III SEMESTER

B.E. Medical Electronics (ML) Choice Based Credit System (CBCS) Semester - III				
ENGINEERING MATHEMATICS-III **(Common to All Branches)**				
Subject Code	: 15MAT31		IA Marks	: 20
Number of Lecture Hours/Week	: 04		Exam Marks	: 80
Total Number of Lecture Hours	: 50		Exam Hours	: 03
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				

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
Module -1	10 Hours	
Module -2	10 Hours	
Module -3	10 Hours	

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 carry16 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. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - III

ELECTRONIC INSTRUMENTATION AND MEASUREMENTS

(Common to EI, BM & ML)

Subject Code	: 15 EI/BM/ML 32		IA Marks	: 20
Number of Lecture Hours/Week	: 04		Exam Marks	: 80
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: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
Module -1 **A).Measurements:** introduction, Significance of measurements, methods of measurements, instruments and measurement systems, Functions of instruments and measurement systems, Applications of measurement systems. **Measurement Errors:** Introduction Gross errors and systematic errors, Absolute and relative errors, basic concepts of accuracy, Precision, Resolution and Significant figures, Measurement error combinations. (relevant problems)	10 Hours	L1,L2
Module -2 **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) **B). Digital Voltmeters:** Introduction, Ramp type, Dual slope integrating type (V–T), integrating type (V–F) and Successive approximation type (relevant problems).	10 Hours	L1,L2,L3, L5

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:** Introduction, electrical indicating instruments, digital instruments, digital display methods, digital display unit. Segmental Displays: Seven segmental display, dot matrices, LED, LCD, decade counting assemblies, display systems. Recorders: Recording requirements, analog recorders- Graphic recorders, strip chart recorders & its types, X-Y recorder, Magnetic & Digital tape 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 carry16 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)
2. "Electronic Instrumentation and Measurements", David A Bell, PHI / Pearson Education2006/ Oxford Higher Education, 2013. (Module 1 & 3)
3. Electrical and Electronic Measurements and Instrumentation – A. K. Sawhney, 17th Edition (Reprint 2004), Dhanpat Rai & Co. Pvt. Ltd., 2004.(Module- 1 & 5)

Reference Books:

1. "Principles of Measurement Systems", John P. Beately, 3rd Edition, Pearson Education, 2000
2. "Modern Electronic Instrumentation and Measuring Techniques", Cooper D & A D Helfrick, PHI, 1998.

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - III

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

Subject Code	: 15 EI/BM/ML 33		IA Marks	: 20
NumberofLectureHours/Week	: 04		Exam Marks	: 80
Total Number ofLecture Hours	: 50		Exam Hours	: 03

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	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
Module -1 BJT AC Analysis BJT modeling, re transistor model: Common Emitter Configuration, Voltage-Divider Bias, CE Emitter-Bias Configuration (Excluding P-spice 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		
Module -3 **FET Amplifiers** Introduction, JFET Small Signal Model, JFET AC equivalent Circuit, Fixed- Bias Configuration, Self-Bias Configuration, Voltage-Divider Configuration, Source Follower Configuration. Relevant problems on above topics. **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)	**10 Hours**	**L1, L2, L3**
Module -4 **Power Amplifiers** Introduction: Definitions and Amplifier Types, Series Fed Class A Amplifier, Transformer Coupled Class A Amplifier, Class B Amplifier operation. **Class B amplifier circuits**: Transformer-Coupled Push-Pull Circuits, Complementary –Symmetry Circuits only, Amplifier Distortion, Class C and Class D Amplifier. Relevant Problems on above topics.	**10 Hours**	**L1,L2, L3,L4**
Module -5 **Feedback and Oscillator Circuits** Feedback Concepts, Feedback Connection Types, Effects of negative feedback, Oscillator operation, Phase Shift Oscillator: FET Phase Shift Oscillator, Transistor Phase Shift Oscillator, Wien Bridge Oscillator, Tuned oscillator Circuit: FET and Transistor Colpitts Oscillator, FET and Transistor Hartley Oscillator, Crystal oscillator. Relevant Problems on above topics Unijunction transistor oscillator.	**10 Hours**	**L2, L3**
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 • AnalyzeFrequency 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		

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:

1. Robert L. Boylestad and Louis Nashelsky, "Electronics devices and Circuit theory", Pearson, 10th Edition, 2009, ISBN:9788131727003

Reference Books:

1. David A. Bell, "Electronic Devices and Circuits", Oxford University Press.
2. I. J. Nagrath, "Electronics: Analog and Digital", PHI

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - III

DIGITAL DESIGN AND HDL

(Common to EI, BM & ML)

Subject Code	: 15 EI/BM/ML 34	IA Marks	: 20
Number of Lecture Hours/Week	: 04	Exam Marks	: 80
Total Number of Lecture Hours	: 50	Exam Hours	: 03

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

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
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.	10 Hours	L2,L3,L4
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

(1:2,1:4,1:8)		
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:

1. Charles H Roth, Jr., "Fundamentals of logic design", Cengage Learning
2. Digital Principals and Design – Donald D Givone,12th reprint, TMH,2008
3. Logic Design, Sudhakar Samuel, Pearson/ Saguine, 2007
4. Fundamentals of HDL- Cyril P R Pearson/Sanguin 2010

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - III

HUMAN ANATOMY AND PHYSIOLOGY

(Common to BM and ML)

Subject Code	: 15 BM/ML 35		IA Marks	: 20
Number of Lecture Hours/Week	: 04		Exam Marks	: 80
Total Number of Lecture Hours	: 50		Exam Hours	: 03

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
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 carry16 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. Ross & Wilson's Anatomy and Physiology in Health and Illness – by Anne Waugh and Allison Grant, 9th Edition, Churchill Livingstone Publications

Reference Books:

1. Concise Medical Physiology- by Sujit K. Chaudhuri, 5th Edition, New Central Book Agency Pvt. Ltd.
2. Essentials of Medical Physiology - by K. Sembulingam and Prema Sembulingam, 3rd Edition, Jaypee Publications
3. Human Physiology: From Cells to Systems – by Lauralee Sherwood, 6th Edition, Thomson India Edition, 2007.

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - III

NETWORK ANALYSIS
(Common to EI, BM & ML)

Subject Code	: 15 EI/BM/ML 36		IA Marks	: 20
Number of Lecture Hours/Week	: 04		Exam Marks	: 80
Total Number of Lecture Hours	: 50		Exam Hours	: 03

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Basic concepts**: Sources of electrical energy, Source transformation & Source shifting, Network reduction using star-delta transformation, loop and node analysis with dependent & independent sources for DC networks, concept of super node and super mesh analysis for only independent sources for DC networks.	10 Hours	L_1=Remembering, L_2=Understanding, L_3=Applying, L_4=Analysis.
Module -2 **Network theorems**: Super position, reciprocity, Millman's theorem (for DC networks), Thevinin's& Norton's theorem (for DC networks), and Maximum power transfer theorems (for AC & DC networks)	10 Hours	L_1=Remembering L_2=Understanding L_3=Applying L_4=Analysis
Module -3 **Transient behavior and initial conditions**: Behavior of circuit elements under switching condition and their representation, evaluation of initial & final conditions in RL, RC & RLC circuits for DC excitations. **Two port network parameters**: Definitions and modeling of Z, Y, H & transmission parameters.	10 Hours	L_1= Understanding L_2= Analyzing L_3=Applying L_4=Synthesis
Module -4 **Resonant Circuits**: Series resonance: Variation of current and voltage with frequency, Selectivity & Bandwidth, Q-factor Parallel resonance: General case-resistance present in both branches, Selectivity & Bandwidth, Maximum impedance conditions with Capacitor, Inductor or	10 Hours	L_1= Understanding L_2= Analyzing L_3=Applying L_4=Realizing

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 carry16 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: 1. Engineering Circuit Analysis, William H Hayt et al, McGraw Hill, 8th Edition. 2. Networks And Systems, D Roy Choudhury, New Age International Publishers, 3rd Edition. 3. Network Analysis, M.E. Van Valkenburg, Prentice-Hall, 3rd Edition.		
Reference Books: 1. Introduction to Electric circuits, Richard C Dorf& James A Svoboda, Wiley, 9th edition. 2. Electric Circuits, MahmoodNahvi, McGraw Hill, 9th edition		

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - III

ANALOG ELECTRONIC CIRCUITS LAB

(Common to EI, BM & ML)

Subject Code	: 15 EI/BM/ML L37		IA Marks	: 20
Number of Practical Hours/Week	: 03		Exam Marks	: 80
Total Number of Practical Hours	: 42		Exam Hours	: 03

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: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Laboratory Experiments NOTE: The experiments are to be carried using discrete components only	**Revised Bloom's Taxonomy (RBT)Level**
1. To design and testing of the following rectifiers with and without filters: (a) Full Wave Rectifier (center tap) (b) Bridge Rectifier.	L3, l4, L5, L6
2. To plot characteristics of UJT and to determine its intrinsic stand-off ratio.	L1, L2, L3, L4
3. To design and test the common emitter amplifier (voltage divider bias) without feedback and determine input, output impedance, gain and bandwidth.	L3, l4, L5, L6
4. To design and test the Emitter follower amplifier (BJT) using voltage divider bias and determine input, output impedance, gain and bandwidth.	L3, l4, L5, L6
5. To plot the Drain and Transfer characteristic for the given FET and to find the Drain Resistance and Trans-conductance.	L1, L2, L3, L4
6. To design, test and to plot the frequency response of Common Source JFET/MOSFET amplifier, and to determine its bandwidth.	L3, l4, L5, L6
7. To plot the input and output characteristics of n-channel MOSFET and calculate its parameters, namely; drain resistance, mutual conductance and amplification factor.	L1, L2, L3, L4

8. Wiring and testing of Complimentary symmetry class B push pull power amplifier and calculation of efficiency.	L1, L2, L3, L4
9. To design and test the RC-Phase shift Oscillator using BJT for the given frequency.	L3, l4, L5, L6
10. To design and test the following tuned oscillator circuits for the given frequency. (a) Hartley Oscillator using BJT (b) Colpitts Oscillator using FET.	L3, l4, L5, L6
11. Testing of crystal oscillator and to determine its frequency of oscillation.	L1, L2, L3, L4
12. Verification of Thevenin's theorem and Maximum Power Transform theorem for the given DC circuits.	L1, L2, L3, L4

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

- Acquire the Working principles, characteristics and basic applications of BJT and FET.
- Modeling of BJT/FET for analysis
- Able to design Single stage, Multistage amplifier, with and without feedback
- Able to analyze Frequency response of BJT and FET.
- Acquire the knowledge of Power amplifiers, operation, and able to design power amplifier.
- Apply the knowledge gained in the design of BJT/FET circuits in Oscillators to generate different frequencies and their applications.
- Knowledge of UJT characteristics and its application.
- Applications of theorems in various practical fields.

Graduate Attributes (as per NBA)

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly)

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. Electronics Lab Manual by K. A. Navas, Volume I, PHI, 5th Edition, 2015, ISBN:9788120351424.
2. Electronics Laboratory Primer - A Design Approach by S.Poorna Chandra, B.Sasikala, S Chand Pub.

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - III

DIGITAL DESIGN AND HDL LAB

(Common to EI, BM & ML)

Subject Code	: 15 EI/BM/ML L38	IA Marks	: 20
Number of Practical Hours/Week	: 03	Exam Marks	: 80
Total Number of Practical Hours	: 42	Exam Hours	: 03

Credits - 2

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.

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

Laboratory Experiments: **Note: (1)** Use discrete components to test and verify the logic gates. (2) Use FPGA/CPLD kits for down loading the Verilog code and test the output.	**Revised Bloom's Taxonomy (RBT) Level**
1. Simplification, realization of Boolean expressions using logic gates/Universal gates	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.	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	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	L2, L3, L4
5. To realize the following flip-flops using NAND Gates (a) T type (b) JK Master slave (c) D type	L2, L3, L4
6. To realize the 3-bit counters as a sequential circuit and Mod-N Counter design (7476, 7490, 74192, 74193)	L2, L3, L4
7. Adder/Subtractor – Full/half using Verilog data flow description	L2, L3, L4
8. Code converters using Verilog Behavioral description a) Gray to binary and vice versa b) Binary to excess3 and vice versa	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	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 down loading 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:

1. Digital Principals and Design – Donald D Givone,12th reprint, TMH,2008
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. Medical Electronics (ML) Choice Based Credit System (CBCS) Semester - III				
ENGINEERING MATHEMATICS-IV (Common to All Branches)				
Subject Code	: 15MAT41		IA Marks	: 20
Number of Lecture Hours/Week	: 04		Exam Marks	: 80
Total Number of Lecture Hours	: 50		Exam Hours	: 03
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				

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
Module -1	10 Hours	
Module -2	10 Hours	
Module -3	10 Hours	

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 carry16 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. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester – IV

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

Subject Code	: 15 EI/BM/ML42		IA Marks	: 20
Number of Lecture Hours/Week	: 04		Exam Marks	: 80
Total Number of Lecture Hours	: 50		Exam Hours	: 03

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 op-amp.
- Design and develop circuits like, amplifiers, filters, Timers to meet industrial requirements.
- Get a firm grasp of basic principles of op-amp.

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
Module -1 **Introduction to Operational Amplifiers:** Introduction, Block schematic of an Op-amp, Power supply connections, Characteristics of an Ideal OP-AMP, Inverting Amplifier, Non-inverting Amplifier, Voltage follower, Differential Amplifier, CMRR. (Relevant problems). **Operational Amplifier Characteristics**: DC characteristics – Input bias current, Input offset current, Input offset voltage, Total output offset voltage, Thermal drift. AC characteristics – Frequency response, Slew rate, PSRR. **Basic op-amp applications** – Scale changer/Inverter. Summing amplifier: Inverting summing amplifier, Non-inverting Summing amplifier, Subtractor, Instrumentation Amplifier. (Relevant problems).	10 Hours	L1,L2, L3,L4
Module -2 **Operational Amplifier Applications:** V – I and I – V converter, Op-amp circuit using diodes, sample and hold circuit, Differentiator and Integrator. **Comparator and waveforms generator:** Comparator, Regenerative comparator (Schmitt Trigger), Astable mutivibrator, Monostable	10 Hours	L1,L2, L3,L4

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 **555 Timer:** Description of Functional Diagram, Monostable operation, Applications of Monostable Multivibrator: Frequency Divider & Pulse Width Modulation. Astable operation, Applications of Astable Multivibrator: FSK Generator and Pulse Position Modulation. **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:

1. "Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4th edition, Reprint 2010, New Age International. (Module -1,2,3,4 & 5)
2. "Op - Amps and Linear Integrated Circuits", Ramakant A. Gayakwad, 4th edition, PHI (Module-3)
3. "A course in Electrical & Electronic Measurements & Instrumentation", A K Sawhney, Dhanpat Rai Publications, 19th edition, 2011.(Module-5)

Reference Books:

1. "Operational Amplifiers and Linear Integrated Circuits", Robert. F. Coughlin &Fred. F. Driscoll, PHI/Pearson, 2006
2. "Op - Amps and Linear Integrated Circuits", James M. Fiore, Thomson Learning, 2001
3. "Design with Operational Amplifiers and Analog Integrated Circuits", Sergio Franco, TMH, 3e, 2005

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - III

EMBEDDED CONTROLLERS

(Common to EI, BM & ML)

Subject Code	: 15 EI/BM/ML 43		IA Marks	: 20
Number of Lecture Hours/Week	: 04		Exam Marks	: 80
total number of lecture hours	: 50		exam hours	: 03

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.

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
Module -1 **Microprocessor and Microcontrollers:** **Introduction: Microprocessor and Microcontroller**, Microprocessor survey, RISC and CISC, CPU Architecture, Harvard and Von-Neumann, CPU Architecture. 8051 Microcontroller Architecture. Pin functions organizations Input/ Output pins, ports and circuits. Internal and External memory Architecture. 8051 Reg. banks and stack, 8051 flag bits and PSW Register. Special function Registers. Timer /Counter, Serial data input/ output, Interrupts, program counter and ROM space in the 8051.	**10 Hours**	**L1,L2**
Module -2 **Addressing modes directives instruction set of 8051 Microcontroller**. Immediate and Register addressing modes. Accessing memory using various addressing modes. Bit addressing for I/o and RAM 8051 data types and directives. Jump Loop and CALL Instructions Arithmetic and Logic Instructions and programming I/o port programming. Assembly Language programs using various Instructions.	**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 **Introduction to Advanced Microcontrollers**. Salient Features of Advanced Microcontrollers. **MSP430F2013** Architecture and pin functions, Memory, Clock Generator, CPU Registers, Addressing modes, Instruction set and emulated Instruction set. Development Environment. Aspects of C for embedded system, Introduction to MSP 430 starter kit, parallel ports.	**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:

1. "The 8051 Microcontroller and Embedded systems-using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinaly,PHI,2006/pearson,2006
2. "MSP430 Microcontroller Basics" John H. Davis, , Elsevier 2010.
3. "Embedded Systems Design using the TI MSP430 series", Cris Nagy, Newnes, Elsevier.

Reference Books:

1. "The 8051 Microcontroller architecture. Programming and applications", Kenneth J Alyala Thomson learning 2005.
2. "The 8051 Microcontroller: Hardware, Software and Applications" V. Udhayashankara and MallikarjunaSwamy ,TMH., 2009.

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - IV

SIGNALS AND SYSTEMS

Subject Code	: 15ML44		IA Marks	: 20
Number of Lecture Hours/Week	: 04		Exam Marks	: 80
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits - 4

Course Objectives: This course will enable the students

- Coverage of continuous and discrete-time signals and systems, their properties and representations and methods that is necessary for the analysis of continuous and discrete-time signals and systems. Knowledge of time-domain representation and analysis concepts as they relate to difference equations, impulse response and convolution, etc.
- Knowledge of frequency-domain representation and analysis concepts using Fourier analysis tools, Z-transform.
- Concepts of the sampling process.
- Mathematical and computational skills needed in application areas like communication, signal processing and control, which will be taught in other courses.

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
Module -1 **Introduction**: Definitions of a signal and a system, classification of signals, basic operations on signals, elementary signals, Systems viewed as interconnections of operations, properties of systems. Introduction to physiological signals.	**10 Hours**	**L1, L2, L3**
Module -2 **Time-domain representations for LTI systems:** Convolution, Impulse response representation, Convolution Sum and Convolution Integral. Properties of impulse response representation, Differential and difference equation representations, Block diagram representations. The above concepts can be implemented by using Matlab.	**10 Hours**	**L1, L2, L3, L4**
Module -3 **Fourier representation of signals:** Introduction, Discrete time, continuous time Fourier series Continuous Fourier transforms (derivations of transforms and properties are excluded). Discrete Fourier transforms (derivations of transforms and properties are excluded) and their properties. The above concepts can be implemented by using Matlab.	**10 Hours**	**L1, L2, L3, L4**

Module -4 **Applications of Fourier representations:** Introduction, Frequency response of LTI systems, Fourier transforms representation of periodic signals, Fourier transform representation of discrete time signals. Synthesis of a physiological signal using Fourier series and Fourier transform**.**	**10 Hours**	**L1, L2, L3, L4**
Module -5 **Z-Transform:** Introduction, properties of ROC, properties of Z-Transform, inversion of Z-transform, transform analysis of LTI Systems, transfer function, stability and causality, unilateral Z- Transform and its application to solve difference equations. Analysis of Physiological signals using ZT.	**10 Hours**	**L1, L2, L3, L4**

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

1. Characterize and analyze the properties of CT and DT signals and systems
2. Analyze CT and DT systems in Time domain using convolution and differential equation
3. Represent CT and DT systems in the Frequency domain using Fourier analysis tools like CTFS, CTFT, DTFS and DTFT.
4. Conceptualize the effects of sampling a CT signal and analyze CT and DT systems using Z Transforms

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design / development of solutions
- 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:

1. Simon Haykin and Barry Van Veen "Signals and Systems", John Wiley & Sons, 2nd edition,2012
2. Suresh R. Devasahayam, Signals and systems in biomedical engineering, Plenum Publishers, 2000.

Reference Books:

1. Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, "Signals and Systems" Pearson Education \ Asia / PHI, 3nd edition, 1997. Indian Reprint 2011
2. H. P Hsu, R. Ranjan, "Signals and Systems", Scham's outlines, TMH, 2011
3. B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2010
4. Ganesh Rao and Satish Tunga, "Signals and Systems", Sanguine Technical Publishers, 2012.

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - IV

BIOMEDICAL INSTRUMENTATION

Subject Code	: 15ML45		IA Marks	: 20
Number of Lecture Hours/Week	: 04		Exam Marks	: 80
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits - 4

Course Objectives:

- To understand the generalized structure of biomedical instrumentation and its development process.
- To study the concepts behind the origin of electricity in human beings.
- To analyze the working principles of electrodes and their applications in biomedical engineering concepts.
- To apply different concepts to design of bio-potential amplifiers for various healthcare applications.
- To study the non-electrical & sensory measurements in human body and their importance in clinical diagnostics

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
Module -1 **Introduction to biomedical instrumentation:** Biometrics, introduction to the man-instrument system, components of man-instrument system, medical instrumentation development process, problems encountered in measuring a living system. **Sources of bioelectric potentials:** Resting and action potentials, propagation of action potentials, the bioelectric potentials.	**10 Hours**	**L1, L2,**
Module -2 **Bio Potential Electrodes:** Origin of bio potential and its Propagation, Electrode theory, Electrode-electrolyte interface, electrode–skin interface, half-cell potential, electrode impedance, polarization effects of electrode-nonpolarizable electrodes, Types of electrodes, electrolysis & arching, Stimulating electrodes, capacitive electrodes, electrode-tissue interaction, internal electrodes, electrodes on a subject, tissue response to electrolytes, skin abrasion	**10 Hours**	**L1, L2,**
Module -3 **Measurement of Non-Electrical Parameter:** Temperature, Respiration rate and pulse rate measurement. Blood pressure: indirect methods-auscultatory method, oscillometric method, direct methods: electronic manometer, pressure amplifiers-systolic, diastolic, mean detector. **Behavioral & sensory measurements**: Instruments for testing motor responses, Instrumentation for sensory measurements, Bio-feedback instrumentation	**10 Hours**	**L1, L2, L3, L4**

Module -4 **Bio Amplifier:** Basic Amplifier configurations**,** Basic requirements-example of typical Electrocardiograph, Problems frequently encountered with bio-amplifiers, transient protection, common–mode and other interference reduction circuits, right leg driven ECG amplifier, Isolation amplifiers-transformer and optical isolation, Isolated DC amplifier and AC carrier amplifier. Chopper amplifiers	**10 Hours**	**L1, L2, L3, L4**
Module -5 Amplifiers for other Biopotential Signals, Example of Biopotential Pre-amplifier, Other Biopotential Signal Processors concepts –Integrators, Filters, Comparators, Modulators, Demodulators	**10 Hours**	**L1, L2, L3, L4**

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

- Explain the sources of Bio Potentials.
- Apply electronic concepts for design of amplifiers and filter for acquisition of physiological signals.
- Analyze different parameters applicable in development of instrumentation for healthcare applications.

Graduate Attributes (as per NBA)

- Engineering Knowledge
- Problem Analysis
- Design / development of solutions
- 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:

1. John G. Webster "Medical Instrumentation Application and Design", John Wiley, New York, 2004.
2. Geddes and Baker "Principles of Applied Biomedical Instrumentation", John Wiley, 3rd Edition, 1989.
3. Joseph J. Carr and John M. Brown "Introduction to Biomedical Equipment Technology ", Prentice Hall, 1998

Reference Books:

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation " 2nd Edition, Tata McGraw Hill, 2003
2. Cromwell "Biomedical Instrumentation and Measurements", l et al., 2nd Edition, PHI, 1990.

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - IV

SCIENTIFIC AND ANALYTICAL INSTRUMENTATION

(Common to EI, BM & ML)

Subject Code	: 15 EI/BM/ML 46		IA Marks	: 20
Number of Lecture Hours/ Week	: 04		Exam Marks	: 80
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits - 4

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: L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
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 Blood analyzer: Introduction, Blood pH measurements, measurement of blood Pco_2, Po_2, A Complete blood gas analyzer. Air pollution monitoring instruments Carbon monoxide, Sulphur dioxide, Nitrogen oxides, Hydrocarbons Ozone, automated wet chemical air analysis, water pollution monitoring instruments.	**10 Hours**	**L1, L2, L3, L4**

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 carry16 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. Instrumental Methods of Analysis, 7th edition. – 2. H.H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, CBS Publishing & Distribution (Module 1, Module 2, Module 3, Module 4 HPLC)
2. Handbook of Instruments – R.S. Khandpur, Tata McGraw Hill (Module 1-IR Spectroscopy, Module 4, Module 5)

Reference Books:

1. Braun R.D., Introduction to Instrumental Analysis, Mc Graw –Hill Singapore, 2006.
2. Frank G. Kerry Industrial Gas Handbook: Gas Separation and Purification, Taylor and francis group, 2007.
3. Principles of Instrumental Analysis 5th Edition – Douglas A. Skoog, F. James Holler, Timothy A. Niemen, Thomason Brooks/ Cole

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester - IV

EMBEDDED CONTROLLERS LAB

(Common to EI, BM & ML)

Subject Code	: 15 EI/BM/ML L47	IA Marks	: 20
Number of Practical Hours/Week	: 03	Exam Marks	: 80
Total Number of Practical Hours	: 42	Exam Hours	: 03

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:L1 – Remembering, L2 – Understanding, L3 – Applying, L4 – Analyzing, L5 – Evaluating, and L6 - Creating

Laboratory Experiments Note: Software and Hardware program using KEIL software and MSP 430 IDE.	**Revised Bloom's Taxonomy (RBT)Level**
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.	**L2, L3, L4**
Software program using MSP 430 IDE 8. Assembly program using MSP 430 for data transfer, Block Move in an array.	**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 8051Microcontroller with C Program. 12. Keyboard Interfacing. 13. **ADC Interfacing**	**L3, L4, L5**

Course Outcomes: After the completion of this Laboratory course, students will be able to:

- Get hands-on exposure in 8051 and MSB 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:

1. "The 8051 Microcontroller and Embedded systems-using assembly and C", Muhammad AliMazidi and Janice Gillespie Mazidi and Rollin D. McKinaly,PHI,2006/pearson,2006
2. "MSP430 Microcontroller Basics" John H. Davis, Elsevier 2010.
3. "Embedded Systems Design using the TI MSP430 series", Cris Nagy, Newnes, Elsevier.
4. "The 8051 Microcontroller architecture. Programming and applications", Kenneth J Alyala Thomson learning 2005.

B.E. Medical Electronics (ML)
Choice Based Credit System (CBCS)
Semester – IV

PHYSIOLOGIC MEASUREMENTS AND BIOMEDICAL INSTRUMENTATION LAB

Subject Code	: 15MLL48		IA Marks	: 20
Number of practical Hours/Week	: 03		Exam Marks	: 80
Total Number of practical Hours	: 42		Exam Hours	: 03

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	Revised Bloom's Taxonomy (RBT) Level
1. Measurement of blood pressure using sphygmomanometer and automatic digital BP instrument. Finding the systolic and diastolic values and calculate Mean Arterial Pressure (MAP)	**L1, L2, L3,L4**
2. Measurement of unknown concentration of given solution/ body fluid using Spectrophotometer and Colorimeter	**L1, L2, L3,L4**
3. (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.	**L1, L2, L3,L4**
4. Record and Trace ECG signal and labeling the amplitude and time components. Calculating Heart Rate	**L1, L2, L3,L4**
5. Measurement of displacement using LVDT& determine its sensitivity and resolution	**L1, L2, L3,L4**
6. Temperature measurement using RTD, Thermistor and Thermocouple, and to find their sensitivity.	**L1, L2, L3,L4**
7. Temperature measurement using AD590 / LM34.	**L1, L2, L3,L4**
8. Characteristics of LDR, Photodiode & Phototransistor by variable illumination & variable distance.	**L1, L2, L3, L4**
9. Measurement of unknown resistance by Wheatstone bridge & finding the sensitivity of the bridge.	**L1, L2, L3**
10. Measurement of self-inductance using Maxwell's bridge.	**L1, L2, L3**
11. Measurement of unknown capacitance using Schering's bridge.	**L1, L2, L3**

12. Characteristics of Load cell and Cantilever beam using Strain gauge (Quarter, Half and Full bridge configuration)	**L1, L2, L3, L4**

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, conductivity & ECG 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)
3. Measurement systems application and design by E.O. Doebline 4th Edition, TMH.
4. Instrumentation for Process Measurement by Norman. A. Anderson, 3rd Edition, CRC
5. Principle of Measurement System by John. P. Bentley, 3rd Edition, Pearson, 2007
6. Handbook of Biomedical Instrumentation- R S Khandpur, 2nd edition, Tata McGraw Hill, 2003.