### III SEMESTER

**B.E. Biomedical Engineering (BM)**  
Choice Based Credit System (CBCS)  
Semester - III

**ENGINEERING MATHEMATICS-III**  
(Common to All Branches)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Number of Lecture Hours/Week</th>
<th>Exam Marks</th>
<th>Total Number of Lecture Hours</th>
<th>Exam Hours</th>
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<tr>
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<td>20</td>
<td>04</td>
<td>80</td>
<td>50</td>
<td>03</td>
</tr>
</tbody>
</table>

Credits - 4

**Course Objectives:** This course will enable the students to

**Revised Bloom’s Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

<table>
<thead>
<tr>
<th>Modules</th>
<th>Teaching Hours</th>
<th>Revised Bloom’s Taxonomy (RBT) Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module -1</td>
<td>10 Hours</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>L1</td>
</tr>
<tr>
<td>Module -2</td>
<td>10 Hours</td>
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<tr>
<td></td>
<td></td>
<td>L1</td>
</tr>
<tr>
<td>Module -3</td>
<td>10 Hours</td>
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</tbody>
</table>
Module -4  

10 Hours

Module -5  

10 Hours

Course Outcomes: After studying this course, students will able to:

Graduate Attributes (as per NBA)

Question Paper Pattern:
- The question paper will have TEN questions.
- Each full question carry 16 marks
- There will be TWO full questions (with maximum of FOUR sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

Reference Books:
## B.E. Biomedical Engineering (BM)
**Choice Based Credit System (CBCS)**
**Semester - III**

### ELECTRONIC INSTRUMENTATION AND MEASUREMENTS
*(Common to EI, BM & ML)*

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Marks</th>
<th>IA Marks</th>
<th>Exam Marks</th>
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<tbody>
<tr>
<td>15 EI/BM/ML 32</td>
<td>20</td>
<td>80</td>
<td></td>
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</tr>
</tbody>
</table>

**Number of Lecture Hours/Week:** 04

**Total Number of Lecture Hours:** 50

**Exam Hours:** 03

**Credits - 4**

### Course Objectives:
This course will enable the students to
- Impart with the knowledge of generalized measurement systems.
- Learn the characteristics of various types of measurement systems and errors in measuring instruments.
- Analyze the circuits for the measurement of Resistance, Capacitance, Inductance, and Frequency.
- Impart with the basic concepts of CRO and its usage for the measurement of various parameters.
- Understand the concepts of Ammeters, Voltmeter and Multimeters
- Understand the importance of Display Devices and Recorders in practical fields

### Revised Bloom’s Taxonomy Levels:

### Modules

<table>
<thead>
<tr>
<th>Modules</th>
<th>Teaching Hours</th>
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</thead>
<tbody>
<tr>
<td><strong>Module -1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A). Measurements: introduction, Significance of measurements, methods of measurements, instruments and measurement systems, Functions of instruments and measurement systems, Applications of measurement systems. <strong>Measurement Errors:</strong> Introduction Gross errors and systematic errors, Absolute and relative errors, basic concepts of accuracy, Precision, Resolution and Significant figures, Measurement error combinations. (relevant problems)</td>
<td>10 Hours</td>
<td>L1, L2</td>
</tr>
<tr>
<td><strong>Module -2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A). Ammeters, Voltmeter and Multimeters: Introduction, DC ammeter principle only, DC voltmeter, Multi-range voltmeter, Extending voltmeter ranges, Loading, Peak responding and True RMS voltmeters. (relevant problems)</td>
<td>10 Hours</td>
<td>L1, L2, L3, L5</td>
</tr>
<tr>
<td>B). Digital Voltmeters: Introduction, Ramp type, Dual slope integrating type (V–T), integrating type (V–F) and Successive approximation type (relevant problems).</td>
<td></td>
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</tr>
</tbody>
</table>
**Digital Instruments:** Introduction, Block diagram of a Basic Digital Multi-meter. Digital frequency meters: Basic circuit of a Digital frequency meter, Basic circuit for frequency measurement.

**Module -3**  
A). **Oscilloscopes** : Introduction, Basic principles, CRT features, Block diagram and working of each block, Typical CRT connections, Dual beam and dual trace CROs, Electronic switch.  
B). **Special Oscilloscopes:**  
Delayed time-base oscilloscopes: Need for a time delay & delayed-time-base system.  
Analog storage oscilloscopes: Need for trace storage, bistable storage CRT, Variable persistence storage CRT.  
Digital storage oscilloscopes: Basic DSO operation only.

| 10 Hours | L1,L2,L3, L4 |

**Module -4**  
A). **Signal Generators** :  
Introduction, Fixed and variable AF oscillator, Standard signal generator, Modern laboratory signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator.  
B). **Bridge Circuits for Measurement of R, L & C:**  
DC bridges: Introduction, Wheatstone’s bridge, Kelvin Bridge  
AC bridges: Capacitance Comparison Bridge, inductance Comparison Bridge, Maxwell’s bridge, Schering Bridge. (relevant problems)

| 10 Hours | L1,L2,L3,L 5,L6 |

**Module -5**  
**Display Devices and Recorders:**  

| 10 Hours | L1,L2,L3,L 5 |

**Course Outcomes:** After studying this course, students will able to:  
- Analyze instrument characteristics, errors and generalized measurement system.  
- Analyze and use the circuit for the measurement of R, L, C, F, I, V etc  
- Use of Ammeters, Voltmeter and Multimeters and CRO for measurement  
- Analyze and interpret different signal generator circuits for the generation of various waveforms  
- Understand and use different display devices and recorders

**Graduate Attributes (as per NBA)**  
- Engineering knowledge  
- Problem analysis  
- Design & Development of Solutions  
- Modern tool usage

**Question Paper Pattern:**
The question paper will have TEN questions.
Each full question carry 16 marks
There will be TWO full questions (with maximum of FOUR sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer FIVE full questions, selecting ONE full question from each module.

**Text Books:**
1. “Electronic Instrumentation”, H. S. Kalsi, TMH, 2004 (Module- 2, 3 & 4)

**Reference Books:**
B.E. Biomedical Engineering (BM)  
Choice Based Credit System (CBCS)  
Semester - III  

**ANALOG ELECTRONIC CIRCUITS**  
(Common to EI, BM & ML)

<table>
<thead>
<tr>
<th>Subject Code</th>
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<tr>
<td>EI/BM/ML 33</td>
<td>20</td>
<td>04</td>
<td>80</td>
<td>50</td>
<td>03</td>
</tr>
</tbody>
</table>

Credits - 4

**Course Objectives:** This course will enable the students
- With the knowledge of Electronic devices.
- To know modeling of BJT and FET for analysis and to Design of BJT Amplifier, Hybrid Equivalent and Hybrid π Models.
- To know construction and characteristics of JFETs and MOSFETs.
- Describe various types of FET biasing, and Demonstrate use of FET amplifiers.
- Demonstrate and Generalize Frequency response of BJT and FET amplifiers at various frequencies.
- Analyze Power amplifier circuits in different modes of operation.
- To know the concept of Feedback and its effect on amplifier circuits and Oscillator circuits-operation and generation of low and high frequency signal using BJT/FET/Op-amp.

**Revised Bloom’s Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing, L5 – Evaluating, and L6 - Creating

### Modules

<table>
<thead>
<tr>
<th>Modules</th>
<th>Teaching Hours</th>
<th>Revised Bloom’s Taxonomy (RBT)Level</th>
</tr>
</thead>
</table>
| **Module -1 BJT AC Analysis**  
BJT modeling, re transistor model: Common Emitter Configuration, Voltage-Divider Bias, CE Emitter-Bias Configuration (Excluding Pspice Analysis), Emitter Follower Configuration, Determining Current Gain, Effect of \( R_L \) and \( R_S \), Cascaded Systems, RC- Coupled BJT Amplifier, Cascade Connection, Darlington Connection. The Hybrid Equivalent model, Approximate Hybrid Equivalent Circuit, Fixed bias configuration, Voltage-Divider configuration. (Relevant problems on above topics) Complete Hybrid Equivalent Model and Hybrid π Model. | 10 Hours | L1 L2 |
| **Module -2 Field Effect Transistors**  
Introduction, Construction and Characteristics of JFETs, Transfer Characteristics, Applying Shockley’s Equation.  
**Depletion Type MOSFET:** Basic Construction, Basic Operation and Characteristics, P-Channel Depletion Type MOSFET and Symbols,  
**Enhancement Type MOSFET:** Basic Construction, Basic Operation | 10 Hours | L1 L2 |
and Characteristics, P-Channel Enhancement Type MOSFETs and Symbols. Relevant problems on above topics, **CMOS-Basics.**

**FET Biasing**
Introduction, Fixed-Bias Configuration, Self-Bias Configuration, Voltage-Divider Biasing. Relevant problems on above topics

<table>
<thead>
<tr>
<th>Module -3</th>
<th>FET Amplifiers</th>
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</table>

| BJT and JFET Frequency Response: |
| Introduction, General Frequency Considerations, Low Frequency Response of BJT Amplifier, Low Frequency Response of FET Amplifier, Miller Effect Capacitance, High Frequency Response of FET Amplifier, Multistage frequency effects. Relevant problems on above topics. (Excluding P-spice Analysis) |

<table>
<thead>
<tr>
<th>Module -4</th>
<th>Power Amplifiers</th>
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</thead>
<tbody>
<tr>
<td>Introduction: Definitions and Amplifier Types, Series Fed Class A Amplifier, Transformer Coupled Class A Amplifier, Class B Amplifier operation.</td>
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</table>


<table>
<thead>
<tr>
<th>Module -5</th>
<th>Feedback and Oscillator Circuits</th>
</tr>
</thead>
</table>

| Course Outcomes: After studying this course, students will able to: |
| - Explain the Working principles, characteristics and basic applications of BJT and FET. |
| - Modeling of BJT/FET for analysis |
| - Design Single stage, Multistage amplifier, with and without feedback |
| - Analyze Frequency response of BJT and FET. |
| - Acquire the knowledge of classifications of Power amplifier, operation, and able to design power amplifier. |
| - Apply the knowledge gained in the design of BJT/FET circuits in Oscillators to generate different |

<table>
<thead>
<tr>
<th>10 Hours</th>
<th>L1, L2, L3</th>
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<table>
<thead>
<tr>
<th>10 Hours</th>
<th>L1,L2, L3,L4</th>
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</table>

<table>
<thead>
<tr>
<th>10 Hours</th>
<th>L2, L3</th>
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</thead>
</table>
frequency signals.

**Graduate Attributes (as per NBA)**
- Engineering Knowledge
- Problem Analysis
- Design / development of solutions (partly)
- Interpretation of data

**Question Paper Pattern:**
- The question paper will have TEN questions.
- Each full question carry 16 marks
- There will be TWO full questions (with maximum of FOUR sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

**Text Books:**

**Reference Books:**
1. David A. Bell, “Electronic Devices and Circuits”, Oxford University Press.
B.E. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester - III

DIGITAL DESIGN AND HDL
(Common to EI, BM & ML)

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<tr>
<td>15 EI/BM/ML 34</td>
<td>20</td>
<td>04</td>
<td>80</td>
<td>50</td>
<td>03</td>
</tr>
</tbody>
</table>

Credits - 4

Course Objectives: This course will enable the students to
- To impart the concepts of simplifying Boolean expression using K-map techniques and provide an understanding of logic families
- To impart the concepts of designing and analyzing combinational logic circuits
- To provide an understanding for the concepts of HDL-Verilog, data flow and behavioral models for the design of digital systems.
- To impart design methods and analysis of sequential logic circuits


<table>
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<tr>
<th>Modules</th>
<th>Teaching Hours</th>
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<tbody>
<tr>
<td>Module -1 Principles of combinational logic: Definition of combinational logic, Canonical forms, Generation of switching equations from truth tables, Karnaugh maps- up to 4 variables, Quine-McCluskey minimization technique Introduction to Verilog: Structure of Verilog module, Operators, data types, Styles of description- Data flow description, Behavioral description, Implement logic gates, half adder and full adder using Verilog data flow description.</td>
<td>10 Hours</td>
<td>L2,L3,L4</td>
</tr>
</tbody>
</table>

Module -2 Combinational Functions: Arithmetic Operations: Adders and subtractors-cascading full adders, Look ahead carry, Binary Comparators – 2 bit and 4 bit, two bit Multiplier, Verilog Description of for above circuits. Multiplexers- Realization of 2:1, 4:1 and 8:1 using gates & Applications. Demultiplexers: - Realization of 1:2 1:4 and 1:8 using basic gates & Applications Verilog Behavioral description: Structure, variable assignment statement, sequential statements, loop statements, Verilog behavioral description of Multiplexers (2:1,4:1,8:1) and De-multiplexers | 10 Hours | L1,L2,L3 |
**Module -3**

**Analysis and design of combinational logic:** Encoders: Binary coded decimal codes, Binary – Gray vice versa, BCD – Excess 3 Encoders: Realization and Priority Encoders, Decoders: BCD – Decimal, BCD – Seven segment, Seven segment display.

**Verilog behavioral description** of Encoders (8 to 3 with priority and without priority), Decoders (2 to 4).

| 10 Hours | L1,L2 |

| **Module -4**

**Sequential Logic Circuits-1:** Latches and Flip-Flops: SR-latch, D-latch, D flip-flop, JK flip-flop, T flip-flop Master slave FF, Edge trigger and Pulse trigger FF, Registers and Shift Registers: PISO, PIPO, SISO, SIPO, Right shift and left shift, Universal Shift register.

**Verilog behavioral description** of latches (D-latch, SR latch) and flip-flops (D, T, JK, SR flip-flops).

| 10 Hours | L2,L3,L6 |

| **Module -5**

**Counters, design and their applications:** Counters-Binary ripple counters, Synchronous binary counters, Modulo N counters – Synchronous and Asynchronous counters.

**Verilog behavioral description** of Synchronous and Asynchronous counters, sequential counters.

**Synthesis of Verilog:** Mapping process in the hardware domain - Mapping of signal assignment, variable assignment, if statements, else if statements, loop statements

| 10 Hours | L2,L3,L4,L6 |

**Course Outcomes:** After studying this course, students will able to:

- Simplify Boolean functions using K-map and Quine-McCluskey minimization technique
- Analyze, design and write verilog code for combinational logic circuits. (MUX, De-MUX, adder and subtractor, and comparator circuits)
- Analyze and design code converters, encoders and decoders.
- Analyze and design of synchronous sequential circuits
- Analyze sequential circuits, Moore/Mealy machines

**Graduate Attributes (as per NBA)**

- Engineering knowledge
- Problem analysis
- Design & Development of Solutions
- Modern tool usage

**Question Paper Pattern:**

- The question paper will have TEN questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with maximum of FOUR sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.
### Text Books:
1. *Digital Logic Applications and Design* by John M Yarbrough, Thomson Learning, 2001 (Modules 1, 2, 3, 4, 5 – Logic design)
2. *HDL Programming VHDL and Verilog* by Nazeih M. Botros, 2009 reprint, Dreamtech press (Modules 1, 2, 3, 4, 5 – Verilog description)

### Reference Books:
B.E. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester - III

HUMAN ANATOMY AND PHYSIOLOGY
(Common to BM and ML)

<table>
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<td>15 BM/ML 35</td>
<td>20</td>
<td>04</td>
<td>80</td>
<td>50</td>
<td>03</td>
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</table>

Credits - 4

Course Objectives:
- To understand the internal environment of human body and homeostasis mechanism
- To provide the basic knowledge of different types of tissues.
- To provide the knowledge of structure and functioning of nervous system, cardiovascular system, respiratory system, digestive system and musculoskeletal system
- To provide the knowledge of physiological parameters of normal health and factors affecting various physiological processes in the body.

**Revised Bloom’s Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

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<tr>
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</thead>
</table>
| **Module -1**  
*Introduction: Homeostasis, Tissue, Cartilage:* The internal environment and homeostasis, survival needs of the body, movement of substances within the body, body fluids, action potential, propagation of action potential, cell-structure and functions. Epithelial tissue- simple epithelium, stratified epithelium, connective tissue- cells of connective tissue, loose connective tissue, Adipose tissue, Dense connective tissue, Lymphoid tissue, Cartilage- Hyaline cartilage, Fibrocartilage, Elastic cartilage. | 10 Hours | L1, L2 |

| **Module -2**  
*Nervous System:* Functional Components of nervous system, Neurons: Properties of neurons, Cell bodies, Axon and Dendrites, Types of nerves, Synapse and neurotransmitters, neuromuscular junction. Central nervous system: Meninges, ventricles of the brain and CSF. Brain: Cerebrum, functions of cerebrum, functional areas of the cerebrum, Brainstem, Cerebellum, Spinal cord- grey matter, white matter, spinal reflex, Spinal nerves (in brief list & functions), Cranial nerves (in brief list & functions), Autonomic nervous system (in brief)- functions and effects. Pituitary gland and hypothalamus. | 10 Hours | L1, L2, L3, L4 |
### Module -3
**Cardiovascular System:** Introduction, Blood vessels- Arteries and Arterioles, Veins and Venules, capillaries, control of blood vessel diameter, blood supply- internal respiration, cell nutrition. Heart-position, structure-pericardium, myocardium, endocardium, interior of the heart, flow of blood through the heart, blood supply to heart, Conducting system of the heart, factors affecting heart rate, the Cardiac cycle, cardiac output, blood pressure, control of blood pressure, pulse and factors affecting the pulse rate. Circulation of the blood- pulmonary circulation, systemic circulation-aorta (different parts of aorta & their blood supply, in brief). Summary of the main blood vessels (arteries & veins, explanation with flow diagram only)

| 10 Hours | L1, L2, L3, L4 |

### Module -4
**Respiratory System:** Organs of respiration, Nose and Nasal cavity-position, structure and functions, pharynx - position, structure, functions. Larynx - position, structure and functions. Trachea, bronchi, bronchioles and alveoli, lungs- position, associated structure, pleura and pleural cavity. Respiration - muscles of respiration, cycle of respiration, variables affecting respiration, lung volumes and capacity

**Digestive System:** Organs of the digestive system – mouth, tongue, teeth, salivary glands, pharynx, oesophagus, stomach, gastric juice and functions of stomach, small intestine-structure, chemical digestion in small intestine, large intestine - structure, functions of the large intestine. Pancreas and Liver.

| 10 Hours | L1, L2, L3, L4 |

### Module -5
**Skeletal System:** Bone, Types of bone, structure, bone cells, functions of bone. Axial skeleton- skull, sinuses, Fontanelles, vertebral column characteristics of typical vertebra, different parts of vertebral column (parts only), features of vertebral column, movements and functions of vertebral column, sternum, ribs, shoulder girdle and upper limb, pelvic girdle and lower limb.

**Muscles and Joints (Study of muscles along with joints):** Muscle tissue: Skeletal muscle, Smooth muscle, Cardiac muscle, functions of muscle tissue, muscle tone and fatigue. Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radioulnar joint, wrist joint, Hip joint, Knee joint, ankle joint.

| 10 Hours | L1, L2 |

### Course Outcomes:
After studying this course, students will able to:
- Describe internal environment of human body and explain the fundamental concept of homeostasis.
- Explain the structure and functioning of various types of tissues.
- Describe the structure and explain the functioning of various nervous system, cardiovascular.
- system, respiratory system, digestive system and musculoskeletal system.
- Demonstrate and analyze various physiological parameters in normal and abnormal conditions.

**Graduate Attributes (as per NBA)**
- Engineering knowledge
- Problem analysis
- Investigation of Complex Problem
- Lifelong learning

**Question Paper Pattern:**
- The question paper will have TEN questions.
- Each full question carry 16 marks
- There will be TWO full questions (with maximum of FOUR sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

**Text Books:**

**Reference Books:**
# B.E. Biomedical Engineering (BM)
## Choice Based Credit System (CBCS)
### Semester - III

## NETWORK ANALYSIS
(Common to EI, BM & ML)

<table>
<thead>
<tr>
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<tr>
<td>: 15 EI/BM/ML 36</td>
<td>20</td>
<td>80</td>
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</table>

### Credits - 4

**Course Objectives:** This course will enable the students to
- To introduce the Basic circuit laws, Network theorems and Analyze the networks.
- To analyze the networks by using optimized methods
- To analyze the network behavior during switching states.
- To realize the network parameters.

**Revised Bloom’s Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analysing, L5 – Evaluating, and L6 - Creating

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<tr>
<td><strong>Module -1</strong>&lt;br&gt;Basic concepts: Sources of electrical energy, Source transformation &amp; Source shifting, Network reduction using star-delta transformation, loop and node analysis with dependent &amp; independent sources for DC networks, concept of super node and super mesh analysis for only independent sources for DC networks.</td>
<td>10 Hours</td>
<td>L₁=Remembering, L₂=Understanding, L₃=Applying, L₄=Analysis.</td>
</tr>
<tr>
<td><strong>Module -2</strong>&lt;br&gt;Network theorems: Super position, reciprocity, Millman’s theorem (for DC networks), Thevinin’s&amp; Norton’s theorem (for DC networks), and Maximum power transfer theorems (for AC &amp; DC networks)</td>
<td>10 Hours</td>
<td>L₁=Remembering, L₂=Understanding, L₃=Applying, L₄=Analysis</td>
</tr>
<tr>
<td><strong>Module -3</strong>&lt;br&gt;Transient behavior and initial conditions: Behavior of circuit elements under switching condition and their representation, evaluation of initial &amp; final conditions in RL, RC &amp; RLC circuits for DC excitations. Two port network parameters: Definitions and modeling of Z, Y, H &amp; transmission parameters.</td>
<td>10 Hours</td>
<td>L₁=Understanding, L₂=Analyzing, L₃=Applying, L₄=Synthesis</td>
</tr>
<tr>
<td><strong>Module -4</strong>&lt;br&gt;Resonant Circuits: Series resonance: Variation of current and voltage with frequency, Selectivity &amp; Bandwidth, Q-factor Parallel resonance: General case-resistance present in both branches, Selectivity &amp; Bandwidth, Maximum impedance conditions with Capacitor, Inductor or</td>
<td>10 Hours</td>
<td>L₁=Understanding, L₂=Analyzing, L₃=Applying, L₄=Realizing</td>
</tr>
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</table>
frequency as variable.

**Module -5**

**Network topology:** Graph of a network, concepts of: tree & co-tree, incidence matrix, tie-set & cut-set schedules, Solution of resistive networks using equilibrium equations in matrix form, Principle of duality.

| 10 Hours | \( L_1 = \) Understanding \( L_2 = \) Analyzing \( L_3 = \) Applying \( L_4 = \) Evaluation |

**Course Outcomes:** After studying this course, students will able to:
- Apply the basic concepts (Laws, theorems) of networks to obtain solution.
- Choose the Appropriate/specific technique to analyze the networks.
- Realize and Analyze the network behavior

**Graduate Attributes (as per NBA)**
- Applying the Engineering concepts to analyze the networks
- Realizing and solving the complex circuits

**Question Paper Pattern:**
- The question paper will have TEN questions.
- Each full question carry 16 marks
- In each full question, preferably 40% should be related to theoretical concepts/derivations and 60% should be related problems/solutions.
- There will be TWO full questions (with maximum of FOUR sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

**Text Books:**

**Reference Books:**
# B.E. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester - III

## ANALOG ELECTRONIC CIRCUITS LAB
(Common to EI, BM & ML)

<table>
<thead>
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</tr>
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<tr>
<td>: 15 EI/BM/ML L37</td>
<td>: 03</td>
<td>: 20</td>
<td>: 80</td>
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<tr>
<td>Number of Practical Hours/Week</td>
<td>: 03</td>
<td>Exam Hours</td>
<td>: 03</td>
</tr>
<tr>
<td>Total Number of Practical Hours</td>
<td>: 42</td>
<td>Exam Hours</td>
<td>: 03</td>
</tr>
</tbody>
</table>

Credits - 2

## Course Objectives:
This laboratory course enables students to get practical knowledge & experience in design, assembly and evaluation/testing of:
- Rectifier circuits without and with filter
- BJT as Amplifier without and with feedback
- JFET Characteristics and as Amplifier.
- MOSFET Characteristics
- BJT as Power Amplifiers
- Oscillators using BJT and FET for frequency generation
- UJT characteristics
- Verification of Theorems and applications in practical fields

## Revised Bloom’s Taxonomy Levels:

## Laboratory Experiments
NOTE: The experiments are to be carried using discrete components only

<table>
<thead>
<tr>
<th>Laboratory Experiments</th>
<th>Revised Bloom’s Taxonomy (RBT)Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>To design and testing of the following rectifiers with and without filters: (a) Full Wave Rectifier (center tap) (b) Bridge Rectifier.</td>
<td>L3, L4, L5, L6</td>
</tr>
<tr>
<td>To plot characteristics of UJT and to determine its intrinsic stand-off ratio.</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>To design and test the common emitter amplifier (voltage divider bias) without feedback and determine input, output impedance, gain and bandwidth.</td>
<td>L3, L4, L5, L6</td>
</tr>
<tr>
<td>To design and test the Emitter follower amplifier (BJT) using voltage divider bias and determine input, output impedance, gain and bandwidth.</td>
<td>L3, L4, L5, L6</td>
</tr>
<tr>
<td>To plot the Drain and Transfer characteristic for the given FET and to find the Drain Resistance and Trans-conductance.</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>To design, test and to plot the frequency response of Common Source JFET/MOSFET amplifier, and to determine its bandwidth.</td>
<td>L3, L4, L5, L6</td>
</tr>
<tr>
<td>To plot the input and output characteristics of n-channel MOSFET and calculate its parameters, namely; drain resistance, mutual conductance and amplification factor.</td>
<td>L1, L2, L3, L4</td>
</tr>
</tbody>
</table>
8. Wiring and testing of Complimentary symmetry class B push pull power amplifier and calculation of efficiency.  

9. To design and test the RC-Phase shift Oscillator using BJT for the given frequency.  

10. To design and test the following tuned oscillator circuits for the given frequency. (a) Hartley Oscillator using BJT (b) Colpitts Oscillator using FET.  

11. Testing of crystal oscillator and to determine its frequency of oscillation.  

12. Verification of Thevenin’s theorem and Maximum Power Transform theorem for the given DC circuits.  

<table>
<thead>
<tr>
<th>Course Outcomes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>After studying this course, students will able to:</td>
</tr>
<tr>
<td>• Acquire the Working principles, characteristics and basic applications of BJT and FET.</td>
</tr>
<tr>
<td>• Modeling of BJT/FET for analysis</td>
</tr>
<tr>
<td>• Able to design Single stage, Multistage amplifier, with and without feedback</td>
</tr>
<tr>
<td>• Able to analyze Frequency response of BJT and FET.</td>
</tr>
<tr>
<td>• Acquire the knowledge of Power amplifiers, operation, and able to design power amplifier.</td>
</tr>
<tr>
<td>• Apply the knowledge gained in the design of BJT/FET circuits in Oscillators to generate different frequencies and their applications.</td>
</tr>
<tr>
<td>• Knowledge of UJT characteristics and its application.</td>
</tr>
<tr>
<td>• Applications of theorems in various practical fields.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Graduate Attributes (as per NBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Engineering Knowledge.</td>
</tr>
<tr>
<td>• Problem Analysis.</td>
</tr>
<tr>
<td>• Design / development of solutions (partly)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conduct of Practical Examination:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All laboratory experiments are to be included for practical examination.</td>
</tr>
<tr>
<td>2. Students are allowed to pick one experiment from the lot.</td>
</tr>
<tr>
<td>3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.</td>
</tr>
<tr>
<td>4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reference Books:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Electronics Laboratory Primer - A Design Approach by S.Poorna Chandra, B.Sasikala, S Chand Pub.</td>
</tr>
</tbody>
</table>
B.E. Biomedical Engineering (BM)  
Choice Based Credit System (CBCS)  
Semester - III  

DIGITAL DESIGN AND HDL LAB  
(Common to EI, BM & ML)  

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Marks</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 EI/BM/ML L38</td>
<td>20</td>
<td>80</td>
<td>2</td>
</tr>
</tbody>
</table>

Number of Practical Hours/Week : 03  
Exam Hours : 03  

Total Number of Practical Hours : 42  

Course Objectives:  This course will enable the students to  
- The operation of various logic gates and digital circuits and write the Verilog code.  
- Design of logic circuits for combinational and sequential circuits and write Verilog code.  
- Synthesis of digital circuits, FFs, shift registers and counters using ICs.  
- To use FPGA/CPLD kits for downloading the Verilog code and test the output.  


Laboratory Experiments:  

Note:  
(1) Use discrete components to test and verify the logic gates.  
(2) Use FPGA/CPLD kits for downloading the Verilog code and test the output.  

1. Simplification, realization of Boolean expressions using logic gates/Universal gates  
   Revised Bloom’s Taxonomy (RBT) Level: L1,L2,L3  

2. To design and implement  
   a) Adder/Subtractor – Full/half using logic gates.  
   b) 4-bit Parallel Adder/subtractor using IC 7483.  
   Revised Bloom’s Taxonomy (RBT) Level: L3, L4, L5,L6  

3. To realize  
   a) BCD to Excess-3 code conversion and vice versa  
   b) Binary to Gray code conversion and vice versa  
   Revised Bloom’s Taxonomy (RBT) Level: L2,L3, L4  

4. To realize  
   a) 4:1 Multiplexer using gates  
   b) 1:8 Demux  
   c) Priority encoder and 3:8 Decoder using IC74138  
   d) One / Two bit comparator  
   Revised Bloom’s Taxonomy (RBT) Level: L2, L3, L4  

5. To realize the following flip-flops using NAND Gates  
   (a) T type (b) JK Master slave (c) D type  
   Revised Bloom’s Taxonomy (RBT) Level: L2, L3, L4  

6. To realize the 3-bit counters as a sequential circuit and Mod-N Counter design  
   (7476, 7490, 74192, 74193)  
   Revised Bloom’s Taxonomy (RBT) Level: L2, L3, L4  

7. Adder/Subtractor – Full/half using Verilog data flow description  
   Revised Bloom’s Taxonomy (RBT) Level: L2, L3, L4  

8. Code converters using Verilog Behavioral description  
   a) Gray to binary and vice versa  
   b) Binary to excess3 and vice versa  
   Revised Bloom’s Taxonomy (RBT) Level: L2, L3, L4  

9. Multiplexers/decoders/encoder using Verilog Behavioral description  
   - 8:1 mux, 3:8 decoder, 8:3 encoder, Priority encoder  
   - 1:8 Demux and verify using test bench  
   Revised Bloom’s Taxonomy (RBT) Level: L2, L3, L4
- 2-bit Comparator using behavioral description

10. Flip-flops using Verilog Behavioral description
   a) JK type    b) SR type    c) T type and    d) D type
   L2, L3, L4

11. Counter up/down (BCD and binary), sequential counters using Verilog
    Behavioral description
   L2, L3, L4

12. Interface experiments: (a) Stepper motor (b) Relay (c) Waveform generation
    using DAC
   L2, L3, L4

Course Outcomes: After studying this course, students will able to:
- Realize Boolean expression using Universal gates / basic gates using ICs and Verilog
- Demonstrate the function of adder/subtractor circuits using gates/ICs & Verilog.
- Design and analyze the Comparator, Multiplexers Decoders, Encoders circuits using ICs and
  Verilog.
- Design and analysis of different Flip-flops and counters using gates and FFs
- Able to use FPGA/CPLD kits for downloading Verilog codes for shift registers and counters and
  check output.

Graduate Attributes (as per NBA)
- Engineering Knowledge.
- Problem Analysis.
- Design/Development of solutions

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be
   made zero

Text Books:
2. HDL Programming VHDLAnd Verilog ByNazeih M. Botros, 2009 reprint, Dreamtech press.

Reference Books:
1. Digital Logic Applications and Design by John M Yarbrough, Thomson Learning,2001
2. Fundamentals of HDL- Cyril P R Pearson/Sanguin 2010
IV SEMESTER

B.E. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester - III

ENGINEERING MATHEMATICS-IV
(Common to All Branches)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Number of Lecture Hours/Week</th>
<th>Exam Marks</th>
<th>Total Number of Lecture Hours</th>
<th>Exam Hours</th>
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<tbody>
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<td>15MAT41</td>
<td>20</td>
<td>04</td>
<td>80</td>
<td>50</td>
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</tbody>
</table>

Credits - 4

Course Objectives: This course will enable the students to


<table>
<thead>
<tr>
<th>Modules</th>
<th>Teaching Hours</th>
<th>Revised Bloom’s Taxonomy (RBT) Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module -1</td>
<td>10 Hours</td>
<td></td>
</tr>
<tr>
<td>Module -2</td>
<td>10 Hours</td>
<td></td>
</tr>
<tr>
<td>Module -3</td>
<td>10 Hours</td>
<td></td>
</tr>
</tbody>
</table>
Module -4

10 Hours

Module -5

10 Hours

Course Outcomes: After studying this course, students will able to:

Graduate Attributes (as per NBA)

Question Paper Pattern:
- The question paper will have TEN questions.
- Each full question carry 16 marks
- There will be TWO full questions (with maximum of FOUR sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

Reference Books:
IV SEMESTER

B.E. Electronics and Instrumentation Engineering (EI)
Choice Based Credit System (CBCS)
Semester – IV

SIGNAL CONDITIONING AND DATA ACQUISITION CIRCUITS
(Common to EI, BM & ML) [Revised]

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Number of Lecture Hours/Week</th>
<th>Exam Marks</th>
<th>Total Number of Lecture Hours</th>
<th>Exam Hours</th>
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<tbody>
<tr>
<td>15 EI/BM/ML42</td>
<td>20</td>
<td>04</td>
<td>80</td>
<td>50</td>
<td>03</td>
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</tbody>
</table>

Credits – 4

Course Objectives: This course will enable the students to
- Define and describe Op Amp, basic concepts, characteristics and specifications
- Gain knowledge about Linear and nonlinear applications opamp.
- Design and develop circuits like, amplifiers, filters, Timers to meet industrial requirements.
- Get a firm grasp of basic principles of opamp.


<table>
<thead>
<tr>
<th>Modules</th>
<th>Teaching Hours</th>
<th>Revised Bloom’s Taxonomy (RBT)Level</th>
</tr>
</thead>
</table>
| Module -1

Basic op-amp applications – Scale changer/Inverter.

Summing amplifier: Inverting summing amplifier, Non-inverting Summing amplifier, Subtractor, Instrumentation Amplifier. (Relevant problems).

| Module -2
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 Hours</td>
<td>L1,L2, L3,L4</td>
</tr>
</tbody>
</table>


Page 23 of 39
comparator (Schmitt Trigger), Astable multivibrator, Monostable multivibrator and Triangular waveform generator. Phase shift oscillator, Wien bridge oscillator. (Relevant problems).

**Module -3**

**Voltage Regulators:** Introduction, Series Op-amp regulator, IC voltage regulators, 723 general purpose regulators, switching regulator.

**Active filters:** First and Second order LPF, First and Second orders HPF, Band Pass Filters, Band Reject filters. (Design examples).

| 10 Hours | L1,L2, L3,L4 |

**Module -4**


**Phase Locked Loops:** Basic Principles, Analog phase Detector/comparator, Voltage controlled oscillator. PLL applications: Frequency Multiplication/Division, Frequency translation, FM demodulation.

| 10 Hours | L2,L3,L4, L5, L6 |

**Module -5**

**Data Acquisition Systems:** Types of instrumentation systems, Components of analog data acquisition system, Digital data acquisition system, Use of recorders in digital systems, Digital recording systems.

**Data Converters:**

**Digital to Analog Converters:** Basic DAC techniques, Weighted Resistor DAC, R – 2R Ladder DAC, DAC 0800 (Data sheet: Features and description only).

**Analog to Digital Converters:** Functional diagram of ADC, Flash ADC, Counter type ADC, Successive approximation ADC, Dual slope ADC. ADC 0809 (Data sheet: Features, specifications and description only), DAC/ADC specifications.

| 10 Hours | L2, L3,L4, L5, L6 |

**Course Outcomes:** After studying this course, students will able to:

1. Understand the basic principles and operation of op-amp.
2. Design and develop circuits to meet the practical applications
3. Implement and integrate the op-amp circuits in electronic gadgets.

**Graduate Attributes (as per NBA)**

- Engineering knowledge
- Problem analysis
- Design & development of solutions
- Investigation of Complex Problem

**Question Paper Pattern:**
The question paper will have TEN questions.
Each full question carry 16 marks.
There will be TWO full questions (with maximum of FOUR sub questions) from each module.
Each full question will have sub questions covering all the topics under a module.
The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

Reference Books:
B.E. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester - III

EMBEDDED CONTROLLERS
(Common to EI, BM & ML)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Number of Lecture Hours/Week</th>
<th>Exam Marks</th>
<th>total number of lecture hours</th>
<th>exam hours</th>
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<tbody>
<tr>
<td>15 EI/BM/ML 43</td>
<td>20</td>
<td>04</td>
<td>80</td>
<td>50</td>
<td>03</td>
</tr>
</tbody>
</table>

Credits - 4

Course Objectives: This course enables students to understand:
- Basics of Microprocessor and Microcontroller
- 8051 Microcontroller architecture and Pin description
- 8051 Addressing modes and instruction set
- Programming of on-chip peripherals in 8051
- Design and develop applications using 8051 Assembly language and C program.
- MSP 430 Microcontroller architecture
- On-chip peripherals and program using Assembly language and C.


<table>
<thead>
<tr>
<th>Modules</th>
<th>Teaching Hours</th>
<th>Revised Bloom’s Taxonomy (RBT)Level</th>
</tr>
</thead>
</table>

Module -1

10 Hours | L1,L2

Module -2

10 Hours | L1,L2
### Module -3
**8051 programming in C and interfacing.** Data types and time delay in 8051 C, I/o programming, Logic operation, data conversion programs, accessing Code ROM Space, data serialization. **8051 interfacing** to LCD and key board, DAC, stepper motor, DC Motor, Parallel and serial ADC, Elevator.

| 10 Hours | L2,L3,L4 |

### Module -4
**Timer/ Counter, Serial communication and Interrupts in 8051.** Programming 8051 timer/ counter, programming timer 0 and 1 in 8051 C, Basics of serial communication, 8051 connections to **RS-232**. 8051 serial port programming in assembly and C. 8051 Interrupts, Programming Timer Interrupts, External hardware Interrupts and serial communication Interrupts. Interrupts priority & Interrupt programming in C.

| 10 Hours | L2,L3,L4,L5 |

### Module -5

| 10 Hours | L1,L2,L3 |

### Course Outcomes:
After studying this course, Student will be able to:
- Learn architecture of 8051 and MSP 430.
- Learn programming skills using Assembly language and C
- Design and interfacing of microcontroller based embedded systems.
- Build projects

### Graduate Attributes (as per NBA)
- Engineering Knowledge
- Problem Analysis
- Design and Development of solutions
- Modern Tool usage

### Question Paper Pattern:
- The question paper will have TEN questions.
- Each full question carry 16 marks
- There will be TWO full questions (with maximum of FOUR sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

### Text Books:
Reference Books:

Course Objectives: This course will enable the students to
- Understand the basic concepts & mathematical modeling of systems
- Draw block diagram & reduction for a given system
- Obtain Transfer functions by reduction and Signal Flow graph techniques.
- Analyze the system response in time and frequency domain
- Understand and Design of control systems using state space analysis


<table>
<thead>
<tr>
<th>Modules</th>
<th>Teaching Hours</th>
<th>Revised Bloom’s Taxonomy (RBT) Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module -1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modeling of Systems and Block diagram:</td>
<td>10 Hours</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>Introduction to Control Systems, Types of</td>
<td></td>
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</tr>
<tr>
<td>Control Systems, with examples. Concept of</td>
<td></td>
<td></td>
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<tr>
<td>mathematical modeling of physical systems-</td>
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<tr>
<td>Mechanical, Translational (Mechanical</td>
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<td>accelerometer, systems excluded), and</td>
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<td>Rotational systems, Analogous systems based</td>
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<td></td>
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<tr>
<td>on force voltage analogy and force current</td>
<td></td>
<td></td>
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<tr>
<td>analogy. Introduction to Block diagram</td>
<td></td>
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<tr>
<td>algebra. Numerical problems on all topics.</td>
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<tr>
<td><strong>Module -2</strong></td>
<td></td>
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<tr>
<td>Signal Flow graph:</td>
<td>10 Hours</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>Introduction to Signal Flow graph, Mason’s</td>
<td></td>
<td></td>
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<tr>
<td>gain formula. Obtaining Transfer functions</td>
<td></td>
<td></td>
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<tr>
<td>for the given SFG using Mason’s gain formula.</td>
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<tr>
<td>Time response analysis:</td>
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<tr>
<td>Introduction. Standard test signals,</td>
<td></td>
<td></td>
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<tr>
<td>response of first order &amp; second order</td>
<td></td>
<td></td>
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<tr>
<td>systems for unit step input. Steady state</td>
<td></td>
<td></td>
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<td>errors &amp; Error constants. Numerical problems</td>
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<tr>
<td>on all topics.</td>
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<td><strong>Module -3</strong></td>
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<tr>
<td>Concepts of stability:</td>
<td>10 Hours</td>
<td>L2, L3, L4, L5</td>
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<tr>
<td>The Concept of stability. Necessary</td>
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<tr>
<td>conditions for stability. Hurwitz</td>
<td></td>
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<tr>
<td>stability criterion. Routh stability</td>
<td></td>
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<tr>
<td>criterion. Relative stability analysis</td>
<td></td>
<td></td>
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<tr>
<td>using RH Criterion.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Root Locus Technique:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduction. Root locus concepts.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Construction of root loci. Stability analysis using Root locus Technique Numerical problems on all topics.

| --- | --- | --- | --- |

| --- | --- | --- | --- |

Course Outcomes: After studying this course, students will able to:
- Apply modeling knowledge in implementation physical systems.
- Understand the reduction of block diagram & analyze using Signal flow graph.
- Comment on performance of a system by evaluating various parameters.
- Model a system by applying the concept of State Space analysis
- Design and develop portable control systems

Graduate Attributes (as per NBA)
- Engineering knowledge
- Problem analysis
- Design & Development of Solutions
- Investigation of Complex Problem

Question Paper Pattern:
- The question paper will have TEN questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with maximum of FOUR sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

Reference Books:
B.E. Biomedical Engineering (BM)  
Choice Based Credit System (CBCS)  
Semester - IV  

<table>
<thead>
<tr>
<th>BIOMEDICAL TRANSDUCERS AND MEASUREMENTS</th>
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<tr>
<td>Subject Code</td>
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<tr>
<td>Number of Lecture Hours/Week</td>
</tr>
<tr>
<td>Total Number of Lecture Hours</td>
</tr>
<tr>
<td>Credits</td>
</tr>
</tbody>
</table>

**Course Objectives:** This course will enable the students to  
- Gain the knowledge of working principle and construction details of Biomedical Transducers.  
- Acquire the knowledge of transducer applications to access the biological signals.  
- Access the performance of various Biomedical Transducers.

**Revised Bloom’s Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

<table>
<thead>
<tr>
<th>Modules</th>
<th>Teaching Hours</th>
<th>Revised Bloom’s Taxonomy (RBT)Level</th>
</tr>
</thead>
</table>
| Module -1  
FUNDAMENTAL CONCEPTS & BASIC TRANSDUCERS:  
Introduction, Classification of Transducers, Measurement, Signals and Noise in the measurement-
Measurement, signals and noise, signal to noise ratio, different types of noise. Characteristics of Measurement system-
Transducer and measurement system, static characteristics, dynamic characteristics, standard and calibration, accuracy and error. Displacement, Position and Motion Transducers. | 10 Hours        | L1, L2, L3                      |
| Module -2  
BIOELECTRIC SIGNALS AND ELECTRODES:  
Sources of Biomedical Signals, Origin of Bioelectric Signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes–Electrode-tissue interface, Electrolyte-Skin interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes. | 10 Hours        | L1, L2, L3                      |
| Module -3  
PRESSURE MEASUREMENT: Pressure Transducers-LVDT pressure transducers and Strain gauge pressure transducers, Physiological pressure ranges and measurement sites, Direct | 10 Hours        | L1, L2, L3                      |
**Module -4**


<table>
<thead>
<tr>
<th>Time</th>
<th>L1, L2, L3</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hours</td>
<td>L1, L2, L3</td>
</tr>
</tbody>
</table>

**Module -5**


<table>
<thead>
<tr>
<th>Time</th>
<th>L1, L2, L3</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Hours</td>
<td>L1, L2, L3</td>
</tr>
</tbody>
</table>

**Course Outcomes:** After studying this course, students will able to:
1. Understand the working principle and construction details of Transducers.
2. Improve the measurement techniques through different approach.
3. Practically can implement the technology in measurement field.

**Graduate Attributes (as per NBA)**
- Engineering knowledge
- Modern tool usage
- Engineer and society
- Environment& sustainability
- Lifelong learning

**Question Paper Pattern:**
- The question paper will have TEN questions.
- Each full question carry 16 marks
- There will be TWO full questions (with maximum of FOUR sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

**Text Books:**
Reference Books:


2. **Transducers and Instrumentation** - D. V. S. Murty Prentice Hall India Pvt ltd. 2nd Edition
## B.E. Biomedical Engineering (BM)  
Choice Based Credit System (CBCS)  
Semester - III  

### SCIENTIFIC AND ANALYTICAL INSTRUMENTATION  
(Common to EI, BM & ML)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>IA Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 EI/BM/ML</td>
<td>20</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Number of Lecture Hours/ Week</th>
<th>Exam Marks</th>
<th>Exam Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>04</td>
<td>80</td>
<td>03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Number of Lecture Hours</th>
<th>Credits - 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

### Course Objectives:
- To introduce the basic concept of qualitative and quantitative analysis of a given sample.
- To impart various spectroscopic techniques and its instrumentation.
- To impart the concept of separation science and its application.
- To impart methods of Industrial analyzers and its application.

### Revised Bloom’s Taxonomy Levels:

<table>
<thead>
<tr>
<th>Modules</th>
<th>Teaching Hours</th>
<th>Revised Bloom’s Taxonomy (RBT)Level</th>
</tr>
</thead>
</table>
| Module -1  
An introduction to instrumental methods: Terms associated with Chemical analysis, Classification of instrumental techniques, A review of important consideration in analytical methods, Basic functions of instrumentation, Nature of EM radiation, EM spectrum. Atomic energy levels, Molecular electronic energy levels, vibrational energy levels, Fundamental Levels of photometry, IR Spectroscopy: Basic Components of IR Spectrophotometers, Fourier Transform IR Spectroscopy | 10 Hours | L1, L2 |
| Module -2  
UV and visible Spectrometers –instrumentation : Radiation Sources, Wavelength selection, Detector, Readout modules, Instruments for absorption photometry | 10 Hours | L1, L2 |
| Module -3  
Flame emission and atomic absorption spectroscopy: Introduction, Instrumentation for flame spectrometric methods, Flame emission spectrometry, atomic absorption spectrometry, Atomic fluorescence spectrometry, Interferences associated with Flames & furnaces, applications, comparison of FES and AAS | 10 Hours | L1, L2 |
| Module -4 | 10 Hours | L1, L2, L3 |
Gas Chromatography: Chromatograph, Basics parts of a chromatograph, Methods of measurements of peak areas, HPLC: HPLC Instrumentation, Mobile –phase delivery system sample introduction, separation of columns, Detectors – Ultraviolet Photometers & Spectrophotometers, electro chemicals detector (amperometric detector), Differential refractometers

Module -5

Course Outcomes:
1. The students get well versed with the principle, construction and working of various analytical instrumentation.
2. Students get detailed information about the application of analytical techniques in medicine, Industry, etc.

Graduate Attributes (as per NBA)
- Engineering Knowledge
- Problem Analysis
- Life-long Learning

Question Paper Pattern:
- The question paper will have TEN questions.
- Each full question carry 16 marks
- There will be TWO full questions (with maximum of FOUR sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

Reference Books:
## B.E. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester - III

### EMBEDDED CONTROLLERS LAB
(Common to EI, BM & ML)

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Exam Marks</th>
<th>Exam Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 EI/BM/ML L47</td>
<td>20</td>
<td>80</td>
<td>03</td>
</tr>
</tbody>
</table>

- **Number of Practical Hours/Week**: 03
- **Total Number of Practical Hours**: 42
- **Credits**: 2

### Course Objectives:
This laboratory course enables students to:
- Write 8051 Assembly language and C programs for 8051 and MSP430.
- Interface hardware modules to Microcontroller board.
- Develop applications based on Microcontroller 8051 and MSP430.

### Revised Bloom’s Taxonomy Levels:

### Laboratory Experiments
Note: Software and Hardware program using KEIL software and MSP 430 IDE.

#### Software program using 8051 μc
Simple Assembly Language;
1. Program using 8051 in Block, Move, Exchange.
2. Program in sorting, finding largest and smallest element in an array.
3. Counters --> For Hex and BCD up/down count.
4. Boolean and Logical Instructions. (Bit Manipulation).
5. Subroutines using CALL and RETURN instructions.
6. Code Conversions --> ASCII to Decimal, Decimal to ASCII, BCD to ASCII
7. Programs to generate delay, programs using serial port and on chip timer/counter.  
   - **Revised Bloom’s Taxonomy (RBT)Level**: L2, L3, L4

#### Software program using MSP 430 IDE
8. Assembly program using MSP 430 for data transfer, Block Move in an array.  
   - **Revised Bloom’s Taxonomy (RBT)Level**: L2, L3, L4

#### Hardware programming (using 8051)
9. Stepper motor Interface to 8051 Microcontroller with C Program.
10. DC Motor Interface to 8051 Microcontroller with C Program
11. DAC Interface for to generate sine wave, square wave, triangular wave, Ramp wave through 8051 Microcontroller with C Program.
13. ADC Interfacing  
   - **Revised Bloom’s Taxonomy (RBT)Level**: L3, L4, L5

### Course Outcomes:
After the completion of this Laboratory course, students will be able to:
- Get hands-on exposure in 8051 and MSP 430 platform.
- Enhance programming skills using Assembly language and C.
- Design and interfacing of microcontroller based embedded systems.
- Build projects

Graduate Attributes (as per NBA)
- Engineering Knowledge
- Problem Analysis
- Design and Development of solutions
- Modern Tool usage
- Individual and Team work

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:
B.E. Biomedical Engineering (BM)  
Choice Based Credit System (CBCS)  
Semester - IV

BIOMEDICAL TRANSDUCERS AND MEASUREMENTS LAB

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>Number of practical Hours/Week</th>
<th>Exam Marks</th>
<th>Total Number of practical Hours</th>
<th>Exam Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>15BML48</td>
<td>20</td>
<td>03</td>
<td>80</td>
<td>42</td>
<td>03</td>
</tr>
</tbody>
</table>

Credits - 2

**Course Objectives:** This Lab course will enable the students to

- Impart the working principle of sensors and transducer
- Testing the response and plot the characteristics of different transducers
- Interpret and analyze experimental results with theoretical concepts.
- Calibrate the sensors/transducers
- Study and interpret data sheets of different transducers to select the suitable transducer for particular application and safe operation.
- Understand the basic concepts and procedure for the measurement of BP, solution concentration, pH and conductivity.

**Revised Bloom’s Taxonomy Levels:** L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

**LIST OF EXPERIMENTS**

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Revised Bloom’s Taxonomy (RBT) Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Measurement of displacement using LVDT &amp; determine its sensitivity and resolution.</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>2. Temperature measurement using RTD, Thermistor and Thermocouple, and to find their sensitivity.</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>3. Temperature measurement using AD590 / LM34.</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>4. Characteristics of LDR, Photodiode &amp; Phototransistor by variable illumination &amp; variable distance.</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>5. Measurement of unknown resistance by Wheatstone bridge &amp; finding the sensitivity of the bridge.</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>7. Measurement of inductance and internal resistance of a choke by three voltmeter method.</td>
<td>L1, L2, L3</td>
</tr>
<tr>
<td>8. Measurement of unknown capacitance using Schering’s bridge.</td>
<td>L1, L2, L3</td>
</tr>
<tr>
<td>9. Characteristics of Load cell and Cantilever beam using Strain gauge (Quarter, Half and Full bridge configuration)</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>10. Measurement of blood pressure using sphygmomanometer and automatic digital BP instrument. Finding the systolic and diastolic values and calculate Mean Arterial Pressure (MAP).</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>11. Measurement of unknown concentration of given solution/body fluid using Spectrophotometer and Colorimeter</td>
<td>L1, L2, L3, L4</td>
</tr>
<tr>
<td>12. (a) Measurement of pH of a given solution/ body fluid using pH meter. (b) Determination of Conductivity of a given unknown solution/ body fluid using conductivity meter</td>
<td>L1, L2, L3, L4</td>
</tr>
</tbody>
</table>
Course Outcomes: After studying this course, students will able to:
- Analyze the response and plot the characteristics of temperature measurement transducers such as RTD, Thermistor, and Thermocouple & AD590.
- Analyze the response and plot the characteristics of displacement measuring transducers such as LVDT and Potentiometric transducer.
- Analyze the response and plot the characteristics of strain gauge type load cell.
- Analyze the response and plot the characteristics of pressure transducer.
- Measure unknown values of resistance, capacitance and Inductance using different bridges.
- Design, build and test the circuits for practical applications using transducers
- Measure BP, solution concentration, pH and conductivity for different biomedical applications.

Graduate Attributes (as per NBA)
- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly)
- Interpretation of data

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:
1. Electronic Instrumentation by H. S. Kalsi, TMH, 2004 (Module-2,3 & 4)
2. Electronic Instrumentation and Measurements by David A Bell, PHI / Pearson Education2006/ Oxford Higher Education, 2013. (Module 1& 3)