. Open Ended Lab  **Recommended Books**  1. Morris Mano and Charles R. Kime, “Logic and Computer Design Fundamentals”, Prentice Hall, ISBN: 013140539X, Latest Edition.  2. Tocci and Widmer, Digital Systems: Principles and Applications | | | | | | | | | | | |
| Linear Algebra & Differential Equation | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** | Theory | | | **3** |
| Practical | | **0** | Practical | | | **0** |
| **Total** | | **48** | **Total** | | | **3** |
| **Course Learning Outcome:**  Upon successful completion of the course, students will be able to:  HEC.   | **S #** | **CLO, Course Learning Outcome** | **Domain** | **Level** | **PLO** | | --- | --- | --- | --- | --- | |  | **Understand** methods to resolve differential equations as they arise in engineering and science | Cognitive | C2 | 1 | |  | **Describe** the linear structure, existence, and uniqueness of solutions to differential equations | Cognitive | C2 | 1 | |  | **Solve** linear algebra problems | Cognitive | C3 | 2 | |  | **Outline** proofs of basic linear algebra results | Cognitive | C4 | 2 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering Knowledge: |  | 7 | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis: |  | 8 | Ethics: |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork |  | | 4 | Investigation: |  | 10 | Communication: |  | | 5 | Modern Tool Usage: |  | 11 | Project Management |  | | 6 | The Engineer and Society: |  | 12 | Lifelong Learning |  |   **Course Outline:**  1. Linear Algebra a. Methods for solution of algebraic linear equations  2. Vectors a. Scalar and vector quantities b. Differentiation and integration of vector functions c. Gradient, Divergence and Curl d. Line integrals e. Green’s Theorem f. Gauss theorem g. Divergence theorem h. Stokes’ theorem  3. Ordinary Differential Equations a. Formulations b. Order, degree and linearity of differential equations c. Complementary and particular solutions, initial and boundary value problems d. Solution of Ordinary Linear Differential Equations of First Order e. Methods of solutions, Bernoulli’s differential equations  4. Linear Second Order Differential Equations a. Characteristic equation and different types of its b. Methods of solving homogeneous linear differential equations with constant coefficients c. Particular solution by variation of parameter’s method and solution by indeterminate coefficient method Suggested Teaching Methodology: Lecturing∙ Written Assignments∙ Report Writing∙  **Text and Reference Books**:   * + - 1. Howard Anton, Elementary Linear Algebra, 11th Edition, ISBN: 9781118473504 2. Gilbert Strang,       2. Introduction to Linear Algebra, 5th Edition, ISBN: 9780980232776 3. Sheldon Axler, Linear Algebra Done Right, 3rd Edition, ISBN: 9783319110790 4.       3. David C. Lay and Steven R. Lay, Linear Algebra and Its Applications, 5th Edition, ISBN: 9780321982384 5.       4. Bernard Kolman and David Hill, Elementary Linear Algebra with Applications, 9 th Edition, ISBN: 9780132296540 6.       5. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, ISBN: 9780470458365 | | | | | | | | | | | |
| Biomechanics | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** | Theory | | | **03** |
| Practical | | **48** | Practical | | | **01** |
| **Total** | | **96** | **Total** | | | **04** |
| **Course Objective:**  Biomechanics is designed to introduce the field of biomechanics. In this course students will explore, describe, analyze and predict the characteristics of movement for the human body. Biomechanics is divided into two sections. In the first section, the knowledge of engineering mechanics including both statics and dynamics, is given to students while the second section is based on the application of these principles to gait analysis and specific sport and exercise activities. This course also deals with mechanics of bone and muscles.  **Course Learning Outcome:**  Upon successful completion of the course, student will be able to:   | **S #** | **CLO, Course Learning Outcome** | **Domain** | **Level** | **PLO** | | --- | --- | --- | --- | --- | |  | **Explain** and solve the basic problems of statics that include vector resolution, vector addition, equilibrium, torque, centroid and moment of inertia. | Cognitive | 2 | 1 | |  | **Apply** the knowledge of temporal spatial parameters, kinematics and kinetics of normal Gait to analyze human movement. | Cognitive | 3 | 2 | |  | **Explain** the mechanics of bone and muscle | Cognitive | 2 | 1 | |  | **Develop** protocol to conduct measurements of forces on the Human Arm Model at Bicep and Triceps Muscle Location and analyze results. | Psychomotor | 4 | 3 | |  | **Design**, construct and analyze results of a Biomechanical model to mimic a real life biomechanical and health related problem. | Psychomotor | 5 | 3 | | | | | | | | | | | | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering Knowledge: |  | 7 | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis: |  | 8 | Ethics: |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork |  | | 4 | Investigation: |  | 10 | Communication: |  | | 5 | Modern Tool Usage: |  | 11 | Project Management |  | | 6 | The Engineer and Society: |  | 12 | Lifelong Learning |  |   **Introduction:** Course learning outcomes, recommended books, weekly course plan, Assessment criteria, Definition of biomechanics, domains of biomechanics. Introduction to statics and dynamics, Kinetics and kinematics. Definitions of ergonomics, rehabilitation biomechanics, orthopedic biomechanics and sports & exercise biomechanics.  **Vectors:**  Definitions of vectors, types of vectors, resolution of a vector.  **Statics:** Addition of two vectors using law of parallelogram and using laws of Sine and Cosine.  **Statics:** Addition of more than two vectors using rectangular components methods.  **Statics:** Addition of more than two vectors using 3-Dimensional problems.  **Statics:** Calculation of Vectors in Cartesian form, unit vectors, coordinates of a point in 3-dimensional problem.  **Equilibrium:** Definition of equilibrium, equilibrium conditions, equilibrium 2-dimensional problems, equilibrium 3-dimensional problems.  **Mid Term Exam**  **Gait Analysis:** Anatomical planes and axes, Sagittal plane movements, frontal plane movements, transverse plane movements, Gait, Gait Cycle, Phases, events and periods of gait cycle, basic terminologies of gait cycle. Detailed explanation of periods of gait cycle, Temporal spatial parameters, and Three-dimensional ground reaction vector.  **Gait Analysis:** Centre of mass, Centre of pressure, relationship between center of gravity and Center of pressure, Gait kinematics, and gait kinetics. Progression of ground reaction vector during stance phase of a gait cycle, gait kinetics, muscle activity, walking and running efficiency, energy consumption per unit time, and energy consumption per unit distance, Gait in the young, kinematics of children’s gait, gait in elderly.  **Moment:** Definition and application of torque in human body. Torque 2-dimensional problems.  **Moment:** Torque 3-dimmensional problems   |  |  | | --- | --- | | | | | | | | | | | | |
| **Practical**   1. To determine the coordinates of the center of gravity (COG) of a body using segmentation method. 2. To determine the center of Gravity Measurement using Reaction Board 3. Volumetric analysis of irregular shaped body segments 4. To determine the muscle force required by the biceps while holding a known weight in hand for a range of elbow joint angles using the mechanical arm model 5. To determine the muscle force using an analytical model comprising two muscles at the elbow joint and compare the results with the previous one. 6. Design and develop a goniometer for upper limb. 7. Design and develop a goniometer for lower limb. 8. Design and develop a dynamometer for wrist. 9. Gait analysis among healthy individuals. 10. Dynamometry of human foot by virtue of body weight 11. Volumetric analysis of irregular shaped body segments 12. Analysis of human motion using Movement Velocity counter 13. Development of static human model using Visual 3D 14. Study of blood flow using blood vessel models 15. To design the human limbs on Solid works. 16. To analyze the human limbs on ANSYS. 17. Open ended lab   **Recommended Books:**   1. *Susan J. Hall, Basic Bio-Mechanics, 6th Ed, 2011.* 2. *Margareta Nordin, Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System* 3. *NihatÖzkaya, et al, Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation* 4. *David A. Winter, Biomechanics and Motor Control of Human Movement*   **Class Attendance:** Minimum 75% class attendance is mandatory to appear in the examinations.   | **Distribution of Theory Marks:** |  | | --- | --- | | Quizzes | 05% | | Assignment | 05% | | Midterm Examinations | 20% | | Final Examination | 50% | | Lab Work | 20% | | **Total** | **100 %** | | | | | | | | | | | | |
| Signal & System | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** | Theory | | | **03** |
| Practical | | **48** | Practical | | | **01** |
| **Total** | | **96** | **Total** | | | **04** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | Explain continuous & discrete time signals and systems mathematical operations on signals and analogue to digital conversion of signals | | | | | | Cognitive | 2 | | 1 | |
| **2** | Apply time domain and frequency domain representation and transformation techniques on the continuous & discrete time signals & systems. | | | | | | Cognitive | 3 | | 2 | |
| **3** | Analyze continuous and discrete time systems including analogue filters using Laplace transform and Z transform | | | | | | Cognitive | 4 | | 4 | |
| **4** | **Reproduce** logical codes for simulation of different signals and their transforms using modern platforms and software tools and their applications in solution of real-world problems. | | | | | | Psychomotor | 3 | | 5 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course outline:**  Continuous time and discrete time signals, periodic signals, even and odd signals, exponential and sinusoidal signals, the unit impulse and unit step functions, continues time and discrete time systems, linear time invariant (LTI) systems, difference equation, causality, BIBO stability, convolution and correlation, discrete time Fourier transforms, DFT and FFT algorithms, time and frequency characterization of signals and systems, the sampling theorem, aliasing, sampling the discrete time signals, z-transform, analysis and characterization of LTI systems using z-transform, case studies: communication systems and linear feedback systems.  **List of Practical:**  1. To be familiarize with the MATLAB and SIMULINK.  2. To plot the sinusoidal, exponential and singularity functions  3. To perform the time-shift, time-scaling and time-reversal operations on the signals  4. To compute and plot the impulse response of the system  5. To compute the convolution of LTI Systems  6. To find the Laplace-Transform and inverse Laplace transform of the system  7. To find the transfer function and system stability  8. To plot the signals spectra using Fourier transform  9. To plot the frequency response of the system  10. To design filter using Butterworth & Chebyshev techniques  11. Open ended lab 1  12. Open ended lab 2  13. Open ended lab 3  Implementation of Signal Processing fundamental concepts using MATLAB.  **Recommended Books**   1. Signals and Systems, Oppenheim A. V., Willsky A. S. and Nawab S. H., Prentice Hall, (Latest Edition).   Signals, Systems and Transforms, Phillips C. L. and Parr J. M., Prentice Hall, (Latest Edition) | | | | | | | | | | | |
|  | | | | | | | | | | | |

| **Semester 5th** | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Biomedical Instrumentation-I | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **3** |
| Practical | | **48** |  | | | | | Practical | | | **1** |
| **Total** | | **80** |  | | | | | **Total** | | | **4** |
| **Objective: - Course Learning Outcomes: -** After completion of this course, the student should be able to understand the working principle of the Clinical Monitoring Instrumentation found in hospital or Clinical Diagnostic setup. Also, the students would cover biomedical application in patient monitoring systems, understand the different treatment and diagnosis techniques.   | **CLO** | **Description** | **Mapping with PLOs** | **Taxonomy level** | **PL0** | | --- | --- | --- | --- | --- | |  | **Define** principles and errors of measurements and **Identify sources** of biopotentials | Cognitive | 1 | 1 | |  | **Analyze** various biomedical sensor and transducer characteristics | Cognitive | 4 | 1 | |  | **Describe** medical devices based on application to physiological systems | Cognitive | 2 | 1 | |  | **Analyze** the response of various biomedical instrumentation devices based on monitoring and recording processes | Cognitive | 4 | 2 | |  | **Design** electronic circuit for biomedical Instruments | Cognitive | 6 | 3 | | 1. **A** | **Apply** the knowledge of electronic circuits design and physiological system for use in biomedical instrumentation | Cognitive | 3 | 3 | |  | **Acquire** technical skills in using sensors such as temperature, pressure, strain gauge, light and ultrasonic sensors and their associated circuits such as ADC. | Psychomotor | 2 | 5 | |  | **Demonstrate** technical skills in using physiological measuring equipment such KL-700, ECG Simulator | Psychomotor | 6 | 5 | |  | **Develop** the skills of scientific inquiry and problem-solving, including:   * recognizing and defining a problem * designing solution by selecting an appropriate sensor designing its excitation/ linearizing circuits and interpreting the physiological resul**ts** | Psychomotor | 6 | 5 | | | | | | | | | | | | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | **1** | Engineering Knowledge : |  | **7** | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | **2** | Problem Analysis: |  | **8** | Ethics: |  | | **3** | Design/Development of Solutions |  | **9** | Individual and Teamwork |  | | **4** | Investigation: |  | **10** | Communication: |  | | **5** | Modern Tool Usage: |  | **11** | Project Management |  | | **6** | The Engineer and Society: |  | **12** | Lifelong Learning |  |   **Course outline:**  **Introduction:** Precision, resolution, sensitivity, accuracy, uncertainty, Principles & development of Biomedical Instrumentation, Problems encountered in living systems.  **Biological Systems:** Study of various Physiological systems, related biopotentials and physiological parameters.  **Diagnostic Equipment:** invasive and noninvasive measurement techniques and related equipment. Cardiovascular Measurements: Electrocardiography, Measurement of Blood pressure, Blood flow and Cardiac output**.**  **Biomedical Sensors & Transducers:** Introduction, principles, theory, design and applications, Principles and design, Speed, Position, Temperature, light & Pressure transducers, Programmable logic controller, PLC interfacing, memory processor.  **Patient Monitoring Equipment:** Patient Monitors, central monitoring system, telemetry system, Gas Exchange and distributions, Respiratory therapy equipment.  **Therapeutic Equipment:** Ventilator, inhaler, defibrillator, pacemaker and heart lung machines. Radiological Equipment: Concept of ionization and non-ionization radiation and related equipment, medical lasers and applications.  **Safety in Medical Equipment:** Electrical/Mechanical safety, Standards of Medical Devices, Biohazards and Safety Regulations.  **Quality Assurance and Quality Control:** Calibration, maintenance and reparability of monitoring equipment. | | | | | | | | | | | |
| **Practical:**  1. To study the principle of various Biomedical Transducer  2. To understand methods and instruments for body temperature measurement and compare temperature sensors for selection on the basis of their properties.  3. To study the working of photo detectors/photo sensors and their application in biomedical  4. To study the techniques of measuring blood pressure and measure the systolic and diastolic pressure.  5. To become familiar with the electrocardiograph as a primary tool for evaluating electrical events within the heart and observe rate and rhythm changes in the ECG associated with body position and breathing.  6. To record maximum clench strength for right and left hands and correlate motor unit recruitment with increased skeletal force.  7. To record EMG response to increased weights lifted by dominant and non-dominant arms and to record EMG when fatigue is induced.  8. To observe respiratory cycle and record breath per minute and respiratory rate in different conditions eupnea, hyperventilation and apnea Vera.  9. To record an EEG from an awake, resting subject with eyes open and eyes closed. Identify and examine alpha, beta, delta, and theta components of the EEG complex.  10. To record EOG on the horizontal plane and compare eye movements under the following conditions: pendulum tracking & pendulum simulation.  11. To observe respiratory cycle and record breath per minute and respiratory rate in different conditions eupnea, hyperventilation and apnea Vera.  12. To observe real time monitoring through a multipara monitor/bedside monitor.  13. To Study the construction and working of x-ray equipment and to practice the safety aspect using standard procedure.  14. To practice the safety aspect of ultrasound machines using standard Procedure.  15. To observe the principle and working of the ventilator.  16. Open ended lab  **Recommended books:**  **1**. Biomedical instrument and measurements by Cromwell 2nd edition  2. Medical-Instrumentation-Application-and-Design-4th- Webster-2010  3. Biomedical instrumentation and measurements by R. Ananda Natarajan, 2011 | | | | | | | | | | | |
| Probability and Statics | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **03** |
| Practical | | **0** |  | | | | | Practical | | | **0** |
| **Total** | | **48** |  | | | | | **Total** | | | **03** |
| **SUGGESTED COURSE LEARNING OUTCOMES:** | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| 1 | **Define** the basic concept of probability and statistical method to formulate basic engineering problems | | | | | | Cognitive | C1 | | 1 | |
| 2 | **Identify** the various probability distributions and statistical inference and rules of probability | | | | | | Cognitive | C3 | | 2 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course outline:**  **1-Basic Statistics**:-  Statistics, Branches of Statistics, Importance of statistics, population, sample, observation, variables, measurement of variable, Data, primary data, secondary data  **2-Data Presentation:-**  Frequency distribution (grouped, ungrouped), stem and leaf display, histogram, frequency polygon, cumulative frequency polygon, Simple & Multiple Bar diagrams  **3- Measure of central tendency:**  Arithmetic Mean (A.M), Geometric Mean (G.M), Harmonic Mean (H.M), Quantiles (Median, Quartiles, Deciles, Percentiles), Mode, Applications of Averages  **4-Measure of Dispersion:**  Background, Range, Quartile deviation, Mean deviation, Variance, Standard deviation, Coefficient of variation, Moments, Moments ratios, Skewness, Kurtosis  Applications in different Engineering Disciplines  **5-Simple Regression, Correlation and Curve fitting:** | | | | | | | | | | | |
| * Introduction to regression theory, Simple linear regression line, Line fitting by least square methods, Coefficient of determination, * Simple correlation, coefficient of correlation, fitting of a first- and second-degree curve, fitting of exponential and logarithmic Curves, related problems. * Principle of least squares.   **6-Probability and random variables:**   * Probability review, Laws of probability, Conditional probability, Bayesian theorem, independent, dependent events. * Random variables, Discrete and Continuous random variables, Probability mass and density functions, Distribution functions, Mathematical expectation, * Variance of random variable, bivariate distribution, Joint probability distribution, Moment generating function   **7-Probability Distributions:**   * discrete distributions: * Bernoulli distribution, Binomial, Geometric, Negative binomial, Hypergeometric, Poisson distribution, Properties and application of these distributions. * Continuous Distributions: Uniform Distribution, Exponential distribution, Normal distribution, Applications   **8-Sampling and Sampling Distributions:**   * Introduction, Population, Parameter & Statistic, Objects of sampling, Sampling distribution of Mean, Standard errors, Sampling & Non-Sampling Errors, * Random Sampling, Sampling with & without replacement, Sequential Sampling, Central limit theorem. * Applications in relevant engineering discipline   **9-Statistical Inference and Testing of Hypothesis:**   * Introduction to inferential statistics, Estimation, hypothesis testing of population mean, proportion, * Variance, Applications in Engineering   **Teaching Methodology (Proposed as applicable):**  Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speake, Group discussion, Report Writing  **Assessment:**  Mid Term, Presentation, Assignments, Quizzes, test and Final Term Suggested  **Books:**   1. Introduction to Statistical theory part 1, by Sher Muhammad Chaudhry (Latest Edition) 2. Advanced Engineering Mathematics, by Erwin Kreyszig (Latest Edition)   . | | | | | | | | | | | |
| Numerical Method | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **03** |
| Practical | |  |  | | | | | Practical | | | **0** |
| **Total** | | **48** |  | | | | | **Total** | | | **03** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | **Find** the concept of various method for interpolation , polynomial approximation | | | | | | Cognitive | C1 | | 1 | |
| **2** | **Apply** the various methods to solve the linear, nonlinear equation and numerical solution of ordinary differential equations. Also perform evaluation of numerical differentiation and integration by applying different methods. | | | | | | Cognitive | C3 | | 2 | |
| **3** |  | | | | | |  |  | |  | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course Outline:**  1. Error analysis a. Floating points b. Errors and types of errors  2. Solution of nonlinear equation a. Bisection, b. Regula-Falsi, c. Fixed-point iterative and Newton-Raphson’s methods. d. Solution of linear algebraic equations.  3. Direct methods a. Crout’s and Cholesky methods;  4. Iterative methods a. Jacobi and Gauss-Seidel methods.  5. Eigenvalues and eigenvectors a. Characteristics equation and Power methods.  6. Interpolations and extrapolations a. Forward, backward, central difference operators and their relations. b. Newton's Forward, Backward and Divided Difference Interpolation Formulae. c. Lagrange’s and Stirling’s Interpolation Formula.  7. Numerical differentiation a. Newton’s-Forward and Backward differentiation Formulae.  8. Numerical quadrature a. Trapezoidal, Simpson’s one-third, Simpson’s three-eight and Weddle’s rules and Gaussian quadrature.  9. Solution of ODEs a. Taylor Series, Euler’s and its modified, b. Runge-Kutta, Miline's, c. Adam-Moltan (Predictor-Corrector) methods.  10. Solution of Higher Order Differential Equations a. Runge-Kutta methods. b. Solution of Partial Differential Equations by Finite Differences Methods (Explicit, Implicit and Crank-Nicolson techniques) and ADI Method. | | | | | | | | | | | |
| Text and Reference Books:  1. Dunn, Stanley M, Alkis Constantinides, Numerical Methods in Biomedical Engineering 2006 2. Canal and Chopra ``Numerical Methods for Engineers”. 3. Curits F. Gerald ``Applied Numerical Analysis”.  4. Erwin Kreyszig “Advanced Engineering Mathematics”.  5. Chung Yau Lam “Applied Numerical Methods for the Solution of Partial Differential Equations”  6. Dr Saeed Akhtar Bhatti “A First Course in Numerical Analysis”.  7. John L. Van Iwaarden “Ordinary Differential Equations with Numerical Techniques | | | | | | | | | | | |
| Microprocessor & Interfacing  | Contact Hours | |  | Credit Hours: | | | --- | --- | --- | --- | --- | | Theory | 32 | Theory | 4 | | Practical | 48 | Practical | 0 | | Total | 80 | Total | 4 |   **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to:   | S # | CLO | Domain | Taxonomy  level | PLO | | --- | --- | --- | --- | --- | | 1 | **Describe** microprocessors and microcontrollers, Architecture, basic concepts, control unit, internal registers, ALU, timing and sequencing, memory and I/O Interfacing, programming of Microprocessor | Cognitive | C2 | 1 | | 2 | **Illustrate** Microprocessor system design based on the knowledge of Architecture, programming and interfacing of microprocessor | Cognitive | C4 | 3 | | 3 | **Interpret** the concepts of the microprocessor system using microprocessor emulator and microcontroller programming and designing tools | Cognitive | C3 | 5 | |  |  |  |  |  |   The course is designed so that students will achieve the following PLOs   | **1** | Engineering Knowledge: |  | **7** | Environment and Sustainability: |  | | --- | --- | --- | --- | --- | --- | | **2** | Problem Analysis: |  | **8** | Ethics: |  | | **3** | Design/Development of Solutions: |  | **9** | Individual and Teamwork: |  | | **4** | Investigation: |  | **10** | Communication: |  | | **5** | Modern Tool Usage: |  | **11** | Project Management: |  | | **6** | The Engineer and Society: |  | **12** | Lifelong Learning: |  |   **Course outline:**  Computer Architecture, Instruction Cycle, Memory Organization,  Address decoding, Memory Hierarchy, Interrupts, Bus Arbitration  Schemes, Programmed I/O, Interrupt-Driven I/O, Direct Memory Access.  General purpose and special purpose processors, Internal Registers,  Internal Bus Architecture, Pin Function, Addressing Modes, Instruction  Set Architecture: (Data Transfer Instructions, Arithmetic & logic  instructions, Branch instruction), Assembler Directives, Macros,  Procedures, Instruction Encoding, Bus Cycles, Reset Circuit, Clock  generation circuits, Wait states, Memory interfacing, Memory Speed  Requirement, I/O Interfacing, Programmable Peripheral Interface,  Programmable interval Timer, Programmable interrupt Controller,  Microprocessor System Design, Recent Microcontroller Architectures.  2. Roger L. Tokheim, Schaum's Outline of Theory and Problems of Microprocessor Fundamentals, Graw Hill Co., 1983, ISBN: 9780070649583 | | | | | | | | | | | |
| **List of Practical:**  **1.** To demonstrate the hardware of microcontrollers and microprocessor  2. To use Proteus and Multisim simulation software for simulation  3. To use Keil Micro vision software for assembly and c programming  4. To generate List and Hex files  5. To interface and simulate ports of microcontroller (General)  6. To interface and simulate LEDs  7. To interface and simulate seven segments  8. To interface and simulate monochrome LCD  9. To program and perform ADC  10. To program and perform DAC  11. To connect external memory elements with microcontroller  12. To program and perform DC motor interfacing and PWM  13. To program and perform serial communication (RS232)  14. To program and perform parallel communication (RS232  **Complex Engineering Problem**  **Recommended Books:**  **1**. Barry B. Brey, The Intel Microprocessor, 8th ed. 2009, ISBN-10: 0135026458 | | | | | | | | | | | |
| 1. **Biomedical Signal Processing** | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **3** |
| Practical | | **48** |  | | | | | Practical | | | **1** |
| **Total** | | **96** |  | | | | | **Total** | | | **4** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  The goal of this course is to educate the students in the signal processing methods and their application to biomedical signals. Signal processing concepts are introduced using real-life biomedical examples. The students learn how to solve problems embedded in these examples by the application of the newly introduced concepts. Another objective is to teach the students how to use a computer workstation as part of a measurement/signal-processing system. This is accomplished in the laboratory, where students work with MATLAB simulations of the examples discussed in class.  The course will cover fundamental concepts in digital signal processing, including discrete-time signals and systems, frequency domain representation of signals, z-transform, LTI system analysis using z-transform, frequency response of discrete-time systems and design of digital filters. | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | **Apply** z-Transform (using definition, table of standard transforms and properties) and Inverse z-Transform (using inspection, partial fraction expansion and power series expansion) | | | | | | Cognitive | 3 | | 1 | |
| **2** | **Analyze** discrete-time signals and systems in the time and frequency domain using Fourier and z-transforms | | | | | | Cognitive | 4 | | 2 | |
| **3** | **Design** FIR and IIR Filters with the given specification using variety of filter design techniques | | | | | | Cognitive | 5 | | 3 | |
| **4** | **Design** and implement a range of elementary signal processing techniques in MATLAB for the analysis and/or design of discrete-time signals and systems | | | | | | Psychomotor | 5 | | 3 | |
| **5** | Realize various aspect of Biomedical signal from real life using advance biomedical signal processing algorithms | | | | | | Affective | A3 | | 12 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course outline:**  Review of Signals and Systems, Sampling and Quantization, Discrete-Time Signals, Discrete-Time Systems, Z-transform and its application in the analysis of discrete LTI systems, Impulse response, Frequency Response, DTFT, DFT and FFT, Design and implementation of digital filters, Introduction to Statistical Signal Processing, Overview of feature extraction and pattern recognition techniques, case studies of various Biomedical Signals: ECG, EEG, EMG  **Practical:**   1. Impulse and Step Responses 2. Convolution and Correlation 3. Z-transform, Pole-Zero Plot, Stability 4. Frequency response analysis 5. Frequency spectra analysis 6. FIR filter design 7. IIR Filter Design 8. Analysis of Filter behavior 9. Filter simulation 10. PPG Signal Analysis. Signal Peaks. Peak widths. Heart rate. SpO2 11. ECG Waveform Analysis. 12. EEG Processing 13. Feature Extraction from EEG Signals. 14. Sound Processing. Detecting cardiac condition from digital stethoscope 15. Open ended lab   **Complex Engineering Problem**  **Teaching Methodology**  Lecturing  Written Assignments  Report Writing  **Assessment**   * **Theory (100%)**  1. Sessional (10%) 2. Midterm (20%) 3. Final Term (50%) 4. Lab Marks (20%)   **Reference Books**   1. “Discrete-Time Signal Processing” Alan V. Oppenheim, Ronald W. Schafer 2. “Biomedical Signal Analysis” Rangaraj M. Rangayyan | | | | | | | | | | | |
| **6th Semester** | | | | | | | | | | | |
| Biomedical Instrumentation II | | | | | | | | | | | |
| **Code: -**  **Contact Hours: Credit Hours:**  **Theory** = 48 **Theory** = **3**  **Practical** = 48 **Practical** = **1**  **Total** = 96 **Total** = **4**  **Course Objective:**     | CLOs | Description | Domain | Taxonomy Level | Mapping with PLO | | --- | --- | --- | --- | --- | | 01 | **Understand** the electroanalytical techniques used for in-vitro diagnostics | Cognitive | 2 | 1 | | 02 | **Explain** the principle, working and applications of microscopic and spectroscopic methods in biomedical engineering | Cognitive | 3 | 1 | | 03 | **Analyze** the impact of chemical safety and biohazard on environment | Cognitive | 3 | 7 | | 04 | **Analyze** the results of spectroscopy, microscopy and chemical analyzers to identify various diseases | Cognitive | 4 | 2 | | 05 | **Use** the electroanalytical techniques to devise in vitro diagnostic assay | Cognitive | 5 | 3 | | 06 | **Understand** the working principles of trending electrochemical immunoassay | Cognitive | 2 | 1 | | 07 | **Analyze** results of molecular diagnostic techniques for disease detection | Psychomotor | 4 | 4 | | 08 | **Practice** operation of biomedical instrumentation used in hospitals and laboratories | Psychomotor | 3 | 5 |   **COURSE OUTLINE**   1. Biomolecules separation by centrifugation (Principle, design and applications)   1.1 Clinical Chemistry Analyzer  1.2 Automated Cell Counter  1.3 Electrophoresis   * 1. Blood Banking and Transfusion   2. Electroanalytical Techniques  2.1 Potentiometric Based Methods for Quantitative Analysis of Biomolecules   * 1. Amperometric Based Methods for Qualitative and Quantitative Analysis of Biomolecules | | | | | | | | | | | |
| 1.  3. Chromatography  3.1 Liquid Chromatography  3.2 Gas Chromatography  3.3 High Performance Liquid Chromatography   1. Spectroscopy   4.1 Spectrophotometry  4.2 Flame Photometry  4.3 Mass Spectrophotometry  4.4 Infrared Spectrophotometry  4.5 Nuclear Magnetic Spectroscopy   1. Microscopy   5.1 Light and Confocal Microscopy  5.2 Atomic Force Microscopy  5.3 Electron Microscopy   1. Laboratory Molecular Diagnostic Methods   6.1 Electrochemical Immunoassay  6.2 Enzyme Linked Immunosorbent Assay  6.3 Fluorescent In-situ Hybridization (FISH)  6.4 Polymerase Chain Reaction (PCR)  6.5 Lab Automation  **LIST OF PRACTICALS**  Demonstration and Troubleshooting of centrifuge  2. Separation of Blood components using Centrifuge  3. Hemoglobin separation using Electrophoresis.  4. Design and Development of Virtual Instruments in LabView.  5. Introduction to Virtual Instrument Designing in Labview  6. Building Applications using For loops in Labview  7. Signal Processing using Labview  8. Analysis of Cefixime Trihydrate using UV Spectrophotometer.  9. Determination of absorption coefficient using UV-spectrophotometer.  10. Wavelength analysis of different light sources using Atomic Spectrometer.  11. Demonstration and working of High-Performance Liquid Chromatography (HPLC)  12. Demonstration and working of Hematology Analyzer.  13. Demonstration and working of Chemistry Analyzer  14. Troubleshooting and repair of Medical Equipment  15. Comprehension of documentation and hospital set-up  16. Open Ended Lab 1  **Recommended Books:**  1. Mary C. Haven (Editor), et al, Laboratory Instrumentation, 4th ed, 1995. ISBN: 978-81-265-2857-8  2. Cromwell, Bio-Medical Instrumentation & Measures 2. 2nd ed,1980. ISBN: 978-81-203-0653-  3. John G. Webster (Editor), Medical Instrumentation 2. 2nd ed. 2010. ISBN: 978-0-471-67600-3 | | | | | | | | | | | |
| Elective I: Medical Devices & Standards | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **03** |
| Practical | | **0** |  | | | | | Practical | | | **0** |
| **Total** | | **48** |  | | | | | **Total** | | | **03** |
| **Course Description:**  This course will provide exposure to different standards applied on the medical devices before commercialization and their usage.  **Area Scope:** Medical Device Commercialization   | CLOs | Description | Domain | Taxonomy level | PLO | | --- | --- | --- | --- | --- | |  | **Acquire** the basic knowledge of medical device quality system standard | Cognitive | 2 | 1 | |  | **Describe** the examples of different medical standards applied on the devices | Cognitive | 2 | 1 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering Knowledge: |  | 7 | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis: |  | 8 | Ethics |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork |  | | 4 | Investigation: |  | 10 | Communication: |  | | 5 | Modern Tool Usage: |  | 11 | Project Management |  | | 6 | The Engineer and Society: |  | 12 | Lifelong Learning |  | | | | | | | | | | | | |
| **Course Outline:**  **Quality Management System:** Term and Definition, General Requirements, Quality Manual, Control of Documents, Controls of Records  **Management Responsibility and Resource:** Management commitment Requirement, Planning, Responsibility, Authority, and Communication, Provision of Resources, Infrastructure and work environments  **Product Realization:** Planning of Product Realization, Customer Related Processes, Design and Development, Purchasing, Production and Service Provision, Validation of Processes of Production, Identification and Traceability, Control of Monitoring and Measuring Device  **Reference Books:**   1. A Complete Guide to Quality Management in the Medical Device Industry, Itay Abuhav   **TEACHING METHODOLOGY**   * Lectures * Report Writing * Written assignments | | | | | | | | | | | |
| Biomedical Control System | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **3** |
| Practical | | **48** |  | | | | | Practical | | | **1** |
| **Total** | | **96** |  | | | | | **Total** | | | **4** |
| Biomedical Control System is the core course of Biomedical Engineering curriculum that stimulates the attention of students to examine the distinct features of Biomedical system when they are working in open and closed loop fashion. This course builds the knowledge of the Biomedical engineering students in modeling of electrical, mechanical and rotational systems, biological system, stability analysis of systems in time and frequency domain. The aim is not to consider only mathematical concept of system using Laplace transform, bode plot, Nicholas plot, controller design including PID Controller, lead lag compensator but also to provide students with hands on experience in design of feedback control system for dc motor through simulation and hardware design to meet the required specifications of industrial clients in Biomedical Industries. The student keen to enroll in this course shall have knowledge of linear algebra, circuit analysis and signal and system. The comprehensive outcomes of this course shall be attained through a diverse range of classroom activity including topic description in lecture, peer or group description, visual inspection, practical demonstration through visit of industrial sector, semester projects, and workshop at computer lab for simulation analysis, quizzes, and assignments.  **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | **Compute** the mathematical models of electrical, mechanical and rotational systems, biological systems based on spatial and frequency domain analysis. | | | | | | cognitive | C3 | | 2 | |
| **2** | **Illustrate** the stability analysis of open and closed loop systems for second order systems. | | | | | | cognitive | C3 | | 2 | |
| **3** | **Employ** frequency domain of second order system using bode plot, root locus, Nichol’s plot. | | | | | | cognitive | C4 | | 2 | |
| **4** | **Illustrate** controller for biological system using linear PID control technique for Biological system | | | | | | cognitive | C4 | | 2 | |
| **5** | **Demonstrate** the concept of system stability and frequency response using modern tools | | | | | | Psychomotor domain | P4 | | 5 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):** | | | | | | | | | | | |
| **1** | Engineering Knowledge | | |  | **7** | Environment and Sustainability | | |  | | |
| **2** | Problem Analysis | | |  | **8** | Ethics | | |  | | |
| **3** | Design/Development of Solutions | | |  | **9** | Individual and Teamwork | | |  | | |
| **4** | Investigation | | |  | **10** | Communication | | |  | | |
| **5** | Modern Tool Usage | | |  | **11** | Project Management | | |  | | |
| **6** | The Engineer and Society | | |  | **12** | Lifelong Learning | | |  | | |
| **.**  **Course Outline: 1.**  Introduction  a. Introduction to control systems  b. Open loop and closed loop control systems.  c. Examples of control systems in Biomedical Engineering.  2. Modeling in the Frequency Domain  a. Electrical/Electronic/Mechanical, biological system systems transfer function  3. Modeling in the Time Domain a. General State-Space Representation and Analysis b. Converting a Transfer Function to State Space & vice versa.  4. Time Response a. Poles, Zeros, and System Response b. Transient and steady state response of first and second order systems  5. Reduction of Multiple Subsystems a. Block Diagrams and reduction techniques b. Signal-Flow Graphs and Mason’s Rule. 6. Control System Stability a. Routh-Hurwitz Criterion and Special Cases  7. Root Locus Techniques a. Root Locus and its Properties b. Sketching the Root Locus plots.  8. Frequency Response Techniques a. Bode and Polar Plots b. Stability via the Nyquist Diagram c. Gain Margin and Phase Margin  9. PID Controller for Biological system **(COMPLEX ENGINEERING PROBLEM)**  **Lab Practical**  Lab Outline: 1. To be familiar with the MATLAB programming and control system toolbox.  2. Find the closed-loop transfer function of the system.  3. To find the impulse and step responses of the control system.  4. To compute the transient response parameters of control systems.  5. To find the partial fraction residues and poles of the system.  6. To find the Eigenvalues of the system.  7. Transfer function to state space conversion.  8. To find the closed-loop pole locations to check the stability of the system.  9. To obtain the root locus of the system.  10. To obtain the Bode plot of the system.  11. To find the gain and phase margins of the system  13. Open ended lab 1  14. Open ended lab 2  **Text and Reference Books:**  1. Control Systems Engineering, by: Norman S. Nise, 7th Edition.  2. Modern Control Engineering, by: Katsuhiko Ogata, 5th Edition.  3. Biomedical Applications of Control Engineering, by Selim S. Hacısalihzade | | | | | | | | | | | |
| Modeling and Simulation | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **32** |  | | | | | Theory | | | **2** |
| Practical | | **48** |  | | | | | Practical | | | **1** |
| **Total** | | **80** |  | | | | | **Total** | | | **3** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | Domain | **Taxonomy Level** | | **PLO** | |
| **1** | **Understand** the basic concept of modeling, electrical modeling, mechanical modeling and biological modeling | | | | | | Cognitive | C2 | | 1 | |
| **2** | **Analyze t**he application of modeling and simulation in physiological system | | | | | | cognitive | C4 | | 2 | |
| **3** | **Demonstrate** the modeling of various biological systemusing simulation software tools | | | | | | Psychomotor | P4 | | 5 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | **Modern Tool Usage:** | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course Outline:**  **1.Introduction** a. What is modeling and simulation b. Application of Modeling and Simulation in Biomedical Engineering c. Types of Models e.g., graphical model, Quantitative models, Multiscale Models d. Hybrid models and its application in Biomedical Engineering e. Conceptual modeling, why, when, where to use the conceptual model. Conceptual model of cardiorespiratory system Subdivision of Physiology models and combining of basic elements of Conceptual models. g. Things necessary before building a model. h. One block model and its examples e.g., Heart, muscles, eye etc. i. Hierarchical and integrated Model. | | | | | | | | | | | |
| **2. Mathematical Models**  a. Mathematical Models and their importance in biomedical engineering b. Mathematical models of Mechanical and Electrical systems. c. Electrical and fluidic modeling of the blood flow through the artery. d. Elementary Vascular Model and Its Electrical Analog e. Electrical modeling of physiological System f. Electrode electrolyte interface model  3. **Application of Modeling and Simulation in Physiological System**  a. Modeling of physiological systems b. Examples of Physiological models c. Medical imaging and its importance in modeling and Simulation d. Importance of modeling and simulation according to new trends and techniques e. Modeling of human organs using 3D printing f. Thermal modeling using Bio heat equations g. Factors affecting thermal models h. Application of thermal models on physiological System  **4. Software Implementations**. Implementation of Biomedical models using software.  **List of Practical:**  **1**. Introduction to modeling using software  2. Design of conceptual model  3. Modeling of cardiovascular system  4. Simulation of Bio heat equation  5. Modeling and simulation of blood flow  6. Modeling and simulation arterial plaque  7. Modeling heat transfer through skin  8. Modeling of electrical stimulation  9. Modeling of human organs  10. Heat simulation using RF coil and high intensity focused ultrasound  11. Modeling through medical images  12. Simulation of light propagation in the eye  13. Glucose and insulin regulation model.  14. Renal clearance modeling using compartmental model  15. Skin Absorption Model using Fick’s Law , 16. Open ended lab 1  **Text and Reference Books:**  1. Modeling and simulation in biomedical engineering, Willem Van Meurs.  2. Physiological Modeling: An Introductory Course for Biomedical Engineers , John Enderle  3. Advances in Numerical Heat Transfer, Volume 3, W. J. Minkowycz.  4. Introduction to Modeling in Physiology and Medicine, Claudio Cobelli and Ewart Carson | | | | | | | | | | | |
| Biomaterials | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **03** |
| Practical | | **48** |  | | | | | Practical | | | **01** |
| **Total** | | **96** |  | | | | | **Total** | | | **04** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| | **Sr No..** | **CLOS** | **Domain** | **Domain’s Level** | **PLO** |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 1 | Understand different classes of biomaterials | Cognitive | 1 | 1 |  |  |  |  | | 2 | Explain the phenomena of failure and fatigue in different classes of biomaterials | Cognitive | 3 | 2 |  |  |  |  | | 3 | Acquire the knowledge for application of biomaterials for soft and hard tissues replacement and organ replacement, drug delivery, implants and adhesives. | Cognitive | 1` | 1 |  |  |  |  | | 4 | Demonstrate separation of biomaterial (protein) by electrophoresis method | Psychomotor | 4 | 4 |  |  |  |  | | 5 | Describe the sustainable biomaterials and its socioeconomic and environmental benefits | Cognitive | 6 | 7 |  |  |  |  | | 6 | Differentiate structures of biomaterials and identify surface properties required for biomedical applications | Cognitive | 4 | 2 |  |  |  |  | | 7 | Design biomaterials for different biological tissues | Psychomotor | 5 | 3 |  |  |  |  | | 8 | Use of characterization techniques to study the properties of biomaterials | Psychomotor | 4 | 5 |  |  |  |  |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | | **√** | **7** | Environment and Sustainability: | | | **√** | | |
| **2** | Problem Analysis: | | | **√** | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | | **√** | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | | **√** | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | | **√** | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **COURSE OUTLINE**   1. An introduction to biomaterials   1.1 An overview & historical perspective  1.2 Generations of Biomaterials  1.3 Recent advances in biomaterials and its applications; a bird’s view of types of implantable biomaterials and devices   1. Classes materials used in medicine   2.1 Chemical bonding and the structure of biomaterials  2.2 Structure of Metals  2.3 Structure of Ceramics  2.4 Structure of Polymers (Chitosan, Collagen, Elastin, Proteoglycan and glycoprotein)  2.4.1 Molecular & Chemical Structure, Molecular weight of polydispersity  2.4.2 Physical behavior of polymers  2.4.3 Methods of Synthesis: Addition, free-radical, condensation polymerization  2.4.4 Hydrogels: Structure and Synthesis and examples (Acrylic, PVA, PEG, degradable and smart hydrogels) | | | | | | | | | | | |
| Biological materials; structure, properties, hard tissues; tooth and bone, soft tissues: skin, blood vessel, tendon  Properties of biomaterials and its characterization techniques  3.1 Introduction to bulk properties: microstructure, strength, deformation, thermal and optical properties  3.2 Surface characterization of biomaterials  3.3 Electron spectroscopy for chemical analysis  3.4 Attenuated total internal reflectance Fourier transform-infrared spectroscopy  3.5 Composite biomaterials  3.6 Three-dimensional structure of biomaterials by bio-X-ray diffraction, application of chitosan and other biopolymers in biomedical | | | | | | | | | | | |
| 1. Biomaterials degradation in the biological environment   5.1 Review of clinical cases of implant failure  5.2 Mechanisms of metallic corrosion  5.3 Polymer degradation  5.4 Ceramic degradation   1. Biocompatibility   6.1 Biological responses to biomaterials  6.2 Toxicity and hypersensitivity  6.3 Blood-materials interactions  6.4 Tumors associated with biomaterials and implants  6.5 Biofilms   1. Special considerations for implants, devices, and biomaterials   7.1 Sterilization of Biomaterials  7.2 Patient Safety  7.3 Device failure mode analysis/ risk analysis  7.4 Biomaterials standards and regulatory compliance  7.5 Ethical issues associated with biomaterials, clinical trials and case studies from the regulatory framework  7.6 Sustainable biomaterials   1. Biointeractions of biomaterials   9.1 Tissue engineering, gene therapy using viral vector materials for scaffolding  9.2 Acute inflammation response to implanted biomaterials  9.3 Biomaterials for wound healing  9.4 Immune response to biomaterials  9.5 Biomaterials and thrombosis  9.6 Infection, tumorigenesis and calcification of biomaterials  **LIST OF PRACTICALS**  1. To build molecular model of a biopolymer from basic repeating peptide units  2. Molecular graphics of basic repeating units of biopolymer  3. Interpretation of bio-X-ray diffraction of a biomaterial expected diffraction pattern  4. Calculate R-value for structural analysis of biopolymers  5. To build a model of CHITOSAN (biomaterials) from basic repeating units.  6. Molecular graphics of basic repeating units of CHITOSAN.  7. Demonstration of features of dental chair & dental operatory.  8. Demonstration of biomaterials (bioceramics, porcelain & metals) its composition & properties  9. Demonstration of the process of sterilization, autoclave & X-ray unit (dental).  10. Separation of biomaterial (protein) by electrophoresis method involved in various diseases.  11. Demonstration of different types of sutures.  12. Fabricate a biomaterial for bone tissue | | | | | | | | | | | |
| 13. Fabricate a biomaterial for dental tissues  14. Tension and compression analysis for fabricated biomaterials.  15. Open ended lab 1  16. Open ended lab 2  **TEACHING METHODOLOGY**   * Lecturing * Written Assignments * Report Writing   **COURSE EVALUATION**   * **Theory (100%)** * Quizzes (20%) * Sessional (20%) * Assignment (10%) * Final Exam (50%) * **Laboratory (100%)**   **RECOMMENDED BOOKS**   1. Buddy D. Ratner, et al, Biomaterials Science, Second Edition: An Introduction to Materials in Medicine 2. Handbook of Biomaterial Properties (Second Edition) edited by William Murphy, Jonathan Black, Garth Hastings. 3. Michael N. Helmus (Editor), Biomaterials in the Design and Reliability of Medical Devices 4. David Hill, Design Engineering of Biomaterials for Medical Devices 5. Jos Vander Sloten (Editor), Computer Technology in Biomaterials Science and Engineering (Biomaterials Science & Engineering) 6. Kay C. Dee, et al, An Introduction to Tissue-Biomaterial Interactions   **CLASS ATTENDANCE :**  Minimum 75% class attendance is mandatory to appear in the examinations. | | | | | | | | | | | |
| **7th Semester** | | | | | | | | | | | |
| Engineering Management | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **3** |
| Practical | | **0** |  | | | | | Practical | | | **0** |
| **Total** | | **48** |  | | | | | **Total** | | | **3** |
| **Course Learning Outcomes: -** After completion of the course, the students will be able   | Sr.no | CLO | Domain | Taxonomy level | PLO Mapping | | --- | --- | --- | --- | --- | |  | Explain the fundamental engineering management principles | cognitive | C2 | 11 | |  | Investigate the knowledge and skills needed to effectively lead a team | cognitive | A2 | 9 | |  | Prepare decision-making and management engineering methodology to analyze problem | Cognitive | C3 | 11 | | 4 | Evaluate the importance of Total Quality Management | cognitive | A1 | 4 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering Knowledge: |  | 7 | Environment and Sustainability | |  | | --- | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis: |  | 8 | Ethics: | |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork | | ✔ | | 4 | Investigation: | ✔ | 10 | Communication: | |  | | 5 | Modern Tool Usage: |  | 11 | | Project Management | ✔ | | 6 | The Engineer and Society: |  | 12 | Lifelong Learning | |  |   **Course Outline**  **1.Introduction to Engineering Management a**. Role of Engineer in Management;8 b. Functions of Management c. Planning and Techniques of Management  **2. Organizational Management Engineering**  **a**. Organizing Engineering and Structure b. Establishment of working relationship c. Market for engineering products d. Types of Markets  **3. Managerial Decision**  **Making and Management of Operations**  a. Efficient Managerial Decision in Healthcare setting b. Simulation Modeling of Healthcare delivery c. Simulation Applications in Healthcare setting d. Modeling clinical engineering activities to support healthcare technology management2. Alexander Kolker, Management Engineering for Effective Healthcare Delivery: Principles and | | | | | | | | | | | |
| **. Management and Supervision**  a. Principles of Hospital management b. Legal, Professional and Ethical Aspects c. Resources, duties and functions of medical and paramedical staff d. Planning, Knowledge of various Hospital services  **5. Cost and Quality Management**  a. New Cost Accounting Model b. New Indicators for Hospital Management Based on Personnel Cost c. Total Quality Management Suggested Teaching Methodology: Lecturing Written Assignments Report Writing  S**uggested Teaching Methodology:**  Lecturing Written Assignments Report Writing  **Recommended Books:**  1. Buchbinder Sharon, Introduction to Healthcare Management Latest ed. | | | | | | | | | | | |
| Medical Imaging | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **32** |  | | | | | Theory | | | **2** |
| Practical | | **48** |  | | | | | Practical | | | **1** |
| **Total** | | **80** |  | | | | | **Total** | | | **3** |
| Course Objectives: **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | Understand the working principles of modern medical Imaging Techniques | | | | | | Cognitive | 2 | | 1 | |
| **2** | Differentiate the radiological and non-radiological diagnostics methods | | | | | | Cognitive | 4 | | 1 | |
| **3** | Explain advancements in detection Technology of CT and MRI scanners as well as detectors | | | | | | Cognitive | 3 | | 5 | |
| **4** | Discuss clinical applications of different medical imaging modalities | | | | | | Cognitive | 3 | | 1 | |
| **5** | Analyze radiological images for clinical diagnosis | | | | | | Psychomotor | 5 | | 4 | |
| **6** | Implement troubleshooting techniques on radiological imaging machines | | | | | | Psychomotor | 5 | | 5 | |
| **7** | Demonstrate operation, maintenance and clinical applications of modern imaging techniques CT, MRI, PET and Sonogrpahic methods. | | | | | | Psychomotor | 4 | | 5 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge | | | **√** | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis | | |  | **8** | Ethics | | |  | | |
| **3** | Design/Development of Solutions | | |  | **9** | Individual and Teamwork | | |  | | |
| **4** | Investigation | | | **√** | **10** | Communication | | |  | | |
| **5** | Modern Tool Usage | | | **√** | **11** | Project Management | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning | | |  | | |
| **COURSE OUTLINE**   1. Introduction to Medical Imaging  * A historical perspective * Image analysis and the method of moments * Strategies of Reconstruction Algorithm for Computerized Tomography  1. X-ray Imaging  * X-ray production and its use in medical imaging * Safe operational radiation dose * Attenuation based X-ray Imaging * X-ray Detection * X-ray Image Quality * Diagnostic Applications of X-ray Imaging * Demonstration of X-rays Equipment  1. Computed Tomography  * Introduction to CT Scanners * Attenuation Tomography * Time of flight Tomography * Reflection Tomography * Diffraction Tomography * Formulation of Attenuation Tomography * Recent Advances in CT Detectors (Slip ring Technology) * Fourier Slice Theorem * Clinical cases, applications and limitations of Computed Tomography  1. Magnetic Resonance Imaging  * Physics and Engineering of MRI * Image Contrast (T1 and T2 weighted images, PD Weighted images, STIR images, gradient echo images) * Image Formation and its Characteristics (Pixels, Matrices, resolutions, slices, SNR, Scan time, artifacts) * Spatial Encoding * Resonance and Relaxation * Modern MRI equipment * Quality control * Clinical cases and applications of MRI | | | | | | | | | | | |
| 1. Positron Emission Tomography  * Physical and physiological principles of PET * PET Signal Acquisition * PET Image formation * Significance of PET * Applications of PET  1. Sonography 2. Ultrasound Imaging  * Generation and detection of ultrasound waves * Physical and physiological principles of Ultrasound * Resolution of Ultrasound imaging * Ultrasound Imaging Modalities * Doppler Ultrasound Imaging * Modes of ultrasound image representation * Ultrasound Image Artifacts * Clinical cases, application and limitations  1. Echocardiography  * Introduction * Physical properties of echocardiography * Imaging Modalities * Clinical applications of cardiac ultrasound * New Techniques in Cardiac Ultrasound * Clinical Cases   **LIST OF PRACTICALS**  1. Demonstration of X-rays Equipment  2. Demonstration of X-ray Tube components  3. Demonstration of the X-ray collimator, Grids, and Filters  4. Demonstration of Ultrasound Equipment and differentiate between contrast  5. Ultrasound of liver and Gallbladder  6. Ultrasound of spleen  7. Ultrasound of kidney  8. Ultrasound of pancreas  9. Visualization of MRI images  10. Demonstration of CT Scan images of the cerebral aneurysm  11. Demonstration of MRI images of the Brain Tumors and discuss the related issues  12. Demonstration of MRI images of the Knees and discuss the related issues  13. Demonstration of the fluoroscopic images of the blood flow through the arteries  14. Demonstration of the PET Scans  15. To understand the difference between PET and MRI and CT scan  16. Open ended lab 1  **RECOMMENDED BOOKS**   1. Rooney, William. "MRI: from picture to proton." (2003): 504-505. 2. Guzzardi, R. (Ed.). (2012). Physics and engineering of medical imaging (Vol. 119). Springer Science | | | | | | | | | | | |
| Nanobiotechnology | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **3** |
| Practical | | **0** |  | | | | | Practical | | | **0** |
| **Total** | | **80** |  | | | | | **Total** | | | **3** |
| **Course Learning Outcome:**  Upon successful completion of the course, students will be able to:   | **S #** | **CLO, Course Learning Outcome** | **Domain** | **Level** | **PLO** | | --- | --- | --- | --- | --- | | 1 | **Explain** materials properties at nanoscale | Cognitive | 2 | 1 | | 2 | **Understand** the working of nanoscale soft machines inside human cell | Cognitive | 2 | 1 | | 3 | **Identify** advanced characterization techniques to study the properties of nanomaterials | Cognitive | 4 | 2 | | 4 | **Discuss** applicability and limitations of top down and bottom-up approaches for fabrication of nanomaterials | Cognitive | 4 | 1 | | 5 | **Explain** the transduction principles of nanosensors designed for biomedical applications | Cognitive | 3 | 5 | | 6 | **Discuss** safety and applications of nanomaterials for biomedical applications | Cognitive | 5 | 7 | | | | | | | | | | | | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering Knowledge | **√** | 7 | Environment and Sustainability | **√** | | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis | **√** | 8 | Ethics |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork |  | | 4 | Investigation |  | 10 | Communication |  | | 5 | Modern Tool Usage | **√** | 11 | Project Management |  | | 6 | The Engineer and Society |  | 12 | Lifelong Learning |  |   **COURSE OUTLINE**   1. Behavior of materials at nanoscale (Nanoscale properties (magnetic, electrical, optical and chemical etc.) 2. Advanced characterization techniques for nanomaterials   2.1 Electron Microscopy (SEM, TEM, Cryo-SEM)  2.2 Scanning probe microscopy (AFM, STM)  2.3 Diffraction Techniques (XRD, Synchrotron)   1. Bionanomaterials   3.1 Biological Building Blocks  3.2 Bionanostructures (nanofibres, nanotubes and nanocellulose)   1. Biological Nanomachines   4.1 Ribosomes  4.2 Photosynthesis systems  4.3 Bio-nanomotors   1. Engineered Nanomaterials   5.1 Carbon Nanomaterials (Fullerenes, graphene, nanotubes, nanofibers)  5.2 Metallic nanoparticles (Synthesis, properties, applications)  5.3 Magnetic nanoparticles (synthesis, properties and applications)  5.4 Quantum dots, liquid crystals  5.5 Nanoporous materials (metallic, zeolite, MOFs)   1. Microfabrication Methods   6.1 Photolithography  6.2 Soft-lithography  6.3 Replication   1. Nanofabrication Methods   7.1 Top-down approaches | | | | | | | | | | | |
| 1. Nanotechnology by self-assembly   8.1 (Bottom-Up approach): Principles, thermodynamics, interactions, properties  8.2 Supramolecular self-assembly  8.3 Protein nanotechnology  8.4 DNA nanotechnology   1. Microfluidics   9.1 Surface Tension  9.2 Capillarity  9.3 Reynold’s number   1. Nanofluidics   10.1 Nanopores and nanocapillaries  10.2 Debye Length  10.3 Lab-on-chips  10.4 Organ-on-chips   1. Biosensors & Nanosensors   11.1 Sensor Characteristics  11.2 Transduction Platforms  11.2 Fabrication and Functionalization  11.3 Applications   1. Nanotechnology safety and the environment 2. Impact of nanotechnology on society and industry   **Reference Books**  1. Brydson, R. M.; Hammond, C., Generic Methodologies for Nanotechnology: Classification and Fabrication. In Nanoscale Science and Technology, John Wiley & Sons, Ltd: 2005; pp 1-55.  2. Brydson, R. M.; Hammond, C., Generic Methodologies for Nanotechnology: Characterization. In Nanoscale Science and Technology, John Wiley & Sons, Ltd: 2005; pp 56-129.  3. Leggett, G. J.; Jones, R. A. L., Bionanotechnology. In Nanoscale Science and Technology, John Wiley & Sons, Ltd: 2005; pp 419-445.  4. Bucke, C., Bionanotechnology—lessons from nature. By David S Godsell. Wiley-Liss, Hoboken, NJ, 2004. 352 pp, ISBN 0 471 41719 X. Journal of Chemical Technology & Biotechnology 2005, 80 (8), 964-965.  5. Goodsell, D. S., In Bionanotechnology, John Wiley & Sons, Inc.: 2004; pp i-xii.  6. Gibbs, M. R. J., Nanomagnetic Materials and Devices. In Nanoscale Science and Technology, John Wiley & Sons, Ltd: 2005; pp 203-236. | | | | | | | | | | | |
| **8th Semester** | | | | | | | | | | | |
| Medical Image Processing | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **03** |
| Practical | | **0** |  | | | | | Practical | | | **0** |
| **Total** | | **48** |  | | | | | **Total** | | | **03** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Medical Image Processing aims at familiarizing the student with the basic concepts of image processing as they are applied to medical imaging problems. The course will cover fundamental concepts in digital image processing, including a brief overview of basic image processing, image enhancement in spatial and frequency domain, morphological image processing, image segmentation, and feature detection.  Image analysis methods on the most common medical imaging modalities (X-ray, MRI, CT, ultrasound) will be covered. MATLAB will be extensively used for implementing and analyzing image processing algorithms. Projects and assignments will provide students experience working with actual medical imaging data.  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | **Discuss** the standard image processing issues and analysis techniques, and their significance and use in medical imaging | | | | | | Cognitive | 2 | | 1 | |
| 2 | **Apply** fundamental spatial domain image processing algorithms for the analysis and enhancement of medical images | | | | | | Cognitive | 3 | | 2 | |
| **3** | **Apply** fundamental frequency domain image processing algorithms for the analysis and enhancement of medical images | | | | | | Cognitive | 3 | | 2 | |
| **4** | **Analyze** medical images by extracting regions of interest using various segmentation techniques and employing morphological filtering techniques to clean up and cluster such regions | | | | | | Cognitive | 4 | | 2 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| COURSE CONTENTS   1. **Digital Image Fundamental**   a. Image file formats  b. Elements of Visual Perception  c. Image Sampling and Quantization  d. An Introduction to the Mathematical Tools Used in Digital Image Processing   1. **Intensity Transformations and Spatial Filtering**   a. Basic Intensity Transformation Functions  b. Histogram Processing  c. Fundamentals of Spatial Filtering  d. Smoothing Spatial Filters  e. Sharpening Spatial Filters   1. **Filtering in the Frequency Domain**   a. Review of Concept about Fourier in 1D  b. Fourier Functions of Two Variable  c. The Basics of Filtering in the Frequency Domain  d. Image Smoothing Using Frequency Domain Filters  e. Image Sharpening Using Frequency Domain Filters   1. **Image Restoration and Reconstruction**   a. Noise Models  b. Restoration in the Presence of Noise Only Spatial Filtering  c. Periodic Noise Reduction by Frequency Domain Filtering  d. Inverse Filtering, Least Squares Filtering, GM filtering  e. Image Reconstruction from Projection   1. **Image Segmentation**   a. Point, Line, and Edge Detection  b. Thresholding  c. Region-Based Segmentation  d. Segmentation Using Morphological Watersheds  e. The Use of Motion in Segmentation   1. **Image Compression**   a. Compression Standards  b. Some Basic Compression Methods (Huffman Coding, Golomb Coding)  **Practical**   1. MATLAB: Introduction to MATLAB and image processing toolbox | | | | | | | | | | | |
| 1. Digital Image Fundamentals: Sampling and quantization, bits per pixel & shades, spatial resolution & image size, Zooming & shrinking images 2. Basic Gray Level transformations: Image Negative, Log transform. 3. Application Of Gamma Correction to enhance image 4. Contrast stretching and thresholding 5. Introduction to image Histogram , Histogram sliding 6. Histogram equalization 7. Enhancement using arithmetic/logic operations 8. Smoothing spatial filters (Mean and Median filters) 9. Sharpening spatial filters (Laplace and Sobel) 10. Un-sharp masking and high-boost filtering Combining Spatial Enhancement methods 11. Review of Fourier transform and convolution theorem, 2D-FT, FT and frequency components of an image 12. Lowpass and High pass Filters: Ideal filters, Butterworth filters, Gaussian filters. Filters comparison, Unsharp Masking 13. Dilation and erosion 14. Detection of discontinuities, Edge linking and boundary detection, Segmentation by thresholding 15. Object recognition, classification and image compression 16. **Reference Books** 17. “Digital Image Processing” R. Gonzalez and R. Woods 18. “Digital Image Processing for Medical Applications” Geoff Dougherty 19. “Medical Image Processing” Wolfgang Birkfellner 20. “Biosignal and Biomedical Image Processing MATLAB-Based Applications” John L. Semmlow | | | | | | | | | | | |
| Technical Report Writing | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **3** |
| Practical | | **0** |  | | | | | Practical | | | **0** |
| **Total** | | **48** |  | | | | | **Total** | | | **3** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to:   | **Sr. No.** | **CLOS** | **Domain** | **Taxonomy Level** | **PLO** | | --- | --- | --- | --- | --- | |  | **Explain** the basics of Report Writing, resumes and writing styles. | Cognitive | C2 | 10 | |  | **Justify** an effective technical report by following the rules and regulations of formal writing prescribed | Affective Domain | A5 | 10 | | | | | | | | | | | | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Recommended Books**  · Technical Report Writing Today by Daniel G. Riordan, Wadsworth Publishing, 10th Edition, ISBN 9781133607380  · Scenarios for Technical Communication by Teresa C. Kynell and Wendy Krieg Stone. ISBN 978-0205275243  · Communication for Engineering Students by J. W. Davies, ISBN 978-0582256484  · Science Research Writing for Non-Native Speakers of English by Hilary Glasman-Deal, Imperial College Press. ISBN 978 1 84816 309 6  · Effective communication for Science and Technology by J V Emden, Palgrave 2001, ISBN 9780333775462  Directions: Use the following rubrics to evaluate and enhance a student's mastery skills in research and to present a solution to a problem in order to prompt action through best presentation skills. Assign a percentile score to each student for each section. Then, add all the student’s percentile scores for each section and divide by the number of students to determine the sample mean for each section. Lower percentile scores suggest areas where students can use improvement    **.** | | | | | | | | | | | |
| Biomedical Engineering Project I | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **0** |  | | | | | Theory | | | **0** |
| Practical | | **48** |  | | | | | Practical | | | **3** |
| **Total** | | **48** |  | | | | | **Total** | | | **03** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to:   | Sr.No | CLO | Domain | Taxonomy level | PLO | | --- | --- | --- | --- | --- | |  | **Design** Project activities to fulfill the desired outcomes | Cognitive | 6 | 3 | |  | **Identify** the research gap to design project | Cognitive | 6 | 4 | |  | **Analyze** the project outcomes using appropriate tools | Cognitive | 4 | 4 | |  | **Use** modern tools to carry out experimental activities | Psychomotor | 5 | 5 | |  | **Present** the research outcomes effectively | Affective | 3 | 10 | | | | | | | | | | | | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | | **✔** | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | | **✔** | **10** | Communication: | | | **✔** | | |
| **5** | Modern Tool Usage: | | | **✔** | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
|  | | | | | | | | | | | |
| **7th Semester** | | | | | | | | | | | |
| Neural Engineering | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **3** |
| Practical | | **0** |  | | | | | Practical | | | **0** |
| **Total** | | **48** |  | | | | | **Total** | | | **3** |
| **Course Learning Outcome:**  The goal of this course is to educate the students in the application of engineering tools in the field of neuroscience. The students will understand the functions of brain after looking into various neural interfaces. They will be able to know about the importance of brain stimulation techniques that will play a vital role in the rehabilitation of the patients. They will also be taught about the neural signal processing and its applications in the field of biomedical engineering.  Upon successful completion of the course, students will be able to:   | S # | CLO, Course Learning Outcome | Domain | Taxonomy level | PLO | | --- | --- | --- | --- | --- | | 1 | **Explain** the microscopic, macroscopic and functional importance of the neural engineering. | Cognitive | 3 | 1 | | 2 | **Illustrate** brain and its functions, concept of neural stimulation and its applications, and various neural interfaces | Cognitive | 3 | 2 | | 3 | **Understand** signal processing of various signals such as EEG, EMG, NIRS, TMS, EOG, and MEG. | Cognitive | 3 | 3 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering Knowledge: |  | 7 | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis: |  | 8 | Ethics: |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork |  | | 4 | Investigation: |  | 10 | Communication: |  | | 5 | Modern Tool Usage: |  | 11 | Project Management |  | | 6 | The Engineer and Society: |  | 12 | Lifelong Learning |  |   **Course Contents**  1**. Microscopic Level**  a. Technology of Electrophysiology  b. Membrane and Ion Channels  c. Single cell physiology  d. Biophysics of the neuron  e. Hodgkin-Huxley-model of action potentials.  **2. Macroscopic Level**  a. Nervous system, motor nervous system and their functionality  b. Brain Stimulation and Diseases  c. Brain pacemaker  d. Human Brain Interfaces  e. Neural Recording Techniques.  **3. Functional level**  a. Neural basis of cognition  b. Neurophysiological studies in humans using fMRI, PET, MEG, EEG,  and TMS.  c. Motor control and learning.  **4. The Brain and Its Functions**  a. Brain waves and Electroencephalogram  b. Evoked Potentials | | | | | | | | | | | |
| c. Diseases of the Central Nervous System  d. EEG for Assessment of Anesthesia  e. Sleep Studies  **5. Neural Interfaces**  a. Neural interfacing for sensory and motor prosthetics  b. Neural interfacing for treatment of disease (functional electrical  stimulation)  c. Neural interfacing for in vitro brain models  **6. Brain stimulation**  a. Effects and safety of electrical stimulation  b. Models of neural stimulation  c. Power and control of devices  d. Electrodes for central stimulation and recording  e. Electrodes for peripheral stimulation and recording  **7. Neural Signal Processing**  a. Real-time neural data analysis and feedback  b. Neurally-controlled robots  c. Diagnostic neural interfacing  **8. Electromyogram**  a. Muscle  b. EMG  c. Neuromuscular Diseases and the EMG  **Recommended Books:**   1. Neuroprosthetics - Theory and Practice (KW Horch and GS Dhillon, eds),Volume 2 in the Series on Bioengineering and Biomedical Engineering, 2004, World Scientific Publishing, is a suggested reference. 2. Dayan, P, Abbott, LF (2001) Theoretical neuroscience 3. Windhorst U, Johansson H (1999) Modern Techniques in Neuroscience Research, 1 Edition. Berlin: Springer 4. Kandel ER, Schwartz JH, Jessel TM (1991) Principles of neural science, Prentice-Hall 5. Koch C, Segev I (1998) Methods in Neuronal Modelling, 2nd Edition. Cambridge, MA: MIT Press | | | | | | | | | | | |
| Professional Practices & Ethics | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **3** |
| Practical | | **0** |  | | | | | Practical | | | **0** |
| **Total** | | **48** |  | | | | | **Total** | | | **3** |
| **Course Learning Outcomes: -** After completion of this course, the student should be able to   | **Sr.no** | **CLO** | **Domain** | **Taxonomy Level** | **PLO** | | --- | --- | --- | --- | --- | | **2** | **Identify** the content of any laws dealing with engineering ethics, or the code of ethics of a professional society; prepare and defend their own definition of what makes for an ethical engineer | **Affective** | A1 | 8 | | **3** | **Discuss** the historical, legal, professional and personal reasons, why engineering ethics exists with the consequences of acting ethically and unethically | Affective | A2 | 8 | | **3** | **Explain** the ethical dilemmas implicit in an article or a document; formulate possible actions that can be taken in response to a given ethical dilemma, and report the probable consequences of these actions | Affective | A4 | 8 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | **1** | Engineering Knowledge: |  | **7** | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | **2** | Problem Analysis: |  | **8** | Ethics: |  | | **3** | Design/Development of Solutions |  | **9** | Individual and Teamwork |  | | **4** | Investigation: |  | **10** | Communication: |  | | **5** | Modern Tool Usage: |  | **11** | Project Management |  | | **6** | The Engineer and Society: |  | **12** | Lifelong Learning |  |   **Course outline:** . Introduction to Ethics ·The Nature of Engineering Ethics  ·Legal, Professional and Historical Definitions  ·Code of Ethics/Conduct of any Professional Society  ·Value of Engineering Ethics  ·Contemporary and Historical Reasons  ·Why an Ethical Engineer 3. Ethic | | | | | | | | | | | |
| calDilemm Common Ethical Dilemmas  ·Resolution of Ethical Dilemmas  ·Possible Actions in Response to Dilemmas  ·Probable Consequences of these Actions  ·Any Religious, National, or International Law Dealing with Engineering Ethics  ·Historical and Professional Reasons of Existence of Multiple Definitions of Ethics  ·Benefits of Acting Ethically and Consequences of Acting Unethically  a. Ethical responsibilities of Biomedical Engineers and Moral Complexities.  b. Health-Ethics c. WHO’s Health Policies d. Codes of law of renowned societies for engineers e. Code of law of Biomedical engineering society f. Biomedical Engineers Pakistan code of ethics g. Ethical challenges for Biomedical Profession.  **Recommended Books:**  Kenneth Blanchard, Professional Ethics, 4th Edition  Reference Books:  Business Ethics: Case Studies and Selected Readings, Marianne M. Jennings, Eight Edition | | | | | | | | | | | |
| Molecular Neuroscience | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **3** |
| Practical | | **0** |  | | | | | Practical | | | **0** |
| **Total** | | **48** |  | | | | | **Total** | | | **3** |
| **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | **Acquire** the understanding of mechanism involved in the transmission of information in the brain. | | | | | | Cognitive | 1 | | 1 | |
| **2** | **Describe** the modulation of brain function | | | | | | Cognitive | 1 | | 1 | |
| **3** | **Analyze** the role of neurotransmitters for various diseases | | | | | | Cognitive | 4 | | 4 | |
| **4** | i**llustrate** the role of signaling pathways for their associated neurons | | | | | | Cognitive | 3 | | 3 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | |  | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | |  | **10** | Communication: | | |  | | |
| **5** | Modern Tool Usage: | | |  | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course outline:**  **Introduction to neuroscience**  a.Nervous system b. Sympathetic c. Parasympathetic and motor nervous system and their functions  d. Brain and its functions e. Neurons and glia, structure of a neuronal cell, types of glia. f. Blood brain barriers.  **2. Neuronal Circuits**  a. Neuronal circuit in emotional control b. Neuronal circuit in reward and addiction c. Neuronal regulation of stress  **3. Receptors**  a. Ionotropic and metabotropic receptors  b. signal transduction pathways  c. G-proteins  d. protein phosphorylation  e. Signaling to the nucleus  f. regulation of gene expression | | | | | | | | | | | |
| **4. Neurotransmitters**  a. Excitatory and inhibitory amino acid neurotransmitters  b. Functions in the brain  c. Pain pathways in brain  d. Role of excitatory neurotransmitter in learning and memory  e. Diseases associated with the malfunctioning of these neurotransmitters  f. Neuronal degeneration  **5. Catecholamines**  a. Functions in the brain  b. Diseases associated with the malfunctioning.  **6. Neural basis of behavioral plasticity**  a. Human and animal memory  b. Cellular mechanisms of neural plasticity  **7. Neuroendocrine and motivational systems**  a. Endocrine systems  b. Feeding behavior  c. Stress  **8. Diseases of the nervous system**  a. Addiction  b. Depression  c. Schizophrenia  d. Epilepsy  e. Alzheimer  f. Parkinson  g. Prion  h. Motor Neuron Disease  **Recommended Books**   1. Progress in Neuroscience, Readings from Scientific American, John Wiley. 2. Philip, G. Srauge, Brain Biochemistry and Brain Disorders, Oxford Press. 3. George, J. Siegal, B. W. Agranoff, S. K. fisher , M. D. Uhler, Basic Neurochemistry: Molecular, Cellular and Medical Aspects, Lippincott D. Uhler. 4. Darakhshan Haleem, Neurochemistry, Neuropharmacology and Behavior, 2010. 5. Mark F. Bear, Barry W. Connors & Michael A. Paradiso, Neuroscience: Exploring the brain, 2006   **Suggested Teaching Methodology:**  Lecturing  Written Assignments  Report Writing  **Suggested Assessment:**  Assignment /Case study: 10%  Quizzes : 10%  Midterm: 20%  final term: 60%   |  | Qualities of Student Communicative Competence and Related Percentile Score | | | Students Score | | --- | --- | --- | --- | --- | | Competency  Students will be able to |  |  |  |  | | Excellent | Average | Poor | | 80-100 % | 50-79 % | 0-49 % | | Understand and clearly state the purpose and thesis of their speech | The purpose and thesis of the communicative competence and presentations are clearly understood and serve to focus the speech. | The purpose and thesis of the communicative competence and presentations are clearly understood, but the presentation strayed from its central point. | The purpose and thesis of the communicative competence and presentations are not clearly stated but were implicit. |  | | Analyze particular audiences and select an appropriate ethical communication strategy | The speaker clearly understood his or her audience and spoke appropriately and ethically with the audience in mind. | The speaker had a general understanding of the audience but missed key opportunities to communicate effectively with the audience. | The speaker had a general understanding of the audience but did not present information effectively with the audience. |  | | Identify access, select, evaluate, and site supporting information for a speech | An appropriate amount of high-quality supporting material was used for the presentation and clearly cited. | An appropriate amount of high-quality supporting material was used, but it was of medium quality and not always cited. | Little supporting material was used from low quality sources, and it was not cited appropriately. |  | | Present a clearly organized set of ideas | The communicative competence and presentation of ideas had a clear and deliberately organizational structure. | The communicative competence and presentation of ideas were organized, but the speaker sometimes strayed from the organization. | The communicative competence and presentation of ideas had easily identifiable main points but lacked internal structure. |  | | | | | | | | | | | | |
| Prosthetics & Rehabilitation Engineering | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **3** |
| Practical | | **0** |  | | | | | Practical | | | **0** |
| **Total** | | **48** |  | | | | | **Total** | | | **3** |
|  | |  |  | | | | |  | | |  |
| **Course Objective:**  **SUGGESTED COURSE LEARNING OUTCOMES:**  Upon successful completion of the course, the student will be able to:   | **S. No** | **CLO** | **Domain** | **Taxonomy level** | **PLO** | | --- | --- | --- | --- | --- | | **CLO-1** | Explain the domains of rehabilitation  engineering. | Cognitive | 2 | 1 | | **CLO-2** | Demonstrate limb Prosthetic devices,  orthotic devices, devices for visually  impaired, and devices for hearing  Impairment | Cognitive | 3 | 1 | | **CLO-3** | Conduct experiments for analysis of  physiological parameter during  electrical stimulation. | Psychomotor | 4 | 2 | | **CLO-4** | Recognize assistive devices for  hearing and visually impaired  population. | Psychomotor | 1 | 1 | |  |  |  |  |  | |  |  |  |  |  |   **The CLO will map with following PLO**   | **1** | Engineering Knowledge: | ✔ | **7** | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | **2** | Problem Analysis: | ✔ | **8** | Ethics: |  | | **3** | Design/Development of Solutions |  | **9** | Individual and Teamwork |  | | **4** | Investigation: |  | **10** | Communication: |  | | **5** | Modern Tool Usage: |  | **11** | Project Management |  | | **6** | The Engineer and Society: |  | **12** | Lifelong Learning |  |   **Course Content**  **Introduction**  a. Introduction to rehabilitation engineering and assistive technology (AT)  b. Domains of rehabilitation engineering  c. Future of rehabilitation engineering  **2. Limb Prosthetic Devices**  a. Classification of amputation  b. Prosthetic prescription and fabrication  c. Components of upper limb prosthesis  d. Components of lower limb prosthesis  **3. Orthotic Devices**  a. Introduction  b. Biomechanical principles of orthoses  c. Design consideration  d. Spinal orthoses  e. Limb orthoses  **4. Devices for Visually Impaired**  a. Dimensions of visual impairment and their impact on task performance  b. General purpose assistive technology solutions  c. Task-specific assistive technologies  d. Technology for readinge. Writing and graphic access  **5. Devices for Hearing Impairment**  a. Types of hearing impairment  b. Historical overview of HAT (Hearing assistance technology)  c. Medical and surgical approaches to restoring hearing function  d. Assistive listening devices solutions  e. Environmental adaptations and universal designs  **6. Wheelchairs**  a. Manual wheelchairs and electrical power wheelchairs with brief history  b. User profiles  c. Basic structural components  d. Power and drive systems  e. Control system  f. Power assisted wheelchairs  g. Multifunctional wheelchairs  h. Wheelchair standards  **7. Neurorehabilitation**  a. Functional Electrical Stimulation  b. Transcutaneous Electrical Stimulation  c. Brain Computer Interface  d. Assessment methods for neurorehabilitation  **List of Practical:**  1. Angle measurements using electronic goniometer in rest and walking  state  2. Foot pressure measurement using force sensitive resistors (FSR)  3. Modeling and simulation of biomechanics arm using AutoCAD  4. Gait parameter analysis  5. EMG measurement during Functional electrical stimulation (FES)  6. Assessment of EMG before and after TENS  7. Design of brain computer interface using neurosky EEG device to detect subject’s response  8. Control of peripheral devices such as using neurosky EEG device to  switch ON/OFF home appliances  9. Demonstration of electrical power wheelchair  10. Demonstration of hearing aid.  11. Demonstration of visually impaired devices.  12. Open ended Lab 1  13. Open ended Lab 2  14. Open ended Lab 3  15. Open ended Lab 4  16. Open ended Lab 5  **Recommended Books:**  Rory A Cooper and HisaichiOhnabe, An Introduction to Rehabilitation  Engineering, 2006, ISBN: 9780849372223  2. Pedro Encarnação and Albert Cook, Robotic Assistive Technologies:  Principles and Practice, 2017, ISBN: 9781498745727  3. Marko B. Popović, Biomechanics and Robotics, 2013, ISBN:  9789814411370  4. Albert M. Cook and Janice Miller Polgar, Assistive Technologies: Principles  and Practice, 4th Edition, ISBN: 9780323096317  5. Kevin Russell Henderson, Wheelchairs: Perceptions, Technology Advances  and Barriers, 2016, ISBN: 9781536103908  6. Michelle M. Lusardi, Orthotics and Prosthetics in Rehabilitation, 3rd Edition,  ISBN: 9781437719369  **Class Attendance:** Minimum 75% class attendance is mandatory to appear in the examinations.   | **Distribution of Theory Marks:** |  | | --- | --- | | Quizzes | 05% | | Assignment | 05% | | Midterm Examinations | 20% | | Final Examination | 50% | | Lab Work | 20% | | **Total** | **100 %** | | | | | | | | | | | | |
| Biomedical Engineering Project (Phase II) | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | |  |  | | | | | Theory | | | **0** |
| Practical | | **48** |  | | | | | Practical | | | **3** |
| **Total** | | **48** |  | | | | | **Total** | | | **3** |
| **SUGGESTED COURSE LEARNING OUTCOMES**  Upon successful completion of the course, the student will be able to: | | | | | | | | | | | |
| **S. No** | **CLO** | | | | | | **Domain** | **Taxonomy Level** | | **PLO** | |
| **1** | **Design** Project activities to fulfill the desired outcomes | | | | | | **Cognitive** | 6 | | 3 | |
| **2** | **Identify** the research gap to design project | | | | | | **Cognitive** | 6 | | 4 | |
| **3** | **Analyze** the project outcomes using appropriate tools | | | | | | **Cognitive** | 4 | | 4 | |
| **4** | **Use** modern tools to carry out experimental activities | | | | | | **Psychomotor** | 5 | | 5 | |
| **5** | **Present** the research outcomes effectively | | | | | | **Affective** | 3 | | 10 | |
| **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs: | | | | | | | | | | | |
| **1** | Engineering Knowledge: | | |  | **7** | Environment and Sustainability: | | |  | | |
| **2** | Problem Analysis: | | |  | **8** | Ethics: | | |  | | |
| **3** | Design/Development of Solutions: | | | **✔** | **9** | Individual and Teamwork: | | |  | | |
| **4** | Investigation: | | | **✔** | **10** | Communication: | | | **✔** | | |
| **5** | Modern Tool Usage: | | | **✔** | **11** | Project Management: | | |  | | |
| **6** | The Engineer and Society: | | |  | **12** | Lifelong Learning: | | |  | | |
| **Course outline:**  **Recommended Books** | | | | | | | | | | | |
| Engineering Entrepreneurship | | | | | | | | | | | |
| **Contact Hours** | | |  | | | | | **Credit Hours:** | | | |
| Theory | | **48** |  | | | | | Theory | | | **3** |
| Practical | | **0** |  | | | | | Practical | | | **0** |
| **Total** | | **48** |  | | | | | **Total** | | | **3** |
| **Course Learning Outcome:**  Upon successful completion of the course, students will be able to:  HEC.   | **S #** | **CLO, Course Learning Outcome** | **Domain** | **Level** | **PLO** | | --- | --- | --- | --- | --- | |  | Develop a business plan with an appropriate business model | Cognitive | 5 | 11 | |  | Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career | Affective | 4 | 9 | |  | Demonstrate the ability to find an attractive market that can be reached economically | Affective | 3 | 6 |   **RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):**  The course is designed so that students will achieve the following PLOs:   | 1 | Engineering Knowledge: |  | 7 | Environment and Sustainability |  | | --- | --- | --- | --- | --- | --- | | 2 | Problem Analysis: |  | 8 | Ethics: |  | | 3 | Design/Development of Solutions |  | 9 | Individual and Teamwork | ✔ | | 4 | Investigation: |  | 10 | Communication: |  | | 5 | Modern Tool Usage: |  | 11 | Project Management | ✔ | | 6 | The Engineer and Society: | ✔ | 12 | Lifelong Learning |  |   **Course Outline:**  1. Course Overview and Introduction to Entrepreneurship   * Entrepreneurship Jigsaw Puzzle. * Intrapreneurship & Entrepreneurship * Allocation of projects   2. Nature & Development of Entrepreneurship  Types of Start-Ups   * Role of Entrepreneurship in Economic Development. * Skill Requirements for Entrepreneurship * Ethics & Social Responsibility of Entrepreneurs * Future of Entrepreneurship.   3 | | | | | | | | | | | |
|  | | | | | | | | | | | |

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| --- |
| . Identifying & evaluating the opportunity   * Developing the Business Plan * Determining the resources required for managing the Enterprise. * Managerial Versus Entrepreneurial Decision Making * Causes for Interest in Entrepreneurship * Corporate Versus Intrapreneurial Culture * Comparison of Entrepreneurial * Intrapreneurial& Traditional Managers. * Climate for Intrapreneurship * Intrapreneurial Leadership Characteristics. * Establishing Intrapreneurship in the Organization. * Problems and Successful Efforts.   4. The Individual Entrepreneur.  Discuss basic criteria for evaluating business ideas  5. Entrepreneurial Strategy   * Entrepreneurial Feelings. * Entrepreneurial Background and Characteristics. * Motivation for Entrepreneurship. * Role Models and Support Systems. * Entrepreneurs versus Inventors. * Non-Entrepreneurial Profiles * Twenty Principles of Entrepreneurship * Writing and Using the Business Plan. * Planning for business operation. * Guest Speaker Session.   6. Product Development   * Essentials of New Product Development. * Examples of change in Product Design & Manufacturing * Development processes & Organizations * Guest Speaker Session. * Identifying Customer Needs * Establishing Product Specifications * Sustainable Manufacturing * Introduce basic marketing plans for entrepreneurial firms * Examine basic organizational forms for entrepreneurial firms   8. Entrepreneurial Financing   * Discuss financing issues for new ventures * Introduce venture capital investment process   9. Project Management Skills for Entrepreneurial projects  10. Project Presentations |

## Mapping of CLO domains with PLOs (Annexure D.1, 1stBoS June 6, 2022)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Department of Biomedical Engineering** | | | | | | | | | | | | | | | |
| **Mapping of Courses to CLOs with PLOs** | | | | | | | | | | | | | | | |
| **S. No.** | **Type of Course** | **Course Title** | **Cour999se Code** | **Engineering Knowledge** | **Problem Analysis** | **Design Development of Solutions** | **Investigation** | **Modern Tool Usage** | **Engineer& Society** | **Environment & Sustainability** | **Ethics** | **Individual &Teamwork** | **Communication** | **Project Management** | **Lifelong Learning** |
|
|
|
| **1st Semester** | | | **PLOs** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| 1 | **Natural Science** | **Applied Physics** | **NS-122** | **C2,C3,C2** | **P3** |  |  |  |  |  |  |  |  |  |  |
| 2 | **ED Computing** | **Introduction to Computing** | **CS-113** | **C2,**  **C3,C2** |  |  |  |  |  |  |  |  |  |  |  |
| 3 | **BME Foundation Core** | **Basic Electrical Engineering** | **EE-120** | **C1** | **C3** |  |  | **P3** |  |  |  |  |  |  |  |
| 4 | **Natural Science** | **Basic Mathematics** | **BMF-114** | **C1,C2**  **C3** | **C2** |  |  |  |  |  |  |  |  |  |  |
| 5 | **Natural Science** | **Basic Biology** | **BME-114** | **C2** |  | **C3** | **C3, C4** |  |  |  |  |  |  |  |  |
| 6 | **BME Foundation Core** | **Introduction to Biomedical Engineering** | **BME-115** | **C2,C2** |  |  |  |  |  |  |  |  |  |  |  |
| 7 | **Humanities** | **Islamic Study** | **HS-117** |  |  |  |  |  | **A2** |  | **C2** |  |  |  | **A3** |
|  | 2nd Semester | | **PLOs** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| 8 | **Humanities** | **Pakistan Study** | **HS-105** |  |  |  |  |  | **C2** | **C1** |  |  |  |  |  |
| 9 | **Natural Science** | **Calculus and Analytical Geometry** | **NS-116** | **C1** | **C3** |  |  |  |  |  |  |  |  |  |  |
| 10 | **BME Foundation Core** | **Physiology I** | **BME-123** | **C1,C2** |  |  |  | **P3** |  |  |  |  |  |  |  |
| 11 | **BME Foundation Core** | **Circuit Analysis** | **EE-121** | **C1** | **C3** |  |  | **P4** |  |  |  |  |  |  |  |
| 12 | **Computing** | **Object Oriented Programming** | **CS-125** | **C1,C2** |  | **P3** |  |  |  |  |  |  |  |  |  |
| 13 | **BME Foundation Core** | **Human Anatomy** | **BME-126** | **C1,C2** |  |  | **C4** |  |  |  |  |  |  |  |  |
|  | **3rd Semester** | | **PLOs** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| 14 | **Natural Science** | **Complex Variable and Transformation** | **NS-211** | **C1, C2** | **C3** |  |  |  |  |  |  |  |  |  |  |
| 15 | **BME Foundation Core** | **Physiology II** | **BME-232** | **C1,C2,P3,P4** |  |  | **C3** |  |  |  |  |  |  |  |  |
| 16 | **Natural Science** | **Biochemistry** | **BME-233** | **C1, C2, C5** |  |  |  |  |  |  |  |  |  |  |  |
| 17 | **BME Foundation Core** | **Basic Electronics** | **EL-103** | **C2** | **C4** |  |  | **P3** |  |  |  |  |  |  |  |
| 18 | **BME Foundation Core** | **Computer Aided Engineering Drawing** | **EE-315** | **C3** |  |  |  | **P1** |  |  |  |  |  |  |  |
| 19 | **Humanities** | **Communication Skills** | **HS-119** |  |  |  |  |  |  |  |  |  | **C2,A2,C1** |  |  |
|  | **4th Semester** | | **PLOs** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| 20 | **BME Major Core Breadth** | **Biomedical Electronics** | **BME-241** | **C2** | **C4** | **C4, C5, P4** |  | **P4** |  |  |  |  |  |  |  |
| 21 | **BME Foundation Core** | **Digital Logic Design** | **CS-219** | **C3, P1** | **P2** | **C5,P5** |  |  |  |  |  |  |  |  |  |
| 22 | **Natural Science** | **Linear Algebra & Differential Equation** | **NS-223** | **C2,** | **C3,C4** |  |  |  |  |  |  |  |  |  |  |
| 23 | **BME Major Core Depth** | **Biomechanics** | **BME-244** | **C2,** | **C3** |  |  | **P4, P5** |  |  |  |  |  |  |  |
| 24 | **BME Major Core Breadth** | **Signal & System** | **EE-224** | **C2** | **C3** |  | **C4** | **P3** |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **5th Semester** | | **PLOs** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| 25 | **BME Major Core Breadth** | **Biomedical Instrumentation I** | **BME-351** | **C1, C2,C4** | **C4** | **C3,C6** |  | **P2,P6C1** |  |  |  |  |  |  |  |
| 26 | **BME Major Core Breadth** | **Probability and Statistics** | **NS-312** | **C1** | **C3** |  |  |  |  |  |  |  |  |  |  |
| 27 | **Natural Science** | **Numerical Methods** | **NS-313** | **C1** | **C3** |  |  |  |  |  |  |  |  |  |  |
| 28 | **BME Major Core Breadth** | **Microprocessor and Interfacing** | **EE-314** | **C2** |  | **C4** |  | **C3** |  |  |  |  |  |  |  |
| 29 | **BME Major Core Breadth** | **Biomedical Signal Processing** | **BME-355** | **C3** | **C4** |  | **C5, P5** |  |  |  |  |  |  |  | **A3** |
|  | **6th Semester** | | **PLOs** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **13** |
| 30 | **BME Major Core Depth** | **Biomedical Instrumentation II** | **BME-361** | **C2,C3** | **C4** | **C5** | **P4** | **P3** |  |  |  |  |  |  |  |
| 31 | **BME-IDE Breadth** | **Elective I** | **BME-362** | **C2** |  |  |  |  |  |  |  |  |  |  |  |
| 32 | **BME Major Core Depth** | **Biomedical Control Systems** | **BME-363** |  | **C3,C4** |  |  | **P4** |  |  |  |  |  |  |  |
| 33 | **Computing** | **Modelling and Simulation** | **CS-324** | **C2** | **C4** |  |  | **P5** |  |  |  |  |  |  |  |
| 34 | **BME-IDE Breadth** | **Biomaterials** | **BME-365** | **C1** | **C3,C4** | **P5** | **P4** | **P4** |  | **C6** |  |  |  |  |  |
|  | **7th Semester** | | **PLOs** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| 35 | **Management Sciences** | **Engineering Management** | **MS-411** |  |  |  | **A1** |  |  |  |  | **A2** |  | **C2,C3** |  |
| 36 | **BME-IDE Breadth** | **Medical Imaging** | **BME-472** | **C2,C3,C4** |  |  | **P5** | **C3,P4,P5** |  |  |  |  |  |  |  |
| 37 | **BME-IDE Breadth** | **Elective II** | **BME-473** | **C2,C4** | **C4** |  |  | **C3** |  | **C5** |  |  |  |  |  |
| 38 | **BME-IDE Breadth** | **Elective III** | **BME-474** | **C2** | **C3,C4** |  |  |  |  |  |  |  |  |  |  |
| 39 | **Humanities** | **Technical Report Writing** | **HS-415** |  |  |  |  |  |  |  |  |  | **C2,A5** |  |  |
| 40 | **Senior Design Project** | **Biomedical Engineering Project Phase I** | **BMP-474** |  |  | **C6** | **C4,C6** | **P5** |  |  |  |  | **A3** |  |  |
| 0 | **8th Semester** | | **PLOs** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| 41 | **BME-IDE Breadth** | **Elective IV** | BME-481 | **C3** | **C3** | **C3** |  |  |  |  |  |  |  |  |  |
| 42 | **Humanities** | **Professional Practices and Ethics** | MS-422 |  |  |  |  |  |  |  | **A1,A2,A4** |  |  |  |  |
| 43 | **BME-IDE Breadth** | **Elective V** | BME-483 | **C1** |  | **C3** | **C4** |  |  |  |  |  |  |  |  |
| 44 | **Senior Design Project** | **Biomedical Engineering Project Phase II** | BMP-474 |  |  | **C6** | **C4,C6** | **P5** |  |  |  |  | **A3** |  |  |
| 45 | **Management Sciences** | **Entrepreneurship** | MS-304 |  |  |  |  |  | **A3** |  |  | **A4** |  | **C5** |  |
| **TOTAL PLO** | | | | **58** | **27** | **08** | **16** | **23** | **02** | **03** | **04** | **02** | **07** | **03** | **01** |

## KSA Chart

|  |  |
| --- | --- |
| KSA | Description |
| Knowledge | Condition of being aware of something (facts or concepts) |
| Skills | Ability based performance measured in time and precision |
| Attitudes | Feelings, emotions, beliefs, or values about something |

**Table 4:**KSA Percentage of courses taught in Energy Systems Engineering Department

|  |  |  |
| --- | --- | --- |
| **KSA** | **Total No.** | **Percentage (%)** |
| **Knowledge** | 130 | 75% |
| **Skills** | 30 | 17.44% |
| **Attitudes** | 12 | 7% |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Summary of Complex Engineering Problem and Open-Ended Labs in Biomedical Engineering Program | | | | |
| **List of Subject** | **Complex Engineering Problem** | **Open Ended Lab** | **Project Based Learning** | **Semester** |
| Introduction to Computing |  | Open Ended Lab I  Open Ended Lab II |  | 1ST |
| Physiology I |  | Open Ended Lab I  Open Ended Lab II |  | 2nd |
| Object Oriented Programming |  | Open ended lab I  Open ended lab II |  | 2nd |
| Biochemistry |  | Open ended lab I  Open ended lab II |  | 3rd |
| Biomedical Electronics | Complex Engineering Problem |  |  | 4th |
| Microprocessor & Programming | Complex Engineering Problem |  |  | 4th |
| Digital Logic design |  | Open ended lab I | PBL | 4th |
| Biomechanics |  | Open Ended Lab I |  | 4th |
| Biomedical Instrumentation I |  | Open Ended Lab 1 |  | 5th |
| Biomedical Signal Processing | Complex Engineering Problem | Open Ended Lab 1 |  | 5th |
| Biomedical Instrumentation II | Complex Engineering Problem | Open Ended Lab 1 |  | 6th |
| Biomedical Control Systems | Complex Engineering Problem | Open Ended Lab 1  Open Ended Lab 2 |  | 6th |
| Modelling and Simulation |  | Open Ended Lab 1 |  | 6th |
| Biomaterials |  | Open Ended Lab 1  Open Ended Lab 2 | PBL | 6th |
| Medical Imaging | Complex Engineering Problem | Open Ended Lab 1 |  | 7th9 |
| Elective I | Complex Engineering Problem |  |  | 6th |
| Elective II | Complex Engineering Problem |  |  | 7th |
| Elective III | Complex Engineering Problem |  |  | 7th |
| Elective IV | Complex Engineering Problem |  |  | 8th |
| Elective V | Complex Engineering Problem |  |  | 8th |

## List of Electives

The following may be offered as elective specialization courses according to the availability of resources

|  |  |  |
| --- | --- | --- |
| **Scheme 01** | **Scheme 02** | **Scheme** |
| **Instrumentation** | **Tissue Engineering and Molecular Bioengineering** | **Biomedical Computing** |
| Biomedical Engineering System | Drug Delivery Systems | Computational Fluid Dynamics |
| Medical Device Quality System and Standards | Neuroscience | Artificial Intelligence |
| Medical Device Regulatory Affairs | Nano Biotechnology | Medical Image Processing |
| Medical Robotics | Genetic Engineering | Hospital Information System |
| Rehabilitation Engineering | Tissue Engineering | Medical Data System |
|  | Biophysics |  |