III SEMESTER

B.E. Biomedical Engineering (BM)

Choice Based Credit System (CBCS)

Semester - III

ENGINEERING MATHEMATICS-III

(Common to All Branches)

Subject Code	: 17MAT31		CIE Marks	: 40
Number of Lecture Hours/Week	: 04		SEE Marks	: 60
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 THREE 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)

Subject Code	: 17 EI/BM/ML 32		CIE Marks	: 40
Number of Lecture Hours/Week	: 04		SEE Marks	: 60
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). **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.	10 Hours	L1,L2,L3, L5
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-	10 Hours	L1,L2,L3, L4

base system. **Analog storage oscilloscopes**: Need for trace storage, bistable storage CRT, Variable persistence storage CRT. **Digital storage oscilloscopes**: Basic DSO operation only.		
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,L5 ,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,L5

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

ANALOG ELECTRONIC CIRCUITS

(Common to EI, BM & ML)

Subject Code	: 17 EI/BM/ML 33	CIE Marks	: 40
Number of Lecture Hours/Week	: 04	SEE Marks	: 60
Total Number of Lecture 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 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	**10 Hours**	**L1 L2**
Module -3 **FET Amplifiers**	**10 Hours**	**L1, L2, L3**

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)		
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 Uni-junction 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
- 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 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 THREE 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. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester - III

DIGITAL DESIGN AND HDL

(Common to EI, BM & ML)

Subject Code	: 17 EI/BM/ML 34	CIE Marks	: 40
Number of Lecture Hours/Week	: 04	SEE Marks	: 60
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 (1:2,1:4,1:8)	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	10 Hours	L2,L3,L6

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).		
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 THREE 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. Digita**l** 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. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester - III

HUMAN ANATOMY AND PHYSIOLOGY

(Common to BM and ML)

Subject Code	: 17 BM/ML 35	CIE Marks	: 40
Number of Lecture Hours/Week	: 04	SEE Marks	: 60
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-	10 Hours	L1, L2, L3, L4

aorta (different parts of aorta & their blood supply, in brief). Summary of the main blood vessels (arteries & veins, explanation with flow diagram only)		
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 THREE 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. Electronics and Instrumentation Engineering (EI)
Choice Based Credit System (CBCS)
Semester – III (Elective-I)

NETWORK ANALYSIS (Revised)

(Common to EI, BM & ML)

Subject Code	: 17 EI/BM/ML 36	CIE Marks	: 40
Number of Lecture Hours/Week	: 03	SEE Marks	: 60
Total Number of Lecture Hours	: 40	Exam Hours	: 03

Credits - 3

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 – Analyzing, L5 – Evaluating, and L6 - Creating

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Basic concepts**: Sources of electrical energy, Source 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. Numerical on all Topics	08 Hours	L1, L2, L3, L4
Module -2 **Network theorems**: Super position, reciprocity, Millman's theorem Thevinin's & Norton's theorem (for DC networks only), Maximum power transfer theorem (for AC & DC networks) Numerical on all Topics	08 Hours	L1, L2, L3, L4
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 Numerical on all Topics	08 Hours	L1, L2, L3, L4
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. Numerical on all Topics	08 Hours	L1, L2, L3, L4
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.	08 Hours	L1, L2, L3, L4

Numerical on all Topics		

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 THREE 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, Mahmood Nahvi, McGraw Hill, 9th Edition

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

ANALOG ELECTRONIC CIRCUITS LAB

(Common to EI, BM & ML)

Subject Code	: 17 EI/BM/ML L37		CIE Marks	: 40
Number of Practical Hours/Week	: 03		SEE Marks	: 60
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. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester - III

DIGITAL DESIGN AND HDL LAB

(Common to EI, BM & ML)

Subject Code	: 17 EI/BM/ML L38	CIE Marks	: 40
Number of Practical Hours/Week	: 03	SEE Marks	: 60
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 - 2-bit Comparator using behavioral description	L2, L3, L4
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	L2,L3, L4

using DAC	

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 VHDL And Verilog By Nazeih 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 - IV

ENGINEERING MATHEMATICS-IV

(Common to All Branches)

Subject Code	: 17MAT41		CIE Marks	: 40
Number of Lecture Hours/Week	: 04		SEE Marks	: 60
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 THREE 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 – IV

SIGNAL CONDITIONING AND DATA ACQUISITION CIRCUITS

(Common to EI, BM & ML)

Subject Code	: 17 EI/BM/ML42		CIE Marks	: 40
Number of Lecture Hours/Week	: 04		SEE Marks	: 60
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 multivibrator and Triangular waveform generator. Phase shift oscillator, Wien bridge oscillator. (Relevant problems).	10 Hours	L1,L2, L3,L4
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,	10 Hours	L2,L3,L4, L5, L6

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.		
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 THREE 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. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester - IV

EMBEDDED CONTROLLERS

(Common to EI, BM & ML)

Subject Code	: 17 EI/BM/ML 43	CIE Marks	: 40
Number of Lecture Hours/Week	: 04	SEE Marks	: 60
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,	**10 Hours**	**L2,L3,L4,L5**

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.		
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 THREE 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. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester - IV

CONTROL SYSTEMS

(Common to EI & BM)

Subject Code	: 17 EI/BM 44	CIE Marks	: 40
Number of Lecture Hours/Week	: 04	SEE Marks	: 60
Total Number of Lecture Hours	: 50	Exam Hours	: 03

Credits - 4

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

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 **Modeling of Systems and Block diagram**: Introduction to Control Systems, Types of Control Systems, with examples. Concept of mathematical modeling of physical systems- Mechanical, Translational (Mechanical accelerometer, systems excluded), and Rotational systems, Analogous systems based on force voltage analogy and force current analogy. Introduction to Block diagram algebra. Numerical problems on all topics.	10 Hours	L_1, L_2, L_3, L_4
Module -2 **Signal Flow graph**: Introduction to Signal Flow graph, Mason's gain formula. Obtaining Transfer functions for the given SFG using Mason's gain formula. **Time response analysis**: Introduction. Standard test signals, response of first order & second order systems for unit step input. Steady state errors & Error constants. Numerical problems on all topics.	10 Hours	L_1, L_2, L_3, L_4
Module -3 **Concepts of stability**: The Concept of stability. Necessary conditions for stability. Hurwitz stability criterion. Routh stability criterion. Relative stability analysis using RH Criterion. **The Root Locus Technique**: Introduction. Root locus concepts. Construction of root loci. Stability analysis using Root locus Technique Numerical problems on all topics.	10 Hours	L2, L3, L4, L5
Module -4 **Frequency domain Analysis**: Introduction to frequency domain analysis, Correlation between time & frequency response, Bode plots. **Polar Plot**: Introduction to Polar plot and Nyquist plots, Nyquist stability criterion. Stability analysis using Polar plot. Numerical problems on all topics	10 Hours	L2, L3, L4, L5
Module -5	10 Hours	L2, L3, L4, L5

State space Analysis: Concept of state, state variables and state model. State diagrams and State models for Linear continuous-time systems (Electrical systems): State space representation using Physical and Phase variables. Derivation of transfer functions from the state model. Numerical problems on all topics. **Solution of state equations**: Solutions of homogeneous and Non-homogeneous state equations. Properties of state transition matrix, computation of state transition matrix by matrix exponential and Laplace transform method. Numerical problems		

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 THREE 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. "Control Systems Engineering", I.J. Nagarath and M. Gopal ,New Age International (P) Limited, Publishers, Fifth edition – 2012.
2. "Modern Control Engineering ", K. Ogata, Pearson Education Asia/ PHI, 4thEdition, 2002.

Reference Books:

1. "Automatic Control Systems", Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8thEdition, 2008.
2. "Feedback and Control System", Joseph J Distefano III et al., Schaum's Outlines, TMH, 2nd Edition 2007.

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

BIOMEDICAL TRANSDUCERS AND MEASUREMENTS

Subject Code	: 17BM45		CIE Marks	: 40
Number of Lecture Hours/Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits - 4

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

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT)Level
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 pressure measurement-catheters for pressure measurement, diaphragm displacement transducers, catheter tip pressure transducers, implantable pressure transducers and pressure telemetering capsules. Indirect pressure measurement-Indirect measurement of systolic, diastolic, and mean blood pressure, Detection of Kortokoff sounds.	10 Hours	L1, L2, L3
Module -4 **TRANSDUCERS AND SENSORS:** Requirements for measurement ranges, Temperature transducers – Thermistors, thermocouples, wire	10 Hours	L1, L2, L3

and thin film thermo-resistive elements, P-N junction diodes and transistors, infrared radiation thermometers, infrared thermography. Clinical thermometer probes, tympanic thermometers, telemetering capsules. Photoelectric Transducers: photovoltaic cells and photoemissive cells. Biosensors and Smart Sensors		
Module -5 **FLOW MEASUREMENT:** Requirements for measurement ranges – blood flow in a single vessel, tissue blood flow, and respiratory gas flow. Electromagnetic flowmeters – principle, methods of magnetic field excitation, perivascular probes, intravascular probes. Ultrasonic blood flowmeters– propagation of ultrasound in the tissue, ultrasonic Doppler flowmeters, blood flow measurement through Doppler imaging. Indicator dilution method – principle and working, thermodilution method, Fick method, thermistor velocity probe, impedance cardiography.	10 Hours	L1, L2, L3

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 THREE 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. **Biomedical Transducers and Instruments –** Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.
2. **Handbook of Biomedical Instrumentation**- R S Khandpur, 2nd edition, Tata McGraw Hill, 2003.

Reference Books:

1. **Biomedical Instrumentation and Measurement** – Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India Pvt. Ltd., 2004.
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 - IV

SCIENTIFIC AND ANALYTICAL INSTRUMENTATION

(Common to EI, BM & ML)

Subject Code	: 17 EI/BM/ML 46		CIE Marks	: 40
Number of Lecture Hours/ Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits - 3

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	**08 Hours**	**L1, L2**
Module -2 UV and visible Spectrometers –instrumentation : Radiation Sources, Wavelength selection, Detector, Readout modules, Instruments for absorption photometry	**08 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	**08 Hours**	**L1, L2**
Module -4 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	**08 Hours**	**L1, L2, L3**
Module -5 Blood analyzer: Introduction, Blood pH measurements, measurement of blood	**08 Hours**	**L1, L2, L3, L4**

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.		

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

EMBEDDED CONTROLLERS LAB

(Common to EI, BM & ML)

Subject Code	: 17EI/BM/ML L47	CIE Marks	: 40
Number of Practical Hours/Week	: 03	SEE Marks	: 60
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 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.
4. "The 8051 Microcontroller architecture. Programming and applications", Kenneth J Alyala Thomson learning 2005.

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

BIOMEDICAL TRANSDUCERS AND MEASUREMENTS LAB

Subject Code	: 17BML48		CIE Marks	: 40
Number of practical Hours/Week	: 03		SEE Marks	: 60
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 displacement using LVDT& determine its sensitivity and resolution.	**L1, L2, L3,L4**
2. Temperature measurement using RTD, Thermistor and Thermocouple, and to find their sensitivity.	**L1, L2, L3,L4**
3. Temperature measurement using AD590 / LM34.	**L1, L2, L3,L4**
4. Characteristics of LDR, Photodiode & Phototransistor by variable illumination & variable distance.	**L1, L2, L3,L4**
5. Measurement of unknown resistance by Wheatstone bridge & finding the sensitivity of the bridge.	**L1, L2, L3,L4**
6. Measurement of self-inductance using Maxwell's bridge.	**L1, L2, L3**
7. Measurement of inductance and internal resistance of a choke by three voltmeter method.	**L1, L2, L3**
8. Measurement of unknown capacitance using Schering's bridge.	**L1, L2, L3**
9. Characteristics of Load cell and Cantilever beam using Strain gauge (Quarter, Half and Full bridge configuration)	**L1, L2, L3,L4**
10. 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**
11. Measurement of unknown concentration of given solution/body fluid using Spectrophotometer and Colorimeter	**L1, L2, L3,L4**
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	**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 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)
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.

5th SEMESTER

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

Management and Entrepreneurship Development

(Common to EC/TC/EI/BM/ML)

Subject Code	: **17ES51**		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module -1

Management: Nature and Functions of Management – Importance, Definition, Management Functions, Levels of Management, Roles of Manager, Managerial Skills, Management & Administration, Management as a Science, Art & Profession (Selected topics of Chapter 1, Text 1).

Planning: Planning-Nature, Importance, Types, Steps and Limitations of Planning; Decision Making – Meaning, Types and Steps in Decision Making(Selected topics from Chapters 4 & 5, Text 1).

Module -2

Organizing and Staffing: Organization-Meaning, Characteristics, Process of Organizing, Principles of Organizing, Span of Management (meaning and importance only), Departmentalisation, Committees–Meaning, Types of Committees; Centralization Vs Decentralization of Authority and Responsibility; **Staffing**-Need and Importance**,** Recruitment and Selection Process (Selected topics from Chapters 7, 8 & 11, Text 1).

Directing and Controlling: Meaning and Requirements of Effective Direction, Giving Orders; Motivation-Nature of Motivation, Motivation Theories (Maslow's Need-Hierarchy Theory and Herzberg's Two Factor Theory); Communication – Meaning, Importance and Purposes of Communication; Leadership-Meaning, Characteristics, Behavioural Approach of Leadership; Coordination-Meaning, Types, Techniques of Coordination; Controlling – Meaning, Need for Control System, Benefits of Control, Essentials of Effective Control System, Steps in Control Process (Selected topics from Chapters 15 to 18 and 9, Text 1).

Module -3

Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance (Selected topics from Chapter 3, Text 1).

Entrepreneurship: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship (Selected topics from Chapter 2, Text 2).

Module -4

Modern Small Business Enterprises: Role of Small Scale Industries, Impact of Globalization and WTO on SSIs, Concepts and definitions of SSI Enterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Ancillary Industry and Tiny Industry (Definition only)(Selected topics from Chapter1, Text 2).

Institutional Support for Business Enterprises: Introduction, Policies & Schemes of Central Level Institutions, State Level Institutions (Selected topics from Chapter 4, Text 2).

Module -5

Projects Management: AProject. Search for a Business idea**:** Introduction, Choosing an Idea, Selection of product, The Adoption process, Product Innovation, Product Planning and Development Strategy, Product Planning and Development Process. Concepts of Projects and Classification**:** Introduction, Meaning of Projects, Characteristics of a Project, Project Levels, Project Classification, Aspects of a Project, The project Cycle, Features and Phases of Project management, Project Management Processes. Project Identification**:** Feasibility Report, Project Feasibility Analysis. Project Formulation**:** Meaning, Steps in Project formulation, Sequential Stages of Project Formulation, Project Evaluation.

Project Design and Network Analysis: Introduction, Importance of Network Analysis, Origin of PERT and CPM, Network, Network Techniques, Need for Network Techniques, Steps in PERT, CPM, Advantages, Limitations and Differences.

(Selected topics from Chapters 16 to 20 of Unit 3, Text 3).

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

1. Learn and explain basic is management and acquirebasic managerial skills.
2. Analyze the nature, purpose & objectives of Planning, Organizing & Staffing.
3. Develop the factual leadership qualities for development of organizations
4. Learn and build the qualities and characteristics of business ethics and entrepreneurs.
5. Describe the importance of small scale industries in economic development and institutional support to start a small scale industry and implement.
6. Demonstrate the project management, product planning, project design and network analysis.

Question paper pattern

- The question paper will have TEN questions.
- Each full question carries 16 marks.
- There will be two full questions (with a maximum of THREE sub questions) from each module.
- Each full question will have sub questions covering all topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Principles of Management – P.C Tripathi, P.N Reddy, McGraw Hill Education, 6th Edition, 2017. ISBN-13:978-93-5260-535-4.
2. Entrepreneurship Development Small Business Enterprises- Poornima M Charantimath, Pearson Education 2008, ISBN 978-81-7758-260-4.
3. Dynamics of Entrepreneurial Development and Management by Vasant Desai. HPH 2007, ISBN: 978-81-8488-801-2.

Reference Book:

1. Essentials of Management: An International, Innovation and Leadership perspective by Harold Koontz, Heinz Weihrich McGraw Hill Education, 10th Edition 2016. ISBN- 978-93-392-2286-4.

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

Fundamentals of Signals and DSP

(Common to EI & BM)

Subject Code	: 17EI/BM52		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module -1

Introduction to Signals and Systems:

Basic elements of a DSP System, Classification of Signals, Sampling Theorem (statement and problems on Nyquist rate), Discrete Time Signals (Representation, Standard Signals, Classification, and Operations), Discrete Time Systems, Convolution Sum, Cross correlation and Auto correlation of sequences.

Text 1: 1.1.1, 1.2, 1.4.2, 2.1, 2.2, 2.3.3, 2.3.7, 2.6.1.

Module -2

Z- Transform and its Application to analysis of LTI Systems:

Direct Z-Transform, Properties of the Z-Transform, Examples, Inverse Z- Transform by Partial-Fraction Expansion method only, System Function of a LTI System, Causality and Stability (from H(z)).

Realization of Digital System: Direct Form I, Direct form II, cascade form and parallel form

Text 1: 3.1.1, 3.2, 3.4.3, 3.3.3, 3.5.3.

Text 2: 9.2,9.3

Module -3

DFT: Properties and Applications:

Definition and Problems on DFT & IDFT, DFT Properties – Periodicity, Linearity, Time Reversal, Circular Time Shift, Circular Frequency Shift, Circular Convolution, Multiplication of two DFTs & Circular Convolution, Parseval's Theorem, DFT in linear filtering. Introduction to FFT, 8-point DFT Computation using Radix-2 DIT-FFT & DIF-FFT methods only, relevant examples.

Text 1: 7.1.3, 7.2, 7.3.1, 8.1.3.

Module -4

IIR & FIR Filters:

IIR Filters: Low-pass filter specifications, IIR filter Design by Impulse Invariance & Bilinear Techniques, Design of Digital IIR filter by Butterworth approach, Examples. Magnitude response of lowpass Chebyshev Type I, II filter (Theoretical concept only)

FIR Filters: Design of FIR filters – Symmetric and Antisymmetric FIR filters, Design of Linear phase FIR filters by Rectangular Hamming & Hanning windows. Summary of window function characteristics (window shape, transition bandwidth, stop band attenuation, etc.). Implementation of FIR filters by direct form and Single-stage lattice structure only.

Text 1: 10.3.2, 10.3.3, 10.3.4, 9.3.1, 9.3.3, 9.3.4, 10.2.1,10.2.2, 10.2.7, 9.2.1, 9.2.4

Module -5

Multirate Digital Signal Processing & Adaptive Filters:

Introduction, Decimation Process, Interpolation Process, Digital Filter Bank, Adaptive Filters, LMS adaptive algorithm, Applications, Features & Architectural of TMS320C54XX processor.

Text 2: 15.1, 15.2, 15.3, 15.4, 16.2, 16.3, 16.5, 19.2, 19.3.

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

1. Visualize, Classify and perform computation on discrete time signals, systems and properties
2. Perform the transformation techniques from time domain to other and vice versa, and analyze the system and properties (Z-Transform, DFT etc.)
3. Realize / implement the Direct/ cascade/ parallel/ lattice forms of the given digital system (IIR/ FIR)
4. ComputeDFT by FFT algorithms
5. Develop transformation from analog system to digital systemand design and implementIIR and FIR filters
6. Demonstrate the advanced concepts of signal processing (Multirate and Adaptive filtering) and architecture of DSP processor

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 THREE 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. Dimitris G Manolakis, John G. Proakis, "Digital Signal Processing: Principles, Algorithms, and Applications", 4th Edition, Pearson India, 2007.
2. V.Udayashankara, "Modern Digital Signal Processing", Third Edition, PHI 2016

Reference Books:

1. Simon Haykin and Barry Van Veen "Signals and Systems", John Wiley & Sons, 2nd edition
2. S K Mitra, "Digital Signal Processing", 4th Edition, McGraw-Hill, Year
3. Avtar Singh, "Digital Signal Processing Implementation", Brooks Cole

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

Clinical Instrumentation-I

Subject Code	: 17BM53		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module 1:

Electrocardiogram: Action potentials in cardiac muscle, Characteristics of the normal ECG, Cardiac arrhythmias and their electrocardiographic interpretation- Abnormal sinus rhythms, Abnormal Rhythms by impulse conduction blocks, Premature contractions, Paroxysmal Tachycardia, Ventricular & Atrial Fibrillation, Atrial Flutter, Cardiac arrest. Heart sounds, Phonocardiogram, Valvular lesions (Abnormal heart sounds)
(Text1: Chapter 9, Chapter 11, Chapter 13, Chapter 23)

Module 2:

Catheterization Laboratory Instrumentation, Arrhythmia monitor, Exercise stress testing, Ambulatory monitoring instruments (Text2: 6.10, 7.2, 7.4, 7.5)
Foetal Monitoring Instruments: Cardiotocograph, Abdominal Foetal Electrocardiogram, Foetal Phonocardiogram (Text2: 8.1, 8.2.1, 8.2.2)
Oximeters: Oximetry, Ear Oximeter, Pulse Oximeter, Skin reflectance Oximeters, Intravascular Oximeter (Text2: 10.1, 10.2, 10.3, 10.4, 10.5)

Module 3:

Anatomy of human eye, Physiology of vision, Errors of refraction and their optical correction, Aqueous humor production and drainage, Strabismus.
Clinical methods: Spectacles and contact lenses, Refractive surgery, Snellen's Chart, Cover – uncover test, Maddox rod test, Maddox wing test.
(Text 3: Chapter 1, Chapter 2, Chapter 3, Chapter 9, Chapter 13, Chapter 21, Chapter 23)

Module 4:

Tonometry and its types, Perimetry - Peripheral Field Charting, Central Field Charting, Fundus Fluorescein Angiography, Electroretinography, Electro-oculography, Loupe & Lens Examination, Slit-Lamp Examination, Gonioscopy, Retinoscope- Principle, Procedure & Types, Refractometry, Keratometry- principle and types, subjective refraction, Ophthalmoscopy-Direct & Indirect
(Text 3: Chapter 21, Chapter 23)

Module 5:

Cataract – list of classification only, Surgical techniques for cataract extraction – Intracapsular cataract extraction &Extracapsular cataract extraction for adulthood cataract, Phacoemulsification, Intraocular lens implantation.
General considerations of Glaucoma, surgical procedures for Glaucoma,
Vitreous Liquefaction, Vitreous Opacities, Vitreous Haemorrhage, Vitrectomy-types and techniques, Lasers in Ophthalmology, Cryotherapy in Ophthalmology,
(Text 3: Chapter 8, Chapter 9, Chapter 10, Chapter 18)

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

1. Analyze and interpret the types of heart abnormalities.
2. Describe the constructional details of equipment's used in cardiology.
3. Explain the basic principles of ophthalmology instruments.

4. Discuss the clinical methods and surgical procedures in ophthalmology.
5. Use few of the ophthalmological instruments for diagnostic purpose.

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 THREE 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. "Textbook of Medical Physiology", Guyton & Hall, 11th Edition, Reed Elsevier Pvt. Ltd., 2007.
2. "Handbook of Biomedical Instrumentation", R S Khandpur, 2nd edition, McGrawHill Education, 2013.
3. "Comprehensive Ophthalmology", A. K. Khurana, 4th Edition, New Age International Ltd., 2010

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

Biomedical Equipment's

Subject Code	: 17BM54		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module 1:

Electrocardiograph, Block Diagram Description of an Electrocardiograph, The ECG leads, Effects of Artefacts on ECG Recordings.(Text 1: 5.1, 5.1.1, 5.1.2, 5.1.3)

Electroencephalograph, Block Diagram Description of an Electroencephalograph. Other Biomedical recorders. (Text 1: 5.4, 5.4.1, 5.6)

Bedside patient monitoring Systems, Measurement of Heart rate (Instantaneous heart rate meters). Measurement of Pulse rate. Blood Pressure measurement(Direct and Indirect-Korotkoff's method,Rheographic method and Oscillometric Measurement method)

Text 1: (6.3, 6.5, 6.5.2, 6.6, 6.7, 6.7.1, 6.7.2.1, 6.7.2.2, 6.7.2.4)

Module 2:

Pulmonary Function Measurements:-Respiratory Volumes, Respiratory Capacities, Compliance and Related pressures, Dynamic Respiratory Parameters. Spirometry: - Basic Spirometer, Wedge Spirometer, Ultra Sonic Spirometer.

Text 1: (13.1, 13.1.1, 13.1.2, 13.1.3, 13.1.4, ,13.2, 13.2.1,13.2.2, 13.2.3)

Basic Audiometer: - General requirements of Audiometers. Masking in audiometer, Pure Tone and Speech Audiometer. Audiometer System (Bekesy). Evoked response Audiometry System. Calibration of audiometers. Hearing aids-Conventional and Digital hearing aid, Cochlear Implants

Text 1: (17.3, 17.3.1, 17.3.2, 17.4, 17.5, 17.6,17.6.1, 17.6.2, 17.7, 17.8, 17.9, 17.9.1, 17.9.2, 17.9.3)

Module 3:

Cardiac pace makers: Need for Cardiac pace maker. Types of pace makers:-external and Implantable pacemakers. Classification codes for Pacemakers. Ventricular synchronous demand pacemaker, Programmable pacemaker. Power sources for Implantable pacemakers.

Text 1: (25.1, 25.1.1, 25.2, 25.3, 25.3.2, 25.3.3, 25.3.4, 25.3.7)

Cardiac defibrillators: Need for defibrillator. DC defibrillator. Pacer-Cardioverter-defibrillator. Text 1:(26.1, 26.2, 26.4)

Principle of surgical diathermy. Solid state electrosurgical machine. Safety aspects in electrosurgical units. Text 1:(27.1, 27.2, 27.3)

Module 4:

Hemodialysis Machine: Function of the Kidneys. Changes in body fluids in renal disease. Artificial Kidney. Dialyzers: Parallel flow, coil, Hallow fibre type dialyzers. Performance analysis of dialyzers. Hemodialysis machine. (Text 1:30.1, 30.1.1, 30.2, 30.3.1, 30.3.2, 30.3.3, 30.3.4, 30.5)

Heart lung machine (Cardiac assist device), Lithotripsy, Ventilator, Infant incubator.

(Text 2: 13.3, 13.5, 13.6, 13.7)

Module 5:

Introduction to man-Instrument system. Components of Man-Instrument system. Problems encountered in measuring a living system. Physiological effects of Electrical current. Shock Hazards from Electrical equipment's. Methods of accident prevention.

(Text 3: 1.4, 1.5, 1.7, 16.1, 16.2, 16.3)

Precautions to minimize Electric shock hazards. Safety codes for Electromedical equipment. (Text 1: 18.2.2, 18.3)

Medical equipment maintenance: Types of maintenance repair organization, Levels of capability, types of organization. (Text 4: 26.4, 26.5, 26.6)

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

1. Define and analyze the ECG, EEG and BP signals.
2. Discuss the factors to be considered in the measurements ofrespiratory and audiometric signals.
3. Describe the principle and working of cardiac pacemakers, defibrillators and surgical devices.
4. Describe the principle and working of therapeutic instruments like Dialysis, heart-lung, ventilator, lithotripter and incubators.
5. Interpret the concepts involved with the measurement of man and instruments.
6. Discuss the physiological effects from electric shocksand maintenance of medical equipment's as per standards.

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 THREE 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. "Handbook of Biomedical Instrumentation", R S Khandpur, 2nd edition, McGrawHill Education, 2013
2. "Medical Instrumentation, Application and Design", John G. Webster, 3rd Edition, John Wiley & Sons
3. "Biomedical Instrumentation and Measurements", Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, 2nd Edition, Prentice Hall of India Private Limited, 2001
4. "Introduction to Biomedical Equipment Technology", Joseph J Carr, John M. Brown, 4th Edition, Pearson Education, 2004.

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

VLSI Design

(Common to EI, BM & ML)

Subject Code	: 17EI/BM/ML551		CIE Marks	: 40
Number of Lecture Hours/Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module -1

Moore's law, speed power performance, nMOS fabrication, CMOS fabrication: n-well, p-well processes, BiCMOS, Comparison of bipolar and CMOS.

Basic Electrical Properties of MOS And BiCMOS Circuits: Drain to source current versus voltage characteristics, threshold voltage, transconductance.

Module -2

Basic Electrical Properties of MOS And BiCMOS Circuits: nMOS inverter, Determination of pull up to pull down ratio, nMOS inverter driven through one or more pass transistors, alternative forms of pull up, CMOS inverter, BiCMOS inverters, latch up.

Basic Circuit Concepts: Sheet resistance, area capacitance calculation, Delay unit, inverter delay, estimation of CMOS inverter delay, driving of large capacitance loads, super buffers, BiCMOS drivers.

Module -3

MOS and BiCMOS Circuit Design Processes: MOS layers, stick diagrams, nMOS design style, CMOS design style, design rules and layout, λ - based design.

Scaling of MOS Circuits: scaling factors for device parameters, limitations of scaling.

Module -4

Subsystem Design and Layout-1 : Switch logic pass transistor, Gate logic inverter, NAND gates, NOR gates, pseudo nMOS, Dynamic CMOS, example of structured design, Parity generator, Bus arbitration, multiplexers, logic function block, code converter.

Subsystem Design and Layout-2 : Clocked sequential circuits, dynamic shift registers, bus lines, subsystem design processes, General considerations, 4-bit arithmetic processes, 4-bit shifter.

Module -5

Design Process-Computational Elements: Regularity, design of ALU subsystem, ALU using adders, carry look ahead adders, Multipliers, serial parallel multipliers, Braun array, Bough – Wooley multiplier.

Memory, Register and Aspects of Timing: Three Transistor Dynamic RAM cell, Dynamic memory cell, Pseudo- Static RAM, JK Flip-flop, D Flip-flop circuits, RAM arrays, practical aspects and testability: Some thoughts of performance, optimization and CAD tools for design and simulation.

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

1. Identify the CMOS layout levels, and the design layers used in the process sequence.
2. Describe the general steps required for processing of CMOS integrated circuits.
3. Design static CMOS combinational and sequential logic at the transistor level.
4. Demonstrate different logic styles such as complementary CMOS logic, pass-transistorLogic, dynamic logic, etc.
5. Interpret the need for testability and testing methods in VLSI.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carry16marks
- There will be TWO full questions (with maximum of THREE 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. Basic VLSI Design -3rd Edition Douglas A Pucknell, Kamaran Eshraghian, Prentice Hall of India publication, 2005.

Reference Books:

1. CMOS Digital Integrated Circuits, Analysis And Design, 3rd Edition, Sung – Mo (Steve) Kang, Yusuf Leblbici, Tata McGraw Hill, 2002.
2. VLSI Technology - S.M. Sze, 2nd edition Tata McGraw Hill, 2003.

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

Rehabilitation Engineering

(Common to BM & ML)

Subject Code	: 17BM/ML552	CIE Marks	: 40
Number of Lecture Hours /Week	: 03	SEE Marks	: 60
Total Number of Lecture Hours	: 40	Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module 1:

Introduction to Rehabilitation:

What is Rehabilitation, Medical Rehabilitation, Preventive Rehabilitation, Impairment, Disability and Handicap, Sociovocational Rehabilitation

Rehabilitation Team: Classification of members, Medical, The Rehabilitation team – The medical team, Physical therapist, Occupational therapist, Prosthetist-Orthotist, Rehabilitation nurse, Speech pathologist, Psychologist and child development Specialist, Horticultural Therapist, Music therapist, Creative Movement Therapist, Dance and play Therapist, Recreational therapist, Biomedical engineer.

(Text 1: Chapter 1, Chapter 2)

Module 2:

Therapeutic Exercise Technique: Coordination Exercises, Balance Training, Gait, Pathological Gaits, Gait Training – Crutch Walking: Patterns of Gait, Relaxation exercises, Methods for training Relaxation, Strengthening exercises, Mobilization exercises

Principles in Management of Communication: Communication, Speech, Language, Aphasia, Dysarthria, Speech therapy, Dysphagia, Communication for Visually impaired, Types of visual aids, Writing aids,

(Text 1: Chapter 3, Chapter 5)

Module 3:

Orthotic Devices in Rehabilitation Engineering: Definition, General Principles of Orthosis, Biomechanics of Orthosis, Classification, Material and fabrication for lower limb Orthosis, Calipers – Foot Orthoses, Ankle-Foot Orthosis, Knee-Ankle-Foot Orthosis, Hip-Knee-Ankle-Foot Orthoses, Functional Electrical Stimulation, Spinal Orthosis- Cervical, Head cervical Orthosis, Head cervical thoracic orthosis, Thoraco lumbar sacral orthosis, Lumbosacro-orthosis, Splints-its functions & types.

(Text 1: Chapter 7)

Module 4:

Amputation: General Principles of Amputation Surgery, Levels of Amputation in Upper limb and Lower limb, Rehabilitation of Lower limb amputations

Prosthetics: Classification, Components of Prosthesis, Upper limb Prosthetics – Terminal Devices, Myoelectric Prosthesis, Lower extremity Prosthesis – Transfemoral prosthesis, Prosthesis for hip disarticulation.

(Text 1: Chapter 8)

Module 5:

Mobility Aids: Functions, Parallel bars, Walking frames - types, Walking stick, Tripods, Quadripods, Crutches - types, Wheel chairs – parts and maintenance

(Text 1: Chapter 9)

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

1. Define rehabilitation and explain the composition of rehabilitation team.
2. Discuss the engineering principles of rehabilitation engineering.
3. Apply engineering skills in the development of prosthetic and orthotic devices.
4. Evaluate the orthopedic design and applications.

5. Apply the principles of engineering in the development of mobility aids for physically handicap.

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 THREE 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. Rehabilitation Medicine - By Dr. S. Sunder, 3rd Edition, Jaypee Medical Publications, Reprint 2004.

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

Hospital Design, Planning & Management

(Common to BM & ML)

Subject Code	: 17BM/ML553		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module-1

Planning & Building a New Hospital: Role of Hospital in Health Care, Hospital Planning & Design, Guiding principle in Hospital facilities & services, Functional Plans for Hospital construction, Design items, Functional program & design stage, Planning the Hospital building.

Module-2

Effective Hospital Management: Planning, Organization, Directing & Leading, Controlling, Financial Management

Administrative Service: Medical Record, Hospital Infection, Hospital Utilization Statistics, Material Management, Evaluation of Hospital services.

Module-3

Planning & Designing Medical Services: Out Patient service, Emergency service, Clinical laboratories, Radiology services, Radiation Therapy Department, Surgical Department, Nursing Department, Operation Theater, CSSD Nursing services.

Module-4

Planning & Designing Engineering Services: Engineering Department, Maintenance management, Clinical [Bio-medical] Engineering, Electrical System, Air Condition System, Water supply & sanitary system, Centralized Medical Gas System, Telecommunication System, Environmental Control, Safety & Security System, Disposal of Hospital Wastes.

Module-5

Planning & Design of Supportive Services: Admitting Department, Medical Record Department, Centralized Sterilization & Supply department, Pharmacy Material Management, Food service Department, Laundry & Linen Services, House Keeping & Val entry Department.

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

1. Design and construct the hospital with an effective administration and financial management.
2. Plan and developan effective hospital supportive system for all types of hospital services.
3. Evaluate the proper functioning and services provided by the hospitals.

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 THREE 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.

Textbook

1. Principles of Hospital Administration & Planning - by B. M.Sakharkar, Jaypee Publications, 1998.
2. Hospital Facilities, Planning & Management - by G. D. Kunders, TataMcGraw Hill, 2004.

REFERENCE BOOKS:

1. Hospital Administration & Management - by S. L. Goel& R. KumarDeep & Deep Publications
2. Applied Clinical Engineering - by Barry N. Feinberg, Prentice Hall,1984.
3. Clinical Engineering Principle & Practices - By John G. Webster &Albert M. Cook, Prentice Hall.

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

Biomedical Nanotechnology

(Common to BM & ML)

Subject Code	: 17BM/ML554		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module-1

Introduction: Converging Technologies: Nanotechnology and Biomedicine, Nanotechnology and Nanobiomedicine, Toward Biomolecular Medicine, Drug Synthesis and Delivery, Implants and Prosthesis, Diagnostics and Screening, Nanotechnology Platforms for Biomedicine.

Module-2

Nanotechnology and Trends in Drug Delivery Systems with Self-Assembled Carriers: Introduction, Drug Delivery Systems since the 1980s, Chemical System Engineering and Nanotechnology, Toward Development of Drug Delivery Systems with Bionanotechnology, Self-Assembly and Self-Organization, Nanoparticles and Nano-Sized Spaces, Quantum Dot (Semiconductor Nanoparticle), Safety of the Human Body and the Environment.

Module-3

Implants and Prostheses: Introduction, Biomaterials, Biological Processes, Wound Healing Processes, Macrophages, Biomaterial Interface Processes, Foreign Body Reaction, Nanotechnology in Implantology, Current Nanofabrication Methods, Lithography, Colloidal Resists, Self-Assembly Systems, Soft Lithography, Biomimetic Approaches.

Module-4

Nano-Enabled Components and Systems for Biodefense: Introduction, Sensor Component of Nano-Enabled Biodefense, Nano-Enabled Sensors for Monitoring Exposures, Nano-Enabled Sensors for Monitoring Airborne Exposures, Nano-Enabled Sensors for Monitoring Contact Exposures, Nanoscale Components of Sensing Systems, Nanolithography of Biological Molecules and Sensing Materials,
Nanoparticle Arrays on Surfaces, Functional Three-Dimensional Nanostructures.

Module-5

Nanobiology in Cardiology and Cardiac Surgery: Diagnostic Applications of Nanobiology and Nanotechnology: Molecular Imaging of Angiogenesis, Cellular Imaging, Artificial Molecular Receptors, Fluid Acceleration Sensors, Therapeutic Applications, Targeted Anti-proliferative Drug Delivery/ Prevention of Restenosis after Percutaneous Revascularization, Smart Drugs, Nanorobotics.
Applications of Nanobiology/Nanotechnology in Cardiological and Cardiosurgical Practice: Applications in the Therapy of Myocardial Ischemia, Nanotechnological Applications in Trauma / Bleeding / Wound Healing in Cardiac Surgery, Nanotechnology and Aortic Surgery.

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

1. Identify the role of nanotechnology in the field of biomedical engineering.
2. Discuss recent trends of nanotechnology in drug delivery systems.
3. Comprehend the processes involved in implants and prosthesis using nanotechnology.
4. Illustrate Nano-Enabled Components and Systems used for Biodefense.
5. Enumerate Nano biological application in cardiology and cardiac surgery.

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 THREE 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. Biomedical Nanotechnology by edited Neelina H. Malsch; CRC Press, Taylor & Francis Group
2. Nanoscale Technology in Biological Systems edited by Ralph S. Greco, Fritz B. Prinz, R. Lane Smith; CRC Press

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

Computer Organization

(Common to EI, BM & ML)

Subject Code	: 17EI/BM/ML561		CIE Marks	: 40
Number of Lecture Hours/Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module -1

Basic Structure of Computers: Basic Operational Concepts, Bus Structures, Performance – Processor Clock, Basic Performance Equation, Clock Rate, Performance Measurement. Machine Instructions and Programs: Memory Location and Addresses, Memory Operations, Instructions and Instruction Sequencing, Addressing Modes, Assembly Language, Basic Input and Output Operations, Stacks and Queues, Subroutines.

Module -2

Input / Output Organization: Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Exceptions, Direct Memory Access, Buses, Interface Circuits, Standard I/O Interfaces – PCI Bus, SCSI Bus, USB.

Module -3

Memory System: Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed, Size, and Cost, Cache Memories – Mapping Functions, Replacement Algorithms, Performance Considerations, Virtual Memories, Secondary Storage.

Module -4

Arithmetic: Numbers, Arithmetic Operations and Characters, Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Positive Numbers, Signed Operand Multiplication, Fast Multiplication, Integer Division, Floating-point Numbers and Operations.

Module -5

Basic Processing Unit: Some Fundamental Concepts, Execution of a Complete Instruction, Multiple Bus Organization, Hard-wired Control, Micro programmed Control. Embedded Systems and Large Computer Systems: Examples of Embedded Systems, Processor chips for embedded applications, Simple Microcontroller. The structure of General-Purpose Multiprocessors.

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

1. Describe basic structure of computers, machine instructions and programs
2. Describe different addressing modes, output operations, Stacks and Queues, Subroutines and Additional Instructions, IEEE standard for Floating point Numbers
3. Apply the techniques accessing of I/O Devices, Interrupts, Direct Memory Access, Busses, Interface Circuits, and Standard I/O Devices.
4. Evaluate the concepts of Semiconductor RAM Memories, Read Only Memories, Cache, Memories, Performance Considerations and Virtual Memories.
5. Execute a Complete Instruction, Multiple Bus Organization, and Microprogrammed Control and Hardwired Control.

Question Paper Pattern:

- The question paper will have TEN questions.

- Each full question carry16marks
- There will be TWO full questions (with maximum of THREE 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. Carl Hamacher, Zvonko Vranesic, Safwat Zaky: Computer Organization, 5th Edition, Tata McGraw Hill, 2002.

Reference Books:

1. William Stallings: Computer Organization & Architecture, 9th Edition, Pearson, 2015.

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

Virtual Bio-Instrumentation

(Common to BM & ML)

Subject Code	: 17BM/ML562		CIE Marks	: 40
Number of Lecture Hours/Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module-1

Graphical System Design (GSD): Introduction, GSD model, Design flow with GSD, Virtual Instrumentation, Virtual Instrumentation and traditional instrumentation, Hardware and software in virtual instrumentation, Virtual Instrumentation for test, control and design, GSD using LabVIEW, Graphical programming and textural programming.

Introduction to LabVIEW: Introduction, Advantages of LabVIEW, Advantages of LabVIEW, Software environment, Creating and saving a VI, Front panel toolbar, Block diagram toolbar, Palettes, Shortcut menus, Property dialog boxes, Front panel controls and indicators, Block diagram, Data types, Data flow program, LabVIEW documentation resources, Keyword shortcuts.

Module-2

Modular Programming: Introduction, Modular Programming in LabVIEW, Build a VI front panel and block diagram, ICON and connector pane, Creating an icon, Building a connector pane, Displaying subVIs and express Vis as icons or expandable nodes, Creating subVIs from sections of a VI, Opening and editing subVIs, Placing subVIs on block diagrams, Saving subVIs, Creating a stand-alone application.

Data Acquisition: DAQ software architecture, DAQ assistant, Channels and task configurations, Selecting and configuring a data acquisition device, Components of computer based measurement system.

Module-3

General Goals of Virtual Bio-Instrumentation (VBI): Definition of VBI and importance, General Goals of VBI applications. Basic Concepts: DAQ basics, LabVIEW basics, BioBench basics.

Neuromuscular Electrophysiology (Electromyography): Physiological basis, Experiment set up, Experiment descriptions, Trouble shooting the nerve –Muscle Preparation.

Cardiac Electrophysiology (Electrocardiology): Physiological basis, Experiment descriptions.

Cardiopulmonary Applications: Cardiopulmonary measurement system, Hiw the Cardiopulmonary measurement system works, Clinical Significance

Module-4

Medical Device Development Applications: The Endotester – A Virtual Instrument –Based Quality control and Technology, Assessment System for surgical video Systems: Introduction, Materials and Methods, Endoscope Tests, Results, Discussion.

Fluid Sense Innovative IV Pump Testing: Introduction, The test System, Training Emulator.

Module-5

Healthcare Information management Systems:

Medical Informatics: Defining medical informatics, Computers in medicine, Electronic Medical record, Computerized physician order entry, Decision support.

Information Retrieval, Medical Imaging, Patient Monitoring, Medical Education, Medical Simulation.

Managing Disparate Information: ActiveX, ActiveX Data Objects(ADO), Dynamic Link Libraries, Database Connectivity, Integrated Dashboards.

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

1. Describe the Graphical System Design approach & basic features and techniques of LabVIEW.
2. Use the Modular Programming concepts for creation of VIs & employ DAQ assistant for configuration of hardware devices.
3. Discuss the basic concepts of DAQ Systems, LabVIEW , and BioBench software.
4. Describe the LabVIEW and BioBench software for EMG, ECG, and Cardiopulmonary system analysis.
5. Discuss the Medical Device Development Applications for Surgical Video Systems and IV Pumps.
6. Explain the Healthcare Information Management Systems using Information Science and Technology.

Note: Wherever possible students should be given appropriate hands on training with Virtual Instrumentation LabVIEW software.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carry16marks
- There will be TWO full questions (with maximum of THREE 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.

Textbook:

1. Virtual Instrumentation using LabVIEW by Jovitha Jerome, PHI Learning Private Limited, 2010. (Module 1 & 2)
2. "Virtual Bio-Instrumentation" Biomedical, Clinical, and Healthcare Applications in Lab VIEW. ,by Jon B. Olansen and Eric Rosow, Prentice Hall Publication, 2002.

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

Operating Systems
(Common to EI & BM)

Subject Code	**: 17EI/BM563**		CIE Marks	: 40
Number of Lecture Hours/Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module -1

Introduction to Operating Systems: What operating systems do, Computer System Organization, Architecture and Operations, Process Management, memory management, Storage Management, Protection and Security, Computing Environments.

Operating system structures: OS Services, User-OS Interface, System calls, System programs, OS structure, System Boot.

Text: 1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 1.8, 1.9, 1.11, 2.1, 2.2, 2.3, 2.5, 2.7, 2.10.

Module -2

Process Management

Processes: Process concept, Process scheduling, Operation on processes, Inter process communication.

Threads – Overview, Multithreading models, Threading issues.

CPU scheduling – Basic concepts, Scheduling criteria, Scheduling algorithms, real time scheduling.

Text: 3.1, 3.2, 3.3, 3.4, 4.1, 4.3, 4.6, 6.1, 6.2, 6.3, 6.6

Module -3

Process Synchronization: Background, The critical section problem, Peterson's Solution, Synchronization hardware, Mutex Locks, Semaphores, Classical problems of synchronization, Monitors.

Deadlock – System model, Deadlock characterization, Methods for handling deadlocks, deadlock prevention, deadlock avoidance, deadlock detection and recovery from deadlock.

Text: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 7.1, 7.2, 7.3, 7.4, 7.5, 7.5, 7.6, 7.7.

Module -4

Memory management:

Main Memory: Background, Swapping, Contiguous, allocation, Paging.

Virtual memory: Background, Demand paging, Copy-on-write, Page replacement.

Text: 8.1, 8.2, 8.3, 8.5, 9.1, 9.2, 9.3, 9.4.

Module -5

Storage Management:

Mass storage structure: Overview of mass storage structure, Disk structure, Disk scheduling, Disk management, Swap space management.

File System Interface: File concept, Access methods, Directory and Disk structure, File system mounting, Protection.

File System Structure: File system structure, File system implementation, Directory implementation, Allocation methods, and free space management.

Text: 10.1, 10.2, 10.4, 10.5, 10.6, 11.1, 11.2, 11.3, 11.4, 11.6, 12.1, 12.2, 12.3, 12.4, 12.5

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

1. Define OS and explain organization of computer system, and components, computing

environments, & typical structure of OS.
2. Analyze the process management, process scheduling and threads.
3. Describe the concepts of process synchronization and analyze the problems of synchronization
4. Evaluate, prevent and avoid the deadlocks
5. Develop the techniques of memory allocation and paging
6. Apply appropriate disk scheduling algorithms.
7. Describe the interfaces to file systems, file structure and implement file systems and directory structure.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carry16marks
- There will be TWO full questions (with maximum of THREE 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. Operating System Concepts-by Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, **9th Edition**, John Wiley &Sons 2016 (India Edition).

Reference Books:

1. Operating system concepts and design- Milan Milankovic, 2nd Edition, McGraw Hill 1992.
2. Operating systems- Harvey M Deital Addison Wesley 1990.
3. Operating Systems concepts based approach, D.MDhamdhere, Tata McGraw Hill 2002.

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

Medical Physics

Subject Code	**:** 17BM564		CIE Marks	: 40
Number of Lecture Hours/Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module 1:
Biomechanics: Properties of materials, the principles of equilibrium, Stress analysis, Structural instability, Mechanical work and energy, Kinematics and Kinetics, Dimensional analysis: the scaling process in biomechanics. (Text 1: Chapter 1)

Module 2:
Biofluid Mechanics: Pressure in the body, Properties of fluids in motion: the constitutive equations, Fundamentals of fluid dynamics, flow of viscous fluids in tubes, flow through an orifice, influence of elastic walls, numerical methods in biofluid mechanics. (Text 1: Chapter 2)

Module 3:
Physics of the Senses: Cutaneous sensation, the Chemical senses, Audition, Vision, Psychophysics. (Text 1: Chapter 3)

Module 4:
Radioisotopes and Nuclear Medicine: Atomic structure, Production of isotopes, Principles of measurement, Non-imaging investigation: Principles, Non-imaging examples, Radionuclide imaging, Table of applications. (Text 1: Chapter 6)

Module 5:
Non-Ionizing Electromagnetic radiation – Tissue absorption and safety issues: Tissue as a Leaky Dielectric, Relaxation process, Overview of non-ionizing radiation effect, Low-frequency effects: 0.1Hz – 100KHz, Higher frequencies: >100KHz, Ultraviolet (Text 1: 8.2, 8.3, 8.4, 8.5, 8.6, 8.7)
Biomechanical Measurements: Static measurements, Dynamic measurements
(Text 1: Chapter 20)

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

1. Describe Biomechanical systems in the human body.
2. Discuss the fluid mechanical systems in the human body.
3. Analyze the physics of the Senses.
4. Explain the diagnostic uses of Radioisotopes.
5. Describe the tissue interactions with electromagnetic fields.
6. Apply the static and dynamic measurements for analysis of mechanics of human body.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carry16marks
- There will be TWO full questions (with maximum of THREE 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 Book(s) :

1. "Medical Physics and Biomedical Engineering"- B H Brown, R H Smallwood, D C Barber, P V Lawford, D R Hose, Taylor & Francis Group, 1999

Reference(s):

1. J. R. Cameron & J. G. Skofronick, Medical Physics , John Wiley and Sons, 1978.
2. Paul Davidovits "Physics in Biology and Medicine " , Academic Press, 3rd Edition, 2007.

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

Signal Conditioning Circuits and Data Acquisition Lab

(Common to EI, BM & ML)

Subject Code	: 17 EI/BM/ML L57		CIE Marks	: 40
Number of Practical Hours/Week	: 03		SEE Marks	: 60
Total Number of Practical Hours	:42		Exam Hours	: 03

Credits - 2

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

Laboratory Experiments: **Note:** Standard design procedure to be adopted Students should build the circuit using discrete components and ICs (models are not to be used)	**Revised Bloom's Taxonomy (RBT)Level**
1. To design and implement • Inverting Amplifier and Inverting Attenuator • Non-Inverting Amplifier and Voltage Follower	L3, L4, L5, L6
2. To realize • Full wave Precision rectifier	L3, L4
3. To design and implement • Butterworth I order Low-pass filter • Butterworth II order High-pass filter	L3, L4, L5, L6
4. To design and implement • RC Phase shift oscillator • Wein Bridge oscillator	L3, L4, L5, L6
5. To realize • ZCD • Positive and Negative Voltage level detectors	L3, L4
6. To design and implement • Astable Multivibrator using 555 timer • Mono-stable Multivibrator using 555 timer	L3, L4, L5, L6
7. To realize • Sample and Hold circuit using discrete components	L3, L4
8. To realize • Programmable Gain Amplifier using Analog Mux	L3, L4
9. To design and implement • 4 bit R-2R DAC using discrete components	L3, L4
10. To design and implement • 8-bit DAC using IC (DAC 0800)	L3, L4, L5, L6
11. To design and implement • 8-bit ADC using IC (ADC 0809)	L3, L4, L5, L6
12. To design and implement • 3 bit Flash ADC using ICs	L3, L4, L5, L6

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

1. Sketch/draw circuit schematics, construct circuits on breadboards, analyze and troubleshoot circuits containing Op-amps, resistors, diodes, capacitors and independent sources.

2. Memorize and reproduce the manufacturer's data sheets of IC 555 timer, IC µa741 op-amp and data converters like IC ADC 0800 and IC DAC 0809.
3. Design and evaluate analog integrated circuits like Amplifiers, Oscillators, Active filters, Precision Rectifiers and Voltage level detectors, and compare the experimental results with theoretical values.
4. Demonstrate and analyze the working of Sample-Hold, Programmable gain amplifier and Analog Multiplexer circuits in data acquisition system.
5. Design and evaluate different resolution data converters using discrete components and ICs.

Conduct of Practical Examination:

5. All laboratory experiments are to be included for practical examination.
6. Students are allowed to pick one experiment from the lot.
7. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
8. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

4. "Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4th edition, Reprint 2010, New Age International.
5. "Op - Amps and Linear Integrated Circuits", Ramakant A. Gayakwad, 4th edition, PHI.
6. "A course in Electrical & Electronic Measurements & Instrumentation", A K Sawhney, Dhanpat Rai Publications, 19th edition, 2011.
7. "Operational Amplifiers and Linear Integrated Circuits", Robert. F. Coughlin &Fred. F. Driscoll, PHI/Pearson, 2006
8. "Op - Amps and Linear Integrated Circuits", James M. Fiore, Thomson Learning, 2001
9. "Design with Operational Amplifiers and Analog Integrated Circuits", Sergio Franco, TMH, 3e, 2005

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

Clinical Instrumentation Lab

Subject Code	: 17BML58		CIE Marks	: 40
Number of Practical Hours/Week	: 03		SEE Marks	: 60
Total Number of Practical Hours	:42		Exam Hours	: 03

Credits - 2

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

Title of the Experiments	Revised Bloom's Taxonomy (RBT)Level
1. Measurement of Operational Amplifier parameters: I/P Offset current, I/P bias current, Slew rate, I/P offset Voltage, PSRR, CMRR & offset nulling.	L3, L4
2. Design and Test the Operational Amplifier as: (i) Adder, (ii) Substractor, (iii) Integrator, and (iv) Differentiator.	L3, L4, L5, L6
3. Conduct an experiment to perform Operational Amplifier as: (i) Comparator (ii) Schmitt Trigger.	L3, L4
4. Design and Test the bio-potential amplifiers for ECG/ or EEG/ or EMG	
5. Design and Test the Notch Filter for 50 Hz and 60 Hz.	L3, L4, L5, L6
6. Design and Testing of Instrumentation amplifier for different gains.	L3, L4, L5, L6
7. Testing an IC based Sample and Hold Circuit and plotting its characteristics.	L3, L4
8. Testing and analysis of the following by hardware circuit/simulation (i) DC Defibrillator (ii) Pacemaker	L3, L4
9. Acquisition of ECG: (i) Single lead (iii) Three lead, and (iii) 12-Leads. Analysis of the acquired ECG in amplitude, time and frequency domain.	L3, L4
10. Acquisition and analysis (time & frequency) of EEG.	L3, L4
11. Acquisition and analysis of Lung Volumes and Lung Capacities using Spirometer.	L3, L4
12. Quantification and assessment of hearing ability using audiometer	
13. (i) Measurement of corneal curvature using keratometer, and (ii) Measurement of Visual Acuity using Snell's Chart.	L3, L4
14. Study Experiments: Baby incubator, Ventilator, Heart-lungmachine, Dialysis machine, Pacemaker, Ophthalmoscope, Recording of pulse & oxygen saturation using Pulse Oximeter, and Infusion Pump.	L1, L2

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

1. Measure the Op-amp parameters and design the circuits using opamp for various applications.
2. Design and verify the different bio amplifiers & filters.
3. Acquire and analyze the ECG, EEG and respiratory signals
4. Analyze the visual ability and audibility using appropriate instruments.
5. Demonstrate the working of different diagnostic and therapeutic hospital equipment's.
6. Install and operate different types of hospital instruments.

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.

6th SEMESTER

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

Analog and Digital Communication Systems

(Common to EI, BM &ML)

Subject Code	**: 17EI/BM/ML61**		CIE Marks	: 40
Number of Lecture Hours / Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module -1

Introduction to analog and Digital Communication, Historical Background and Applications.

Amplitude Modulation: Amplitude Modulation,Virtues, Limitations, and Modifications of AM,DSBSC Modulation, Costas Receiver, Single Side band Modulation, Vestigial Sideband Modulation, Theme Examples.(Text 1:1.1,1.2,3.1, 3.2, 3.3, 3.4, 3.6, 3.7, 3.9)

Module -2

Angle Modulation: Basic Definitions, Properties of Angle-Modulated Waves, Relationship between PM and FM Waves, NBFM, WBFM, Transmission Bandwidth of FM Waves, Generation of FM waves, Demodulation of FM Signals, Theme Example.(Text 1:Chapter 4)

Module -3

Pulse Modulation: Transition from Analog to Digital Communications: Sampling Process, PAM, Completing the Transition from Analog to Digital, Quantization Process, PCM, Delta Modulation, Theme Examples.(Text 1: 5.1, 5.2, 5.4, 5.5, 5.6, 5.7, 5.10)

Module -4

Digital Band-Pass Modulation Techniques: Binary Amplitude Shift Keying (BASK): Generation and Detection, Binary Phase Shift-Keying (BPSK): Generation and Detection, Quadriphase Shift Keying (QPSK): Generation and Detection, Binary Frequency Shift Keying (BFSK), Minimum-Shift Keying (MSK), Differential Phase Shift Keying (DPSK): Generation and Detection, Theme Examples.
(Text 1: 7.2, 7.3, 7.4, 7.6, 7.9)

[Note: Excluding Computer Experiments in all the above Modules]

Module -5

Wireless Personal Area Networks (WPAN): Network Architecture, WPAN Components, WPAN Technologies and protocols (Bluetooth &Zigbee), WPAN Applications.(Text2: 4.1, 4.2, 4.3, 4.4, 4.5)

Wireless Wide Area Networks: Cellular Networks: Principles, GSM, CDMA, Handover in Cellular Networks.**(** Text 2: 7.1 (Excluding GPRS and CDPD)).

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

1. Explain the basics concepts of analog modulation techniques.
2. Discuss the basic concepts of digital modulation techniques.
3. Describe the basic concepts of digital data and pulse communication.
4. Explain and analyze different digital modulation techniques.
5. Describe different wireless area networks and their applications.

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 THREE 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 Book:

1. Simon Haykin, John Wiley & sons, "Introduction to Analog and Digital Communications"-Second Edition, 2012, ISBN 978-81-265-3653-5.
2. Dr. SunilKumarS.Manvi, Mahabaleshwar S. Kakkasageri, "Wireless and Mobile Networks Concepts and Protocols", John Wiley & sons, 2014 Edition, ISBN 978-81-265-2069-5.

Reference Books:

1. John G Proakis and MasoudSalehi, "Fundamentals of Communication Systems", 2014 Edition, Pearson Education, ISBN 978-8-131-70573-5.
2. Ian A Glover and Peter M Grant, "Digital Communications", Pearson Education, Third Edition, 2010, ISBN 978-0-273-71830-7.
3. B. P. Lathi and Zhi Ding, "Modern Digital and Analog communication Systems", Oxford University Press, 4th Edition, 2010, ISBN: 978-0-198-07380-2.

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

Medical Image Processing

(Common to BM & ML)

Subject Code	**: 17BM/ML62**		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module -1

Introduction: Background, Examples of fields that use DIP, Fundamental steps in Digital Image Processing (DIP), Components of DIP system, Image sensing and acquisition, A simple image formation model, Image sampling and quantization. Basic relationship between pixels, Colour image processing fundamentals and models.

Text: Chapter 1, 2.3, 2.4, .2.5, 6.1, 6.2

Module -2

Image Enhancement in Spatial Domain: Background, Point processing – Image negatives, Log transformations, Power law transformations, Contrast stretching, Intensity level slicing, Bit plane slicing, Histogram processing – Histogram equalization, Histogram matching (specification), Arithmetic/Logic operations – Image subtraction, Image averaging. Fundamentals of spatial filtering, Smoothing spatial filters, Sharpening spatial filters

Text: 3.1, 3.2, 3.3, 2.6.1, 2.6.2, 2.6.3, 2.6.4, 3.4, 3.5, 3.6

Module -3

Image Enhancement In Frequency Domain: Background, 2D-Discrete Fourier Transform and its Inverse, Basic properties of the 2D-Discrete Fourier Transform, Basicsof filtering in the frequency domain.

Image smoothing using frequency domain filters – Ideal lowpass filters, Butterworth lowpass filters, Gaussian lowpass filters; Image sharpening using frequency domain filters – Ideal highpass filters, Butterworth highpass filters, Gaussian highpass filters, Homomorphic filtering.

Text: 4.1, 4.2, 4.5.5, 4.6, 4.7,4.8, 4.9

Module -4

Image Restoration: Model of the Image degradation/restoration process, Noise models, Restoration using spatial filtering: Mean filters, Order statistic filters - Median filter, Min and Max filters, Midpoint filter.

Image Compression: Fundamentals, Image compression models, Basic compression methods – Huffman coding, Arithmetic coding, LZW coding, Run-length coding.

Text: 5.1, 5.2, 5.3.1, 5.3.2, 8.1, 8.2.1, 8.2.3, 8.2.4, 8.2.5

Module -5

Image Segmentation: Fundamentals, Point detection, Line detection, Edge models, Edge detection, Cannyedgedetector. Thresholding, Region based segmentation.

Text: 10.1, 10.2.1 – 10.2.6, 10.3, 10.4

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

1. Define the general terminology of digital image processing.
2. Identify the need for image transforms and their types both in spatial and frequency domain.
3. Identify different types of image degradation and apply restoration techniques.
4. Describe image compression models and learn image compression techniques.

5. Explain and apply various methodologies for image segmentation.
6. Implement image processing and analysis algorithms.6

Note: It is suggested to give assignments / hands-on-experience on the above image processing concepts using Matlab / C programming on medical images like x-ray / CT / MRI.

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 THREE 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. Digital Image Processing - Rafael. C. Gonzalez and Richard. E. Woods, Third Edition, Pearson Education, 2008.

Reference Books:

1. Fundamentals of Digital Image Processing - Anil K. Jain, 5th Indian Print, PHI, 2002.
2. Digital Image Processing and Computer Vision - Milan Sonka, India Edition, Cengage Learning.

B.E. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester – VI

OOPS with C++

(Common to EI, BM & ML)

Subject Code	**: 17EI/BM/ML63**		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module -1

C++ Programming Basic: Need for object oriented programming, Characteristics of OOPS, Preprocessor directives, Data types, Manipulators, Boolean types, Functions : Functions Declaration, Calling the function, function definition, Passing Arguments to functions, Returning values from functions, Reference arguments, Overloaded functions, inline functions. (Text Book 1)

Module -2

Classes and Objects: Classes & Objects, Specifying the class, Defining objects, calling members functions, objects as data types, constructors, Destructors, overloaded constructors. Arrays: arrays as class member data types, passing arrays, arrays as objects, friend function & friend classes. (Text Book 1)

Module -3

Strings and Pointers: Strings: String variable & string constants, coping a string, array of a string, string as class members, user defined string type. **Pointers :** Pointers and arrays, pointers & functions, pointers & strings, pointers to objects,'this' pointer, Array of pointers to objects, memory management using keywords new & delete (Text Book 1)

Module -4

Operator Overloading andInheritance: Unary operators, binary operators.

INHERITANCE: Derived class and base class, overriding member functions, scope resolution, Public & private inheritance, Public & private inheritance, levels of inheritance, multiple inheritance.(Text Book 1)

Module -5

Virtual Functions and Polymorphism: Virtual function, calling a virtual function through a base class reference, virtual attribute is inherited, virtual functions are hierarchical, Pure virtual functions, Abstract classes, using virtual function, early Vs late binding. (Text Book 2)

Templates: Generic functions, A function with two generic types, explicitly overloading a generic functions, generic classes. Applying template classes, A generic classes using default arguments with template classes. Exception handling: Exception handling fundamentals, catching class types, using multiple catch statement. (Text Book 2)

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

1. Explain the basic concepts of OOPS.
2. Apply the concept of OOPS to realize the existing algorithms.
3. Analyse the given program for debugging to obtain correct output
4. Create suitable application programs to solve real world problems.

Question Paper Pattern

- The question paper will have TEN questions.
- Each full question carries 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. Object oriented programming in TURBO C++ - Robert Lafore, Galgotia Publications, 2002(Module 1,2,3,4)
2. Herbert Schildt: The Complete Reference C++, 4th Edition, Tata McGraw Hill, 2003. (Module 5)

Reference Books:

1. Object Oriented Programming with C++, E Balaguruswamy, 4th Edition, Tata McGraw Hill, 2006.
2. K R Venugopal, RajkumarBuyya, T Ravi Shankar: Mastering C++, Tata McGraw Hill, 1999

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

Clinical Instrumentation - II

Subject Code	**: 17BM64**		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module -1: Neurology and Instrumentation

Clinical Method of Neurology: Approach to the patient with Neurologic disease, Taking the history, Neurologic Examination - Testing of Higher Cortical Functions, Cranial nerves, Motor function, Reflex function, Sensory function, Gait and Stance, Shortcomings of Clinical methods, Indications and Technique of Lumbar puncture, Radiographic Examination of Skull and Spine, Clinical significance of EEG Abnormalities, Evoked potentials. Epilepsy - Classification, Generalized Seizures, Partial Seizure, EEG in Epilepsy.

Sleep and its Abnormalities - Physiology of Sleep, The function of sleep and dreams, Sleep disorders. (**Text** 1: Chapter 1, Chapter 2, Chapter 16, Chapter 19)

Module -2: Neurology and Instrumentation

Motor Paralysis: Definition, Patterns of Paralysis and their diagnosis, Electrodiagnosis of Neuromuscular disease - Studies of Nerve conduction, Electrodiagnostic studies of Nerve roots and Spinal segments, Jolly test, Needle examination of muscle, Imaging of muscle and nerve, Biopsies of muscle and nerve. (Text 1: Chapter 3, Chapter 45)

Electrodignostic/Therapeutic Apparatus – Electrodiagnosis, Electrotherapy, Types and Functional block description, Interferential Current therapy, Types of electrodes, Transcutaneous Electrical nerve stimulator, Spinal cord stimulator, Magnetic stimulation. (**Text** 2: 29.5, 29.6)

Module -3: Anaesthesia and Instrumentation

Supply of Anaesthetic Gases: Cylinders, Pin Index System, Oxygen Concentrators, Bulk store, Liquid Oxygen, Nitrous Oxide, Entonox, Medical Compressed Air, Piped Medical vacuum, Differential Pressure Flowmeters, Variable – Area Constant Differential Pressure Flowmeter.

Vaporizers: Vaporization of Liquid Anaesthetic agents, Vaporizing systems, Factors affecting vapour concentration, Boyle's Vaporizer, Its problem and Practical use, Safety Features – Non Return Valve, Emergency Oxygen, Oxygen Failure warning devices.

Electronics in Anaesthetic Machine – Control Engineering, New components, Electronically controlled Anaesthetic machine, Servo controlled Anaesthesia.**(Text** 3: Chapter 3, Chapter 5, Chapter 6, Chapter 7, Chapter 8)

Module -4: Anaesthesia and Instrumentation

Breathing systems: Definition, Classification, Non – Rebreathing Systems – Mapleson A, Mapleson A and Controlled Ventilation, Mapleson D with Spontaneous and Controlled Ventilation.

Humidifiers: Definitions, Importance of Humidification, Examples of Humidification Equipment.

Monitoring of Gases: Inspired Oxygen Concentration, Nitrous Oxide and Volatile Agents, Position of Sampling. Anaesthetic Room and Recovery Area: Introduction, Layout and Contents of Anaesthetic Room, Pipeline outlets, Management of Anaesthetic Room, Layout of Recovery Area. (**Text** 3: Chapter 9, Chapter 13, Chapter 15, Chapter 25)

Module -5: Orthopaedics and Instrumentation

Pathology of Fractures and Fracture Healing: Classification, Closed and Open Fracture, Patterns of Fracture, Healing of Fractures, Repair of Tubular Bone, Repair of Cancellous Bone, Rate of Union, Fatigue or Stress Fractures, Pathological Fractures, Radiological Features – History, Clinical

Examination, Addition Clinical Investigations, Radiographic and Imaging Techniques, Test of Union.

Principles of Fracture Treatment: Treatment of Uncomplicated Closed Fractures – Reduction, Methods of Reduction, Methods of Immobilization, Treatment of Open Fractures, Delayed Union and Non Union, Bone Grafting, Mall Union.(**Text** 4: Chapter 1, Chapter 2, Chapter 3, Chapter 4)

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

1. Analyze the principles of clinical examinations in Neurology.
2. Explain the constructional details of Anaesthetic machine and Anaesthetic room.
3. Discuss electronic control of anaesthetic gases and vapours with servo control.
4. Describe the non-invasive gas monitoring techniques.
5. Evaluate the type of fracture and its treatment in Orthopedics.

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 THREE sub questions) from each module.
- Each full question will have 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. **"**Adams and Victor's Principles of Neurology", Allan H. Ropper and Robert H. Brown, 8th Edition, McGraw-Hill, 2005.
2. **"**Handbook of Biomedical Instrumentation", R S Khandpur, 2nd Edition, McGraw-Hill Education, 2013.
3. **"**Ward's Anaesthetic Equipment", Andrew Davey, John T. B. Moyle, Crispian S. Ward, 3rd Edition, W. B. Saunders Company Ltd.
4. **"**Outline of Fractures", John Crawford Adams, David Hamblen, 11th Edition, Churchill Livingstone, 1999.

Reference Books:

1. "Concise Medical Physiology", Sujith K. Chaudhuri, 5th Edition, New Central Book Agency Pvt. Ltd, 2004.
2. "A Text book of Anaesthesia", R. D. Miller, 5th Edition, Vol-2, Churchill Livingston, 2000.
3. "Outline of Orthopaedics", John Crawford Adams, David Hamblen, 13th Edition, Jaypee Publication, 2007.

B.E. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester – VI

Biosensors and Smart Sensors

(Common to BM & ML)

Subject Code	**: 17BM/ML651**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module - 1

Introduction: A historical perspective, Bio-analytical sensors & systems, Transduction modes & classifications, Approaches to Immobilization, Basic designs of discrete sensors, calibration & figures of merit

Chemical Measurement: Objectives of chemical Measurement, Requirements & limitations in chemical measurement. Chemical transducer – Electro-chemical transducer, electrical potential & reference electrodes, potentiometric sensors, Amperometric sensors, electrochemical gas sensors

Module - 2

Biosensors – Enzyme based biosensors, immunosensors, Microbial sensors, continuous measurement of chemical quantities – intravascular measurements, tissue measurements, Measurement - by blood drainage, Measurements by Microdialysis, Measurements by effluent fluid analysis. Transcutaneous Measurements of pO_2, pCO_2. Transcutaneous arterial oxygen saturation monitoring – basics of oximetry, pulse oximeter. Polymerase Chain Reaction (PCR): Principle, procedure, instrumentation& applications. Surface Plasmon resonance (SPR): Principle, procedure, instrumentation & applications.

Module -3

Basics of Smart Sensors and Micromachining: Introduction, Mechanical-Electronic transitions in sensing, nature of sensors, overview of smart sensing and control systems, integration of micromachining and microelectronics, introduction to micromachining, bulk micromachining, wafer bonding, surface micromachining, other micromachining techniques

Module -4

MCUs and DSPs for Sensor: Introduction, MCU control, MCUs for sensor interface, DSP control, Software, tools and support, sensor integration.

Module -3

Sensor Communication and MEMS: Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Micro optics, micro-grippers, micro-probes, micro- mirrors, FEDs, communications for smart sensors - sources and standards, automotive protocols, industrial networks, office and building automation, home automation, protocols in silicon, other aspects of network communications.

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

1. Describe the basics of biosensors used in biomedical engineering and their fabrication techniques.
2. Discuss the working principles enzyme sensors, enzyme electrodes and applications of biosensors in healthcare.
3. Discuss the basic concepts of smart sensors and principles of micromachining techniques.
4. Design the smart sensors with different controls, interfacing circuits and software tools.
5. Develop the smart sensor technology for automation and networking.

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 THREE 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. Introduction to Bioanalytical Sensor by Alice Cunningham, John Wiley and Sons, 1998.
2. Biomedical Transducers and Instruments by Tatsuo Togawa, Toshiyo Tamura, P. AKE Oberg, CRC Press 1997.
3. Understanding Smart Sensors - by Randy Frank, 2nd Edition, ArtechHouse Publications, 2000.

Reference Books:

1. Biosensors - by A.E.GGass, IRL Press, 1990.
2. Smart Sensors - by Paul W. Chapman, ISA Press.

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

Distributed Sensor Networks

Subject Code	**: 17BM652**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	:40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1
Introduction: Challenges, Sensor Network Architectures, Sensor Node Deployment**,** Energy-Efficient Information Processing, Data Dissemination, Self-Configuration Methods

Module -2
Sensor Node Deployment: Sensor Node Detection Models, Virtual Force Algorithm, Virtual Forces, Overlapped Sensor Detection Areas, Energy Constraint on the VFA Algorithm, Procedural Description. VFA Simulation Results. Uncertainty Modeling, Modeling of Non-Deterministic Placement, Uncertainty-Aware Placement Algorithms, Procedural Description, Simulation Results.

Module -3
Energy-Aware Target Localization: Detection, Probability Table, Score-Based Ranking Selection of Sensors to Query, 3Energy Evaluation Model, Primitive Energy Evaluation Model, Refined Energy Evaluation Model, Procedural Description, Simulation Results, Case Study

Module -4
Energy-Efficient Self-Organization: Introduction, Relevant Prior Outline of SCARE Basic Scheme, Network Partitioning Problem, Details of SCARE
Energy-Aware Information Dissemination: Introduction, Related Prior Work Location-Aided Flooding, Modified Flooding, Location Information, Virtual Grids, Packet Header Format, LAF Node Types

Module -5
Optimal Energy Equivalence Routing In Wireless Sensor Networks: Related Work, Networking Characteristics of WSN, WSN Protocol.
Data-Centric Routing and Directed Diffusion: Energy Equivalence Approach, Basics, Neighbor Switching Path, Rerouting EER Algorithms, and Assumptions. Procedures and Functions Formats of Packets

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

1. Describe sensor network technologies from three different perspectives: sensing, communication, and computing.
2. Evaluate the concepts on sensor deployment, energy consumption, dissemination and optimization.
3. Analyze the wireless sensor networks (WSN) based on structure, energy and routing techniques.
4. Apply different strategies to choose best packet routing methodology.
5. Formulate and solve problems creatively in the area of WSN

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 THREE 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. Scalable Infrastructure for Distributed Sensor Networks-Krishnendu Chakrabarty and S. S. Iyengar, Springer 2005, ISBN-10: 1852339519.

Reference Books:

1. Distributed sensor Networks- a Multi-agent perspective, Victorlesser, Charles Oritiz, Tambe, Kluwer Academic Publishing, 2003.
2. Distributed Sensor N/W- By Sundararaja S. Iyengar, Richard R. Brooks, CRC Press.
3. Wireless Sensor networks- Freng Zhao, Leonidas Guibas, Morgan Kaufmann Publishers, New Delhi.

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

Bioinformatics

(Common to BM & ML)

Subject Code	**: 17BM/ML653**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1

Introduction To Bioinformatics: Introduction, dawn of sequencing, bioinformatics, biological sequence, genome projects, importance of bioinformatics, pattern recognition & prediction, folding problem, role of chaperones, sequence analysis, homology & analogy.

Information Networks: Introduction, internet, computer network, facilities used on the internet, world wide web, web browsers, HTTP, HTML, & URL, EMB net, NCBI, Bioinformatics Programme, Servers in India, virtual tourism.

Text1:(Chapter1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9,1.10,1.11.),Chapter(2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8,2.9,2.10, 2.11)

Module -2

Protein & Genome Information Resources: Introduction, biological databases, primary sequence databases, composite protein sequence databases, secondary databases. Introduction to genome information resources, DNA sequence databases, specialized genomic resources.

DNA Sequence Analysis: Introduction, why analyze DNA, gene structure and DNA sequences, features of DNA sequence analysis, issues in the interpretation of EST searches.

Text 1: (Chapter 3.1,3.2,3.3,3.4,3.5 to 3.5.7., Chapter 4.1 ,4.2,4.3 to 4.3.4., Chapter 5.2,5.3,5.4,5.5 to 5.5.4)

Module -3

Pairwise Alignment Techniques: Introduction, database searching, alphabets and complexity, algorithms and programs, comparing two sequences-a simple case, sub-sequences, identity and similarity.

The Dotplot, local and global similarity, global alignment-Needleman &Wunsch algorithm, local alignment-Smith-Waterman algorithm, dynamic programming, pairwise database searching.

Text 1: (Chapter 6.1, 6.2,6.3,6.4,6.5,6.6,6.7,6.8,6.9,6.10,6.11,6.12,6.13 to 6.13.2)

Module -4

Multiple Sequence Alignment: Introduction, goal of multiple sequence alignment &definition, consequences, computational complexity, manual methods, simultaneous methods, progressive methods, databases of multiple alignments & searching.

Secondary Database Searching: Introduction to secondary database searching, why secondary databases & its contents, regular expressions, fingerprints, blocks, hidden Markovmodels.

Text 1: (Chapter 7.1,7.2,7.3,7.4,7.5,7.6,7.7,7.8,7.9,7.10., Chapter 8.1,8.2,8.3 to 8.3.5)

Module -5

Building A Sequence Search Protocol: Introduction, practical approach, when believe the result, structural and functional interpretation.

Analysis Packages: Introduction to analysis package, commercial databases, commercial software, comprehensive packages, packages for DNA analysis, intranet packages, internet packages, laboratory information management systems.

Text 1: (Chapter 9.1,9.2,9.3,9.4., Chapter 10.1,10.2,10.3,10.4,10.5,10.6,10.7,10.8,10.9)

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

1. Apply the basic principles of biology, computer science & mathematics to extract the information from large biological databases.
2. Develop new algorithms and sequence analysis methods.
3. Identify appropriate method for aligning sequences, visualizing and analyzing protein structures.
4. Classify the secondary structure elements and modeling protein structures from sequence.
5. Explain the language of structure-function relationships, information theory, gene expression and database queries.

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 THREE sub questions) from each module.
- Each full question will have 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. Introduction to Bioinformatics - by T. K. Attwood & D.J.ParrySmith, Pearson Education Low Price Edition, 2004.
2. Fundamental Concepts - of Bioinformatics by Dan E. Krane & Michael L. Raymer, Pearson Education Low Price Edition, 2004

Reference Books:

1. Bioinformatics - Concepts, Skills & Applications by S.C.Rastogi, Namita Mendiratta & Parag Rastogi, CBS Publications, 2004.
2. Bioinformatics - by Andreas D. Boxevanies, Wiley Inderscience, 1998.
3. Bioinformatics - Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor, 2001.

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

Biomechanics and Biodynamics

(Common to BM & ML)

Subject Code	**: 17BM/ML654**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits –3 (Each module – 08 Hours)

Module -1

Biomechanics Applications to Joint Structure and Function: Introduction to Kinematics, Displacement in space, Force vectors and gravity, Linear forces and concurrent forces. Kinetics of rotary and translatory forces. Classes of levers. Close chain force analysis.

Constitutive Equations: Equations for Stress and Strain, Non-viscous fluids, Newtonian viscous fluids, Elastic solids. Visco-elasticity and its applications in biology.

Module -2

Joint Structure and Function: Properties of connective tissues; Human Joint design; Joint Function and changes in disease.

Integrated Functions: Kinetics and Kinematics of Postures; Static and Dynamic Postures; Analysis of Standing, Sitting and Lying Postures.

Module -3

Gait Analysis: Gait cycle and joint motion; Ground reaction forces; Trunk and upper extremity motion; internal and external forces, moments and conventions; Gait measurements and analysis.

Force Platform and Kinematic Analysis: Design of force platforms, Integrating force and Kinematic data; linked segment, free-body analysis.

Module -4

Bio-Viscoelastic Fluid: Viscoelasticity, Viscoelastic Models: Maxwell, Voigt and Kelvin Models Response to harmonic variation. Use of viscoelastic models. Bio-Viscoelastic fluids: Protoplasm. Mucus, saliva, semen, synovial fluids.

Module -5

Rheology of Blood in Microvessels: Fahreus·Lindqulst effect and inverse effect, hematocrit in very narrow tube.

Finite Element Analysis in Biomechanics: Model creation, Solution, Validation of results and applications of FEA.

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

1. Analyze the types of forces applied to joints & derive the basic constitutive equations for solid and liquid bio-elements.
2. Describe the properties, structures and functions of human joints for normal & diseased.
3. Analyze static &dynamic postures, gait, integrating force, and kinematic data.
4. Develop model for bio-fluids and explain their uses.
5. Discuss the rheology of blood in microvessels
6. Develop simple FEA models for biomechanics problems.

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 THREE 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. Biomechanics: Mechanical Properties of living tissues by Y. C. Fung, 2nd Edition, Springer Verlag, 1993.
2. Joint Structure and Function, A Comprehensive Analysis – by Pamela K. Levangie and Cynthia C. Norkin, Jaypee Publications, 4th Edition, 2006.

Reference Books:

1. Biomechanics of Human Motion - by T. McClurg Anderson, Sports Pub., 2007.
2. Biomechanics, Structures and Systems - by A. A. Biewener, Sports Publication.

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

Mobile Communication

(Common to EI, BM &ML)

Subject Code	: **17EI/BM/ML661**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module -1

Wireless Transmission: Frequencies for radio transmission, signals, antennas, signal propagation, multiplexing, spread spectrum.

Medium Access Control: Motivation for a specialized MAC, SDMA, FDMA, TDMA, fixed TDM, Reservation TDMA, multiple access with collision avoidance, polling, inhibit sense multiple access, CDMA.

Module -2

Telecommunications Systems: GSM, mobile services, system architecture, radio interface, protocols, localization and calling, handover, security, new data services, DECT, system architecture TETRA, UMTS system architecture, UTRAN, core network.

Module -3

Satellite Systems: Basics GEO, LEO, MEO, Routing, localization, handover.

Broadcast Systems: Cyclic repetition of data, digital audio broadcasting, digital video broadcasting, convergence of broadcasting and mobile communications.

Module -4

Wireless LAN: Infrared Vs radio transmission, infrastructure and ad-hoc Network, IEEE802.11-, system architecture, protocol architecture, HiperLAN2, Blue tooth. Dynamic host configuration, protocol, mobile ad-hoc networks Routing, destination sequence distance vector, Dynamic source routing, alternative metrics.

Module -5

Mobile Network Layer: Mobile IP, Goals, assumptions and requirements, entities and terminology, IP packet delivery, agent discovery, registration, tunneling and encapsulation, optimizations, reverse tunneling,PIV6 343, IP micro- mobility support.

Mobile Transport Layer: Traditional TCP, Congestion control, slow start, fast retransmit/ fast recovery, implications of mobility, Classical TCP in improvements, indirect TCP, Snooping, mobile, Fast retransmit/ fast recovery, Transmission/time-out freezing, selective retransmission, Transaction-oriented TCP, TCP over 2.5/3G wireless networks.

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

1. Explain the basics of radio frequencies and their transmission, and distinguish the process of accessing the medium for wireless communication
2. Recognize and analyze various telecommunication systems such as DECT, 2G and 3G technologies.
3. Describe the working of satellites and broadcasting system.
4. Discuss the issues involved in different ad-hoc routing and networking.
5. Explain wireless communication standards, network devices and their functions within a network.
6. Apply the techniques for transmitting the data packet through Network/TCP layer of ISO/OSI

model.

7. Demonstrate the implementation of simple mobile communication system.

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 THREE sub questions) from each modu
- 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 ea module.

Text Books:

1. Mobile Communications-Jochen Schiler, 2nd Edition, Addison-Wesley Publications, Imprint Pearson Education, 2003.

Reference Books:

1. Mobile Communications engineering, Theory and applications- 2nd Edition, WILLIM C.Y. LEE, McGraw-Hill, 1997, Singapore.
2. Introduction to Wireless and Mobile Systems-Second edition, Dharma Prakash Agarwal, Qing An Zeng, 2nd Edition, Thomson,2007.
3. Electronic Communications systems Fundamentals through Advanced-5th Edition, Wayne Tomasi, Pearson education 2007.

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

Software Engineering

Subject Code	: **17BM662**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module 1

Introduction (Chapter 1): Professional Software Development (Sec 1.1), Software Engineering Ethics (Sec 1.2),

Software Processes(Chapter 2): Software Processes Models (Sec 2.1),

Requirements Engineering(Chapter 4): Functional and non-functional requirements (Sec 4.1), The software Requirements Document (Sec 4.2), Requirements Specification (Sec 4.3), Requirements Engineering Processes (Sec 4.4), Requirements Elicitation and Analysis (Sec 4.5). Requirements validation (Sec 4.6), Requirements Management (Sec 4.7)

Module 2

System Modeling (Chapter 5): Context models (Sec 5.1), Interaction models (Sec 5.2), Structural models (Sec 5.3), Behavioral models (Sec 5.4), Model-driven engineering (Sec 5.5),

Design and Implementation(Chap 7): Object-oriented design using the UML (Sec 7.1), Design patterns (Sec 7.2),Implementation issues (Sec 7.3), Open source development (Sec 7.4)

Module 3

Software Testing (Chap 8): Development testing (Sec 8.1), Test-driven development (Sec 8.2), Release testing (Sec 8.3), User testing (Sec 8.4),

Software Evolution (Chap 9): Evolution processes (Sec 9.1), Program evolution dynamics (Sec 9.2), Software maintenance (Sec 9.3), Legacy system management (Sec 9.4).

Module 4

Project Planning (Chap 23): Software pricing (Sec 23.1), Plan-driven development (Sec 23.2),Project scheduling (Sec 23.3), Estimation techniques (Sec 23.5),

Quality management(Chap 24): Software quality (Sec 24.1), Software standards (Sec 24.2), Reviews and inspections (Sec 24.3), Software measurement and metrics (Sec 24.4)

Module 5

Agile Software Development(Chap 3): Process Activities (Sec2.2), Coping with Change (Sec 2.3), Agile methods (Sec 3.1), Plan-driven and agile development (Sec 3.2), Extreme Programming (Sec 3.3), Agileproject management (Sec 3.4), Scaling agile methods (Sec 3.5).

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

1. Outline software engineering principles and activities involved in building large software programs.
2. Identify ethical and professional issues in software engineering.
3. Describe the process of requirements gathering, requirements classification, requirements specification and requirements validation.
4. Differentiate system models, UML diagrams,validation testing and defect testing.
5. Discuss the importance of software maintenance and intricacies involved in software evolution.
6. Apply estimation techniques, schedule project activities and compute pricing.
7. Identify software quality parameters and quantify software using measurements and metrics.
8. Recognize the need of agile software development and apply agile practices

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 THREE sub questions) from each modu
- 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 ea module.

Text Books:

1. Ian Sommerville: Software Engineering, 9th Edition, Pearson Education, 2011.(Listed topics only from Chapters 1,2,3,4, 5, 7, 8, 9, 23, and 24)

Reference Books:

1. Roger S. Pressman: Software Engineering-A Practitioners approach, 7th Edition, Tata McGraw Hill.
2. PankajJalote: An Integrated Approach to Software Engineering, Wiley India

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

Embedded System Design and Programming

(Common to EI, BM & ML)

Subject Code	**:17EI/BM/ML663**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08Hours)

Module -1

Introduction: An Embedded System, Characteristics and Constraints of an Embedded system, Processor embedded into a system, Embedded Hardware units and devices in a system, Software embedded in a system, Design metrics, examples of embedded system.

Module -2

Embedded Microcontroller Core and Architecture: 8051 micro controller; Architecture; Instruction sets; Assembly language programming. Timer / counter programming, Serial Communication; Interrupts.

Module -3

Processor and Memory Organization: Structural Units in a Processor; Memory Devices, Memory selection for an embedded system, Processor selection, Direct Memory Access, DMA controllers.

Module -4

Interrupt Servicing (Handling) Mechanism: Context and the periods for context switching; Deadline and interrupt latency. Language Features: Parameter passing, Recursion, Dynamic allocation, Typing, exception handling, abstract data typing, modularity.

Module -5

Real Time Kernels: Real Time and Embedded Operating Systems; Interrupt Routines in RTOS environment; co routines, Interrupt driven systems, Foreground/background systems, Full-featured Real Time Operating Systems.

Real Time Specifications and Design Technique: Mathematical specifications, flow charts, structure charts, Finite state automata, data flow diagrams, Petri Nets, Warnier Orr Notation.

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

1. Explain different embedded systems and their design metrics.
2. Discuss the 8051 microcontroller architecture and instruction set
3. Write ALP for implementation of mathematical and logical operations.
4. Illustrate accessing I/O devices, direct memory access, buses, and interface circuits.
5. Evaluate interrupt latency, context switching and different interrupt handling mechanisms.
6. Design an embedded system based on real-time specifications.

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 THREE sub questions) from each modu
- 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 ea module.

Text Books:

1. Embedded Systems Architecture; Programming and Design-Rajkamal; Tata McGraw Hill Publications.
2. Real–Time Systems Design and Analysis–-3rd Edition, Phillip A. Laplante. Apr 2004. Wiley-IEEE Press.

Reference Books:

1. Real Time Systems- C.M. Krishna, Kang G.Shin McGraw-Hill, 1997.
2. An Embedded software primer-David E Simon; Addison Wesley; 2000.
3. Embedded Real Time system-Concepts, Design and Programming, Dr. K. V. K. K. Prasad Dream Tech Pres, New Delhi 2003.

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

Statistics and Numerical Methods

(Common to EI&BM)

Subject Code	: **17EI/BM664**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1 :
Testing of Hypothesis- Large sample test based on Normal distribution for single mean and difference of means - Tests based on t, Students t-test, statistical significance '*p*' value, lamba^2 and F distributions for testing means and variances – Contingency table (Test for Independency) – Goodness of fit.

Module -2:
Design of Experiments- One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - 22 factorial design.

Module -3:
Solution of Equations And Eigen value Problems- Newton Raphson method – Gauss elimination method – pivoting – Gauss Jordan methods – Iterative methods of Gauss Jacobi and Gauss Seidel – Matrix inversion by Gauss Jordan method – Eigen values of a matrix by power method.

Module -4:
Interpolation, Numerical Differentiation and Numerical Integration- Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

Module -5:
Numerical Solution of Ordinary Differential Equations- Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge-Kutta method for solving first order equations – Milne's predictor corrector methods for solving first order equations – Finite difference methods for solving second order equations.

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

1. Perform hypothesis testing.
2. Apply completely randomized design for the experimental data classification.
3. Develop and implement iterative methods to solve algebraic and transcendental equations, simultaneous linear equations, and ordinary differential equations.
4. Apply the knowledge of finite differences, interpolation, numerical differentiation and numerical integration to different area.
5. Apply statistical and numerical methods for the analysis of simple and complex signals/data related to projects, research and real world problems.

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 THREE 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. R.A. Johnson and C.B. Gupta, "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007.
2. Grewal, B.S. and Grewal,J.S., "Numerical methods in Engineering and Science", 6th Edition, Khanna Publishers, New Delhi, 2004.

Reference Books:

1. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia , 8th Edition, 2007.
2. M.R. Spiegel, J. Schiller and R.A. Srinivasan, "Schaum's Outlines Probability and Statistics", Tata McGraw Hill edition, 2004.
3. Chapra S. C and Canale, R. P, "Numerical Methods for Engineers", 5th Edition, Tata McGraw-Hill, New Delhi, 2007.
4. Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", 6th Edition, Pearson Education Asia, New Delhi, 2006.

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

Medical Image Processing Lab

(Common to BM & ML)

Subject Code	**: 17 BM/ML L67**		CIE Marks	: 40
Number of Practical Hours /Week	: 03		SEE Marks	: 60
Total Number of Practical Hours	: 42		Exam Hours	: 03

Credits – 2

Title of the Experiments

1. Display of an image, negative of an image.
2. Contrast stretching of a low contrast image.
3. Display of a histogram, and histogram equalization.
4. Bit plane slicing of an image.
5. Image enhancement by Intensity/Gray level slicing.
6. Implementation of FT for an image.
7. Implementation of High pass, Low pass filtering.
8. Mean and Median filtering of an image.
9. Implementation of image sharpening filters and edge detection using gradient filters.
10. Image Rotation (Clockwise and anticlockwise) and Flipping (Horizontal and Vertical)
11. Canny edge detection.
12. Image compression by DCT.
13. Implementation of image segmentation techniques.

(Note: It is suggested to carry out the above experiments by Matlab / C programming on diagnostic images such as x-ray / CT / MRI / Ultrasound)

Course Outcomes: After studying this course, students will get hands on exposure to:

1. Implement and analyze image enhancement techniques.
2. Implement and analyze Image segmentation and image compression techniques.
3. Develop and analyze Image processing algorithms in practical applications/case studies.

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.

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

OOPs with C++ Lab

(Common to EI, BM & ML)

Subject Code	: **17EI/BM/MLL68**		CIE Marks	: 40
Teaching Hours/Week	:03		SEE Marks	: 60
Total No. of Practical hours	:42		Exam Hours	: 03

Credit-2

1) Write a C++ program to swap two Variables or Numbers by both call by value & call by reference.
2) Write a program to find largest, smallest & second largest of three numbers using inline functions MAX & Min.
3) Write a C++ program to calculate the volume of different geometric shapes like cube, cylinder and sphere using function overloading concept.
4) Design, develop and execute a program in C++ based on the following requirements: An EMPLOYEE class containing data members & members functions:
   i) Data members: employee number (an integer), Employee_ Name (a string of characters), Basic_ Salary (in integer), All_ Allowances (an integer), Net_Salary (an integer). (ii) Member functions: To read the data of an employee, to calculate Net_Salary& to print the values of all the data members. (All_Allowances = 123% of Basic, Income Tax (IT) =30% of gross salary (=basic_ Salary_All_Allowances_IT).
5) Define a STUDENT class with USN, Name & Marks in 3 tests of a subject. Declare an array of 10 STUDENT objects. Using appropriate functions, find the average of the two better marks for each student. Print the USN, Name & the average marks of all the students.
6) Create a class for counting the numbers of objects created and destroyed within various block using constructors & destructors.
7) Write a C++ program to create class called MATRIX using two-dimensional array of integers, by overloading the operator == which checks the compatibility of two matrices to be added and subtracted. Perform the addition and subtraction by overloading + and – operators respectively. Display the results by overloading the operator <<. If (m1 == m2) then m3=m1 + m2 and m4 = m1 –m2 else display error.
8) Demonstrate simple inheritance concept by creating a base class FATHER with data members: First Name, Sur name, DOB & bank Balance & creating a derived class SON, which inherits: Surname & Bank Balance feature from base class but provides its own feature: First Name & DOB. Create& initialize F1 & S1 objects with appropriate constructors & display the Father & Son details.
9) Write a C++ program with different class related through multiple inheritance& demonstrate the use of different access specified by means of members variables & members functions.
10) Write a C++ program to create three objects for a class named count object with data members such as roll_no& Name. Create a members function set_data ( ) for setting the data values & display ( ) member function to display which object has invoked it using 'this' pointer.
11) Write a C++ program to explain virtual function (Polymorphism) by creating a base class polygon which has virtual function areas Two classes rectangle & triangle derived from polygon & they have area to calculate & return the area of rectangle & Triangle respectively.
12) Write a program to define class name FATHER& SON that holds the income respectively calculate & display total income of a family using Friend function.
13) Write a program to accept the student detail such as name & 3 different marks by get_data ( ) method & display the name & average of marks using display ( ) method. Define a friend function for calculating the average marks using the method mark_avg ( ).
14) Write a programme to implement exception handling with minimum 5 exceptions classes

including two built in exceptions.
Note: Additional C++ programs depicting / demonstrating high-end concepts and applications may be given as assignments.
Course Outcome: After the completion of this Laboratory course, students will be able to: 1. Write C++ program to solve simple and complex problems 2. Apply and implement major object oriented concepts like message passing, function overloading, operator overloading and inheritance to solve real-world problems 3. Use major C++ features such as Templates for data type independent designs and File I/O to deal with large data set. 4. Analyze, design and develop solutions to real-world problems applying OOP concepts of C++
Conduct of Practical Examination: • All laboratory experiments are to be included for practical examination. • Students are allowed to pick one experiment from the lot. • Strictly follow the instructions as printed on the cover page of answer script for breakup of marks. • Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

7th Semester

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

Biomedical Digital Signal Processing

(Common to BM & ML)

Subject Code	**: 17BM/ML71**		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module -1

The nature of biomedical signals, objectives of biomedical signal analysis, difficulties encountered in biomedical signal analysis, Computer aided diagnosis. **Text-1:** 1.1, 1.3, 1.4, 1.5

Neurological Signal processing: Brain and its potentials, Electrophysiological origin of Brain waves, EEG signal and its characteristics, EEG analysis, Linear prediction theory, Autoregressive (AR) method, Recursive Estimation of AR parameters, Spectral error measure, Adaptive segmentation. **Text-2:** 4.1 to 4.9

Module -2

Filtering for Artifacts Removal : Random noise, structured noise and physiological interference, stationary versus non-stationary processes, typical case study, time domain filters with application: Synchronized averaging, moving-average filters

Frequency domain filters with examples, removal of high frequency noise by Butterworth low pass filters, removal of low frequency noise by Butterworth high pass filter, removal of periodic artifacts by notch and comb filters. Weiner filter.

Text-1: 3.1, 3.1.1, 3.1.2, 3.3, 3.3.1, 3.3.2, 3.3.3, 3.4, 3.4.1, 3.4.2, 3.4.3, 3.5.

Module-3

Basics of signal averaging, Signal averaging as a digital filter, A typical average, Software for signal averaging, Limitations of signal averaging. **Text-**3: 9.1 to 9.5

Data Acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of Sleep-wave Transitions, Hypnogram Model Parameters.

Text-2: 5.1 to 5.4

Module -4

ECG Parameters and their estimation, A review of wiener filtering problem, Principle of an adaptive filter, the steepest descent algorithm, Adoptive noise canceller, Cancellation 60Hz Interference in ECG, Cancelling Donor heart Interference in Heart-transplant ECG, Cancellation of Electrocardiographic signals from the electrical activity of chest muscles, Cancelling of maternal ECG in Fetal ECG, Cancellation of higher frequency noise in electro-surgery.

Text-2: 7.4, 6.1, 6.2, 6.3, 6.5, 6.6.

Module -5

Direct data compression techniques, Direct ECG data compression techniques, Transformation compression techniques, Other data compression techniques, Data compression techniques comparison.

Text-2: 8.1 to 8.5

Note: Assignments can be given on analysis other important biomedical signals like EMG, ERG, EOG, Evoked potentials.

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

1. Analyze the nature of Biomedical signals and related concepts
2. Apply filters to remove noise from biomedical signals.
3. Apply averaging technique on biomedical signals and extract the features of EEG signals.
4. Analyze event detection techniques for EEG and ECG signals.
5. Apply signal compression techniques on biomedical signals.
6. Write simple algorithms for biomedical signal processing

Question Paper Pattern

The question paper will have TEN questions.

- Each full question carry16 marks
- There will be TWO full questions (with maximum of THREE 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. Biomedical signal analysis- A case study approach, Rangayyan Rangaraj, Wiley (IEEE Press)-2005
2. Biomedical Signal Processing- Principles and Techniques - D.C.Reddy, Tata McGraw-Hill, 2005.
3. Biomedical Digital Signal Processing-Willis J.Tompkins, PHI, 2000.

Reference Books:

1. Biomedical Signal Processing -Akay M, , Academic: Press 1994
2. Biomedical Signal Processing (Vol. I Time & Frequency Analysis) - Cohen.A,, CRC Press, 1986.

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

Computer Communication Networks in Healthcare

(Common to BM & ML)

Subject Code	**: 17BM/ML72**		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module -1

Computer Networks In Health Care: Introduction, history, impact of clinical data, information types, platforms, current technologies, identifier standards, communication (message format) standards.

Introduction To Computer Networks: Uses of Computer Networks: Business Applications, Home Applications, Mobile Users. Network Hardware: Local Area Networks, Metropolitan Area Networks, Wide Area Networks, Wireless Networks. Network Software: Design Issues for the Layers, Connection – Oriented and Connectionless Services, Service primitives. The Relationship of Services to Protocols. Reference Models: The OSI Reference3 Model, The TCP/IP Reference Model, A Comparison of the OSI and TCP/IP Reference Models. Example Networks: Internet Usage, Architecture of the Internet, Connection– Oriented Networks: X.25, Frame Relay, and ATM.

Module -2

The Physical Layer: The Theoretical Basis For Data communication: Bandwidth Limited Signals, The Maximum Data Rate of a Channel. Guided Transmission Media: Magnetic Media, Twisted Pair, Coaxial Cable, Fiber Optics. Wireless Transmission: The Electromagnetic Spectrum, Radio Transmission, Microwave Transmission, Infrared and Millimeter Waves, Light wave Transmission. The Public Switched Telephone Network: Structure of the Telephone System. Trunks and Multiplexing: FDM, WDM & TDM, Switching, Internet over Cable

Module -3

The Data Link Layer: Data Link Layer Design Issues: Services Provided to the Network Layer, Framing, Error Control, Flow Control. Elementary Data Link Protocols: A Simplex Stop–and–Wait Protocol. Sliding Window Protocols: A One – Bit Sliding Window Protocol, A Protocol Using Go Back N, A Protocol Using Selective Repeat, HDLC –High – Level Data Link Control, The Data Link Layer in the Internet.

Module -4

The Medium Access Control Sublayer: Multiple Access Protocols: ALOHA, Carrier Sense Multiple Access Protocols, Wireless LAN Protocols. Ethernet: Ethernet Cabling, Manchester Encoding, The Ethernet MAC Sublayer Protocol, The Binary Exponential Backoff Algorithm, Ethernet Performance. Wireless Lans: The 802.11 Protocol Stack, The 802.11 Physical Layer, The 802.11 MAC Sublayer Protocol, The 802.11 Frame Structure, Services.

Module -5

Blue Tooth: Blue tooth Architecture, Bluetooth Applications. Data Link Layer SWITCHING: Local Internet Working, Repeaters, Hubs, Bridges, Switches, Routers, and Gateways, Virtual LANs.

The Network Layer: Network Layer Design Issues: Store-and- Forward Packet Switching, Services Provided to the Transport Layer, Implementation of Connectionless Service, Implementation of Connection –Oriented Service. Routing Algorithms: The Optimality Principle, Shortest Path Routing, Distance Vector Routing, Link State Routing, Hierarchical Routing, Broadcast Routing,

CONGESTION control Algorithms: General Principles of Congestion Control. Quality of Service: Requirements, Techniques for Achieving Good Quality of Service-leaky bucket algorithm, token bucket algorithm. Internetworking: How Networks Differ, How Networks Can Be Connected. The Network layer In The Internet: The IP Protocol, IP Address Formats, IPV6 Header Format.

Note: Assignments may be given on the computer networking in the hospital and connecting to hospital database.

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

1. Explain the different formats of data generated in clinical field or Medical field.
2. Discriminate the functionality between the layers in OSI model and TCP/IP suite.
3. Discuss the concept of physical and data link layer.
4. Distinguish the IEEE standards designed to understand the interconnectivity between different LANs.
5. Apply different algorithms to route a packet to the destination for process to process delivery.
6. Discuss the concepts of Bluetooth technology, and transport & application layer.

Question Paper Pattern

- The question paper will have TEN questions.
- Each full question carry16 marks
- There will be TWO full questions (with maximum of THREE 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 Biomedical Engineering Handbook-Volume II (2nd Edition) – by Joseph D. Bronzino, CRC/IEEE Press, 2000.
2. Computer Networks – Andrew S. Tanenbaum, 4thEdn, Pearson Education / PHI, 2004.

Reference Books:

1. Data and Computer Communication – William Stallings, 7th Edition, Pearson Education, 2004.
2. Data Communications and Networking – Behrouz A Forouzan, 4th Edition, Tata McGraw Hill, 2006.
3. Computer Networking – Kurose and Ross, Pearson Education, 2004.

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

ARM Processor

(Common to EI, BM & ML)

Subject Code	: **17EI/BM/ML73**		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module -1

ARM Embedded Systems

Introduction, RISC design philosophy, ARM design philosophy, Embedded system hardware - AMBA bus protocol, ARM bus technology, Memory, Peripherals, Embedded system software – Initialization (BOOT) code, Operating System, Applications.

ARM Processor Fundamentals

ARM core dataflow model, registers, current program status register, Pipeline, Exceptions, Interrupts and Vector Table, Core extensions.

Module -2

Introduction to the ARM Instruction set:

Introduction, Data processing instructions, Load - Store instruction, Software interrupt instructions, Program status register instructions, Loading constants, ARMv5E extensions, Conditional Execution.

Module -3

Introduction to the THUMB instruction set:

Introduction, THUMB register usage, ARM – THUMB interworking, Other branch instructions, Data processing instructions, Stack instructions, Software interrupt instructions.

Efficient C Programming:

Overview of C Compilers and optimization, Basic C Data types, C looping structures.

Module -4

Exception and Interrupt Handling:

Exception Handling-ARM Processor Exceptions and Modes, Vector Table, Exception Priorities, Link Register Offset, Interrupts- Interrupt Latency, Basic Interrupt Stack design and implementation, Interrupt Handling Scheme- Non nested Interrupt Handler, Nested Interrupt Handler, Reentrant Interrupt Handler, Prioritized Simple Interrupt Handler, Prioritized Standard Interrupt Handler, Prioritized Direct Interrupt Handler, Prioritized Grouped Interrupt Handler.

Embedded Operating Systems:

Fundamental Components, SLOS Directory Layout, Memory Interrupts and Exceptions handling, scheduler, Context Switch, Device Driver Framework.

Module -5

CACHES:

The memory Hierarchy and caches memory-caches and memory management units, Cache Architecture-basic architecture of caches memory, basic operation of cache controller, the relationship between cache and main memory.

Memory Management Units:

Moving from an MPU to an MMU**,** Virtual memory Working-Defining regions using pagers, multitasking and the MMU, Memory organization in a virtual memory system, page tables Translational look aside buffer.

Note: Two or four tutorial classes need to be conducted (in a semester) to discuss the Embedded ARM

Applications, such as GSM Chip and Bluetooth controller & assignment should be based on applications only.

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

1. Depict the organization, architecture, bus technology, memory and operation of the ARM microprocessors
2. Employ the knowledge of Instruction set of ARM processors to develop basic Assembly Language Programs
3. Recognize the importance of the Thumb mode of operation of ARM processors and develop C programs for ARM processors
4. Describe the techniques involved in Exception and Interrupt handling in ARM Processors and understand the fundamental concepts of Embedded Operating Systems
5. Develop embedded C programs to interact with Built in Peripherals
6. Design, analyze and write programs using RTOS (Micro C/OS) on ARM based development boards.

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 THREE sub questions) from each module.
- Each full question will have sub questions covering all topics under a module.
- The students will have to answer FIVE full questions, selecting ONE full question from each module.

Text Books:

1. Andrew N Sloss, Dominic System and Chris Wright," ARM System Developers Guide", Elsevier, Morgan Kaufman publisher, 1st Edition, 2008/,ISBN:1558608745.

Reference Books:

1. David Seal, "ARM Architecture Reference Manual", Addison- Wesley, 2nd Edition, 2009, ISBN: 978-0201737196.
2. Furber S, "ARM System on chip Architecture", Addison Wiley, 2nd Edition 2008, ISBN:978-0201675191
3. Rajkam, "Embedded System", Tata McGraw-Hill Publishers, 2nd Edition, 2008, ISBN: 0070494703.

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

Database Management System in Healthcare

(Common to BM & ML)

Subject Code	**: 17BM/ML741**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1

Database and Database Users: Introduction, Characteristics of the Database Approach, Advantages of Using the DBMS Approach. (**Text Book** 2 : 1.1, 1.3, 1.6)

Database System Concepts and Architecture: Data models, Schemas, and Instances, Three – Schema Architecture and Data Independence, Database Languages and Interfaces, Classification of Database Management Systems. (Text Book 2 : 2.1, 2.2, 2.3, 2.6)

Patient Database: Patient Database strategies for HIS, data acquisition, patient admission, transfer, discharge, evaluation & management. Computer based patient record, clinical decision support systems. (Text Book 3)

Overview of Database Systems: A Historical Perspective, File Systems versus a DBMS, Describing and Storing Data in a DBMS, Queries in a DBMS, Transaction Management, Structure of a DBMS.(**Text Book** 1 : 1.2, 1.3, 1.5, 1.6, 1.7, 1.8)

Module -2

Data Modeling using the Entity – Relationship (ER) Model: Using High – Level Conceptual Data Models for Database Design, An Example Database Application; Entity Types, Entity Sets, Attributes and Keys, Relationship types, Relationship Sets, Roles and Structural Constraints, Weak Entity Types, Refining the ER Design for the COMPANY Database, ER Diagrams, Naming Conventions and Design Issues. (**Text Book**2 : 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7)

Relational Model: Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions, and Dealing with Constraint Violations. (Text Book 2 : 5.1, 5.2, 5.3)

Relational Algebra and Relational Calculus: Unary Relational Operations: SELECT and PROJECT. (**Text Book**2 : 6.1)

Module -3

Relational Algebra and Relational Calculus: Relational Algebra Operations from Set Theory, Binary Relational Operations: JOIN and DIVISION, Additional Relational Operations. (**Text Book**2 : 6.2, 6.3, 6.4)

SQL – 99: SQL Data Definition and Data Types, Specifying Constraints in SQL, Schema Change Statements in SQL, Basic Queries in SQL, More Complex SQL Queries, INSERT, DELETE and UPDATE Statements in SQL, Specifying Constraints as Assertions and Triggers, Views (Virtual Tables) in SQL , Additional Features of SQL. (**Text Book**2 : 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9)

Module -4

Database Design Theory and Methodology: Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form. (**Text Book**2 : 10.1, 10.2, 10.3, 10.4, 10.5)

Relational Database Design Algorithms and Further Dependencies: Properties of Relational Decompositions, Algorithms for Relational Database Schema Design, Multivalued Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form, Inclusion Dependencies, Other Dependencies and Normal Forms. (**Text Book**2 : 11.1, 11.2, 11.3, 11.4, 11.5, 11.6)

Module -5

Overview Of Transaction Management: The ACID Properties, Transactions and Schedules, Concurrent Execution of Transactions, Lock-Based Concurrency Control, Performance of Locking, Transaction Support in SQL, Introduction to Crash Recovery. (**Text Book** 1 : Chapter 16)

Concurrency Control : 2PL, Serializability and Recoverability, Introduction to Lock Management, Lock Conversions, Dealing with Deadlocks, Specialized Locking Techniques, Concurrency Control without Locking.(Text Book 1 : Chapter 17)

Crash Recovery : Introduction to ARIES, The Log, Other Recovery- Related Structures, The Write-Ahead Log Protocol, Check-pointing, Recovering from a System Crash, Media Recovery.(**Text Book** 1 : 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7)

Note: Assignment may be given on the topics on semantic web and natural language processing (NLP) for semantic web, software for the hospital database management.

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

1. Describe the basic concepts of DBMS, languages, and DBMS architecture.
2. Describe the concept of ER model and Relational Model.
3. Apply the Relational operations and Structured Query Languages for RDBMS.
4. Analyze the data model based on normalization theory.
5. Discuss database transactions management and data recovery from system crash.

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 THREE 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. Database Management Systems - by Raghu Ramakrishna and Johannes Gehrke, (3rd Edition), McGraw Hill, 2003.
2. Fundamentals of Database Systems - by RamezElmasri and ShamkantB.Navathe (5th Edition), Pearson Education, 2007.
3. The Biomedical Engineering Handbook-Volume II (2nd Edition) – by Joseph D. Bronzino, CRC/IEEE Press, 2000.

Reference Books:

1. Data base System Concepts - by Silberschatz, Korth and Sudharshan. (4th Edition), McGraw Hill, 2002.

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

Medical Informatics and Expert Systems

(Common to BM & ML)

Subject Code	**: 17BM/ML742**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module- 1:

Medical Informatics: Aim and scope, salient feature, Introduction, history, definition of medical informatics, bio-informatics, online learning, introduction to health informatics, prospectus of medical informatics.

Hospital Management And Information Science: Introduction, HMIS: need, Benefits, capabilities, development, functional areas. Modules forming HMIS, HMIS and Internet, Pre-requisites for HMIS-client server technology, PACS, why HMIS fails, health information system, disaster management plans, advantages of HMIS.**Text**1: (Section I - 1 and 2, Section II-3)

Module-2 :

Hospital Management And Information Systems-Structure And Functions : Central Registration Module, OPD / Consultant Clinic / Polyclinic Module, Indoor Ward Module, Patient Care Module, Procedure Module, Diet Planning Module, MLC Register Module, Pathology Laboratory Module, Blood Bank Module, Operation Theatre Module, Medical Stores Module, Pharmacy Module, Radiology Module, Medical Records Index Module, Administration Module, Personal Registration Module, Employee Information Module, Financial modules, Health & Family Welfare, Medical Examination, Account Billing, Medical Research, Communication, General Information. **Text** 1: (Section II-6)

Module–3:

Computer Assisted Medical Education: CAME, Educational software, Simulation, Virtual Reality, Tele-education, Tele-mentoring.

Computer Assisted Patient Education: CAPE, patient counseling software. Computer assisted surgery (CAS), Limitations of conventional surgery, 3D navigation system, intra-operative imaging for 3D navigation system, merits and demerits of CAS.**Text**1: (Section III – 7 & 8)

Module–4:

Telecommunication Based Systems: Tele-Medicine, Need, Advantages, Technology- Materials and Methods, Internet Tele-Medicine, Applications.

Tele-Surgery: Tele-surgery, Robotic surgery, Need for Tele-Surgery, Advantages, Applications.**Text**1: (Section V- 13 & 14)

Module–5:

Knowledge Based And Expert Systems: Introduction, Artificial Intelligence, Expert systems, need for Expert Systems, materials and methods- knowledge representation & its methods, production rule systems, algorithmic method, OAV, object oriented knowledge, database comparisons, statistical pattern classification, decision analysis, tools, neural networks, advantages of ES, applications of ES. **Text 1**: (Section II – 4)

Note: Assignments may be given on topics, rule based techniques for prediction, SNOMED standards, International classification of Diseases (ICD) codes.

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

1. Explain the basics and importance of medical informatics in hospital management.
2. Describe the different modalities functions exists in the hospital for effective management.
3. Explain the role of technology both hardware & software in training the medical personalities.
4. Discuss the role of tele communication, tele-surgery, robotics in healthcare.
5. Explain the decision making concepts used in healthcare and their applications.
6. Apply information and communication technology in healthcare.

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 THREE 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. Medical Informatics: A Primer - by Mohan Bansal, 1st Print, Tata McGraw Hill, Publications, 2003.

Reference Books:

1. Medical Informatics: Computer Applications in Health Care and Biomedicine by E.H.Shortliffe, G. Wiederhold, L.E.Perreault and L.M.Fagan, 2nd Edition, Springer Verlag, 2000.
2. Handbook of Medical Informatics by J.H.VanBemmel, Stanford University Press/ Springer, 2000.

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

Hardware Software Co-Design

Subject Code	**: 17BM743**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module- 1:
Introduction
Motivation hardware & software co-design, system design consideration, research scope & overviews
Hardware Software background
Embedded systems, models of design representation, the virtual machine hierarchy, the performance modeling, Hardware Software development.

Module-2 :
Hardware Software Co-Design Research
An informal view of co-design, Hardware Software tradeoffs, crosses fertilization, typical co-design process, co-design environments, limitation of existing approaches, ADEPT modeling environment.
Co-design Concepts
Functions, functional decomposition, virtual machines, Hardware Software partitioning, Hardware Software partitions, Hardware Software alterations, Hardware Software tradeoffs, co-design.

Module–3:
Methodology for Co-Design
Amount of unification, general consideration & basic philosophies, a framework for co-design, an example.
Unified Representation for Hardware & Software
Benefits of unified representation, modeling concepts, a unified representation.

Module–4:
An Abstract Hardware & Software Model
Requirement & applications of the models, models of Hardware Software system, an abstract Hardware Software models, generality of the model.
Performance Evaluation
Application of the abstract Hardware & Software model, examples of performance evaluation.

Module–5:
Object Oriented Techniques in Hardware Design
Motivation for object oriented technique, data types, modeling hardware components as classes, designing specialized components, data decomposition, Processor example.
Conclusions on Hardware Software Co-Design and Future work

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

1. Outline the motivation, scope, and background of hardware software co-design.
2. Explain the co-design concepts, typical co-design processes and limitations of existing approaches.
3. Describe the general considerations, framework for co-design with examples and unique representation and basic modelling concepts.
4. Develop the hardware software system model and evaluate their performance on usage.
5. Explain the data types, model hardware component as classes and data decomposition.

Design specialized component.
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 THREE 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. Sanjaya Kumar, James H. Ayler "The Co-design of Embedded Systems: A Unified Hardware Software Representation", Kluwer Academic Publisher, 2002.
REFERENCE BOOKS: 1. Peter Mwrwedel, "Embedded System Design", by Springer P.O. Box 17, 3300 AA Dordrecht, The Netherlands 2. R. Gupta, "Co-synthesis of Hardware and Software for Embedded Systems", Kluwer 1995. 3. S. Allworth, "Introduction to Real-time Software Design",Springer-Verlag, 1984. 4. C. M. Krishna, K. Shin, "Real-time Systems", McGraw Hill, 1997 5. Peter Marwedel, G. Goosens, "Code Generation for Embedded Processors", Kluwer Academic Publishers, 1995.

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

Biometric Systems

(Common to BM & ML)

Subject Code	: **17BM/ML744**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module -1

Introduction to Biometrics: Introduction, Identification Methods, Biometrics, Biometrics Technology Overview, Biometrics technologies: A Comparison, Automatic Identification, Research Issues – Acquisition, Representation, Feature Extraction, Matching, Search, Organization and Scalability, Privacy, Novel Applications.(**Text** 1: Chapter 1)

Module -2

Finger Print Verification: Matching – Verification and Identification, Feature type, Image Processing and Verification, System Issues, Recognition Rate, Multi-modal Biometrics

Face Recognition: Introduction, Approaches, The SHOSLIF.(**Text** 1: Chapter 2, Chapter 3)

Module -3

Hand Geometry Base Verification: Introduction, System Operation, Implementation Issues, Applications.

Recognizing By Iris Patterns: Introduction, Iris Patterns – Complex Phenotypic Features, Statistical Recognition Principle, Decidability of Iris Based personal Identification, Identification versus Verification, Stability of Iris Pattern Overtime.(**Text** 1: Chapter 4, Chapter 5)

Module -4

Retina Identification: Retina/Choroid as Human Descriptor, Background, Technology, Eye Signature, RI Camera, Signal Acquisition and Computing Subsystem, System Operation, Performance.

Key stroke Dynamics Based Authentication: Introduction, Types of Security Attacks, Predicting Human Characteristics, Applications of Keystroke Dynamics using Interkey Times and Hold Times as Features.(**Text** 1: Chapter 6, Chapter 10)

Module -5

Multimodal Biometrics: Introduction, Decision Fusion, Experimental Results.

Biometrics: Identifying Law & Policy Concerns: Introduction, Definition and Advantages, Biometric Applications, Context of Biometrics, Privacy Concerns, Biometrics as Privacy's Foe-Criticisms, Biometric Centralization vs. Biometric Balkanization.(**Text** 1: Chapter 16, Chapter 19)

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

1. Explain the general principles of designing biometric-based systems.
2. Analyze various biometric systems, their characteristics and performance.
3. Discuss the online identification biometric techniques.
4. Recognize some of the personal privacy and security implications of biometrics based identification technology.
5. Analyze the privacy and security issues of biometrics.
6. Develop simple model of biometric system.

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 THREE sub questions) from each module.
- Each full question will have 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. "Biometrics, Personal Identification in Networked Society", Anil Jain, Ruud Bolle, Sharath Pankanti, Kluwer Academic Publishers, 2002

Reference Books:

1. "Biometrics -Identity verification in a networked World", Samir Nanavathi, Michel Thieme, and Raj Nanavathi, Wiley Eastern, 2002.
2. "Implementing Biometric Security", John Chirillo and Scott Blaul, Wiley Eastern Publications, 2005.
3. "Biometrics for Network Security", John Berger, Prentice Hall, 2004.

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

Biostatistics

(Common to BM & ML)

Subject Code	**: 17BM/ML751**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1

Getting Acquainted With Biostatistics: Introduction, Some Basic Concepts, Measurement and Measurement Scales, Sampling and Statistical Inference, The Scientific Method and The Design of Experiments, Computers and Bio statistical Analysis. (Text Book 1 : Chapter 1)

Strategies For Understanding The Meanings Of Data: Introduction, The Ordered array, Grouped Data : The Frequency Distribution, Descriptive Statistics : Measure of Central Tendency, Descriptive Statistics : Measure of Dispersion. (**Text Book** 1 : Chapter 2)

Module -2

Probability: The Basis Of Statistical Inference: Introduction, Two Views of Probability: Objective and Subjective, Elementary Properties of Probability, Calculating the Probability of an Event. (Text Book 1 : 3.1, 3.2, 3.3, 3.4)

Probabilistic Features Of Certain Data Distributions: Introduction, Probability Distributions of Discrete Variables, The Binomial Distribution, The Poisson Distribution, Continuous Probability Distributions, The Normal Distribution, The Normal Distribution Applications. (**Text Book** 1 : Chapter 4)

Module -3

Probabilistic Features Of The Distributions Of Certain Sample Statistics: Introduction, Sampling Distribution, Distribution of the Sample Mean, Distribution of the Difference Between Two Samples Means, Distribution of the Sample Proportion, Distribution of the Difference Between Two Sample Proportions. (T**ext Book** 1 : Chapter 5)

Using Sample Data To Make Estimates About Population Parameters : Introduction, Confidence Interval for a Population Mean, The *t* Distribution, Confidence Interval for the Difference Between Two Population Means, (**Text Book** 1 : 6.1, 6.2, 6.3, 6.4)

Module -4

Using Sample Data To Make Estimates About Population Parameters: Confidence Interval for a Population Proportion, Confidence Interval for the Difference Between Two Population Proportions, Determination of Sample Size for Estimating Means, Determination of Sample Size for Estimating Proportions, Confidence Interval for the Variance of a Normally Distributed Population, Confidence Interval for the Ratio of the Variances of Two Normally Distributed Populations. (**Text Book**1 : 6.5, 6.6, 6.7, 6.8, 6.9, 6.10)

Using Sample Statistics To Test Hypotheses About Population Parameters: Introduction, Hypotheses Testing : A Single Population Mean. (**Text Book** 1 : 7.1, 7.2)

Module -5

Using Sample Statistics To Test Hypotheses About Population Parameters: Hypotheses Testing : The Difference Between Two Population Means, Paired Comparisons, Hypotheses Testing : A Single Population Proportion, Hypotheses Testing : The Difference Between Two Population Proportions, Hypotheses Testing : A Single Population Variance, Hypotheses Testing : The Ratio of Two Population Variances. The Type II Error and the Power of a Test, Determining Sample Size to

Control Type II Errors. (**Text Book**1 : 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 7.10)

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

1. Describe the basic statistical terms, concepts, procedures and statistical measures.
2. Apply probability concepts and probability distributions for statistical inferences.
3. Apply sampling distribution concepts and estimation procedures for population parameters.
4. Select and apply appropriatehypotheses tests for statistical analysis.

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 THREEsub 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. Biostatistics: Basic Concepts and Methodology for the Health Sciences – by Wayne W. Daniel, John Wiley & Sons Publication, 9th Edition, 2009.

Reference Books:

1. Principles of Biostatistics - by Marcello Pagano and KimberleeGauvreu, Thomson Learning Publication, Indian Edition, 2007.
2. Biostatistics - by Ronald N Forthofer, EunSul Lee and M. Hernandez, Academic Press, 2007.
3. Basic Biostatistics and its Applications - by Animesh K. Dutta, 2006.

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

Lasers and Optical Fibers in Medicine

(Common to BM & ML)

Subject Code	**: 17BM/ML752**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module -1

Applications Of Lasers In Therapy & Diagnosis: Introduction, laser assisted diagnosis and therapy-fundamentals, interaction of laser beams and materials-principles (except 3.3.4), laser interaction with tissue-principles, laser assisted diagnostics-principles, applications of lasers in diagnosis and imaging-advances, laser surgery and therapy-principles photo-thermal & photomechanical mechanisms, thermal interaction between laser and tissue-advances.

Module -2

Single Optical Fibers: Introduction, historical background, optical fibers-fundamentals, light transmission in optical fibers-principles, optical properties of optical fibers-advances, fabrication of optical fibers-principles, optical fibers for UV, visible, IR light-principles, power transmission through optical fibers-principles, modified fiber ends and tips-principles, fiber lasers advances.

Module -3

Optical Fiber Bundles: Introduction, non-ordered fiber-optic bundles for light guides-fundamentals & principles, ordered fiber-optic bundles for imaging devices-fundamentals & principles, fiber-scopes and endoscopes fundamentals, fiber optic imaging systems-advances.

Module -4

Endoscopy: Introduction, endoscopic imaging systems-fundamentals, principles, advances, endoscopic diagnostics-advances, endoscopic therapy fundamentals, endoscopic ultrasound imaging-principles.

Module -5

Clinical Applications Of Fiber Optic Laser Systems: Introduction, fiber-optic laser systems in cardiovascular disease (except 9.2.6), gastroenterology, gynecology, neurosurgery, oncology, ophthalmology, orthopedics, otolaryngology (ENT), urology, flow diagram for laser angioplasty & photodynamic therapy.

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

1. Explain the basics and principles of LASERS in Medicine.
2. Discuss the fundamentals and properties of optical fibers for UV, IR, power transmission and advancement.
3. Describe the working of optical fibre bundles for imaging devices applying the light guided fundamentals & principles.
4. Explain and demonstrate the working of endoscopic therapy, diagnostic & imaging principles.
5. Outline the clinical applications of fiber optic Lasers systems.

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 THREE 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. Lasers and Optical Fibers in Medicine - by Abraham Katzir, Academic Press, 1998.

Reference Books:

1. Lasers in Medicine - by Ronal W. Waynant, CRC Press, 2002.

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

Ergonomics

(Common to BM & ML)

Subject Code	**: 17BM/ML753**		CIE Marks	: 40
Number of Lecture Hours/Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1

The Design of Work Places: Working heights, Room to grasp and move things, Seating at work.
Heavy Work: Physiological principles, Energy consumptions at work, Limits and norms of energy consumption at work, Organization of heavy work.
Handling loads: Lifting, Carrying a burden.

Module -2

Skilled work: Acquiring skill, Maximum control of skilled movements, Facilitating skilled work.
Mental activity: Uptake of information, Memory, Sustained alertness.
Fatigue: Fatigue in industrial practice, Measuring fatigue.

Module -3

Boredom: Boredom from the standpoint of psychology, Problems of monotonous, repetitive work.
Working hours and eating habits: Flexible and continuous working schedules, Rest pauses, Nutrition and work.
Night work and shift work: Night work and health, Organization of shift work.

Module -4

Man – machine systems: Visual perception, Perception of sound, Display equipment, Controls, Relationship between controls and display instruments.
Light and colour in surroundings: Light measurement and light sources, Physiological requirements of artificial lighting, Lighting for the work place, Daylight, Colour in the work room.

Module -5

Noise and Vibration: Measurement and sources of noise, Damage to hearing through noise, Physiological and psychological effects of noise, Protection against noise, Music and work, Vibrations.
Indoor climate: Thermal regulation in man, Comfort, Dryness of the air during heating periods, Recommendations for comfort indoors, Air pollution and ventilation, Heat in industry.

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

1. Define the principlesof Ergonomics.
2. Describe the work places in order to suit the physical and psychological requirements of the Workers.
3. Employ the principles of Ergonomics in design of work places.
4. Evaluate the work places based on efficiency, accuracy, and safety measures.

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 THREE 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 Book:

1. Fitting the Task to the Man – An ergonomic approach, by E. Grandjean, 3rd Edition, Taylor & Francis Ltd, London.

Reference Books:

1. Fitting the Task to the Human - A Text Book of Occupational Ergonomics by H. E. Kroemer and Etienne Grandjean, 5th Edition, Taylor & Francis Ltd, London.
2. Human Factors in Engineering and Design - by Mark S. Sanders and Ernest J. McCormick, 1993.

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

Big Data and Cloud Computing

(Common to EI, BM & ML)

Subject Code	**: 17EI/BM/ML754**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours

Module -1

Introduction To Big Data:

Characteristics of Data, Evolution of Big Data, Definition of Big Data, Challenges with Big Data, What is Big Data?, Other Characteristics of Data, Why Big Data?, Information?, Traditional Business Intelligence (BI) versus Big Data, A Typical Data Warehouse Environment, A Typical Hadoop Environment, What is New Today?, What is changing in the Realms of Big Data?

Big Data Analytics: What is Big Data Analytics? What Big Data Analytics Isn't? Classification of Analytics, Top Challenges Facing Big Data, Why is Big Data Analytics Important? Data Science, Few Top Analytics Tools.

Module -2

Technologies And Tools For Big Data Analytics:

NoSQL (Not Only SQL), Hadoop.

Module -3

Introduction :Cloud Computing at a Glance, Historical Developments, Building Cloud Computing Environments,

Computing Platforms and Technologies,

Virtualization: Introduction, Characteristics of Virtualized, Environments Taxonomy of Virtualization Techniques, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples.

Module -4

Cloud Computing Architecture: Introduction, Cloud Reference Model, Architecture, Types of Clouds, Economics of the Cloud, Open Challenges,

Aneka: Cloud Application Platform: Framework Overview, Anatomy of the Aneka Container, Building Aneka Clouds,

Cloud Programming and Management.

Module -5

Cloud Platforms In Industry: Amazon Web Services, Google App Engine, Microsoft Azure.

Cloud Applications: ECG Analysis in the Cloud, Satellite Image Processing, Social Networking, Media Applications, Multiplayer Online Gaming.

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

1. Describe the concepts and technologies of big data analytics.
2. Apply the techniques in handing and analysis of big data.
3. Discuss the concepts and terminologies of cloud computing.
4. Demonstrate cloud frameworks and technologies
5. Describe and apply fine data intensive computing.
6. Demonstrate cloud applications.

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 THREE sub questions) from each modu
- 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 ea module.

Text Books:

1. Big Data and Analytics – Seema Acharya, Subhashini Chellappan Willey India ISBN 13 9788126554782
2. Mastering Cloud Computing – Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi McGraw Hill Education.

Reference Books:

1. Big Data Analytics with R and Hadoop – Vignesh Prajapati, 2013 Packt Publishing.
2. Cloud Computing Bible - Barrie Sosinsky, Wiley-India, 2010.
3. Cloud Computing: A Practical Approach - Toby Velte, Anthony Velte, Robert Elsenpeter, McGraw Hill Professional Publications, 2009. [ISBN: 0071626956].

B.E. Biomedical Engineering (BM)
Choice Based Credit System (CBCS)
Semester – VII

Biomedical DSP Lab

(Common to BM & ML)

Subject Code	**: 17BM/MLL76**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 42		Exam Hours	: 03

Credits – 2

Write programs in C or Matlab

1. Introduction to basic Operations using Mat lab
2. Write a program to Compute Linear & Circular convolution, Cross & Auto correlation.
3. Write a program to Compute DFT, FFT, Power spectrum and power spectral density
4. Write a program to Display Static and Moving ECG signal.
5. Write a program to Implement 50Hz notch filter for ECG signal and display PSD.
6. Write a program to Implement IIR filters for ECG (LPF,HPF,BPF)
7. Write a program to Implement Low-Pass FIR filter for ECG
8. Write a program to Implement FIR Filter using Kaiser Window.
9. Write a program to detect QRS complex and measure the heart rate of a given ECG signal
10. Write a program to improve the SNR using signal averaging technique
11. Write a program to obtain the DCT & IDCT of ECG signal
12. Write a program to down sample the given ECG signal
13. Write a program to obtain Adaptive noise cancelling
14. Write a program to compress the data using Turning point & FAN algorithm

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

1. Apply the signal processing techniques onbiomedical signals and evaluate their performance.
2. Develop/Write signal processing algorithms forthe analysis of biomedical signals

Conduct of Practical Examination:

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

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

ARM Processor Lab

(Common to EI, BM & ML)

Subject Code	**: 17 EI/BM/ML L77**		CIE Marks	: 40
Teaching Hours/Week	: 03 (1I+2P)		SEE Marks	: 60
Total No. of Practical hours	: 42		Exam Hours	: 03

Credits – 2

PART-A: Conduct the following experiments by writing Assembly Language Program (ALP) using ARM Cortex M3 Registers using an evaluation board/simulator and the required software tool.

1. Write an ALP to multiply two 16 bit binary numbers.
2. Write an ALP to find the sum of first 10 integer numbers.
3. Write an ALP to find factorial of a number.
4. Write an ALP to add an array of 16 bit numbers and store the 32 bit result in internal RAM
5. Write an ALP to add two 64 bit numbers.
6. Write an ALP to find the square of a number(1 to 10) using look-up table.
7. Write an ALP to find the largest/smallest number in an array of 32 numbers .
8. Write an ALP to arrange a series of 32 bit numbers in ascending/descending order.
9. Write an ALP to count the number of ones and zeros in two consecutive memory locations.
10. Write an ALP to Scan a series of 32 bit numbers to find how many are negative.

PART-B: Conduct the following experiments on an ARM CORTEX M3 evaluation board using evaluation version of Embedded 'C' & Keil Uvision-4 tool/compiler.

1. Display "Hello World" message using Internal UART.
2. Interface and Control a DC Motor.
3. Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction.
4. Determine Digital output for a given Analog input using Internal ADC of ARM controller.
5. Interface a DAC and generate Triangular and Square waveforms.
6. Interface a 4x4 keyboard and display the key code on an LCD.
7. Using the Internal PWM module of ARM controller generate PWM and vary its duty cycle.
8. Demonstrate the use of an external interrupt to toggle an LED On/Off.
9. Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay in between.
10. Interface a simple Switch and display its status through Relay, Buzzer and LED.

Note: More weightage should be given for PART-B experiments in the evaluation of Internal Assessment and Laboratory Examinations.

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

1. Write ALP for implementation of specific arithmetic or logical operations.
2. Write programs to demonstrate functioning of various devices interfaced to ARM processor.
3. Develop programs for ARM processors to implement real world problems.
4. Design and develop mini projects.

Conduction of Practical Examination:

1. All laboratory experiments (Part-A + Part-B) are to be included for practical examination.
2. Students are allowed to pick & execute one experiment from each part.
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% of Marks allotted to the procedure part to be made zero.

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

Project Work Phase- I + Project Work Seminar

Subject Code	**: 17BMP78**		CIE Marks	: 100
Teaching Hours/Week	: 03		Exam Marks	: --
Total No. of Practical hours	: 42		Exam Hours	: --

Credits – 2

During Project Work Phase – I , students are expected to do the followings;

1. Identify the project domain and topic.
2. Carryout necessary literature survey.
3. Define the problem and objectives of the proposed project work.
4. Finalize the methodology to carry out the project work in Phase- II and submit the Synopsis.
5. Present a Seminar on topic selected for the project.

Evaluation Procedure:

- As per the University guidelines.
- The Internal Assessment marks shall be awarded based on the relevance of the proposed Project Domain & Topic, Quality of the Synopsis and timely submission, Seminar presentation on the proposed project work, participation in the question and answer session, and attendance in the seminar presentations.

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

1. Collect the literature and materials in the proposed project work.
2. Analyze the current state of art work in the proposed project work
3. Prepare synopsis with objectives and methodology
4. Justify the proposed project and its probable outcome in the seminar presentation.
5. Communicate the concepts by effective presentation
6. Participate effectively as an individual and member of project team.

8th SEMESTER

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

Medical Imaging Systems

(Common to BM & ML)

Subject Code	**: 17BM/ML81**		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module -1

X-Ray Imaging: Fundamentals of X-ray – Electromagnetic radiation, Interactions between X-rays and matter, Intensity of X-ray beam, Attenuation, Generation and Detection of X-rays – X-ray generation, X-ray generators, Filters, Beam restrictors and grids, Intensifying screens, fluorescent screens, and image intensifiers, X-ray detectors, Biological effects of ionizing radiation.

X-Ray Diagnostic Methods: Conventional X-ray radiography, Fluoroscopy, Angiography, Mammography and Xeroradiography.

Computed Tomography: Conventional tomography, Computed tomography – Projection function, Algorithms for image reconstruction, CT number, Spiral CT. Recent developments – Digital radiography, Digital subtraction angiography (DSA), Dynamic spatial reconstructor (DSR),

Module -2

Ultrasound Imaging: Fundamentals of acoustic propagation - Characteristic impedance, Intensity, Reflection and refraction, Attenuation, Doppler effect. Generation and detection of Ultrasound- Piezoelectric effect, Ultrasonic transducers, Axial and Lateral resolution, Focusing, Arrays.

Ultrasonic Diagnostic Methods: Pulse echo systems- Amplitude mode (A-mode), Brightness mode (B-mode), Motion mode (M-mode), Doppler methods, Duplex imaging, Tissue characterization, Colour Doppler flow imaging, Image characteristics – Ultrasonic texture or speckle, Speckle reduction, Compensation of phase aberration, Biological effects of ultrasound.

Module -3

Radionuclide Imaging: Introduction, Fundamentals of Radioactivity – Nuclear particles, Nuclear activity and half-life, Units of measuring nuclear activity, Specific activity, Interaction of nuclear particles and matter, Attenuation of Gamma radiation, Radionuclides, Generation & Detection of Nuclear Emission – Radionuclide generators, nuclear radiation detectors, Collimators, Diagnostic methods using radiation detector probes – Thyroid function test, Renal function test, Blood volume measurement, Radionuclide imaging systems- Rectilinear scanner, Scintillation camera, SPECT, PET.

Module - 4

Basics of Magnetic Resonance Imaging: Fundamentals of nuclear magnetic resonance- Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Free induction decay (FID), Fourier spectrum of the NMR signal, Spin density, Relaxation times, Pulse sequences.

MRI System & Imaging Methods: Introduction, Magnet, NMR Coil/Probe, Transmitter, Receiver, Data acquisition. Imaging Methods- Introduction, slice selection, frequency encoding, phase encoding, Spin-Echo imaging- Gradient echo imaging, Characteristics of MRI images- Spatial resolution, image contrast. Biological effects of magnetic fields- Static magnetic fields, Radio-frequency fields, Gradient magnetic fields, Imaging safety, Functional MRI (brief introduction only).

Module 5 :

Thermal Imaging: Medical thermography, Physics of thermography, Infrared detectors,

Thermographic equipment, Quantitative medical thermography, Pyroelectric vidicon camera, Thermal camera based on IR sensor with digital focal plane array.

Advances in Medical Imaging: Image guided intervention- Introduction, Stereotactic neurosurgery, Stereotactic neurosurgery based on digital image volumes- image acquisition, planning and transfer, Intraoperative Imaging- Intraoperative diagnostic imaging, transfer by matching preoperative with intraoperative images, augmented reality.

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

1. Describe the fundamentals of x-ray radiography and computed tomography, and analyze the system requirements.
2. Explain principles of ultrasound imaging and diagnostic methods and analyze the system requirements.
3. Discuss the fundamentals of radionuclide imaging, MRI, thermal imaging and analyze the system requirements.
4. Describe the concepts of image Guided Intervention and image guided surgery.
5. Design and develop prototype of simple medical imaging system.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carries 16 marks
- There will be TWO full questions (with maximum of THREE 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. Principles of Medical Imaging – by Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 1992.
2. Handbook of Biomedical Instrumentation – by R.S.Khandpur, 2nd Edition, Tata McGraw Hill, 2003.
3. Fundamentals of Medical Imaging – by Paul Suetens, Cambridge University Press, 2002.

Reference Books:

1. The Physics of Medical Imaging – by Steve Webb (Editor), Adam Hilger, Bristol and Philadelphia Publications, 1988.

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

Biomaterials and Artificial Organs

Subject Code	**: 17BM82**		CIE Marks	: 40
Number of Lecture Hours /Week	: 04		SEE Marks	: 60
Total Number of Lecture Hours	: 50		Exam Hours	: 03

Credits – 4 (Each module – 10 Hours)

Module -1

Biomaterials: Introduction to biomaterials, uses of biomaterials, biomaterials in organs & body systems, materials for use in the body, performance of biomaterials.

Metallic Biomaterials: Introduction, Stainless steel, Cobalt- Chromium alloy, Titanium alloys, Titanium-Nickel alloys, Dental metals, Corrosion of metallic implants, Manufacturing of implants.

Ceramic Biomaterials: Introduction, non-absorbable/relatively bioinert-bioceramics, biodegradable/resorbable ceramics, bioreactive ceramics, deterioration of ceramics, bioceramic-manufacturing techniques

Module -2

Polymeric Biomaterials: Introduction, polymerization and basic structure, polymers used as biomaterials, sterilization, surface modifications to for improving biocompatibility.

Composite Biomaterials: Structure, bounds on properties, anisotropy of composites, particulate composites, fibrous composites, porous materials, biocompatibility.

Biodegradable Polymeric Biomaterials: Introduction, Glycolide based biodegradable homopolymers polyesters, non-glycolide linear aliphatic polyesters, aliphatic and aromatic polycarbonates, and biodegradation properties of synthetic biodegradable polymers. TISSUE DERIVED BIOMATERIALS: Structure and properties of collagen and collagen-rich tissues, biotechnology of collagen, design of resorbable collagen-based medical implant.

Module -3

Hard Tissue Replacements: Bone repair and joint implants-long bone repair and joint replacements, dental implants- effects of material selection, effects of surface properties, surface chemistry.

Preservation Techniques For Biomaterials: Phase behavior, nonfreezing storage-hypothermic, freeze-thaw technology, freezedrying, and vitrification.

Artificial Organs: Introduction: Substitutive medicine, outlook for organ replacement, design consideration, evaluation process.

Module - 4

Artificial Heart And Circulatory Assist Devices: Engineering design, Engg design of artificial heart and circulatory assist devices, blood interfacing implants – introduction, total artificial hearts & ventricular assist devices, vascular prostheses, Non-blood interfacing implants for soft tissues-sutures and allied augmentation devices, percutaneous and skin implants, maxillofacial implants, eye and ear implants.

Cardiac Valve Prostheses: Mechanical valves, tissue valves, current types of prostheses, tissue versus mechanical, engineering concerns and hemodynamic assessment of prosthetic heart valves, implications for thrombus deposition, durability, current trends in valve design, vascular grafts-history, synthetic grafts, regional patency, thrombosis, neointimal hyperplasia, graft infections.

Artificial Kidney: Functions of the kidneys, kidney disease, renal failure, renal transplantation, artificial kidney, dialyzers, membranes for haemodialysis, haemodialysis machine, peritoneal dialysis equipment-therapy format, fluid and solute removal.

Module 5 :

Artificial Blood: Artificial oxygen carriers, flurocarbons, hemoglobin for oxygen carrying plasma expanders, hemoglobin based artificial blood.
Artificial Lungs: Gas exchange systems, Cardiopulmonary bypass (heart-lung machine)-principle, block diagram and working, artificial lung versus natural lung. Liver functions, hepatic failure, liver support systems, general replacement of liver functions.
Artificial Pancreas: Structure and functions of pancreas, endocrine
pancreas and insulin secretion, diabetes, insulin, insulin therapy, insulin administration systems. Tracheal replacement devices, laryngeal replacement devices, artificial esophagus Artificial Skin: Vital functions of skin, current treatment of massive skin loss, design principles for permanent skin replacement.

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

1. Explain the principle and biology underlying the design of implants and artificial organs.
2. Differentiate classes of materials used in medicine.
3. Discuss the application of biomaterials in medicine.
4. Discuss concept of biocompatibility and the methods of biomaterial testing.
5. Discuss the design process in some of the prominent artificial organs.

Question Paper Pattern:

- The question paper will have TEN questions.
- Each full question carries 16 marks
- There will be TWO full questions (with maximum of THREE 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. Biomedical Engineering Handbook-Volume1 (2nd Edition) by J.D.Bronzino (CRC Press / IEEE Press, 2000).
2. Biomedical Engineering Handbook-Volume 2 (2nd Edition) by J.D.Bronzino (CRC Press / IEEE Press, 2000)
3. Handbook of Biomedical Instrumentation (2nd Edition) by R.S.Khandpur (Tata McGraw Hill, 2003).

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

Bio-MEMS

(Common to BM & ML)

Subject Code	**: 17BM/ML831**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module -1

Overview of MEMS and Micro systems: MEMS and Microsystems, Typical MEMS and Microsystem Products, Evolution of Microfabrication, Micro systems and Microelectronics, Multidisciplinary nature of Microsystem design and Manufacture, Microsystems and Miniaturization, Applications of Microsystem in Health-care Industry. (**Text** 1: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8.1)

Bio-MEMS: Fabrication of Bio-MEMS, Structure, The Driving Force behind Biomedical Application, Biocompatibility, Reliability consideration. (Text 2: 1.1, 1.1.1, 1.1.2, 1.2, 1.3, 1.4)

Microsensors: Acoustic wave sensor, Biomedical Sensors and Biosensors, Chemical Sensors, Optical Sensors, Pressure sensors, Thermal sensors.(**Text** 1: 2.2)

Module -2

Microactuation: Principal means of Microactuation, MEMS with Microactuators, Microaccelrometer, Microfluidic. (Text 1: 2.3, 2.4, 2.5, 2.6)

Engineering Science for Microsystem Design and Fabrication: Ions and Ionization, The Diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics. (**Text** 1: 3.3, 3.6, 3.7, 3.8, 3.9)

Scaling Laws: Scaling in Geometry, Scaling in Rigid body Dynamics, Scaling in Electrostatic force, Electricity, Fluid mechanics, Heat Transfer.(**Text** 1: 6.2, 6.3, 6.4, 6.6, 6.7, 6.8)

Module -3

Engineering Mechanics for Microsystem Design: Static Bending of Thin plates – Circular Plates, Rectangular Plates, Square Plates with all Edges Fixed, Mechanical vibrations – General Formulation, Resonant Vibration, Design theory of Accelerometers. (**Text** 1: 4.2, 4.2.1, 4.2.2, 4.2.3, 4.3, 4.3.1, 4.3.2, 4.3.4)

Detection and Measurement methods: Detection Scheme – Electrochemical Detection, Chemiluminescence and Bioluminescence, Fluorescence, Molecular Beacons, Measurement Systems. (**Text** 2: 10.2.1, 10.2.2, 10.2.3, 10.2.4, 10.3)

Module -4

Materials for MEMS and Microsystems: Substrates and wafers, Active Substrate materials, Silicon as a Substrate material – Ideal Substrate, Crystal Structure, Mechanical Properties of Silicon, Silicon Compounds, Silicon Peizoresistors, Gallium Arsenide, Quartz, Polymers, Packaging Materials.
(**Text 1**: 7.2, 7.3, 7.4.1, 7.4.3, 7.4.5, 7.5, 7.6, 7.7, 7.8, 7.10, 7.11)

Emerging Bio-MEMS Technology: Minimally invasive Surgery, Cardiovascular, Diabetes, Endoscopy, Oncology, Ophthalmology, Tissue Engineering, Cell-Based Biosensors, Home land Security.
(**Text** 2: 13.2, 13.4, 13.5, 13.6, 13.8, 13.9, 13.11, 13.12, 13.13)

Module -5

Microsystem Fabrication Process: Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapour Deposition, Physical Vapour Deposition, Deposition By Epitaxy, Etching, The LIGA Process, Design Consideration Overview, Design Constraints. (**Text 1**: 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 9.4, 10.2, 10.2.1)

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

1. Discuss MEMS with current and potential markets for types of Microsystems.
2. Identify the suitable material to develop a microsystem.
3. Explain the principles of emerging Bio-MEMS technology.
4. Apply the principles of microsensors and microactuators to design microsystem.
5. Illustrate micromanufacturing techniques.

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 THREE sub questions) from each module.
- Each full question will have 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. **"**MEMS & Microsystems: Design and Manufacture", Tai-Ran Hsu, Tata McGraw-Hill, 2002.
2. "Fundamentals of Bio-MEMS and Medical Microdevices**",** Steven S. Saliterman**,** Wiley Interscience, 2006.

Reference Books:

1. "Introduction to Bio-MEMS", Albert Folch, CRC Press, 2012.
2. "Bio-MEMS: Technologies and Applications", Wanjun Wang, Steven A. Soper, CRC Press, 2006.

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

Medical Devices Regulations

(Common to BM & ML)

Subject Code	**: 17BM/ML832**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 08 Hours)

Module -1

The medical device as an entity: What is a medical device?, Defining the device, The product definition process, Overview of quality function deployment, The QFD process, The business proposal Reliability: Definition, Quality Vs Reliability, Reliability Vs Unreliability, Types of Reliability, Optimizing reliability, Reliability's effects on medical devices. Concept of Failure: Causes of Failure, Practical aspects of failure, Failure rates, Hardware failure, Software Failure, Failure due to human errors, Failures from customer's point of view. Safety and Risk Management: Medical device safety and risk management, Effectiveness/performance of medical devices, Phases in the life span of a medical device, The risk management processes, Tools for risk estimation, Participants in ensuring the safety of medical devices, The role of each participant/stakeholder, Shared responsibility for medical device safety and performance.

Module -2

Global Harmonization Task Force (GHTF): Objectives, Scope of the four GHTF study groups, Benefits of the GHTF, Final documents from the GHTF, Global Medical Device Nomenclature (GMDN) The Food and Drug Administration: History of device regulation, Device classification, Registration and listing, The 510 (k) Process, Declaration of conformance to a recognized standard, The PMA application, Investigational Device Exemptions (IDEs), Good Laboratory Practices (GLPs), Good Manufacturing Practices(GMPs), Human Factors, Design Control, The FDA and Software, Software classification, The FDA Inspection.

Module-3

The European Union: European Directives, European Standardization Bodies, European Standards Development Process, Other European Standards Considerations, Conformity Assessment and Testing, European Organization for Testing and Certification, the NVCASE Program The Medical Devices Directives: Definition of a medical device, The Medical Devices Directives process, Choosing the appropriate directive, Identifying the applicable essential requirements, Identification of corresponding harmonized standards, Essential requirements, Classification of the medical devices, identification and choice of a notified body.

Module -4

Standards and Regulations Background: Standards: What are standards? Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000 Series of Standards.

Module -5

Software and Quality system regulation: Software as a Technology, Domestic Software Regulations, Domestic Software Standards, International Software Regulations, International Software Standards, The Move Toward One Software Standard History of the quality system regulations, Scope, General provisions, Quality system, Design controls, Document controls, Purchasing controls, Identification and traceability, Production and process controls, Acceptance activities, Non-conforming product, Corrective and preventive action

Note: Assignments may be given on the Indian medical device regulations and medical instrument certification

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

1. Define and explain the basic concepts of medical device regulations
2. Discuss the global policies on medical device regulations
3. Analyze implications of the regulations
4. Analyze the way design concepts are imbibed in practical scenarios.

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 THREE sub questions) from each module.
- Each full question will have 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. Reliable Design of Medical Devices, Second Edition by Richard Fries, CRC Press, 2006
2. Medical Device Quality Assurance and Regulatory Compliance by Richard C Fries, CRC Press, 1998.

Reference Books:

1. Medical device regulations: global overview and guiding principles By Michael Cheng, World Health Organization
2. Product Safety in the European Union by GáborCzitán, Attila Gutassy, Ralf Wilde, TÜVRheinlandAkadémia, 2008.

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

Picture Archiving and Communication Systems

(Common to BM & ML)

Subject Code	**: 17BM/ML833**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8Hours)

Module -1

Introduction to PACS: Interpretation Workstations, Strategic Plan, PACS Impact Analysis, Financial Analysis, Technical Requirements, Project Planning and Evaluation, Contract Negotiations, DICOM Standard, Queuing Perspective, Quality Assurance, HL7, IHE.

Module -2

Computer Fundamentals: Digital Imaging Fundamentals, Image Acquisition, Image Processing Algorithms, Quality Assurance, Future trends, Image Compression, Compression Applications to medical imaging.

Module -3

PACS Architecture: Centralized model, Medical-legal Archive, Networking Fundamentals, Factors to consider in building a network**.**

Servers and Operating Systems: Disaster recovery, Storage and enterprise archiving, RAID, Direct attached storage, Storage area network, Hierarchical storage.

Module -4

Image Displays: Digital Mammography, Web distribution.

PACS Workstation Software: Role of Workstation, User Interface, Future of Workstations, Breast Imaging, CAD, CASS.

Module -5

3 Dimensional Imaging In Radiology: Voice recognition, Order entry in Radiology.

Tele Radiology: Image Acquisition and Image Digitization, Image Transmission, Applications of Tele Radiology, Legal and Socioeconomic
Issues ACR Standards.

Note: Assignment may be given on the topics, DICOM standards and content based image retrieval (CBIR) system.

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

1. Explain the fundamental concepts of PACS and DICOM standards.
2. Discuss the various operations performed on digital image
3. Discuss the architecture of a typical PACS and requirements for implementations
4. Apply display techniques for medical images.
5. Apply the PACS in different domains of medical imaging and radiology.

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 THREE 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: PACS – A guide to the Digital Revolution- Keith Dreyer – Springer, 2006.
Reference Books: PACS in Medicine by H.K.Huang, Wiley-IEEE, 2004.

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

Neural Network and AI in Biomedical Engineering

Subject Code	**: 17BM834**		CIE Marks	: 40
Number of Lecture Hours /Week	: 03		SEE Marks	: 60
Total Number of Lecture Hours	: 40		Exam Hours	: 03

Credits – 3 (Each module – 8 Hours)

Module -1
Overview: Early Biomedical Systems, Medical and Biological Data.(Text 1: O.1, O.2)
Neural Network: Introduction, Human Brain, Benefits of Neural Networks, Models of a Neuron, Neural Networks viewed as Directed Graph, Feedback. (Text 2: 1.1, 1.2, 1.3, 1.4, 1.5)

Module -2
Classes of Neural Networks: Basic Network Properties, Classification Models, Association Models, Optimization Models, Self Organization models, Radial Basis Functions.(Text 1: Chapter 2)
Classification Networks and Learning: Network Structure, Feature Selection, Types of Learning. (Text 1: Chapter 3)

Module -3
Supervised Learning: Decision Surfaces, Two Category Separation, Linearly Separable Sets, Non-Linearly Separable Sets, Multiple Category Classification Problems**,** Relationship to Neural Networks Models, Comparison of Methods, Applications. (Text 1: Chapter 4)
Unsupervised Learning: Clustering, Kohonen Networks and Competitive Learning, Hebbian Learning, Adaptive Resonance Theory, Applications. (Text 1: Chapter 5)
Design Issues: Introduction, Input Data Types, (Text 1: 6.1, 6.2)

Module -4
Foundations of Computer-Assisted Decision Making: Motivation, Data Bases and Medical Records, Mathematical Modeling and Simulation, Pattern Recognition, Bayesian Analysis, Decision Theory, Symbolic Reasoning Techniques. (Text 1: Chapter 9)
Knowledge Representation: Production Rules, Frames, Data Bases, Predicate Calculus and Semantic Nets, Temporal Data Representation. (Text 1: Chapter 10)

Module -5
Knowledge Acquisition: Expert Input, Learned Knowledge, Meta Knowledge, Knowledge Based Maintenance. (Text 1: Chapter 11)
Reasoning Methodologies: Problem Representation, Blind Searching, Ordered Search, AND/OR Trees, Searching Game Trees, Searching Graph, Rule Based Searching, Higher Level Reasoning Methodologies.
(Text 1: Chapter 12)

Note: Assignment may be given on Clinical Decision Support Systems and Deep learning.

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

1. Describe the classes of neural networks and their models.
2. Explain the approaches to the development of neural network models.
3. Employ the learning techniques to classify the data.
4. Discuss general types of knowledge representations that are useful in decision-support systems.
5. Explain the reasoning methodologies utilized in knowledge based systems.

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 THREE sub questions) from each module.
- Each full question will have 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. **"**Neural Networks and Artificial Intelligence for Biomedical Engineering", Donna L. Hudson, Maurice E. Cohen, IEEE Press, 2000.
2. "Neural Networks: A Comprehensive Foundation", Simon Haykin, 2nd Edition, Prentice Hall International.

Reference Books:

1. "Artificial Neural Networks", Robert J. Schalkoff, Tata McGraw Hill, 1997.
2. "Introduction Artificial Neural System", Jacek M. Zurada, Jaico Publication House, 2004.
3. "Neural Networks: A Classroom Approach, Sathish Kumar, Tata McGraw Hill, 2004.
4. "Artificial Intelligence: A Modern Approach", Stuart Russell, Peter Norvig, 2nd Edition, Pearson Education, 2013.

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

Internship / Professional Practice

Subject Code	**: 17BM84**		CIE Marks	: 50
Number of Lecture Hours /Week	: --		SEE Marks	: 50
Total Number of Lecture Hours	: --		Exam Hours	: 03

Credits – 2

Course objectives:
Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To put theory into practice
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently.

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.
Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

Course outcomes: At the end of the course the student will be able to:

- Acquire practical experience within industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Recognizethe areas for future knowledge and skill development.
- Acquire the basic knowledge of administration, marketing, finance and economics.
- Develop the skills to enable lifelong learning.

Evaluation Procedure:

- **As per University guidelines.**
- **Evaluation of IA Marks:** The Internal Assessment marks shall be awarded based on the Internship/Professional Practice Report and Seminar Presentation.
- **Semester End Examination**: The marks shall be awarded based on the Internship/Professional Practice Report and Seminar Presentation as per the University norms by the examiners appointed VTU.

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

Project Work Phase-II

Subject Code	: **17BMP85**		CIE Marks	: 100
Number of Lecture Hours /Week	: --		SEE Marks	: 100
Total Number of Lecture Hours	: --		Exam Hours	: 03

Credits – 6

Course objectives:

- To support independent learning.
- To develop interactive, communication, organization, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgment, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instill responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes: At the end of the course the student will be able to:

- Describe the project and be able to defend it.
- Develop critical thinking and problem solving skills.
- Learn to use modern tools and techniques.
- Communicate effectively and to present ideas clearly and coherently both in written and oral forms.
- Develop skills to work in a team to achieve common goal.
- Develop skills of project management and finance.
- Develop skills of self learning, evaluate their learning and take appropriate actions to improve it.
- Prepare themselves for life-long learning to face the challenges and support the technological changes to meet the societal needs.

Evaluation Procedure:

- **As per University guidelines**
- **Internal Marks:** The Internal marks (100 marks) evaluation shall be based on Phase wise completion of the project work, Project report, Presentation and Demonstration of the actual/model/prototype of the project.
- **Semester End Examination:** SEE marks for the project (100 marks) shall be based on Project report, Presentation and Demonstration of the actual/model/prototype of the project, as per the University norms by the examiners appointed VTU.

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

Seminar

Subject Code	: **17BMS86**		CIE Marks	: 100
Number of Lecture Hours /Week	: --		SEE Marks	: --
Total Number of Lecture Hours	: --		Exam Hours	: --

Credits – 1

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas. Each student, under the guidance of a Faculty, is required to choose, preferably, a recent topic of his/her interest relevant to the course of specialization. Carryout literature survey, organize the Course topics in a systematic order.

- Conduct literature survey in the domain area to find appropriate topic.
- Prepare the synopsis report with own sentences in a standard format.
- Learn to use MS word, MS power point, MS equation and Drawing tools or any such facilities in the preparation of report and presentation.
- Present the seminar topic orally and/or through power point slides.
- Communicate effectively to answer the queries and involve in debate/discussion.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

At the end of the course the student will be able to:

- Develop knowledge in the field of Biomedical Engineering and other disciplines through independent learning and collaborative study.
- Identify and discuss the current, real-time issues and challenges in engineering & technology.
- Develop written and oral communication skills.
- Explore concepts in larger diverse social and academic contexts.
- Apply principles of ethics and respect in interaction with others.
- Develop the skills to enable life-long learning.

Evaluation Procedure:

- As per University guidelines.
- The Internal Assessment marks for the seminar shall be awarded based on the relevance of the seminar topic, quality of the report, presentation skills, participation in the question and answer, and attendance in the seminar classes/sessions.