SHRI G.S. INSTITUTE OF TECHNOLOGY AND SCIENCE, INDORE

(An Autonomous Institute Established in 1952)

23, Sir M. Visvesvaraya Marg, Indore-452003

BACHELOR OF ENGINEERING

BIOMEDICAL ENGINEERING

&

MASTER OF TECHONOLOGY

BIOMEDICAL ENGINEERING

(SPECIALIZATION: BIOMEDICAL SIGNAL PROCESSING & INSTRUMENTATION)

SYLLABUS

2021-22

Session 2021-22
Semester A- Syllabus

Biomedical Engineering

B.E. IInd Year

BM- 29007: Bioelectricity and Transducers

Course Outcomes: -

CO1: To understand basic principle of bioelectric signal & its propagation.
CO2: Acquiring knowledge on type of transducer, working principle, selection procedure and application.
CO3: Understand principle of working of various temperature and pressure transducer.
CO4: Understand the working of reference electrode and chemical electrodes.
CO5: To be able to define basic principle of biosensors & optical transducer.

Subject Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-29007	Bioelectricity and Transducers	3	-	2	3	1	4	70	30	40	60	200

Unit 1. Bioelectric Signals & Biopotential Electrodes

Sources of Bioelectric potentials, Propagation of Action potential. Bioelectric potentials ECG, EEG and EMG responses. Development of bioelectric potential measurement electrode theory and recording issues: electrode-tissue interface, metal-electrolyte interface, electrode-skin interface and motion artifact, electrode impedance, electrical conductivity of electrodes: jellies and creams, body surface electrodes. Internal electrodes: needle and wire electrodes, micro-electrodes: metal, micropipette.

Unit 2. Transducers and Applications

Transducer, transduction principles, active and passive transducers, transducers for biomedical applications. Displacement and pressure measurement: (with applications) resistive: potentiometers, strain gauges, bridge circuits, inductive: variable inductance and LVDT, capacitive type, piezoelectric transducers**.**

Unit 3. Temperature and Pressure Measurement

Different types of temperature transducers: thermistor, thermocouple, resistive temperature detector, IC based measurement temperature. Different types of pressure transducers: types of diaphragms, bellows, bourdon tubes.

Unit 4. Bio-Chemical Electrodes

Blood gas and acid−base physiology, potentiometric sensors, ion selective electrodes, ISFETs, amperometric sensors, Clark's electrode with examples − pH, pO_2, pCO2 electrodes, reference electrodes.

Unit 5. Biosensors and Optical Sensor

Classifications: Biological phenomenon, transduction phenomenon i.e. enzyme sensor and electrode based: affinity sensors (catalytic biosensors), two examples of each biosensors and immunosensors, optical sensors, photo detectors, pyrometers, optical sources.

Practicals

List of Experiments:

1. To measure strain using strain gauge cantilever-based assembly.
2. To measure displacement using LVDT.

3. Angular measurement using rotary pot.
4. Strain gauge as a displacement transducer.
5. Humidity measurement.
6. To measure temperature using thermistor.
7. To understand working of RTD.
8. To understand working of Thermocouple.
9. To perform temperature measurement using IC based temperature sensor.

Note: Some Practical's available on virtual lab platform are included in the list

Text books

1. A.K. Sawhney, *A course in Electrical and Electronic Measurement and Instrumentation*, Dhanpat Rai, 2005.
2. R.S. Khandpur, *Handbook of Biomedical Instrumentation*, 2nd ed., Tata McGraw Hill, 2003.

References

1. Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, *Biomedical Transducers and Instruments*, 1st ed., CRC Press, 1997.
2. Joseph J. Carr and John M. Brown, *Introduction to Biomedical Equipment Technology*, 4th ed., Prentice Hall, 2001.
3. B. C. Nakra and K. K. Chaudhry, *Instrumentation, Measurement and Analysis*, Tata McGraw-Hill, 2003.

Session 2021-22
Semester A- Syllabus

Biomedical Engineering

B.E. IInd Year

BM- 29003: Human Anatomy and Physiology

Course Outcomes: -

CO1: Define and describe the cell cytology in detail.

CO2: Describe and demonstrate the working of cardiovascular and respiratory systems.

CO3: Describe and demonstrate the working of nervous and musculoskeletal systems.

CO4: Describe and demonstrate the working of digestive and excretory systems.

CO5: Describe and demonstrate the working of special organs and endocrine glands.

Subject Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-29003	Human Anatomy and Physiology	3	-	2	3	1	4	70	30	40	60	200

Unit 1. Introduction to Human Body

Cell, overview of organ systems, basic terminologies (directional, regional, planes, feedback). cell:- different types of cells, cell structure and its organelles, functions of each component in the cell membrane, transport across membrane, origin of cell membrane potential, action potential and propagation, blood composition:- RBC, WBC and platelets.

Unit 2. Cardiovascular and Respiratory Systems

Structure of heart, circulation types, cardiac cycle, volume and pressure changes, ECG, heart sounds, blood pressure, regulation of BP, parts of respiratory system, mechanics of respiration carbon dioxide and oxygen transport, regulation of respiration, volumes and capacities of lung, types of hypoxia.

Unit 3. Nervous System and Musculoskeletal System

Nerve cell anatomy, functions of nervous system, brain anatomy and hemispheres, meninges, cerebro spinal fluid, circulation and absorption, spinal cord anatomy, reflex action, PNS, skeletal system -functions -anatomy of long bone –formation, growth and repair, structural and functional classification of joints, functions of muscular system, types of muscles - sliding filament model, neuromuscular junction, physiology of muscle contraction**.**

Unit 4. Digestive and Excretory System

Digestive system, organization, movements of GI tract, digestion at various parts (mouth to large intestine), accessory organs of digestion (salivary glands, liver, pancreas, gall bladder), defecation, excretory system, functions of urinary system, microanatomy and functions of nephron, physiology of urine formation, micturition.

Unit 5. Reproductive System ,Special Organs and Endocrine Glands

Human Reproductive System (Male & Female); Physiology and functionsEyes-retina layers, visual pathway, internal ear, physiology, auditory pathway, sense of taste, sense of smell, touch, endocrine glands, different glands and their hormones, pituitary, thyroid parathyroid glands-secretions, maintenance of calcium homeostasis, maintenance of glucose homeostasis.

Practicals

List of Experiments:

1. To study of various physiological models.
2. To study of Cardio Pulmonary Resuscitation (CPR).
3. To measure the systolic and diastolic blood pressure value of human heart.
4. To measure the Heart-Rate/Pulse-Rate of human body.
5. To Study of abnormalities (Tachycardia, Bradycardia) present in human cardiovascular system using ECG simulator.
6. To measure respiration rate of human body
7. To record the changes in pulmonary volume and capacities by using spirometer.
8. To determine blood group of subject.
9. To understand the basic concept of blood cell differentiation

Text books

1. Charles Herbert Best and Burke Taylor, *Living body*, Chapman & Hall Ltd, 1944.
2. Dr. T. S. Ranganath, *Textbook of Human Anatomy*, S. Chand & Company, 2000.
3. W.G. Sears and R. S. Winwood, *Anatomy and Physiology for Nurses and Students of Human Biology*, Hodder & Stoughton Educational, 1974.

References

1. Anantha Narayana and R. Jeyaram Panickar, *Textbook of Microbiology*, Orient Longman, 2009.
2. Paul and Reich, *Hemetology, Physio Pathological Basis for Clinical Practice*, Little Brown, 1978.
3. Warrik C. K, *Anatomy and Physiology for Radiographers*, Oxford University Press, 1977.
4. Cyril A. Keele and Eric Neil, *Samsons Wright's Applied Physiology*, Oxford University Press, 1979.

Session 2021-22
Semester A- Syllabus

Biomedical Engineering
B.E. IInd Year
MA- 29024: Mathematics- III

Course Outcomes:-

CO1: Modelling of biological systems through ordinary differential equations, solution of Differential equations.
CO2: Calculus of finite differences, different rules.
CO3: Formation of partial differential equations of different orders.
CO4: Euler's Equation.
CO5: Fourier series & Integral Transforms.

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	C W	SW	Pr.	
MA-29024	Mathematics -III	3	1	-	4	-	4	70	30	-	-	100

Unit 1. Calculus of Finite Differences and Difference equations

Difference operator, shift operator, Newton's forward & backward interpolation, Lagrange's interpolation, numerical differentiation and integration, difference equations.

Unit 2. Modeling of Biological Systems through ordinary differential Equations

Growth and decay, dynamics of tumor growth, radioactivity and carbon data, temperature rate of change, biological growth, a problem in epidemiology, detection of diabetes.

Elements of Partial Differential equations:

Formation of partial differential equations, partial differential equation of first order and first degree, i.e., $Pp + Qq = R$, linear homogeneous partial differential equation of n^{th} order with constant coefficient, separation of variables, applications to simple problem.

Unit 3. Statistics

Modern view of probability theory, random experiments, sample space, random variables, distribution function and density function, random variables of discrete and continuous type, functions of two random variables, bivariate probability with conditional and marginal probability distribution.

Unit 4. Fourier Analysis

Euler's formula, Dirichlet's condition, function having point of discontinuity, change of intervals, odd and even functions, half-range series, Fourier integrals, Fourier sine and cosine integrals, complex form of Fourier integral, Fourier transform and its application..

Unit 5. Laplace Transform

Laplace Transform (LT), LT of elementary and periodic functions, properties of LT, inverse Laplace transform, convolution theorem. Application of Laplace transform to the solution of ordinary differential equations.

Text books and References

1. Ramana B. V., *Higher Engineering Mathematics*, Tata McGraw Hill, 2006.
2. Jain, R.K. and S.K. Iyengar, *Advanced Engineering Mathematics*, Narosa Publishing House, 2006.
3. Erwin. Kreyszig, *Advanced Engineering Mathematics*, 8th ed., John Willy and sons Publications, 1999.
4. Balagurusamy, *Numerical Methods*, Tata McGraw-Hill Publishing Company Ltd., 1999.
5. H.K. Das, *Higher Engineering Mathematics*, S. Chand, 2014.

Session 2021-22
Semester A- Syllabus

Biomedical Engineering
B.E. IInd Year
EI- 29017: Basic Electronics

Course Outcomes:-

CO1: Understand basics of diode, its characteristic and types in detail.
CO2: Learn transistor with its configuration, ratings and characteristics.
CO3: Understand transistor biasing and thermal stabilization along with the q-point analysis.
CO4: Learn low frequency model of transistor and amplification function of transistor in different configuration.
CO5: Gain knowledge of FET, JFET and MOSFET, their Characteristics and biasing.

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
EI-29017	Basic Electronics	3	-	2	3	1	4	70	30	40	60	200

Unit 1. Introduction to Basic Electronics

Drift of carriers in electric and magnetic fields, Hall Effect, diffusion of carriers, continuity equation, carrier injection & its gradients. Effect of contact potential on carrier injection, recombination (direct and indirect) and regeneration in the transition region, volt-ampere (V-I) characteristics of PN junction and its temperature dependence, space charge & diffusion capacitance, switching time, zener diode, Schottky diode, breakdown diode, tunnel diode, PIN and avalanche diode, photo diode, LED, photovoltaic effect, seven-segment display.

Unit 2. Rectifier, Clipper and Clamper Circuits

Rectifiers and filters of different types, clippers, clampers, comparators, samplers, voltage doublers, peak detectors, Review of regulators using zener diode.

Unit 3. BJT Characteristics

Charge transport in BJT and FET, minority carrier distribution and terminal currents, Eber's Moll model, drift in the base region and base narrowing, BJT characteristics in CB, CE and CC configurations.

Unit 4. FET Characteristics

Charge transport in FET and junction FET, V-I characteristics, pinch-off and saturation, gate control, MOSFET and its V-I characteristics, common gate, common source and common drain configuration. JFET & MOSFET biasing techniques.

Unit 5. Different Biasing Techniques

Transistor biasing and operating point, DC and AC load lines, bias stability, different biasing techniques of BJTs, stabilization against variations in Ico, Vbe and β , bias compensation, thermal runaway and stability.

Practicals

List of Experiments:

1. Measurement of Amplitude, frequency and phase using CRO.
2. Study and hands-on on power supply, function generator and multimeter.

3. Component testing using CRO and multimeter.
4. To obtain VI Characteristics of a silicon/Germanium P-N Junction diode.
5. To obtain VI Characteristics of Light emitting diode
6. To obtain VI Characteristics of Zener diode.
7. To implement a voltage regulator on bread broad using a zener diode.
8. Performance verification of clipper circuit.
9. Performance verification of clamper circuit.
10. Implement and verify the behaviour of half wave rectifier.

Text books

1. Millman & Halkias, *Integrated Electronics*, Tata McGraw Hill Publication, 2009.

2. R. Boylestad & Louis Nashelsky, *Electronic Devices and Circuit Theory*, Prentice Hall, 2012.

3. Sedra & Smith, *Microelectronic Circuits*, Fourth Edition, Oxford University press, 1998.

References

1. Ben G. Streetman, *Solid State Electronics Devices*, Sixth Edition, Pearson Prentice Hall, 2009

Session 2021-22
Semester A- Syllabus

Biomedical Engineering

B.E. IInd Year

EE- 29011: Network Analysis

Course Outcomes:-

CO1: Basic Lumped circuit analysis, topology.
CO2: Laplace Transform.
CO3: Two port network parameters.
CO4: Steady state analysis, different theorems.
CO5: Magnetically coupled circuit's analysis of balanced & unbalanced circuit.

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
EE-29011	Network Analysis	3	-	2	3	1	4	70	30	40	60	200

Unit 1. Lumped circuits and Kirchhoff's Laws, Circuit elements, physical components v/s circuit elements, Power and energy, Passivity, Network Topology, Loop and Nodal equations, State equations.

Unit 2. First and second order networks, zero state, zero input, transient and steady state response, Solution of network equations using Laplace transform, Network functions, their pole zero description.

Unit 3. Two port networks, various two port network parameters and their interrelationships.

Unit 4. Sinusoidal steady state analysis, frequency response, resonance, complex power, power factor improvement, maximum power transfer theorem, locus diagram, Superposition, Reciprocity, Thevenin's and Norton's theorem.

Unit 5. Magnetically coupled circuit, analysis of circuits with controlled sources, analysis of balanced and unbalanced poly-phase circuits, Fourier analysis of periodic waveforms, frequency spectrum, Power and energy of complex waveforms.

Practicals

List of Experiments:

1. To determine equivalent network by application of thevein's theorem.
2. To determine equivalent network by application of Norton's theorem.
3. Study of transistance in RC circuit.
4. Study of series and parallel resonance phenomenon.
5. To verify the voltage ad current relations in star and delta connection system.
6. To verify open circuit and short circuit parameter for two port network.
7. Verification of superposition theorem.
8. Verification of reciprocity theorem.
9. Verification of maximum power transfer theorem.
10. Passive Filter: Design of passive low pass and high pass filter.

Text books

1. M.E Van Valkenburg, *Network Analysis*, Third Edition, PHI, New Delhi, 1998.
2. Desoer and Kuh, *Basic circuit theory*, Tata McGraw Hill Edition 2009.
3. William Hart Hayt, Jack E. Kemmerly, Steven M. Durbin, *Engineering Circuit Analysis*, Eight Edition, McGraw-Hill Higher Education, 2012.

References

1. Ronald E. Scott, *Linear circuits Vol.I and II*, Addison-Wesley Publication, 2007.
2. Joseph A Edminister, *Electric circuits Schaum's outlines*, Fifth Edition, Tata McGraw Hill Education Private Limited 2009.
3. G K Mithal, *Network Analysis*, Khanna Publication, edition 2011.
4. Robert L. Boylestad, *Introductory Circuit Analysis*, Twelfth Edition, Pearson Education Limited, 2012.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering
B.E. IInd Year
EI 29572: Fundamentals of Measurement System

Course Outcomes:-

CO1: Understand fundamentals of measuring instruments theoretically as well as practically.
CO2: Study of cathode ray oscilloscope in detail with its applications and probe compensation.
CO3: Attain basic knowledge about analog instruments.
CO4: Study measurement of low resistances, voltage, current, phase frequency etc.
CO5: Understand compensation, calibration and testing of measuring instruments.
CO6: Gain knowledge about A.C. bridges and its applications.

Subject Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
EI-27002	Fundamentals of Measurement System	3	-	2	3	1	4	70	30	40	60	200

Unit 1. Fundamentals of Measuring Instruments

Fundamental methods of measurement, classification of measuring instruments, static and dynamic characteristics, error classification and analysis, standards for displacement, force, time, frequency, temperature and electrical standards. IEEE standards.

Unit 2. Cathode Ray Oscilloscope

Construction and operation, measurement of amplitude, phase and frequency with CRO, lissajous patterns. Fundamentals of EMI, RF measurements techniques, network analysers, noise reduction techniques, compatibility of measuring instruments.

Unit 3. Analog Instruments

Analog indicating type instruments based on various operating principles, ammeters, voltmeters, ohmmeters. Extension of instrument range, instrument transformers.

Unit 4. Calibration and Testing of Instruments

Measurement of low resistances, voltage, current, phase, frequency, power and energy, Q factor, resistance, noise etc., compensation, calibration and testing of measuring instruments.

Unit 5. A.C. Bridges

A.C bridges for measurement of inductance, capacitance, Q factor and loss angle, universal impedance bridge. Design aspects. Design aspects of digital multimeter and panel meters. Distortion and spectrum analysis.

Practicals

List of Experiments:

1. Study of Cathode Ray Oscilloscope (CRO).
2. To measure Amplitude and Frequency of unknown signal using CRO.
3. To measure Phase and Frequency of unknown signal using Lissajous pattern.
4. Study of PMMC Instrument (Analog Ammeter and Voltmeter).
5. To measure current and voltage in a circuit using Analog Ammeter and Voltmeter respectively.
6. To measure medium range resistance using Wheatstone bridge.

7. To find percentage limiting error in the measurement of value of a given resistor and study of colour coding system of resistor for 4 band, 5 band and 6 band.
8. Study of A.C Bridges (Maxwell's, Inductance Bridge, Hay's Bridge, Anderson's Bridge, Owen's Bridge, De- Sauty's Bridge, Schering's Bridge).
9. To measure unknown inductance of a coil using Maxwell's Inductance Capacitance Bridge.
10. Study of Digital Storage Oscilloscope.

Text book

1. A.k. sawhney, *electrical & electronic measurement & instrumentation*, dhanpat rai, 2015.

References

1. W. D. Cooper, *Electronic Instrumentation and Measurement*, Prentice Hall, 1985.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering
B.E. II[nd] Year
EC- 29562/EC-29509- : Digital Electronics

Course Outcomes

CO1: Understand the digital circuits through basic logic gates.
CO2: Analyse and design computational digital circuit which can perform logical and arithmetic operation.
CO3: Analyse and design finite state machine and data storage elements.
CO4: Analyse and design digital integrated circuits.
CO5: Analyse and design converters which facilitate the conversion of real world analog signals to digital and vice versa.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
EC-29562/EC-XXXXX	Digital Electronics	3	-	2	3	1	4	70	30	40	60	200

Unit 1. Introduction to Digital Logic

Review of semiconductor device as a switch, wave shaping circuits, time base generators. Number system, number base conversion, binary codes, boolean algebra, boolean functions, logic gates. Simplification of boolean functions, combinational logic, Karnaugh map methods, SOP-POS simplification, NAND-NOR implementation, variable mapping.

Unit 2. Combinational Logic

Half adder, full adder, carry look ahead, multiplexer - demultiplexer, encoder - decoder, arithmetic circuits, ALU.

Unit 3. Sequential Logic

Flip flops, D, T, S-R, J-K, Master-Slave, racing condition, edge & level triggered circuits, shift registers, asynchronous and synchronous counters, their types and state diagrams. Semiconductor memories, introduction to digital ICs 2716, 2732 etc. & their address decoding. Modern trends in semiconductor memories such as DRAM, FLASH RAM etc.

Unit 4. Comparison of N-MOS, P-MOS, C-MOS, H-MOS etc.

Logic families : TTL, ECL, CMOS, IIL and their comparison on the basis of Fan in, Fan out, speed, propagation delay and noise margin, interfacing between ICs of different logic families.

Unit 5. Applications of Digital Circuits:

Introduction to A/D & D/A conversion & their types, sample and hold circuits, voltage to frequency & frequency to voltage conversion. Multivibrators: bistable, monostable, astable, schmitt trigger, IC555, IC565 & their applications.

Practicals

List of Experiments:

1. To study various logic gates.
2. To verify properties of NAND and NOR Gates as universal building blocks.
3. Simplification and implementation of boolean function.
4. Implementation of basic boolean arithmetic logic circuit
5. Implementation of even and odd parity generator and checker.
6. Conversion from binary to grey and grey to binary code.
7. To verify two bit magnitude comparator for all possible condition.
8. Connection of various logical functions using 8 to 1 Multiplexer.
9. Construction of a 4 bit ripple counter and study of its operation.
10. Design and implement of various types of flip flop using JK flip flop.
11. Design of a 3-bit synchronous counter and study of its operation.

Text books

1. Morris Mano, *Digital Circuits & Logic Design*, PHI, 2000.

2. Floyd, *Digital Fundamentals*, Pearson, 2001.

References

1. Tocci, *Digital Electronics*, PHI, 2004.

2. Malvino & Leach, *Digital Principles & Applications*, TMH, 2011.

3. Taub and Schilling, *Digital Integrated Electronics*, Mc Graw Hill, 1977.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering

B.E. II[nd] Year

BM- 29508/BM-29551: Analog Electronics

Course Outcomes: -

At the end of this course students will be able to:

CO1: Understand, analyse and design different BJT Circuits i.e amplifiers and oscillator circuits.
CO2: Understand concept and applications of power amplifiers and Tuned amplifiers.
CO3: Compare and apply different concept of feedback methods in practical circuits.
CO4: Understand detail working of OP-AMP and its different configurations.
CO5: Design of different Op- Amp circuits for practical electronic project design.

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-XXXXX	Analog Electronics	3	-	2	3	1	4	70	30	40	60	200

Unit 1. Transistor Amplifiers

Small-signal high-frequency hybrid-π model of a BJT, Frequency Response of Amplifiers – low-frequency, mid, and high-frequency.

Power supplies- review of regulators using zener-diode and series and shunt regulators, switching regulators, calculation and measurement of regulation characteristics. Over current protection using limiting fold-back and crowbar protection, regulators using ICs.

Unit 2. Power Amplifiers and Tuned Amplifiers

Power Amplifiers: Classification of power amplifiers, Class A, B, AB, C & D. Efficiency of power amplifiers.

Tuned Amplifiers: General behaviour of tuned amplifiers, series and parallel resonant circuit, calculations of circuit impedance at resonance. Variation of impedance with frequency. Q-factor of a circuit & coil, band width of series & parallel resonant circuit. Advantages and disadvantages of tuned amplifiers. Single tuned amplifiers, voltage gain & frequency response of single tuned amplifiers, double tuned amplifiers.

Unit 3. Feedback Amplifiers

Basic Feedback concept, Effect of positive and negative feedbacks. Properties of negative feedback. Basic feedback topologies & their properties.

Analysis of positive feedback amplifiers, Sinusoidal Oscillators, Barkhaussen criterion, Wien-bridge and phase shift oscillators, Colpitt, Hartley crystal oscillator.

Unit 4. Operational Amplifiers

Operational Amplifier Fundamentals. Ideal characteristics, OP-AMP parameters, characteristics of the practical op amp (IC 741), the input differential amplifier and other stages of the IC 741 op amp. Basic OP-Amp configurations.

Unit 5. Operational Amplifiers Applications

Circuits with Resistive Feedback: voltage to current, current to voltage converter, current amplifiers, difference amplifier, Instrumentation amplifier, Summer circuits.

Non Linear Circuits: Voltage comparators, Schmitt trigger, integrator and differentiator, logarithmic and anti-logarithmic amplifier.

Practicals

List of Experiments:

1. To study the operation of single-stage and multi-stage RC-Coupled Amplifier.
2. To calculate Av, AI, Z_{in} and Z_{out} of CE RC-Coupled amplifier with potential divider biasing.
3. To plot the frequency response of RC-Coupled amplifier.
4. To study the effect of load resistance and source resistance on operation of an Amplifier.
5. To calculate the current gain and input impedance of Darlington pair & β of a transistor.
6. To calculate the voltage gain of Darlington pair using voltage divider biasing.
7. Observing the functioning of voltage follower i.e. buffer.
8. Observing Op amp as inverting summer, average, differentiator, and integrator.
9. To study the operation of a class A, B and C amplifiers.
10. To study the operation of a Differential Amplifier.

** 2-3 Experiments will be conducted on Virtual Lab platform.

Text books

1. J. Millman & A. Grabel,*Microelectronics*,TataMcGraw-Hill, 2001.
2. Millman and Halkias, *Integrated Electronics*, Tata McGraw-Hill, 2001.
3. R. A. Gayakwad, *Op amp and Linear Integrated Circuits*, Prentice-Hall (India), 1983.

References

1. B. S. Sonde, *Power Supplies and Regulators*, Tata Mc-Graw Hill,1980.
2. Schilling and Belove, *Electronics Circuits*, Tata Mc-Graw Hill, 2002.
3. Robert Boylestad, *Electronics Devices and Circuits*, 9th ed., Dorling Kindersley (India) Pvt Ltd, 2009.
4. David Bell, *Electronics: Devices and Circuits*, 4th ed., Prentice-Hall (India), 1999.
5. *IC Voltage Regulators*: National Semiconductor Data Book.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering

B.E. IInd Year

MA- 29501: Mathematics-IV

Course Outcomes:-

CO1: Students should be able to learn contour integration.
CO2: Understanding of random variable and stochastic process.
CO3: Understand stages of Markov chain.
CO4: Basic concepts of reliability.
CO5: Basic concepts of graph theory

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
MA-29501	Mathematics -IV	3	1	-	4	-	4	70	30	-	-	100

Unit 1. Functions of Complex Variables

Analytic function, Cauchy-Riemann equations and Harmonic functions: Conjugate functions and their applications. Complex integrals. Cauchy's integral theorem and integral formula. Singularities, poles residues, residue theorem, Contour integration for simple cases, conformal mapping and its application to two-dimensional problems in electric field.

Unit 2. Stochastic Process

Modern Definition of Probability, Random Experiments, Sample Space, Random variables. Distribution Function and Density Function, Concept of stochastic process. Mean, Auto Correlation and Covariance. Classification of Stochastic Process.

Unit 3. Markov Chain

Probability Vector, Stochastic Matrix, Fixed Point of a Matrix, and Definition of Markov Chain, Transition Matrix. Some Theorems and problems. Queuing Theory, Birth and Death Process.

Unit 4. Reliability

Basic concepts, Failure law, Bath Tub Curve, Evaluation of Reliability of a component from test data, System Reliability, Components in series and parallel, Redundancy, Non-series parallel system. A brief idea of software reliability.

Unit 5. Graph Theory and Combinatorial Optimization

Graphs – Definitions and basic properties. Isomorphism, Euler Circuits and Hamiltonian cycle. Digraphs. Trees- properties, spanning trees, Planer graphs. Shortest path problem, Dijkstra algorithm, spanning tree-Kruskal and Prim algorithm, Flow augmented paths-Ford-Fulkerson algorithm, cut sets. Max. Flow min. cut Method theorem.

Text books

1. Ramana B V, *Higher Engineering Mathematics*, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2006
2. Jain, R.K. and S.K. Iyengar, *Advanced Engineering Mathematics*, Narosa Publishing House, New-Delhi, 2006.

References

1. Baisnab A, and M Jas, *Elements of Probability and Statistics*, Tata McGraw Hill, New Delhi, 1993.

Session 2021-22
Semester A-Syllabus

Biomedical Engineering
B.E. IInd Year
OC-I (BM-XXXXX): Physiology for Engineers

Course Outcomes:-

CO1: To get familiar with anatomical structures and physiologic functions of major organ systems.
CO2: To understand mechanism of working of neurophysiological system.
CO3: To understand working of heart as pump.
CO4: To get familiar with gastrointestinal Physiology
CO5: To understand role of hormones in human body.

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
OC-I BM-XXXXX	Physiology for Engineers	2	-	-	2	-	2	70	30	-	-	100

Unit 1. Introduction to Human Physiology

Physiology overview. What is physiology? Cell membrane. Resting membrane potential. Action potential. Ionic channels. Muscle Physiology. Synaptic transmission. Post-synaptic potentials. Muscle structure and mechanics. Excitation-Contraction Coupling.

Unit 2. Neurophysiology

Structure and function of the Central Nervous System (CNS). Olfactory and taste physiology. Vision Physiology. Auditory Physiology. Sensorial Somatic physiology. Autonomous Nervous System.

Unit 3. Cardiac Physiology

The heart as a pump. Cardiac electrophysiology. Electrocardiography. Hemodynamic. Circulation. Microcirculation. Special circulation.

Unit 4. Gastrointestinal Physiology

GI regulation. Motility. Secretion. Salivary Gland. The Stomach. Digestion. Hepatobiliary function. Exocrine pancreas. Absorption. The Intestines.

Unit 5. Endocrine Physiology

Hormone-cell interaction. Pituitary and Thyroid function. Pancreatic physiology. Insulin-glucose regulation. The Adrenal gland.

Text books

1. W. Boron and Saunders Boulpaep, *Medical Physiology - 2nd edition*, 2011.
2. Michael Chappel and Stephan Payne, *Physiology for Engineers*, Springer, 2016.
3. K. Sembulingam, Prema Sembulingam, *Essentials of Medical Physiology*, Jaypee, 2018.

References

1. Karl H.E. Kroemer, Hiltrud J. Kroemer, Katrin E. Kroemer-Elbert, *Engineering Physiology*, Springer, 2010

Session 2021-22
Semester B-Syllabus

Biomedical Engineering
B.E. IInd Year
OC-II (BMXXXXX): Regulatory Requirement for Medical Devices in India

Course Outcomes:-

CO1: Basic knowledge of medical devices and its classification.
CO2: To understand regulatory procedures for manufacturing of new medical device.
CO3: To understand Safety requirements of medical devices
CO4: To understand procedure of clinical trials of medical devices
CO5: To perform a case study on manufacturing and relies of new medical device in India.

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
OC-II BM-XXXXX	Regulatory Requirement for Medical Devices in India	2	-	-	2	-	2	70	30	-	-	100

Unit 1. Introduction

Medical device definition and Types. Classification of medical devices. Market trends and safety issues. The development of regulation and standards.

Unit 2. Regulations and Standards

General Standards and regulation of medical device in India**.** Procedure for gaining approval/license for new medical device manufacturing.
The Rules: - Rules 109-A - Labelling of medical devices, Rule
125-A - Standards for medical devices, Schedule M III - QMS requirements, Schedule R-Standard for mechanical contraceptives, Schedule R1-Standards for medical devices.

Unit 3. Safety Testing of device

Safety testing of a new medical device: Introduction, Biocompatibility test, Implantation, Hemocompatibility, Biodegradation, Sterility test, Electrical appliances tests, Mechanical tests, Third-party laboratories testing.

Unit 4. Clinical Testing of a new medical device

Introduction: the role of clinical testing, Setting up and running clinical test, Good clinical practices, Reporting findings, Future trends.

Unit 5. Inspection of medical devices

Import and export Procedure. Inspection and fees, Inspection before licensing
Case study:- Successful development and approval of a new medical device.

References

1. www.cdsco.nic.in

Session 2021-22
Semester A-Syllabus

Biomedical Engineering

B.E. IIIrd Year

BM- 39011/BM-39001: Signals and Systems

Course Outcomes: -

CO1: Define and discuss different types of signals & systems.
CO2: Understand, practice and examine LTI systems.
CO3: Describe, illustrate and analyze the frequency analysis of continuous and discrete periodic Signals.
CO4: Describe, illustrate and analyze the frequency analysis of continuous and discrete aperiodic signals.
CO5: Define and discuss Laplace and Z-transform and differentiate them with Fourier transforms.

Subject Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th	CW	SW	Pr.	
BM-39001	Signals and Systems	3	1	2	4	1	5	70	30	40	60	200

Unit 1. Introduction to Signals & Systems

Continuous-time and discrete-time signals, signal classification, transformations of the independent variable, continuous-time and discrete-time systems, system classification, sampling and reconstruction of signals.

Unit 2. Linear Time-Invariant Systems

Discrete-time LTI systems: convolution sum, continuous-time LTI systems: convolution integral, properties of linear time-invariant systems, causal LTI systems- described by differential and difference equations, singularity functions.

Unit 3. Fourier series Representation of Periodic Signals

The response of LTI systems to complex exponentials, Fourier series representation of continuous-time periodic signals, convergence of the Fourier series (Dirichlet's conditions), properties of continuous-time Fourier series, Fourier series representation of discrete-time periodic signals, properties of discrete-time Fourier series, Fourier series and LTI systems. Case study: frequency analysis of ECG signals.

Unit 4. Continuous-Time and Discrete-Time Fourier Transform

Continuous-time Fourier transform: Fourier transform for periodic signals, properties of the continuous-time Fourier transform, systems characterized by linear constant-coefficient differential equations.

Discrete-Time Fourier Transform: Fourier transform for periodic signals, properties of the discrete-time Fourier transform, systems characterized by linear constant-coefficient difference equations.

Unit 5. Laplace and Z - Transform

Laplace Transform: Region of convergence for Laplace transform, properties of the Laplace transform, inverse Laplace transform, system function algebra and block diagram representations, the unilateral Laplace transform.

Z-Transform: Region of convergence for the z-transform, inverse z-transform, properties of the z-transform.

Practicals

List of Experiments

1. Waveform Generation.
2. Basic Operation on Signals.
3. Properties of Discrete Time Systems
4. Discrete Convolution
5. Discrete Fourier Transform
6. Time Domain Response of LTI Systems
7. Frequency Response of LTI Systems

** Some experiments will be conducted using Virtual Lab Platform

Text books

1. Alan Oppenheim, Alan Willsky & Hamid, *Signals and Systems*, Pearson, 2015.
2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, *Signals and Systems: Continuous and Discrete*, 4th ed., Pearson, 1998.

References

1. A.V. Oppenheim, A.S. Willsky and I.T, *Signals and Systems*, Prentice Hall, 1983.
2. R. Gopal, *Problems and Solutions in Signals and Systems*, 1st ed., CBS, 2006.

Session 2021-22
Semester A-Syllabus

Biomedical Engineering

B.E. IIIrd Year

BM-39013: Biomedical Instrumentation I

Course Outcomes: -

CO1: Describe origin of various bioelectric signals and technical specifications of various bioelectric electrodes required for their analysis. Outline basic functional components of medical Instrumentation systems.

CO2: Explain the fundamental concepts of Biomedical recorders and be able to select the bio-amplifiers based on application.

CO3: Identify and describe various techniques/Instruments for measuring physiological parameters.

CO4: To be able to compare and distinguish between cardiac output measurement techniques.

CO5: Analyze, classify and select various analytical techniques and Instruments as per requirement of biomedical applications.

Subject Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-39003	BMED Instrumen-tation-I	3	1	2	4	1	5	70	30	40	60	200

Unit 1. Bio signal generation and analysis

Fundamentals/origin of Bioelectric signals: generation of action potential and effect of electric field on various muscles. Sources of Bio-signals and evoked potential. Basics of Medical Instrumentation: Basic functional components (measurand, sensor, conditioner, display) and block diagram of medical instrumentation system. Electrodes-tissue interface, skin contact impedance. Half-cell potential, bio-electrodes. Design constraints and safety aspects of medical instruments.

Unit 2. Biomedical recorders and Bio amplifiers

Introduction of Biomedical recorders: Basics of ECG, VCG, PCG, EEG, EMG, EOG, ERG, Significance of Einthoven triangle in ECG recording. Introduction of Bio amplifiers and biosensors: carrier amplifier, isolation amplifier, differential amplifier, chopper amplifier, instrumentation amplifier.

Unit 3. Patient Monitoring Systems

Measurement of temperature, Measurement of respiration rate, Measurement of heart rate, Measurement of pulse rate. Introduction of oximeter: Basics of oximetry, Pulse oximeter, Ear oximeter. Introduction of blood flow meters: Electromagnetic, ultrasound and laser doppler blood flow meter. heart lung machine (HLM), computerized patient monitoring system.

Unit 4. Cardiac output Measurement

Dye dilution method, Thermal dilution method, BP method, Measurement of blood pressure: Direct and indirect methods, Plethysmography, Introduction of cardiac arrhythmias: Arrhythmias, arrhythmia monitor, QRS detection techniques, stress testing and ambulatory monitoring instruments.

Unit 5. Analytical techniques and instruments

Fundamentals of analytical instruments: Types of chemical analysis, sensors, display systems, Methods of analysis and calibration techniques. Introduction of colorimeters and spectrophotometers: spectrophotometer, colorimeters, sources of error in spectrophotometers. Fundamentals of flame photometers. chemical biosensors, Fundamentals of fluorescence sensors and glucose sensors. Introduction of blood cell counters: electrical conductivity method, optical method. Coulter counter, Fundamentals of chromatography, Fundamentals of mass spectrometer, pH meter, blood gas analysers. Performance requirements of analytical instruments.

Practicals

List of experiments

1. To observe ECG waveforms generated by ECG simulator in different leads configuration.
2. To observe Phonocardiogram waveforms (PCG) of the subject (Human body).
3. To measure the systolic and diastolic blood pressure of the human heart.
4. To study abnormalities (Tachycardia, Bradycardia) present in the Human cardiovascular system using ECG simulator.
5. To study EEG waveforms in unipolar recording and average recording mode.
6. To study EMG waveforms generated by built-in EMG simulators.
7. To measure the respiration-rate of a subject (Human body).
8. To understand the transmission and reception of biological signals using a telemetry system.
9. To study the pacemaker system using simulator kits**.**
10. Defibrillator Simulator @Virtual Lab.

Text books

1. John G. Webster, *Medical Instrumentation: Application and design*, 3rd ed., John Wiley, 2012.

2. Khandpur R.S, *Hand-book of Biomedical Instrumentation*, Tata McGraw Hill, 2nd Edition, 2003.

References

1. Stuart R, MacKay, *Bio-Medical Telemetry: Sensing and Transmitting Biological Information from Animals and Man*, 2nd ed., Wiley, 1998.

2. L. Cromwell, Fred J et al., *Biomedical Instrumentation and Measurements*, Prentice Hall, 1973.

Session 2021-22
Semester A-Syllabus

Biomedical Engineering
B.E. IIIrd Year
IP-39201: Industrial Engineering and Management

Course Outcomes:-

CO1: Basic knowledge of method engineering.
CO2: Introduction to operational management.
CO3: Introduction to organization & management.
CO4: Decision making techniques.
CO5: Introduction to quality control.

Subject Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-39201	Industrial Engineering and Management	3	1	-	4	-	4	70	30	-	-	100

Unit 1. Methods Engineering

Introduction to methods engineering and productivity, method study, recording techniques work measurement tools and techniques.
Work place design, fundamentals of workplace design.
Introduction to job evaluation and wage incentive schemes.

Unit 2. Operational Management

Introduction to production planning and control, function, tools and techniques, types of production systems.
Facilities planning, introduction to plant layout and material handling, tools and techniques.

Unit 3. Organization and Management

Principles of management and management functions.Organization principles, structures, span of control, delegation, centralization and decentralization, formal and informal organization.Personnel management- introduction, communication, motivation and leadership.

Unit 4. Quantitative techniques for decision making

Introduction to operations research, linear programming, transportation and assignment models and its application, network techniques and its application.

Unit 5. Quality control

Quality planning and quality control operation, economics of quality control process capability studies and control charts for variables and attributes.

Text book

1. Koontz and O' Donnel, *Principles of Management: An Analysis of Managerial Functions*, McGraw Hill, 1972.

References

1. Sharma, *Operational Research: Theory and Application*, Laxmi Pub., 2009.

Session 2021-22
Semester A-Syllabus

Biomedical Engineering
B.E. IIIrd Year
BM-39254: Programming Tools & Techniques (Elective I)

Course Outcomes: -

CO1: To understand the basic concepts of OOPS and varies programming platforms.
CO2: To get acquainted with basic Python and MATLAB programming.
CO3: To apply the concepts of OOPs in Python.
CO4: To apply the Python programming and MATLAB for solving standard engineering problems.
CO5: To evaluate and compare the performance of different existing platforms.

Subject Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-39004	Programming Tools and Techniques	3	-	2	3	1	4	70	30	40	60	200

Unit 1. Introduction to Object Oriented Programming

Comparison with procedural programming, features of object oriented paradigm– merits and demerits of Oops methodology, object model. Concept of classes and object in OOPs programming.

Unit 2. Introduction to Python Programming

Python Data Types, Python Program Flow Control, Functions, Modules and Packages, Python String, List and Dictionary Manipulations.

Unit 3. Object Oriented Programming using Python

Python Object Oriented Programming: Classes, Methods, Objects and the Standard Objective Features; Exception Handling and Working with Files. Python File Operation, python programming.

Unit 4. Getting Started With MATLAB

Introducing MATLAB and its applications, MATLAB interface, data files and data types, understanding the MATLAB math syntax, loops and conditional statements, M files, operations on matrix, understanding plotting basics, writing user defined functions.

Unit 5. GUI, SIMULINK and Image Processing with MATLAB

Introduction of Graphical User Interface, GUI function property, GUI component design, GUI Container, writing the code of GUI Callback, dialog box, menu designing, introduction of SIMULINK, SIMULINK environment & interface, some examples of image processing.

Practicals

List of Experiments

1. Creating Class and Object in Python.
2. Creating Methods in Python.
3. Use of Inheritance in Python.
4. Data Encapsulation in Python.
5. Using Polymorphism in Python.
6. Matlab GUI and Simulink Introduction.

Text books

1. Timothy Budd, *An Introduction to Object-Oriented Programming*, 3rd ed., Addison-Wesley Publication, 2002.
2. Rudra Pratap, *Getting Started with MATLAB*, Oxford University Press, 2002.
3. Mark Summerfield, *Programming in Python 3: A Complete Introduction to the Language*,1st Edition, 2008.

References

1. G. Booch, *Object Oriented Analysis & Design*, Addison Wesley, 2006.
2. James martin, *Principles of Object-Oriented Analysis and Design*, Prentice Hall/PTR, 1992.
3. Peter Coad and Edward Yourdon, *Object Oriented Design*, Prentice Hall/PTR, 1991.

David Beazley, *Python Essential Reference*, 4th Edition 2009.

Session 2021-22
Semester A- Syllabus

Biomedical Engineering
B.E. IIIrd Year
BM-39251: Embedded Systems (Elective I)

Course Outcomes: -

After completion of course, students will be able to:

CO1: Describe & understand the fundamental concepts of 8085 Microprocessor.
CO2: Categorize the difference between Microprocessors and Microcontrollers and understand the architecture and programming of 8051 Microcontroller.
CO3: Demonstrate the Architecture and Processors of Embedded systems.
CO4: Explain & learn the Memory system architecture of Embedded systems.
CO5: Illustrate the fundamentals of Internet of Things (IoT) & to design solutions for real world Problems.

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th	CW	SW	Pr.	
BM-49025	Embedded Systems	3	-	2	3	1	4	70	30	40	60	200

Unit 1. Advanced Hardware Fundamentals

Introduction to Microprocessors: 8085 Microprocessor, Programming model, Buses, Instruction set classification, Microprocessor architecture and its operations, Direct Memory Access, Interrupts, Comparison of 8085 and 8086 microprocessors.

Unit 2. Microcontroller and Programming

Microcontroller verses General-purpose microprocessor, 8051 Microcontroller: Architecture, Block diagram, Memory organization, Special function registers, I/O Ports, Timers/Counters, Interrupts, Programming in Embedded C.

Unit 3. Embedded System Architecture

Definition of Embedded system, Embedded system verses General computing system, Classification, Major application areas, Purpose of Embedded system, CISC and RISC architecture, General purpose processor, Application specific processor, Single purpose processor, Basic embedded processor.

Unit 4. Memory System Architecture

Memory management schemes in embedded system: Memory hierarchy, Cache, Virtual memory and MMU, Advanced RAM, Memory write ability and Storage permanence, Common memory types, Composing memory, Memory Interfacing.

Unit 5. Introduction to Internet of Things (IoT)

Introduction to IoT, Sensing and Actuation, Applications of IoT, Different Communication Protocols, Introduction to Arduino and Raspberry Pi.

Practicals

List of Experiments

1. Introduction to various development environments: Keil and Arduino.
2. Write an assembly language program to generate a square wave of 10 KHz using 8051 microcontroller.
3. Write an assembly language program to interface LEDs and switch with 8051.
4. Write an assembly language to interface a stepper motor with 8051 microcontroller.
5. Write a C program to serially interface 8051 microcontroller with computer.
6. Write a C program to interface ADC with 8051 microcontroller.
7. Write a program to interface LCD in multiplexed mode with arduino board.
8. Write a program to interface stepper motor with arduino.
9. Write a program to interface 4 × 4 hex keypad with arduino.
10. Interfacing temperature and pressure sensor with 8051 and arduino.

List of Experiments which can be performed on Virtual Labs:

1. LCD-MCU interfacing and displaying a string.
2. Keyboard-MCU interfacing, take a input from keypad and display on LCD.
3. Temperature control using ATmega16.
4. Serial communication between Microcontroller & PC.
5. Interfacing a LED matrix and display number on the matrix.
6. Stepper motor control using ATmega16 microcontroller.

Text books

1. F Vahid, T Giogarvis, *Embedded systems: A unified hardware/software approach*, Wiley, 1999.
2. Raj Kamal, *Embedded Systems Introduction*, 2nd Ed., TMH publication, 2015.
3. Galvin Silberschatz *Operating system Principals*, 7th edition, Wiley Publication
4. Muhammad Ali Mazidi, *The 8051 Microcontroller and Embedded Systems*, 2nd Ed., Pearson

References

1. David E Simons, *An Embedded Software Primer*, Pearson, 1999.

Session 2021-22
Semester A-Syllabus

Biomedical Engineering
B.E. IIIrd Year
BM XXXX: Biomaterials for Engineering Applications (OC-III)

Course Outcomes: -

CO1: Introduction and classification of various classes of materials i.e. metals, ceramics and polymers for the biomedical application along with their physical as well as biocompatibility properties.

CO2: Study of mechanical properties of material along with in vivo and in vitro testing.

CO3: Introduction to arthroplasty its major laws, concept of fracture along with the associated implants.

CO4: Study of cardiovascular application of biomaterials along with the concept of fluid mechanism and designing of various prosthetic devices i.e. artificial heart and valves.

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
OC-III	Biomaterials for Engineering Applications	-	-	-	-	-	-	-	-	-	-	-

Unit 1. Introduction

Definition and classification of biomaterial, properties of material. Host reaction to biomaterials, introductory overview of some existing prosthetic devices. Discussion of some design considerations of specific implants/organs, the fundamentals of biocompatibility. Metallic, ceramic and polymeric implant material, testing of implants, and sterilization of implants. Degradation of materials in biological environment.

Unit 2. Mechanical Behaviour of Materials

Stress-Strain curve characteristics, visco elasticity, mechanical properties & remodelling of biological materials: bone, cartilage, muscle, tendon, and ligament. Some specific implant-materials.

Unit 3. Testing of Biomaterials

Introduction, in vitro and in vivo assessment of tissue compatibility, implant associate infection.

Unit 4. Application of Material in Medicine and Dentistry

Sutures, orthopedic application, cardiovascular application & dental application.

Unit 5. Host Reaction to Biomaterial and their Evaluation

Immunology and complimentary system, systemic toxicity, blood coagulation, sterilization of implants, tumor genesis and biomaterials.

Text books

1. Joseph Bronzino, *The Biomedical Engineering Handbook*, 2nd ed., CRC Press, 2000.
2. Nigg and Herzog, *Biomechanics of the Musculoskeletal System*, Wiley, 1995.

References

1. David Williams, *Biocompatibility of Orthopedic Implants*, (two volumes) CRC Press, 1982.

Session 2021-22
Semester A- Syllabus

Biomedical Engineering
B.E. IIIrd Year
BM- xxxxx: Digital Image Processing (OC-III)

Course Outcomes: -

CO1: Compute image convolution using various matrices.
CO2: Implement and interpret color models on an image.
CO3: Apply image enhancement techniques on an image and interpret it.
CO4: Illustrate image segmentation algorithm.
CO5: Distinguish / Analyze the various concepts and mathematical transforms necessary for image Processing.

Subject Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
OC-III	Digital Image Processing	-	-	-	-	-	-	-	-	-	-	-

Unit 1.

Digital Image Fundamentals: Image representation, basic relationship between pixels, elements of DIP system, Review of matrix theory: row and column ordering- Toeplitz, Circulant and block matrix.

Unit 2.

Colour image fundamentals-RGB, CMY, HIS models, 1D- 2D sampling, quantization, Brightness, contrast, hue, saturation, Mach band effect.

Unit 3.

Image Enhancement: Spatial domain methods: point processing- intensity transformations, histogram processing, image subtraction, image averaging, Spatial filtering- smoothing filters, sharpening filters, Frequency domain methods: low pass filtering, high pass filtering.

Unit 4.

Image segmentation: Classification of Image segmentation techniques, region approach, clustering techniques, Segmentation based on thresholding, edge based segmentation, Classification of edges, edge detection, Hough transform, active contour.

Unit 5.

2D Image transforms : DFT, its properties, Walsh transform, Hadamard transform, Haar transform, DCT, KL transform and Singular Value Decomposition, application of image transforms.

Text books

1. Gonzalez Rafel C, *Digital Image Processing*, Pearson Education, 2009.
2. S Jayaraman, S Esakkirajan, T Veerakumar, *Digital image processing*,Tata Mc Graw Hill, 2015.

References

1. Jain Anil K, *Fundamentals of digital image processing*, PHI,1988.
2. Kenneth R Castleman , *Digital image processing:*, Pearson Education,2/e,2003.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering
B.E. IIIrd Year
BM- xxxxx: Health Research Fundamentals (OC IV)

Course Outcomes: -

CO1: Demonstrate knowledge of research processes
CO2: Perform literature reviews using print and online databases
CO3: Identify, explain, compare, and prepare the key elements of a research proposal/report
CO4: Describe sampling methods, measurement scales and instruments, and appropriate uses of each
CO5: Define and develop a possible research interest area using specific research designs;

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
OC-IV	Health Research Funda-mentals	-	-	-	-	-	-	-	-	-	-	-

Unit 1. Conceptualizing a research study
Introduction to health research, formulating research question, hypothesis and objectives. know-how of literature review.

Unit 2. Epidemiological considerations in designing a research study
Measures of disease frequency, descriptive study designs, analytical study designs, experimental study designs: clinical trials, validity of epidemiological studies, overview of Qualitative research methods.

Unit 3. Bio-statistical considerations in designing a research study
Measurement of study variables, sampling methods, calculating sample size and power.

Unit 4. Planning a research study
Selection of study population, study plan and project management, designing data collection tools, principles of data collection, data management, overview of data analysis.

Unit 5. Conducting a research study and writing a research protocol
Ethical framework for health research, conducting clinical trials, preparing a concept paper for research projects, elements of a protocol for research studies.

Text books

1. KOTHARI (C R). *Research methodology: Methods & Techniques* (Rev. Ed.), (2006) New Age International. New Delh.
2. Daniel (W.W), *Biostatistics: A foundation Analysis in Health Sciences* Wiley & Sons.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering
B.E. IIIrd Year
BM-xxxx: Embedded Systems (OC IV)

Course Outcomes: -

After completion of course, students will be able to:

CO1: Describe & understand the fundamental concepts and processors of Embedded Systems.
CO2: Apply the programming concepts for developing software programs.
CO3: Demonstrate the Input & Output and peripheral devices of Embedded Systems.
CO4: Explain & learn the memory system architecture of Embedded Systems.
CO5: Illustrate the fundamentals of Operating Systems.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-49025	Embedded Systems	-	-	-	-	-	-	-	-	-	-	-

Unit 1. Advanced Hardware Fundamentals

Introduction to Microprocessors and Microcontrollers: 8085 Microprocessor Architecture and Interrupts, Microcontroller verses General-purpose microprocessor, Introduction to 8051 Microcontroller.

Unit 2. Introduction to Embedded Systems:

Microprocessor vs. Microcontroller, Definition of embedded system, embedded systems vs. General computing systems, History of embedded systems, Classification, Major application areas, Purpose of embedded systems.

Unit 3. Input Output and Peripheral Devices

I/O devices, Interfacing, Timers, Interrupts, DMA controller, Analog to digital converters, Introduction to communication protocols: RS-232, USB and Bluetooth.

Unit 4. Memory System Architecture

Concept of memory, Memory hierarchy, Memory interface, Common memory types, Caches, virtual memory, Memory management.

Unit 5. Embedded System Supporting Technologies

Introduction to operating systems, Structure of operating system, Functions of operating systems, Difference between normal OS and RTOS.

Text books

1. F Vahid, T Giogarvis, *Embedded systems: A unified hardware/software approach*, Wiley, 1999.
2. Raj Kamal, *Embedded Systems Introduction*, 2nd Ed., TMH publication, 2015.
3. Operating system Principals, Galvin Silberschatz, 7th edition, Wiley Publication

References

1. David E Simons, *An Embedded Software Primer*, Pearson, 1999.

Session 2021-22
Semester B-Syllabus

Biomedical Engineering
B.E. IIIrd Year
BM-39501: Biomedical Signal Processing

Course Outcomes:-

CO1: Introduction to signals, systems and fundamentals of signal processing.
CO2: Transform analysis of LTI systems.
CO3: Study of various algorithms of DFT.
CO4: Designing of filters and their realizations.
CO5: Developments of algorithms and visualizations of various elements and processes of BSP.

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-39501	Biomedical Signal Processing	3	1	2	4	1	5	70	30	40	60	200

Unit 1. Introduction to Signal Processing

Signals and systems, signal processing, concept of frequency in continuous time and discrete time signals, analog to digital and digital to analog conversion, sampling and reconstruction of signals.

Unit 2. Frequency Domain Analysis of Signals and Systems

Analysis of linear time invariant systems in the z-Domain, analysis and characterization of LTI systems using the Laplace transform, correlation functions and spectra at the output of LTI systems, linear time-invariant systems as Frequency-Selective filter, inverse systems and deconvolution, linear filtering methods based on the DFT, frequency analysis of signals using the DFT, discrete cosine transform.

Unit 3. Efficient Computation of the DFT: Fast Fourier Transform Algorithms

Fast Fourier transform, decimation in time FFT algorithms, decimation in frequency FFT algorithms, FFT algorithms for N composite number- Spectrum analysis of bio signals. Quantization effects in the computation of the DFT. Case study: frequency analysis of ECG signals.

Unit 4. Design of FIR Digital Filter

FIR digital filters realizations, direct, cascade, lattice forms, FIR filter design using Fourier series, use of window functions like rectangular, raised cosine, kaiser.

Unit 5. Design of IIR Digital Filter

IIR digital filters realizations, direct, cascade, parallel forms, analog filter approximations, and Butterworth and Chebyshev approximations, frequency transformation techniques. Case study: PCA and ICA for biomedical signal.

Practicals

List of Experiments

1. Introduction to MATLAB.
2. Study of sampling theorem and the effects of under sampling.
3. Study of quantization of continuous amplitude, discrete time analog signals.

4. Study of properties of linear time invariant system.
5. Study of convolution: series and parallel system.
6. Study of discrete Fourier transform and it's inverse.
7. Study of transform domain properties and their applications.
8. Study of FIR filter design using windowing technique.
9. A case study on principal component analysis.
10. A case study on independent component analysis.

Text books

1. Oppenheim & R W Schafer, *Digital Signal Processing*, Prentice Hall, 2008.
2. R Rabiner & B. Gold, *Theory & Application of Digital Signal Processing*, Prentice Hall (India), 1975.

References

1. Andreas Antonion, *Digital Filters Analysis & Design*, Prentice Hall (India), 2007.

Session 2021-22
Semester B-Syllabus

Biomedical Engineering
B.E. IIIrd Year
BM-39512: Biomedical Instrumentation II

Course Outcomes: -

CO1: Discuss various pulmonary aid equipments with working principle, their design specifications and requirements.
CO2: Describe various Electrotherapeutic equipments their technical and functional specifications.
CO3: To perform mathematical analysis of techniques used in BMD.
CO4: Review various instruments used for monitoring and diagnosis of sensory organs.
CO5: Design and application of various types of endoscope and drug delivery systems.

Subject Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-39504	Biomedical Instrumen -tation II	3	1	2	4	1	5	70	30	40	60	200

Unit 1. Pulmonary Analyzers and Aid Equipment's
Regulation of breathing - pulmonary gas flow measurements, pulmonary volume measurements, respiratory gas analysers, nitrogen gas analyser, oxygen analyser, humidifier, nebulizer, ventilators, IPPB unit, and anaesthesia machine.

Unit 2. Physiotherapy and Electrotherapy Equipments
Tissue response, short wave diathermy, microwave diathermy, ultrasonic therapy unit, electrotherapy - FES, TENS, bladder stimulator, lithotripter system, extra corporeal shock wave therapy.

Unit 3. Instruments Dealing with Kidney and Bones
Regulation of water and electrolyte balance, artificial kidney, hemo dialysis, crafts for dialysis, peritoneal dialysis, dialyzers. BMD measurements – SXA – DXA, quantitative ultrasound bone densitometer-LASERS.

Unit 4. Sensory Instrumentation
Mechanism of hearing, sound conduction system, basic audiometer- pure tone audiometer, audiometer system Bekesy, hearing aids, ophthalmoscope, tonometer, measurement of basal skin response and galvanic skin response, instruments for testing motor responses, experimental analysis of behaviour.

Unit 5. Special Equipments
Endoscopy, laparoscopy, cryogenic equipment, automated drug delivery system, components of drug infusion system, implantable infusion systems.

Practicals

List of Experiments

1. Study of ventilator machine.
2. Demo of anesthesia machine.
3. Study of ultrasound diathermy machine.
4. Application and physiotherapy of muscles and effect of different modes in ultrasound machine.

5. To measure the respiration-rate of subject (Human body).
6. Designing a galvanic skin response meter.
7. Course project/presentations notes.

Text books

1. Geoddes L.A, and Baker L.E, *Principles of Applied Biomedical Instrumentation*, John Wiley, 3rd Edition, 1975.

2. John G. Webster, *Medical Instrumentation: Application and design*, 3rd ed., John Wiley, 2012.

References

1. Khandpur R.S, *Hand-book of Biomedical Instrumentation*, Tata McGraw Hill, 2nd Edition, 2003.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering
B.E. IIIrd Year
EE-39508: Control System

Course Outcomes:-

CO1: Modeling & simulation of dynamic systems. Feedback control systems
CO2: Time domain analysis of feedback control systems
CO3: Frequency domain analysis of feedback control systems.
CO4: Compensation Techniques to achieve desired frequency response.
CO5: State space method of analysis of feedback control systems.

Subject Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
EE-39508	Control Systems	3	1	2	4	1	5	70	30	40	60	200

Unit 1. Modeling of Dynamic Systems and Simulation

Integro-differential equation of linear systems such as mechanical, hydraulic, pneumatic and electrical systems. Block diagram and Signal flows graph method of representing the dynamic equations, analogue simulation, linearity, impulse response and concept of transfer function, Mason's gain formula, control system components: errors detectors ac and dc servomotors, servo amplifier(ac & dc) using operational amplifiers, gyro, resolver. Typical study of characteristics of these components. Concept of feedback as control theory-Mathematical theory of feedback, return ratio, return difference, open and closed loop, understanding the necessity of feedback as real control action supplemented by a small example.

Unit 2. Time-Domain Analysis of Feedback Control Systems

Typical references test signals and their significance, transient behavior of closed loop systems under feedback control. Proportional plus derivative and rate feedback control actions for improving the transient response. Steady state behavior of closed loop feedback control systems. Types of open loop transfer functions. Steady state errors. Proportional plus integral control action for the improvement of steady state errors.

Unit 3. Frequency-Domain Analysis of Feedback Control Systems

Concept of frequency-domain analysis, Bode plots, polar plots. Bode of closed loop transfer function and bode plots of error transfer functions, principle of argument, Nyquist criteria. Conditionally stable closed loop systems, transportation lag, constant M and constant N loci, Loci of closed loop poles (root loci).

Unit 4. Compensation Techniques

Need for frequency-domain compensation, different types of compensation, phase lead and phase lag compensation, design of compensating networks for the desired frequency-domain close loop performance.

Unit 5. State Space Method of Analysis

Fundamentals of state space: Concept of state variables. Representation of linear system through state dynamics, calculation of Eigen values and Eigen vectors, modal matrix, modal transformation, elementary understanding of controllability and observability, state feedback control. Stability analysis of feedback.

Control system-concept of stability: BIBO stability, asymptotic stability, Routh-Hurwitz analysis. Nyquist stability analysis and relative stability, gain margin and phase margin.

Practicals

List of Experiments

1. To determine the performance characteristics of an angular position error detector using potentiometers.
2. To determine the characteristics of a Synchro Transmitter Receiver pair and use as a torque synchro and angular error detector.
3. To find the transfer function of an A.C. Servomotor.
4. To find the transfer function of a D.C. Servomotor.
5. To control the angular position of an AC servo motor as a carrier control system.
6. Determination of the time response characteristics of a DC Servo angular position control system.
7. To perform closed loop speed control of a D.C Servomotor.
8. To determine the performance characteristics of a DC motor speed control with PWM type power driver.
9. To determine the performance characteristics of a DC motor speed control with SCR type power driver.
10. Analysis of Proportional + Integrator + Derivative (PID) control actions for first and second order systems.

Text books

1. B.C. Kuo, *Automatic Control system*, Prentice Hall, 1975.
2. K Ogata, *Modern Control Engineering*, Prentice Hall of India Ltd., 2010.

References

1. J.L. Melsa and D.G. Schultz, *Linear Control Systems*, McGraw Hill, 1970.
2. I.J. Nagrath and M. Gopal, *Control systems Engineering*, New Age International (P) Ltd., 1999.

Session 2021-22
Semester B-Syllabus

Biomedical Engineering
B.E. IIIrd Year
EC-39602: Analog and Digital Communication (Elective II)

Course Outcomes:-

CO1: Review of basic signals, different types of categorization of signals.
CO2: Study of amplitude modulation in communication.
CO3: Study frequency modulation.
CO4: Study of Noise associated with receivers and elimination /reduction techniques.
CO5: Introduction to digital communication.

Subject -Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
EC-39502	Analog and Digital communication	3	-	-	3	-	3	70	30	-	-	100

Unit 1. Signals and Random Variables

Types of signals: deterministic & random, periodic & non-periodic, analog & discrete, energy & power signals. Fourier series, Fourier transform and its properties, Gaussian and Rayleigh probability density function, mean, variance and standard deviation, central limit theorem, voltage & power decibel scales.

Unit 2. Amplitude Modulation

Need of modulation in a communication system, block schematic of a typical communication system. AM modulation system, modulation index, generation & detection of AM wave, side bands & power content in an AM wave, DSB-SC, SSB, their methods of generation & detection, AM transmitter block diagram.

Unit 3. Frequency Modulation

Relationships between phase & frequency modulation, FM wave & its spectrum, phasor diagram of narrowband FM signal, wideband FM, methods of generation & detection of FM, discriminators, pre-emphasis & de-emphasis.

Unit 4. Receivers and Noise

TRF receiver & its limitations, necessity of heterodyning, super heterodyne radio receivers, IF amplifiers & selection of intermediate frequency, RF amplifiers, detectors. Sources of noise, noise figure, noise bandwidth, effective noise temperature.

Unit 5. Introduction to Digital Communication

Nyquist sampling theorem, time division multiplexing, pulse modulations and PCM, quantization error, introduction to BPSK & BFSK, Shannon's theorem for channel capacity.

Text books

1. Lathi B.P., *Anolog and Digital Communication Systems*, Oxford Press, 2009.
2. Singh R.P. & Sapre, *Communication Systems Analog & Digital*, TMH, 2017.

References

1. Haykin Simon, *Communication Systems*, John Willey & Sons, 2013.
2. Taub & Schilling, *Principles of Communication Systems*, McGraw Hill, 1986.

Session 2021-22
Semester B -Syllabus

Biomedical Engineering
B.E. IIIrd Year
BM-39603: Biomedical Statistical Signal Processing (Elective II)

Course Outcomes:-

CO1: Describe and illustrate data collection and sampling, hypothesis testing
CO2: Define and understand the concept of random variable.
CO3: To solve various distribution and density functions.
CO4: Analyse and Evaluate statistical tests using SPSS software
CO5: Design signal processing unit for Biomedical Applications

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Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-39503	Biomedical Statistical Signal Processing	3	-	-	3	-	3	70	30	-	-	100

Unit 1. Data Collection and Sampling Methods

Concepts of population and sample and need for sampling methods of collecting data. Types of sampling- simple random sampling with and without replacement, errors in sampling and data acquisition. Statistical tests of hypotheses, box plots of a data sample, distribution & scatter plots.

Unit 2. Random Variables

Discrete and continuous variables, probability mass function, probability density function and cumulative distribution function, jointly distributed random variables: marginal and conditional distributions, independence of random variables. Expectation of a random variable and its properties

Unit 3. Distributions of Function of Random Variables

expectation of sum of random variables, product of independent random variables, conditional expectation and related problems, moments, moment generating function & their properties, random vectors and central limit theorem.

unit 4. Statistical Tests

correlation, regression, multiple and partial correlation, one-way and two-way analysis of variance (ANOVA**),** $\chi 2$ (chi-square), t and F distributions (central cases only) and their limiting forms, bivariate normal distribution and its properties, tests of goodness of fit, tests of independence.

Unit 5. Case Studies for Biomedical Application

Processing of biomedical signals like ECG, EMG, EEG etc.**,** removal of high frequency noise (power line interference), motion artefacts (low frequency) and power line interference in ECG**,** cancellation of ECG from EMG signal.

Text books

1. Wayne W. Daniel Chad L. Cross, *BIOSTATISTICS: A Foundation for Analysis in the Health Sciences,*
2. Statistical Package for the **S**ocial **S**ciences (SPSS) Software.

References

1. Rangaraj M Rangayyan, *Biomedical Signal Analysis* case study approach, PHI, 2004.

Session 2021-22
Semester A-Syllabus

Biomedical Engineering
B.E. IVthYear
BM-XXXXX: Biomechanics

Course Outcomes:-

CO1: Apply the knowledge of joint mechanics to day to day human movement.
CO2: Examine the principles of bio-fluid dynamics.
CO3: Explain the fundamentals of bio-solid mechanics.
CO4: To visualize the biomechanics principles and gait analysis of human locomotion
CO5: Derive the joint force and muscle force for various biomechanical systems in human

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
2	1	2	3	1	4	70	30	40	60	200

Prerequisite: -PH 10006, CE 10003, MA 10001, MA 10501

Unit 1. Biomechanics of Joints

Biomechanics of Joints: Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle.

Unit 2. Hard Tissue Mechanics

Hard Tissues: Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, and Maxwell&Voight models – anisotropy.

Unit 3. Soft Tissue Mechanics

Structure and functions of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle; Material Properties: Cartilage, Tendon, Ligament, and Muscle; Modelling of soft tissues: Cartilage, Tendon, Ligament, and Muscle, Hills's muscle model.

Unit 4. Bio-fluid Mechanics

Introduction, viscosity and capillary viscometer, Rheological properties of blood, laminar flow, Couette flow and HagenPoiseuille equation, turbulent flow.

Unit 5. Gait Analysis

Gait analysis, measurement of gait parameters, techniques for recording and measuring movements and forces - force platforms and motion analysis system, Applications of these equipment in biomechanics, performance improvement and injury prevention. Centre of gravity.

Text Books

1. NihatOzkaya and Margareta Nordin, *Fundamentals of biomechanics: Equilibrium, Motion and deformation*, 2nd Edi. Springer 1999.
2. (Undergraduate Lecture Notes in Physics) EmicoOkuno, Luciano Fratin (auth.) - *Biomechanics of the Human Body*-Springer-Verlag New York (2014)

References

1. D. Dowson and V. Wright, *An introduction to Biomechanics of joints and joint replacements*, Mechanical Engineering Publications, 1980
2. George L. Lucas M.D., Francis W. Cooke Ph.D., Elizabeth A. Friis Ph.D. (auth.) - *A Primer of Biomechanics*-Springer-Verlag New York (1999)

Session 2021-22

Semester A- Syllabus

Biomedical Engineering
B.E. IVthYear
BM- xxxxx/BM-49305: Medical Imaging Systems

Course Outcomes: -

CO1: To learn principles of sectional imaging in X-Ray, CT scanner configuration and 2D image reconstruction techniques.

CO2: Recognize basic physics of MRI, its instrumentation and areas of application.

CO3: Interpret basic physics of ultrasound, the instrumentation involved and modes of operation.

CO4: To classify Emission Computed Tomography with emphasis on SPECT and PET imaging.

CO5: To explain basic knowledge of IR imaging, its advantages and application.

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
3	1	-	4	-	4	70	30	40	60	200

Prerequisite:- PH 10006, MA 10001, MA 10501, MA-29024, MA-29501

Unit 1. X-Ray Computed Tomography

Principles of sectional imaging, scanner configuration, data acquisition system, image formation principles, conversion of X-ray data into scan image, 2D image reconstruction techniques - iteration and Fourier transform methods.

Unit 2. Magnetic Resonance Imaging (MRI)

Principles of MRI, pulse sequence, image acquisition and reconstruction techniques, MRI instrumentation: magnets, gradient system, RF coils, receiver system, functional MRI, applications of MRI.

Unit 3. Ultrasound in Medicine

Introduction, production of ultrasonic - properties - principles of image formation, capture and display, principles of A-mode, B-mode and M-mode display, principles of scan conversion, Doppler ultra sound and colour flow mapping, application of diagnostic ultrasound.

Unit 4. Radio Isotope Imaging

Rectilinear and scanners, SPECT, PET, gamma camera, radionuclide for imaging, emission computed tomography, Biomarkers.

Unit 5. Infra-Red Imaging

Physics of thermography, imaging systems, pyro-electric vidicon camera, clinical thermograph, liquid crystal thermography.

Text Books

1. Jerry L Prince, Jonathan Links, *Medical Imaging Signals and Systems, 2016, Pearson Publication.*
2. P. Allisy-Roberts, J. Williams and R.Farr, *Farr's physics for medical imaging*. Edinburgh: Saunders Elsevier, 2008.

References

1. S. Webb, *The Physics of Medical Imaging*, 2nd ed. CRC Press, 1999.
2. A.C.Kak,*Principle of Computed Tomographic Imaging*, IEEE PressNewYork, 1988.
3. G. A. Hay, *Medical Image Formation Perception and Measurement*, John Wiley & Sons, 1977.
4. W. Hendee and E. Ritenour, *Medical Imaging Physics*. Hoboken: Wiley, 2003.

Session 2021-22
Semester A- Syllabus

Biomedical Engineering
BM-XXXXX: Biological Control Systems

Course Outcomes:-

CO1: Interpreting physiological systems in terms of control systems and summarizing their properties**.**
CO2: Developing simple respiratory model.
CO3: Developing simple cardiovascular model.
CO4: Summarizing various physiological models.
CO5: Interpreting different system identification techniques.

L	T	P	Theory Credits	Practical Credits	Total credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
3	-	2	3	1	4	70	30	40	60	200

Prerequisite: - EE -39508, BM-29003, BM 39254

Unit 1. Control Systems Perspective for Biological Systems:
Introduction to physiological control systems, examples of a physiological control system, differences between engineering and physiological control systems, art of modelling physiological systems, distributed parameters versus lumped parameter models, simple models of muscle stretch reflex action, across and through variables, generalized system properties (viz., impedance, compliance and inertance).

Unit 2. Human Respiratory Modeling
Respiratory mechanism, linear model of respiratory mechanics, gas exchange and ventilation–perfusion relationships in the lung, chemical regulation of ventilation.

Unit 3. Cardiovascular System Modeling
Theoretical basis- cardiac cycle & pressures-volume loops, cardiac pressure versus time graph, the cardiac output curve, the venous return curve, closed-loop analysis: heart and systemic circulation combined.

Unit 4. Various Physiological Models
The Hodgkin-Huxley model. Wetheimer'ssaccade eye model, compartmental models, integrated cardiopulmonary model.

Unit 5. Art of Modeling the Biological Control System
Basic problems in physiological system analysis, nonparametric and parametric identification: numerical deconvolution, least square estimation, estimation using correlation functions, estimation in the frequency domain, optimization techniques. Problems in parameter estimation.

Text Books

1. Michael C.K. Khoo, *Physiological control systems: Analysis, Simulation and Estimation*, 2nd ed. Wiley-IEEE press, 2018.
2. Frank C., Hoppenstead, Charles,*Modelling and Simulation in Medicine and the Life Sciences*, Springer, 2002.

Reference

1. John H. Milsum, *Biological Control System analysis*, McGraw hill, 1966.

Session 2021-22
Semester A- Syllabus

Biomedical Engineering
B.E. IVth Year
BM-XXXXX: Rehabilitation Engineering
Elective III.1

Course Outcomes:-

CO1: Understand need and concepts of rehabilitation engineering in general.
CO2: Understand the concept of mobility and functioning of sensory augmentation.
CO3: Identify the key components and design of universal accessibility.
CO4: Analyse the design of orthotics and prosthetics of upper and lower extremities.
CO5: Design manual and power wheelchair.

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
2	-	-	2	-	2	70	30	-	-	100

Prerequisite: -BM-29003

Unit 1. Engineering Concepts in Rehabilitation Engineering

Anthropometry: methods for static and dynamic measurements. Area measurements-measurement of characteristics and movement, measurement of muscular strength and capabilities. Measurement tools and processes in rehabilitation engineering: fundamental principles, structure, function. Measurement systems for performance and behaviour.

Unit 2. Sensory Rehabilitation Engineering

Sensory augmentation and substitution, visual system, visual augmentation, tactual vision substitution, and auditory vision substitution. Auditory system: auditory augmentation, audiometer, hearing aids, cochlear implantation, visual auditory substitution, tactual auditory substitution. Tactual system: tactual augmentation, tactual substitution.

Unit 3. Universal Design and Accessibility

Design Considerations, Total Quality Management in Rehabilitation Engineering, Steel as a Structural Material, Aluminium for Assistive Technology Design, Use of Composites for Assistive Technology Design, Design with Engineering Materials, Fabrication, Basic Electric Circuits. Barrier-Free Design, Elemental Resource Model, Factors Affecting Barrier-Free Design, Interior Space Design, Design for People with Disabilities, Accessible Transportation

Unit 4. Orthopaedic Prosthetics and Orthotics

Upper-Extremity Prostheses, Upper-Extremity Orthoses, Lower-Extremity Prostheses, Lower-Extremity Orthoses, Functional Neuromuscular Stimulation, Ambulation Aids, Aids to Daily Living.

Unit 5. Wheelchair Safety Standards and Testing

Standard Tests, Normative Values, Static Stability, A Geometric Approach to Static Stability, Stability with Road Crown and Inclination, Impact Strength Tests, Fatigue Strength Tests, Finite-Element Modelling Applied to Wheelchair, Design/ Testing, Test Dummies, Power Wheelchair Range Testing, Power Wheelchair Controller Performance, Designing for Safe Operation. Design of manual and powered wheel chairs.

Text Books

1. Bronzino, Joseph, *Handbook of Biomedical Engineering*, 2nd ed., CRC Press, 2000
2. Robinson C.J, *Rehabilitation Engineering*, CRC press, 1995.
3. (Medical science series) Rory A Cooper - Rehabilitation engineering applied to mobility and manipulation _ Rory A. Cooper-Institute of Physics Pub (1995)

References

1. H N Teodorecu, L.C.Jain, *Intelligent Systems and Technologies in Rehabilitation Engineering*, CRC, 2000.
2. Etienne Grandjean, H. Oldroyd, *Fitting the task to the man*, Taylor & Francis, 1988.

Session 2021-22
Semester A- Syllabus

Biomedical Engineering
B.E. IVth Year
BM-XXXXX: Hospital Technology Systems
Elective-III.2

Course Outcomes:-

CO1: Acquire knowledge classification of hospital & architecture, various departments.
CO2: Design of Electrical power system in hospital
CO3: Design of Air-conditioning and gas supply system, its criticality
CO4: Analyse and implement maintenance protocols of hospital equipment's.
CO5: Identify need and application of hospital information system.

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
2	-	-	2	-	2	70	30	-	-	100

Prerequisite: -Nil

Unit 1. Classification of Hospital & Architecture

General hospital, specialized hospital, primary health care – their role and 8L functions. Aspects of hospital services – inpatient, outpatient and emergency. Location and environment of hospital, Hierarchy of medical and paramedical staff & their functions and responsibilities. Modern Hospital Architecture- space in a hospital building, design of ward, intensive care units, air conditioning, plumbing & sanitation, gas supply, waste disposal, cleaning, dietary, sterilizing, laundry, storage and operation theatre systems, Radiology, Central labs, Blood banks, OPD, Casualty, etc

Unit 2. Electrical Power Systems in Hospitals

Safety of electrical systems, Protective systems - interference of patient's protection grounding. Design of sub stations, breakers, Surge protectors, EMI filters, voltage stabilizers, generator sets and UPS. 8L Uninterrupted power supply for ICU and computerized monitoring units. Specification & estimation for hospital wiring.

Unit 3. Air Conditioning & Gas Supply Systems

Air conditioning and refrigeration systems for small and large areas. Air changes, filtering and sterility. Deodourization, disinfection, dehumidification and cryogenic systems. Centralized supply of air, 6L oxygen, nitrous oxide & vacuum - Principle of production of liquid oxygen. Management lifts fire fighting equipments.

Unit 4. Hospital Engineering & Management

Definition of biomedical Engineering, clinical engineering & hospital engineering. Importance of BME department – servicing and maintenance, testing, acceptance & maintenance protocols, Computerized preventive maintenance planning, MROs. Training of men for medical equipments preventive and periodical maintenance 10L procedures. Preparation of estimates, specifications, tender details etc. Importance of ISO 9000 Certificates - Obtaining ISO certificates in hospitals.Proposed protocols.

Unit 5. Hospital Information system

Role of database in HIS. Need of Networking in HIS. Overview of Networking, topologies and its configuration. Structuring medical records to carry out functions like admissions, discharges, treatment history etc. Computerization in pharmacy & billing. Automated clinical laboratory systems & radiology information system.

Text Books

1. Harold E. Smalley, "*Hospital Management Engineering – A guide to the improvement of hospital management system"*
2. L. C. Redstone ,"Hospital and Health Care Facilities
3. PHI. C. A. Caceras ,"Clinical Engineering"
4. Ward,"Anesthetics Equipments".
5. BIS, "ISO Certification details"

References

1. Bhaumick and Bhattachary," EHV Substation equipments"
2. Alexander Kusko," Emergency and Standby Power Systems"
3. Balagune Swamy,"Reliability Engineering"
4. Anantha Narayanan,"Basic Refrigeration and Air Conditioning"

Session 2021-22
Semester A- Syllabus

Biomedical Engineering
B.E. IVth Year
BM-XXXXX: Medical Image Processing
Elective-III.3

Course Outcomes: -

CO1: Understand the concept of 2D signal and apply it on image
CO2: Evaluate the techniques for image enhancement.
CO3: Analyse images in the frequency domain using various transforms.
CO4: Apply and compare various image segmentation techniques on images.
CO5: Interpret Image the output of morphological operations on images.

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
2	-	-		-	2	70	30	60	40	200

Prerequisite: -Nil

Unit 1. Two-dimensional systems

Linear systems and shift invariance. Fourier transform - Z - transform - Block matrices, Toeplitz and Kronecker product. Luminance, brightness and contrast. Color representation, color matching and reproduction, color vision model.Image sampling and quantization. Two dimensional sampling theory, reconstructions of images from its samples. Image acquisition.

Unit 2. Image Enhancement in the Spatial and Frequency Domain

Gray level transformations, Histogram processing, Arithmetic and logic operations, Spatial filtering: Introduction, Smoothing and sharpening filters. Frequency domain filters

Unit 3. Image Transforms

Completeness and orthogonality property of image transforms. Introduction to Fourier transform, DFT and 2-D DFT, Properties of 2-D DFT, FFT, IFFT, Walsh transform, Hadamard transform, Discrete cosine transform, Slant transform: Karhunen - Loeve transform

Unit 4. Morphological Image Processing

Introduction, Dilation, Erosion, Opening, closing, Hit -or-miss transformation, Morphological algorithm operations on binary Images, Morphological algorithm operations on gray-scale Images.

Unit 5. Feature extraction algorithms

Image Segmentation, Representation and Description: Detection of discontinuities, Edge linking and Boundary detection, Thresholding region based segmentation, Image Representation schemes, Boundary descriptors, and Regional descriptors.

Text Books

1. R.C Gonzalez and R. Woods *:-Digital Image Processing*, (Indian reprint: Pearson publication, 2001)
2. Anil K. Jain *:- Digital Image Processing* (Prentice-Hall, India)

Reference

1. W. K. Pratt *:- Digital Image Processing*, - 2nd Edition, (John Wiley & Sons).
2. B. Chanda& D. DuttaMajumder, *Digital Image Processing and Analysis*, (Prentice-Hall, India)
3. M. A. Sid-Ahmed :- *Image Processing- Theory, Algorithms & Architecture*, (McGraw-Hill).

Session 2021-22
Semester A- Syllabus

Biomedical Engineering
B.E. IVth Year
BM-XXXXX-Design and Manufacturing of Medical Devices
Elective-III.4

Course Outcomes: -
CO1.

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
2	-	-	2	-	2	70	30	-	-	100

Prerequisites:-

Introduction to basic medical Science for engineers, Introduction to principles of design and product development, Basic Mechanical Engineering, Introduction of Finite Element Method

Objectives:

1. Provides an overview of design and manufacturing technique for medical devices development.
2. Define the equipments, instrumentations and control systems used in bio manufacturing.
3. Explain standard design and manufacturing programs, validation practices and regulatory requirement used in biomedical industry.

Unit 1.

Generating Ideas and Concepts, Design Process versus Design Control, Implementation of Design Procedures, Material selection and Biocompatibility, Design Specification, Quality in Design, Detailed Design (hardware/ Software design), Computer-Aided Design, Design Evaluation (Validation and Verification), Obtaining Regulatory Approval to Market.

Unit 2.

Introduction to Finite Element Method, Finite element modelling of cells, tissues and organs Medical device design and prototyping, Customized and universal design of Implants and prosthesis.

Unit 3.

Design of orthopaedic Implants, orthoses and Assistive devices.

Unit 4.

Additive manufacturing processes; Machining, forming, electro-discharge machining (EDM) and electrochemical machining (ECM), laser-based processing, casting and molding, and others.

Unit 5.

Machines and equipment including tooling, fixturing, sensors systems, and control; Metrology, material handling, joining, and assembly; Implants, Prostheses and orthoses manufacturing; Assistive technolog

Text Books

1. The Design and Manufacture of Medical Devices by Paulo Davim, Woodhead Publishing
2. Medical Device Design: Innovation from Concept to Market, by Peter J. Ogrodnik, Academic Press is an imprint of Elsevier
3. Handbook of Medical Device Design by Richard C. Fries, CRC Press
4. Introduction to Bio manufacturing, Margaret Bryans, Northeast Bio manufacturingceter

Session 2021-22

Semester B- Syllabus

Biomedical Engineering
B.E. IVth Year
BM-4XXXX: Artificial Intelligence and Machine Learning for Medical Applications
Elective IV.1

Course Outcomes: -

CO1: Understand and describe the basics of Artificial Intelligence and Machine Learning.
CO2: Learn and reframe the machine learning algorithm and its classification.
CO3: Understand, describe and practise various training models of machine learning.
CO4: Learn, classify and examine the process of decision trees and dimensionality reduction in machine learning.
CO5: Practice and infer the different medical applications of AI & ML.

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
3	-	2	3	1	4	70	30	40	60	200

Prerequisite: - Nil

Unit 1. Introduction to Artificial Intelligence (AI) & Machine Learning (ML)

AI Fundamentals: - Definition, Comparison between Human Intelligence and Artificial Intelligence, Types of AI techniques, State Space Search and Heuristic Search Techniques. Predicate Logic and Representing Knowledge as Rules, Non-monotonic Reasoning and its logic, Statistical Reasoning.

Introduction to Machine Learning: - What is Machine Learning? Importance of Machine Learning, Types of Machine Learning systems, Main Challenges of Machine Learning.

Unit 2. Steps of Machine Learning (ML) & Its Classification

Various Steps of Machine Learning, Classification of ML:- MNIST, Training a Binary Classifier, Performance Measures : Measuring Accuracy Using Cross-Validation, Confusion Matrix, Precision and Recall, Precision/Recall Tradeoff, The ROC Curve; Multiclass Classification, Error Analysis, Multilabel Classification, Multi output Classification.

Unit 3. Training Models of ML & Support Vector Machines (SVM)

Training Models: - Linear Regression, Gradient Descent, Polynomial Regression, Learning Curves, Regularized Linear Models, Logistic Regression.

Support Vector Machines: - Linear SVM Classification, Nonlinear SVM Classification, SVM Regression, Decision Function and Predictions, Training Objective, Quadratic Programming, The Dual Problem, Kernelized SVM. Case Study 1 - Predicting Atrial Fibrillation/Flutter.

Unit 4. Decision Trees &Dimensionality Reduction

Decision Trees:- Training and Visualizing a Decision Tree, Making Predictions, Estimating Class Probabilities, The CART Training Algorithm, Computational Complexity, Regularization Hyper parameters, Regression, Instability, Random Forests and its classification.

Dimensionality Reduction: - Approaches of Dimensionality Reduction – Projection and Manifold learning, PCA, Kernel PCA. Case Study 2 – Prediction of Infection in Human lungs from CT/MRI Image.

Unit 5. Applications of AI & ML in Medical Systems

Neural Networks, Pattern Imaging Analytics, Drug Discovery & Manufacturing, Clinical Trial Research, Predicting Epidemic Outbreaks, Maintaining Healthcare Records.

Practicals:

List of Experiments

1. To study some basic neuron models and learning algorithms by using Matlab's neural network toolbox.
2. Prediction of First degree Cardiac Block.
3. Classification of heart sound recording.
4. Detection and analysis of T-wave in ECG recording.
5. Prediction of Cancer/Tumour in Human lungs from CT scan.

Text Book

1. AurélienGéron, *Machine Learning with Scikit-Learn&TensorFlow*, O'ReillyUSA, 2017.

References

1. Stuart Russell and Peter Norvig, *Artificial Intelligence - A Modern Approach,* Third Edition, Prentice Hall Series, 2010.

2. Keith Frankish and William M. Ramsey, *The Cambridge Handbook of Artificial Intelligence*, Cambridge University Press, 2014.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering
B.E. IVth Year
EE-47002: Power Electronics
Elective IV.2

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
3	-	2	3	1	4	70	30	40	60	200

Prerequisite: - Basic knowledge of Electronics and semiconductor devices.

Course Objectives:

- To provide students a deep insight in to the operational behaviour of practical power switching devices with respect to their static and dynamic characteristics
- To learn the working principle of classified topologies of Thyristor based AC/DC, AC/AC, DC/DC and DC/AC converters.
- To design and analyze the operation of above converters considering their applications.
- To understand design of firing circuits for Thyristor based line commutated converters.

Course Outcomes:

EE47002 (T). CO1: Acquire knowledge about fundamental concepts and switches used in power electronics.
EE47002 (T). CO2: Ability to analyze various single phase and three phase line commutated power converter circuits and understand their applications.
EE47002 (T). CO3: Nurture the ability to identify basic requirements for line commutated converter based design application.
EE47002 (T). CO4: To develop skills to build, and troubleshoot power electronics circuits.
EE47002 (T). CO5: Understand the firing circuit design for line commutated converters.
EE47002 (T). CO6**:** Foster ability to understand the use of line commutated converters in professional engineering.

Course Contents:

Theory:

Unit 1.

Static power devices: Thyristor family, two transistor analogy of SCR, construction, characteristics, parameters, turn on and turn off methods, firing circuits, isolation and amplifier circuits, synchronization circuits.

Unit 2.

Converters: AC to DC converters, single phase rectifier circuits with different load, various quadrant operation, basic principle and power circuits of dual converter and cycloconverter.

Unit 3.

DC to DC converter: Basic principle of chopper circuits, various chopper circuits and their working, stepup chopper, performance analysis.

Unit 4.

Inverters: CSI and VSI inverters, single phase inverters, principle of operation, voltage and frequency control techniques.

Unit 5.

Industrial Application of Power Electronics, SMPS, UPS, AC and DC drives, Power Supplies.

Assessment:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the coursetopics.

B. The end-term theory examination weightage is70%.

Practicals:

List of Experiments

1. Verification of steady state characteristics of different staticswitches.
2. Phase control of TRIAC using DIAC and RC circuit in light dimmingcircuit.
3. Firing pulse generation using UJT based relaxationoscillator.
4. Firing pulse generation for SCR using TCA 785IC.
5. Performance evaluation of single phase uncontrolled converter for R, RLload.
6. Performance evaluation of single phase controlled converter for R, RLload.
7. Performance Analysis of step downchopper
8. Performance evaluation of current commutation circuit forSCR
9. Performance evaluation of voltage commutation circuit forSCR.
10. Effect of duty cycle on the output voltage of buck-boostconverter.

Assesment:

A. Continuous evaluation of laboratory journals with a weightage of 40%. It includes lab attendance as well as experiments performed in thelab.

B. The end-term practical examination weightage is60%.

Text Books

1. M H Rashid, –Power Electronics Circuits, Devices, and Applications‖, third edition Pearson/Prentice Hall, 2009.
2. NedMohan,–PowerElectronics:Converters,Applications,andDesign‖,thirdedition,John Wiley & Sons Inc, 2007.
3. Joseph Vithayathil,–Power Electronics Principles and applications‖, Tata McGraw-Hill, 1995.

References

1. C.M.Pauddar,–SemiconductorPowerElectronics (DevicesandCircuits)‖,firstedition,Jain Brothers New Delhi, 1999.
2. M.H.Rashid,–Handbook of Power Electronics‖,PearsonEducationIndia,2008.
3. M.D.Singh, K.B.Khanchandani,–PowerElectronics‖, TataMcGraw-Hill, 2008.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering
B.E. IVth Year
BM-XXXXX: Hospital Management and Information Systems
Elective IV.3

Course Outcomes:

CO1: To write algorithms for linear data structures & their application.
CO2: To develop algorithms for nonlinear data structure-trees &graphs.
CO3: Learn basic concepts, components & applications of database system as well as ER model to use efficiently to improve performance of hospital database.
CO4: Write SQL queries for solving problems related to current scenarios in hospital database.
CO5: Design of HIS and its integration in a networked hospital scenario.

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
3	-	2	3	1	4	70	30	40	60	200

Prerequisite: - Nil

Unit 1. Introduction to Data Structures, Linear Data Structures

Concepts of data and information, Classification of data structures. Introduction to linear data structures- Array, Linked List.Representation of linked list.Implementation of linked list, circular linked list. Stacks and Queues. Implementation and different types of Stacks and Queues.

Unit 2. Non-Linear Data Structures

Tree: Definitions – Height, depth order, degree etc. Binary Search Tree - Operations. Graphs: Introduction, classification of graph: Directed and Undirected graph. Application of Trees and Graphs.

Unit 3. Introduction to Database Models

Basic concepts of data and information.Introduction to DBMS-characteristics of DBMS, DBMS architecture, components of DBMS. Relational data model: domains, tuples, attributes, relation keys and type of keys.

Unit 4. Relational Database Design- Normalization

Normalization theory and database methodologies- Relational schemas, functional dependency.1NF, 2NF and 3NF indexing and hashing. Query Language: SQL-Basic SQL queries, functions, constraints, joins.

Unit 5. Hospital Information System

Role of database in HIS. Need of networking in HIS, overview of networking, topologies and its configuration. Detailed study of picture archiving and communication systems (PACS).

Practicals:

List of Experiments

1. Write a program to perform push and pop operations on stack using array or linked list.
2. Write a program to perform different operations on queue such as insert, delete and display.
3. Insert and delete a node at the beginning of a linear linked list.
4. Write a Program to implement Bubble sort using array.
5. Create table “Patient” with following details and constraints*.
6. List the name, address and phone number of all the patients who have taken a medical test in a medical lab outside Indore.
7. Find the name and clinic address of all doctors who have prescribed at least three "CTscan" to a patient during the year 2011.
8. List the name, address and phone number of all the patients who may take "bone marrow check"
9. List the name, address and phone of all the patients who took more tests than the average in one year.
10. List the name and address of all patients who have taken exactly one non X-ray test in the last one year.

Text Books

1. H. Dominic Covvey, *Computer in practice of medicines*, Addison Wesley, 1980.

2. Edward Shortlife, *Computer based medical consultation*, Elsevier Scientific, 1976.

3. Date C. J, *An introduction to database systems*, 8th ed., Pearson, 2003.

References

1. RemezElmasri, Shamkant B. Navathe, *Fundamentals of Database Systems*, 7th ed., Pearson, 2017.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering
B.E. IV Year
BM-XXXXX: Biomaterials
Elective V.1

Course Outcomes:-

CO1: Illustrate the fundamental concepts of biomaterials, its classification and detailed understanding of different implant material.
CO2: Demonstrate and test the bulk and surface properties of biomaterials.
CO3: Describe the biological testing of biomaterials & fundamentals of tissue engineering
CO4: Explain detailed understanding of practical applications of biomaterials in medicine and dentistry.
CO5: Identify and predict the host reaction on application of biomaterials.

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
3	1	-	4	-	4	70	30	-	-	100

Prerequisite: -BM 29003

Unit 1. Introduction

Definition and classification of biomaterial, Types of bonds in material, Introductory overview of some existing prosthetic devices, Fundamentals of biocompatibility, Metallic, Ceramic and Polymeric implant material, Sterilization of implants & devices.

Unit 2. Mechanical Behaviour & Surface Characterization of Materials

Stress-Strain curve characteristics, Viscoelasticity, Mechanical properties & Mechanical testing of materials, Surface characterization of biomaterials.

Unit 3. Testing of Biomaterials & Tissue Engineering

Introduction, In- Vitro and In-Vivo assessment of tissue compatibility, Overview of tissue engineering.

Unit 4. Application of Material in Medicine and Dentistry

Sutures, Basic fundamentals of Drug delivery systems, Orthopedic application, Cardiovascular application & Dental application.

Unit 5. Host Reaction to Biomaterial and Their Evaluation

Introduction: Biomaterials-Tissue interactions, Systemic toxicity and Hypersensitivity, Biofilms & Device-related Infections.

Text Books

1. Joseph Bronzino, *The Biomedical Engineering Handbook*, 2nd ed., CRC Press, 2000.
2. Joon Park, R.S. Lakes, *Biomaterials An Introduction*, Springer, Third Edition, 2007.
3. Joo L. Ong, Appleford, and Mani, *Introduction to Biomaterials,* Cambridge University Press, 2014

References

1. Buddy D. Ratner, *Biomaterials Science-An Introduction to Materials in Medicine*, 2nded. Elsevier Academic Press, 2004.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering
B.E. IVth Year
BM-XXXXX: Telemedicine
Elective V.2

Course Outcomes:-

CO1: Demonstrate the basic knowledge of telemedicine and telehealth
CO2: Understand the technology of Telemedicine Systems.
CO3: Interpret the clinical applications, standards, and guidelines in telemedicine
CO4: Design of integrated telemedicine architecture with sub systems
CO5: Describe the often complex legal, ethical, regulations and laws in telemedicine.

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
3	1	-	4	-	4	70	30	-	-	100

Prerequisite: - BM39013

Unit 1. History, Definitions and Current Applications

History of Telemedicine, Definition of telemedicine, Tele health, Tele care, origins and Development of Telemedicine, Block diagram of telemedicine system, Scope, Benefits and limitations of Telemedicine.

Unit 2. Technology of Telemedicine Systems

Network technologies: topologies, LAN, WAN, MAN, OSI model, physical layer, data link layer, network layer, transport layer, TCP/IP model, and comparison of OSI & TCP/IP model.

Types of information: Audio, Video, still Images, text and data, Fax. Types of Communication and Network: PSTN, POTS, ATM, ISDN,wireless transmission, wireless technologies, 802.11, 802.16, satellite communication.

Unit 3. Clinical Applications

Clinical parameters, Tele-cardiology Tools and Devices, Tele-dermatology, Tele-radiology, homecare, neurology, Tele-oncology, Tele-ophthalmology, Tele-rehabilition, Tele-pathology &Tele-surgery.

Unit 4. Telemedicine Equipments

Data Exchanges: Network Configuration, Circuit and packet switching, H.320 series (Video phone based ISBN) T.120, h.324 (Video phone based PSTN), Video Conferencing Network equipments – Telemedicine workstations, DSL, ADSL, SDSL, cable modems, VoIP modem, Fast switched ethernet, routers, switches, hubs, multi point conferencing units. Monitoring devices –electronic stethoscope, vital sign monitoring devices. Respiratory monitoring devices, neurological monitoring devices, video scopes, robotics and virtual reality devices.

Unit 5. Legal and Ethical Issues

Confidentiality, Patient Rights and Consent.Data Protection and Security.Ethical and Legal Aspects of the Internet. International and National protocols- HL7, HIPAA, DICOM, and Indian IT act.

Text Books

1. Andrew S Tanenbaum, *Computer Networks*, PHI, 2003.
2. Norris A.C., *Essential of Telemedicine and Telecare*,John Wiley & Sons, 2001.

References

1. M Marlene, W Pamela, A Allen, *E-Health, Telehealth, and Telemedicine: A Guide to Start-up & Success*, Wiley, 2001.

Session 2021-22
Semester B- Syllabus

Biomedical Engineering
B.E. IVth Year
BM-XXXXX: Nanosensors
Elective V.3

Course Outcomes: -

CO1: To understand the basics concepts of nanotechnology
CO2: To compare different materials used in the field of nanotechnology
CO3: To analyse and categorize the nanosensors
CO4: To apply the knowledge of nanomaterials in the development of nanosensors
CO5: To analyse and evaluate the performance of different nanosensors

L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
						Theory		Practical		Total
						Th.	CW	SW	Pr.	
3	1		3		3	70	30			100

Prerequisite: - Nil

Unit 1. Introduction to Nanotechnology

Basic properties of nanomaterials and the unusual behaviour at nanoscales, difference between bulk and nano materials, comparison of 0D, 1D, 2D and 3D materials Classification of nanomaterials, application of nanomaterials, nanomaterials for sensor applications.

Unit 2. Nanosensors

Properties of materials used for nanosensors, materials for nanosensors, synthesis techniques, characterisation of nanosensors: characterisation techniques.

Unit 3. Classification of Nanosensors

Classification of nanosensors: physical, chemical, and biological nanosensors. Mechanical nanosensors, thermal nanosensors, optical nanosensors, magnetic nanosensors, chemical nanosensors, nanobiosensors

Unit 4. Nanosensors for Chemical and Biological Applications

Chemical and biological sensing with carbon nanotubes, electrochemical nanosensors for blood glucose analysis, electropolymers for (nano-) imprinted biomimetic biosensors, nanoporous silicon biochemical sensors

Unit 5. Nanobiosensors

Biomolecular components of a biosensor: fundamentals**,** nanoparticle-based electrochemical biosensors, CNT-based electrochemical Biosensors, functionalization of CNTs for biosensor fabrication, quantum dot-based electrochemical biosensors, nanotube- and nanowire-based FET nanobiosensors, cantilever-based nanobiosensors, optical nanobiosensors, microarrays

Text Books

1. Bharat Bhushan, *Handbook of Nanotechnology*, Springer 4thedition.
2. Vinod Kumar Khanna , *Nanosensors: Physical, Chemical, and Biological*, 1st Edition.
3. Joseph M. Irudayaraj, *Biomedical Nanosensors*, 1st Edition.
4. Kevin C. Honeychurch , *Nanosensors for Chemical and Biological Applications: Sensing with Nanotubes, Nanowires and Nanoparticles*.

References

1. CNR Rao, *Nanoworld : An Introduction To Nanoscience&Technology* .

Biomedical Engineering
BM 75201: Adaptive Signal Processing
Syllabus

For Students from B.E. Biomedical Engineering

Course Outcomes:-

CO1: To understand fundamental of signal processing.
CO2: To learn techniques of linear prediction filtering.
CO3: Have experience in designing frequency domain filters.
CO4: Apply filtering technique in biomedical applications.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75201	Adaptive Signal Processing	4	-	-	4	-	4	70	30		-	100

Unit. 1 Introduction

Random variables, random processes, filtered random processes. Ensemble averages, correlation, covariance, power spectrum, cross power spectrum-ergodicity, time averages, biased & unbiased estimators, consistent estimators.

Unit. 2 Linear Prediction Filtering

Direct form linear prediction filtering. Normal equations for linear prediction filtering. Levinson algorithm, linear prediction lattice filtering.

Unit. 3 Digital Wiener Filtering

Wiener smoothing and prediction filters. Application of Wiener smoothing to noise cancelling. Application of Wiener prediction filters. Constrained, linear MMSE filtering. Minimum variance beam forming.

Unit. 4 Adaptive Filters

Least mean squares adaptive filter, LMS adaptive algorithm. Properties of LMS adaptive filter. Normalized forms, finite precision effects, adaptive beam forming.

Unit. 5 Frequency Domain Filters

Frequency domain adaptive filters, adaptive lattice filters, adaptive IIR filtering, blind adaptive filtering, and Haykin cost functions. Higher-order statistics.

TEXT BOOKS

1. Simon Haykin and Adali, *Adaptive Signal Processing*, Wiley-IEEE, 2010.
2. Ali H. Sayed, *Fundamentals of Adaptive Filtering*, John Wiley, 2003.

REFERENCE BOOKS

1. J. Triechler, C. Johnson, M. Larimore, *Theory and Design of Adaptive Filters*, Prentice-Hall, 1995.

Biomedical Engineering
BM 75702: Advanced Biomechanics
Syllabus

Course Outcomes:-

CO1: To understand the need of Biomechanics study

CO2: To understand key concept of tissue characterization.

CO3: To understand key concepts of mechanics of skeletal muscle.

CO4: To understand the role of motion in biomechanics and basic principles cardiovascular mechanics

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75702	Advance Biomechanics	4	-	-	4	-	4	70	30	-	-	100

Unit. 1 Introduction

Introduction to Biomechanics, History, Perspectives in Biomechanics. Rigid Body Biomechanics. Anatomical Concepts in Biomechanics.

Unit. 2 Material Characterization of Tissues

Classification of Tissues, Properties of: Tissues from Mechanics Point of View, Modeling of Tissues.

Unit. 3 Mechanics of Skeletal Muscles

Skeletal Muscles as Elastic fibers in one dimension, Viscous behavior, Non-linear viscoelasticity; Continuum Mechanics, Concepts in Modeling of large deformation; Stress in three-dimensional continuous media.

Unit. 4 Motion

The time as an extra dimension; Deformation and rotation, deformation, rate and spin; Constitutive modeling of solids and fluids.

Unit. 5 Cardiovascular Mechanics

Cardiovascular Physiology, Blood Flow Models, Blood Vessel Mechanics, Heart Valve Dynamics, Prosthetic Valve Dynamics

TEXT BOOKS

1. Biomechanics, by Fung C., Springer, 1993

REFERENCE BOOKS

1. Basic Biomechanics by Hall et., McGraw Hill, 2011

Biomedical Engineering
BM 75701: Advanced signal Processing
Syllabus

Course Outcomes:-

CO1: To acquire the fundamental concepts of Signal processing.
CO2: To understand various design techniques for linear phase analysis.
CO3: To introduce multi rate signal processing.
CO4: To study various signal model.
CO5: To apply concept of power spectrum analysis to various engineering problems.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75701	Advanced Signal Processing	4	-	-	4	-	4	70	30	-	-	100

Unit. 1 IIR Filter Design

Review of classical analog filter design (Butterworth, Chebyshev, Elliptic)–design of digital filters based on continuous-time filters–mapping of differentials–impulse invariant transformation–modified impulse invariant transformation–bilinear transformation–matched.

Unit. 2 Linear Phase Analysis

Review of conditions needed for precise linear phase–design techniques for linear phase. FIR filters: (a) windowing method, (b) frequency sampling, (c) weighted Chebyshev approximation. All pass Filters: All pass transfer function and its properties–digital two-pair–design of all pass filters using digital two-pair–parallel all pass realization of certain IIR transfer functions. Hilbert transformers.

Unit. 3 Multi-rate Signal Processing

Introduction, decimation by a factor D, interpolation by a factor I, sampling rate conversion by a rational factor I/D, filter design and implementation for sampling rate conversion, multistage implementation of sampling rate conversion, sampling rate, conversion of band-pass signals, sampling rate conversion by an arbitrary factor, applications of multi-rate signal processing. Haar wavelet transform. Daubechies wavelet transform.

Unit. 4 Signal Models

Autoregressive model, moving average model, autoregressive moving average model, state variable model, lattice structures.

Unit. 5 Power Spectrum Estimation

Estimation of spectra from finite-duration observations of signals, nonparametric methods for power spectrum estimation, parametric methods for power spectrum estimation, minimum variance spectral estimation, eigen analysis algorithm for spectral estimation.

TEXT BOOKS

1. Monson H. Hayes, *Statistical Digital Signal Processing and Modeling*, John Wiley & Sons, 2001.
2. Andreas Antoniou, *Digital Filters: Analysis, Design, and Applications*, 2nd ed., Tata McGraw-Hill Publishing Co. Ltd., 1993.

REFERENCES

1. Leland B. Jackson, *Digital Filters and Signal Processing***,** 3rd ed., Kluwer Academic, 1996.

Session: 2021-22

Biomedical Engineering
MA 75503: Applied Computational Linear Algebra
Syllabus

Course Outcomes:-

CO1: To provide students with a good understanding of the concepts and methods of linear algebra, described in detail in the syllabus.

CO2: To help the students develop the ability to solve problems using linear algebra.

CO3: To connect linear algebra to other fields both within and without mathematics.

CO4: To develop abstract and critical reasoning by studying logical proofs and the axiomatic method as applied to linear algebra.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th	CW	SW	Pr.	
MA-75503	Applied Computational Linear Algebra	4	-	-	4	-	4	70	30	-	-	100

Unit 1. Vector Spaces

Vector spaces, subspaces, linear equations, linear independence and linear dependence, basis and dimension, four fundamental spaces, linear transformation, matrix and representation of linear transformation, null space, range dimension theorem. Solving systems of linear equations, imposing constraints**,** rank of a matrix, representing a linear transformation, the geometry of Euclidean space, dot products.

Unit 2. Orthogonality

Cauchy's inequality, vectorization of a matrix, systems of linear equations, row-reduction, row operations as matrix multiplications, determinants, homogeneous systems of linear equations, real and complex systems of linear equations, determined systems of linear equations, over-determined systems of linear equations, perpendicular vectors and orthogonal subspaces, inner product spaces, projection onto lines, projection, least square approximations, orthogonal bases, orthogonal matrices and gram Schmidt orthonormalization process – Fast Fourier Transforms.

Unit 3 Eigenvalues, Eigenvectors and Positive Definite Matrices

Diagonal form of a matrix, difference equations and the powers, differential equations and the exponential, similarity transformations, minima, maxima and saddle points, test for positive, negative and semi definite and indefinite matrices.

Unit 4 Numerical Solution of Linear System of Equations

Solution of linear system of equations, direct method: Gauss elimination method, pivoting – Gauss-Jordan method, LU decomposition method, Cholesky decomposition method - Iterative methods: Gauss-Jacobi and Gauss-Seidel, SOR Method. 51.

Unit 5 Numerical Solution of Eigenvalue Problems and Generalized Inverses

Eigenvalue problems: power method, inverse power method- Jacobi's rotation method, conjugate gradient method – QR algorithm. Singular value decomposition method, principal-component analysis and the SVD, using the SVD in PCA, the PCA and factor analysis, the MUSIC method, singular values of sparse matrices.

TEXT BOOKS

1. Strang, G., *Linear Algebra and Its Applications*, Thomson (Brooks/Cole), 2005.

2. Faires, J.D. and Burden, R., *Numerical Methods*, Thomson Publications, 2002.

REFERENCES

1. Kumaresan, S., *Linear Algebra – A geometric approach*, Prentice – Hall of India, 2010.

2. Friedberg, A.H., Insel, A.J. and Spence, L., *Linear Algebra*, Prentice - Hall of India, 2004.

Biomedical Engineering
BM 75004: Bio-MEMS

For Students from B.E. Biomedical Engineering

Course Outcomes:-

CO1: To understand fundamental of microsystems engineering.
CO2: Knowledge of micro fabrication and micromachining
CO3: Have experience in design consideration for Bio-MEMS device.
CO4: Understand its applications in field of biomedical devices.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75004	Bio-MEMS	4	-	-	4	-	4	70	30		-	100

Unit. 1 Introduction to Microsystems

Overview of biomedical microsystems technology. Definition - MEMS materials. Laws of scaling, the multi-disciplinary nature of MEMS, and applications of MEMS in biomedical.

Unit. 2 Micro Fabrication and Micromachining

Introduction to micro fabrication, photolithography, crystallography, deposition processes, mask design, wet and dry etching; substrate bonding, silicon based MEMS processes- surface and bulk micromachining, non-silicon micro fabrication- LIGA and SU-8, molding.

Unit. 3 Biomedical Micro Sensors and Micro Actuators

Working principle of micro sensors, micro sensors for biomechanics, chemical bio systems, and electrical bio systems. Micro actuation techniques, micromanipulators, surgical microsystems, micro needles, micro filters, micro valves.

Unit. 4 Biomedical Microsystems

Micro fluidic systems, micro total analysis systems (u-TAS), fluid control components, sample handling, lab-on-a-chip, various therapeutic and diagnostic bio-MEMs device, drug delivery systems, optical biosensors.

Unit. 5 Microsystems Designing and Packaging

Design considerations, mechanical design, process design, case study. Overview of micro assembly, micro assembly processes, and technical challenges in micro assembly, overview and general consideration in micro packaging micro packaging processes, design case study.

TEXT BOOKS

1. Marc J. Madou, *Fundamentals of Micro-fabrication: The Science of Miniaturization Detection*, CRC Press, 2002.
2. Manz and H. Becker, Eds., *Microsystem Technology in Chemistry and Life Science*, Springer, 1998.

REFERENCE BOOKS

1. Tai- ran- Hsu, *MEMS and Microsystems: Design, Manufacture, and Nano scale Engineering*, Wiley, 2008.
2. A Sadana, *Engineering Biosensors: Kinetics and Design Applications*, Academic Press, 2001.

Biomedical Engineering
BM 75204: Biomaterials: Design and Application
Syllabus

Course Outcomes:-

CO1: To understand the classes of biomaterials used.
CO2: To get an introduction to host reactions to biomaterials.
CO3: To have knowledge of biomaterial design applications.
CO4: To get aware to the various implantation techniques.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75204	Biomaterial: Design and Application	4	-	-	4	-	4	70	30		-	100

Unit. 1 Introduction

Classes of materials used in medicine: metals, polymers, FRPs, fabrics, nano-composites, bio resorbable and bio-erodible materials, ceramics, glasses.

Unit. 2 Host Reactions to Biomaterials

Host reactions to biomaterials: biocompatibility, implant associated infection.

Unit. 3 Testing of Biomaterials

In vitro assessment, in vivo assessment, blood materials interactions.

Unit. 4 Design of Materials for Biomedical Application

Cardiovascular, dental implants, orthopedic application, skin, ophthalmologic, applications, wound healing, sutures.

Unit. 5 Practical Consideration

Implantation techniques for soft tissue and hard tissue replacements. Problems and possible solutions in implant fixation. Failure analysis of medical devices and implants.

TEXT BOOKS

1. S Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, *Biomaterials Science: An Introduction to Materials in Medicine*, Academic Press, 2004.
2. J.B. Park and J.D. Bronzino, *Biomaterials: Principles and Applications*. CRC Press, 2002.

REFERENCE BOOKS

1. T. M. Wright, and S. B. Goodman, *Implant Wear in Total Joint Replacement: Clinical and Biologic Issues, Material and Design Considerations*, American Academy of Orthopaedic Surgeons, 2001.
2. L Ambrosio, *Biomedical composites*, Woodhead Publishing Limited, UK, 2009.

Biomedical Engineering
BM-75002: Bio Sensors & Instrumentation
Syllabus

Course Outcomes:-

CO1: To make the student acquire an adequate knowledge of the physiological systems of the human body and relate them to the parameters that have clinical importance.
CO2: Identify to describe how bio specific interaction is used for various applications.
CO3: To describe the most common sensor principles used today, such as electric, optical, and mechanic.
CO4: To compare different techniques with emphasis on sensitivity and selectivity.
CO5: To provide awareness of electrical safety of medical equipment's.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75002	Bio Sensors & Instrumentation	4	-	-	4	-	4	70	30		-	100

Unit. 1 Electrophysiological Measurements

Resting and action potential, Nernst and GHK potentials. Basic block diagram of biomedical instruments, instrumentation amplifier, electrodes tissue interface, skin contact impedance, sensor design and characteristics for measurement of bio-signals - ECG, EMG, EEG.

Unit. 2 Measurement of Blood Pressure

Cardiac output, heart rate, heart sound, pulmonary function measurements, spirometer, photo plethysmography, body plethysmography, blood gas analyzers, pH of blood, measurement of blood pCO2, pO2 - pulse oximeter.

Unit. 3 Introduction of Biosensors

Introduction of biosensors, classification of biosensors, sensor characteristics. Different transduction mechanism in biosensor, electrochemical, optical, enzymatic, immune, DNA biosensors. Applications of biosensors. Analytical modeling of biosensors.

Unit. 4 Medical Imaging Systems

X-Ray, computed tomography and MRI. Biomedical telemetry**.**

Unit. 5 Electrical Hazards & their Prevention

Physiological effects of electrical currents, preventive measures to reduce shock hazards, leakage current, isolation of patient circuit, open ground problems and earthing methods.

TEXT BOOKS

1. John G Webster, *Medical Instrumentation - Application and Design*, Wiley, 2009.
2. Marks, Robert S, *Handbook of Biosensors and Biochips*, John Wiley, 2007.
3. R.S.C. Cobbold, *Transducers for Biomedical Measurements: Principles and Applications*. Wiley, 1974.

REFERENCE BOOKS

1. Donald G. Buerk, Lancaster, *Biosensors: Theory and Applications*, CRC Press, 1995.

Biomedical Engineering
BM 75501: Bio-Statistics
Syllabus

Course Outcomes:-

CO1: Introduction to measurement & descriptive statistics in medical practices.
CO2: Get familiar with statistics software.
CO3: Knowledge of regression & correlation.
CO4: Understand basics of sampling.
CO5: Study of Hypothesis testing.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75501	Biostatistics	4	-	-	4	-	4	70	30			100

Unit. 1 Measurements and Descriptive Statistics in Medical Research and Practice

Data types and scales of measurement: continuous vs. enumeration data, sampling distributions - normal distribution (continuous data), binomial distribution (proportions, based on enumeration data), measures of central tendency-mean, median, mode, measures of variability-standard deviation and standard error.

Unit. 2 Introduction to R - Software for Statistical Computing

Basics of R programming, data entry and exporting data, grouping, loops and conditional execution, functions. Summary statistics, graphics in R, probability and distribution

Unit. 3 Sampling

Concept of a source population, random sampling, estimation of population statistics, standard error of a sample mean and of a proportion, and their differences, confidence intervals

Unit.4 Inference and Hypothesis Testing

Hypothesis generation, null hypothesis, Type I and II errors, statistical power, interpretation of P-values and confidence intervals, statistical and clinical significance. Comparing 2 or more groups: Comparing means of two populations with the t-test (continuous data), comparing proportions of responders in two populations (enumeration data), Chi square with corrections (goodness of fit, test of independence). One - Way ANOVA: F distribution test.

Unit.5 Regression and Correlation

Simple, partial and multiple correlation, simple linear /nonlinear regression, introduction to data mining for patterns, analytics.

TEXT BOOKS

1. Rao S, *Introduction to Biostatistics and Research Methods*, PHI, 2012.
2. Chad L., C. Wayne, W. Daniel, *Biostatistics: Basic Concepts and Methodology for the Health Sciences*, Wiley, 2014.

REFERENCES

1. B.K Mahajan, *Methods in Biostatistics*, Jaypee Brothers, 2010.

Biomedical Engineering
BM 75703: Computer Vision and Machine Learning
Syllabus

Course Outcomes:-

CO1: **To** introduce student to computer vision algorithms.
CO2: To introduce mechanisms used in biological visual systems that inspire design of artificial unit.
CO3: Introduction to techniques of image segmentation.
CO4: Various techniques for image representation.
CO5: To introduce principles of motion analysis and object recognition.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75703	Computer Vision and Machine Learning	4	-	-	4	-	4	70	30	-	-	100

Unit. 1 Digital Image Formation, Depth Estimation and Multi-Camera Views

Fundamentals of image formation, transformation: orthogonal, Euclidean, affine, projective, etc; Fourier transform, convolution and filtering, image enhancement, restoration, histogram processing. Perspective, binocular stereopsis: camera and epipolar geometry; homography, rectification, direct linear transform, random sample consensus **(**RANSAC**)**, 3-D reconstruction framework; auto-calibration.

Unit. 2 Feature Extraction

Edges - Canny, Laplacian of Gaussian, difference of Gaussian; line detectors (Hough Transform), corners - Harris and Hessian Affine, orientation histogram, scale invariant feature transform, SURF, histogram of oriented gradients scale-space analysis- image pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Unit. 3 Image Segmentation

Region growing, edge based approaches to segmentation, graph-cut, mean-shift, MRFs, texture segmentation; object detection.

Unit. 4 Shape Representation

Deformable curves and surfaces, snakes and active contours, level set representations, Fourier and wavelet descriptors, medial representations, multiresolution analysis.

Unit. 5 Object Recognition and Motion Analysis

Shape correspondence and shape matching, principal component analysis, shape priors for recognition background subtraction and modeling, optical flow, KLT, spatio-temporal analysis, dynamic stereo; motion parameter estimation.

TEXT BOOKS

1. Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer-Verlag, 2011.
2. D. A. Forsyth, J. Ponce, *Computer Vision: A Modern Approach*, Pearson Education, 2003.

REFERENCES

1. H Richard, Z Andrew, *Multiple View Geometry in Computer Vision*, Cambridge Press, 2003.
2. R.C. Gonzalez and R.E. Woods, *Digital Image Processing*, Addison- Wesley, 1992

Biomedical Engineering
BM 75502: Embedded Systems
Syllabus

Course Outcomes:-

CO1: Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.

CO2: Become aware of the architecture of the ATOM processor and its programming aspects (assembly Level).

CO3: Design real time embedded systems using the concepts of RTOS.

CO4: Analyse various examples of embedded systems based on ATOM processor.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75502	Embedded Systems	4	-	-	4	-	-	70	30	-	-	100

Introduction to Embedded Systems

Difference between general purpose systems and embedded systems, review of fundamentals of CPU, memory and I/O – performance evaluation – instruction set principles – design issues, example architectures, instruction level parallelism, pipelining and handling hazards

Unit. 1 Programming Embedded Systems

Embedded program, role of infinite loop, compiling, linking and locating, downloading and debugging, emulators and simulators processor, external peripherals, memory testing, flash memory, role of device drivers, device driver designing.

Unit.3 Operating Systems

Operating system basics, process creation. inter process communication, virtual memory, embedded operating system, real time characteristics, selection process, RTOS, tasks and task states, semaphores, shared data – message queues, mail boxes and pipes, memory management, hard real-time scheduling

Unit.4 Hardware Fundamentals

Various electrical components- relay, motors (stepper, dc, servomotor), basic electronic components-counters, timers, driver ICs, switches, A/D conversion, communication basics-importance of baud rate, protocols and their meaning.

Unit 5 Embedded Software Development Tools

Host and target machines, linkers / locators for embedded software, debugging techniques – instruction set, simulators laboratory tools, practical example – source code.

TEXT BOOKS

1. Daniel W.Lewis, *Fundamentals of embedded software where C and assembly meet*, Pearson Education., 2001.
2. F Vahid, T Giogarvis, *Embedded systems: A unified hardware/software approach*, Wiley, 1999.
3. Raj Kamal, *Embedded Systems Introduction*, 2nd Ed., TMH publication, 2015.

REFERENCES

1. David E Simons, *An Embedded Software Primer*, Pearson, 1999

1. .

Biomedical Engineering
BM-75451: Electronic System Design
Syllabus

Course Outcomes:-

CO1: Learn about circuit analysis and synthesis.
CO2: Hardware and software for data acquisition.
CO3: Basics of op amp based circuits.
CO4: Design and development of biomedical based project.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75451	Electronic System Design Laboratory	4	-	-	4	-	4	70	30		-	100

Unit. 1 Detailed study of CRO.
Unit. 2 Detailed study of DSO.
Unit. 3 Op-amp based experiments list:

a. Characterization of op-amp: To measure the input bias current, input offset current, input offset voltage, input and output voltage ranges, the slew rate and bandwidth of op - amp.
b. To measure and adjust the offset of an amplifier, measure its bandwidth and see how its performance is limited by its slew rate.
c. To design and realize inverting, non-inverting and buffer amplifier using 741 op-amp
d. To design and realize op-amp based filters, integrators and differentiator.

Unit. 4 PCB layout design using CAD.
Unit. 5 Biomedical based project.

TEXT BOOKS

1. Gary Johnson, *Lab-VIEW Graphical Programming*, Second edition, McGraw Hill, 1997.
2. Lisa K. wells & Jeffrey Travis, *Lab-VIEW for everyone*, Prentice Hall, 1997.
3. Kevin James, *PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control*, Newness, 2000.

REFERENCE BOOKS

1. Peter W. Gofton, *Understanding Serial Communications*, Sybex International
2. Robert H. Bishop, *Learning with Lab-view*, Prentice Hall, 2003.

Biomedical Engineering
BM 75851: Finite Element Method
Syllabus

Course Outcomes:-

CO1: To learn basic principles of finite element analysis procedure
CO2: To learn the characteristics of finite elements that represent engineering structures.
CO3: To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75851	Finite Element Method	-	-	4	-	4	4	-	-	40	60	100

Unit. 1 Introduction to Hyper-mesh
Unit. 2 Construction and analysis of 3-D Model of teeth.
Unit. 3 Construction and analysis of 3-D Model of hip Joint.
Unit. 4 Construction and analysis of 3-D Model of bone.
Unit. 5 Construction and analysis of 3-D Model of spinal section.

REFERENCES

1. G.R. Liu, *The Finite Element Method: A Practical Courses*, Elsevier, 2013.

Session: 2021-22

Biomedical Engineering
BM 75704: Mechatronics

Course Outcomes:-

CO1: To develop understanding of basics of mechatronics.
CO2: Familiarity with various types of drives used in automated systems.
CO3: To understand hydraulics and mechanical design.
CO4: To understand industrial and medical robotics.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th	CW	SW	Pr.	
BM 75704	Mechatronics	4	-	-	4	-	4	70	30	-	-	100

Unit. 1 Introduction

Definition of mechatronics, mechatronics in manufacturing, products, and design. Comparison between traditional and mechatronics approach, review of fundamentals of electronics. Data conversion devices, sensors, micro-sensors, transducers, signal processing devices, relays, contactors and timers, microprocessors controllers and PLCs.

Unit. 2 Design of Hydraulic Systems

Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, and pumps. Design of hydraulic circuits. Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

Unit. 3 Design of Mechanical Element

The phases of design, design considerations, codes and standards, optimum design process, design variables, cost functions, design constraints, optimum design. Springs, rolling contact bearing, journal bearing, spur and helical gear, bevel and worm gears, shafts, axes and spindles, flexible mechanical elements, belts, timing belts, chain and sprocket, flexible shafts, brakes, clutches, cams, four bar mechanism.

Unit. 4 Simulation Techniques

Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation by finite element method, transfer function and frequency response, non-parametric methods, transient, correlation, frequency, Fourier and spectra analysis, design of identification experiments, choice of model structure, scaling, numeric methods, validation, methods of lumped element simulation, modelling of sensors and actuators, hardware in the loop simulation (HIL), rapid controller prototyping, coupling of simulation tools, simulation of systems in software (MATLAB, LabVIEW) environment.

Unit. 5 Industrial and Medical Robotics

Application in manufacturing processes, e.g. casting, welding, painting, machining, heat treatment and nuclear power stations, etc., medical robots: image guided surgical robots, radiotherapy, cancer treatment, etc.

TEXT BOOKS

1. HMT, Mechatronics, Tata McGraw-Hill, 1988.
2. T.O. Boucher, *Computer Automation in Manufacturing - An Introduction*, Chappman and Hall, 1996.

REFERENCES

1. Musa Jouaneh, *Fundamentals of Mechatronics*, 1st Edition, Cengage Learning, 2012.
2. V. Giurgiutiu and S. Lyshevski, *Micromechatronics, Modeling, Analysis, and Design with MATLAB*, CRC Press, 2009.
3. D. Patranabis, *Principles of Industrial Instrumentation*, Tata McGraw-Hill, 2008.

Biomedical Engineering
BM-75003: Medical Imaging Systems
Syllabus

Course Outcomes:-

CO1: This course aims to provide an introduction to the physics and engineering of tomographic imaging devices.

CO2: Compare and contrast the benefits and limitations of different tomographic modalities.

CO3: Introduction to the mathematical, physical and computational principles underlying modern imaging techniques.

CO4: To understand electronics and other hardware used in imaging modalities.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75003	Medical Imaging Systems	4	-	-	4	-	4	70	30		-	100

Unit. 1 Radiographic Imaging

Physics of radiography, introduction, instrumentation, X-ray tubes, filtration and restriction, compensation filters & contrast agents, grids, airgaps & scanning slits, film-screen detector, X-ray image intensifiers, image formation, noise and scattering, filters, fundaments of active filters.

Unit. 2 Computed Tomography

Introduction, CT instrumentation, image formation, parallel ray reconstruction, fan-beam reconstruction, helical CT reconstruction, cone beam reconstruction, image quality in CT, OCT-introduction, instrumentation, OCT imaging technique, OCT image formation and reconstruction

Unit. 3 Magnetic Resonance Imaging

Nuclear magnetic resonance (NMR), magnetic resonance imaging (MRI). Spatial localization, K-space, basic MRI techniques, signal and noise in MRI, fast MRI techniques, magnetic resonance spectroscopy, RF receive coil array, conductor less signal transmission, possible implementations.

Unit. 4 Ultrasound Imaging

Physics of ultrasound, ultrasound imaging principles, instrumentation for diagnostic ultrasound, ultrasound scanning, understanding ultrasound images, ultrasound beam formation, and ultrasound transmit/receive cycle, imaging techniques, transducers characteristics, and ultrasound imaging modes, steering and focusing.

Unit. 5 Nuclear Medicine

Introduction, nuclear medicine imaging, radioactive decay, modes of decay, radiotracers, detection systems, clinical SPECT & PET principles of operation, SPECT & PET-instrumentation, image formation, image quality in SPECT and PET.

TEXT BOOKS

1. Jerry L. Prince, Jonathan M. Links, *Medical Imaging Signals and Systems*, PHI, 2010.
2. Krzystof Iniewski, *Medical Imaging Principles Detectors and Electronics*, Wiley, 2009.
3. Gengsheng Lawrence Zeng, *Medical Image: Reconstruction A Conceptual Tutorial*, Springer, 2010.

REFERENCE BOOKS

1. Kavita Garg et al., *Practical Differential Diagnosis for CT and MRI*, Thelme, 2008.
2. Pablo R et al.., *Learning Diagnostic Imaging: 100 Essential Cases*, Paperback.
3. Govind Chavhan, Bhavin Jankharia, *Cross Sectional Anatomy CT & MRI*, 1st Edition.

Biomedical Engineering
BM 75852: Modeling & Simulation
Syllabus

Course Outcomes:-

CO1: To review background information required for studying virtual instrumentation.
CO2: To study the basic building blocks of simulation.
CO3: To study a few applications of physiological molding.
CO4: An ability to design and conduct experiments, as well as to analyse and interpret results.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75852	Modeling and Simulation	-	-	4	-	4	4	-	-	40	60	100

Unit. 1 Introduction to Simulation

Basics of modelling and simulation. Need of simulation.

Unit. 2 Basic Blocks of Simulink

Closed loop control system, integrators and derivatives, time response of second order system

Unit. 3 Physiological Modeling 1

Linear model of respiratory mechanics, linear model of muscle mechanics, steady –state analysis of the muscle reflex model. Regulation of glucose and insulin model, neuromuscular reflex model.

Unit. 4 Physiological Modeling 2

To determine the study-state operating point of ventilator control system, pupillary light reflex model.

Unit. 5 Designing and analysis of any physiological model.

TEXT BOOK

1. M.C. KHOO, *Physiological Control Systems: Analysis, Simulation and Estimation*, Wiley, 1999.

REFERENCES

1. Mark L, David A., *Learning Python*, Shroff, 2009.

Biomedical Engineering
BM 75203: Neural Network and Fuzzy Logic
Syllabus

Course Outcomes:-

CO1: Provide knowledge of supervised and unsupervised learning in neural networks.
CO2: Provide knowledge of computation and dynamical systems using neural networks.
CO3: Provide hands-on experience in selected applications.
CO4: Understand the role of neural networks and fuzzy logic in engineering, artificial intelligence, and cognitive modelling.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75203	Neural Network and Fuzzy Logic	4	-	-	4	-	4	70	30		-	100

Unit. 1 Feed Forward Networks

Structure and function of a single neuron: Biological neuron, artificial neuron, definition of ANN, single layer network, learning and adaptation, Mc Cullloh Pitt's neuron model, neural network learning rules- perceptron training algorithm, linear separability, Widro & Hebb's learning rule/Delta rule, ADALINE, MADALINE, AI vs. ANN.

Unit. 2 Feedback Networks

Generalized delta learning rule; delta learning rule for multi-layer perceptron. Learning factors, the back propagation algorithm single layer feedback networks: basic concept of dynamic networks, the Hopfield network both discrete and gradient forms.

Unit. 3 Other Networks

Associative memory: linear associator, recurrent associative memory, bidirectional associative memory matching and self-associating networks: Hamming net and Max net, unsupervised learning of clusters, counter propagation network, feature mapping, self-organizing feature maps, ART 1.

Unit. 4 Basics of Fuzzy Sets

Basic concepts of fuzzy sets, fuzzy logic, operations on fuzzy sets, fuzzy relations, equivalence and similarity relations, ordering, morphisms, fuzzy relation equations, fuzzy measures.

Unit. 5 Uncertainty Based Information

Probability measures, possibility and necessity measures, measures of uncertainty, dissonance, confusion and non-specificity. Principles of uncertainty and information, applications of fuzzy sets in management, decision making, computer science and systems science.

TEXT BOOKS

1. Dr. R.P. Das and L. Sreedhar, *Neural Networks and Fuzzy Logic*, S.K. Kataria & Sons, 2012.
2. Sushil Kumar Singh, *Soft Computing: Neural Networks, Fuzzy Logic and Genetic Algorithms*, Galgotia, 2012.

REFERENCE BOOKS

1. Vinoth Kumar and R. Saravana Kumar, *Neural Networks and Fuzzy Logic*, S.K. Kateria & Sons, 2012.
2. Chennakesava R. Alavala, *Fuzzy Logic and Neural Networks: Basic Concepts & Applications*, New Age, 2008.
3. Bhaska, *Neural Networks and Fuzzy Logic*, BS Publication, 2011.

Biomedical Engineering
BM 75001: Physiology For Engineers
Syllabus

Course Outcomes:-

CO1: Knowledge about cellular structure, tissues organs, blood.
CO2: Understand the cardiovascular & respiratory systems.
CO3: Get familiar with gastrointestinal and renal system.
CO4: Understand basics of nervous system
CO5: Clinical and technological implications.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM 75001	Physiology for Engineers	4	-	-	4	-	4	70	30		-	100

Unit. 1 Basic Cell Physiology

Anatomy nomenclature, introduction to cellular-sub-cellular structure and function, extra cellular matrix, physiology of membrane transport: basic structure and function, osmosis and its implication. Neuromuscular transmission and muscle contraction mechanism (including skeletal, cardiac and smooth muscle characteristics).

Unit. 2 Blood, Lymphatic and other Body-Fluids

Basic structure function, circulation and interrelation with other systems. Red blood cells and oxygen transport, white blood cells their types and role in immunity, platelets and coagulation, blood groups and blood typing, blood pressure measurement.

Unit. 3 Cardiovascular and Respiratory System

Cardiovascular: Basic structure function, circulation, heart valves, prosthetic valves, cardiac cycle, heart sounds and electrical activity of heart with basic ECG interpretation. Respiratory: - basic structure function, mechanism of breathing, principle of gas exchange: - lung volumes and capacities. Various implications: - nitrogen narcosis, asthma and aerosol, lung surfactant.

Unit. 4 Gastrointestinal and Renal System

Salivary secretion, GI tract, stomach, lever, large & small intestine pancreas interaction with other systems. Renal system: - basic structure and function, nephron hemodynamics, clearance and regional transport, acid-base disturbance.

Unit. 5. Nervous system and Special Senses

Nervous system: Structure of neuron and nerve fibre, synapse, autonomic nervous system. Central nervous system: - parts of brain& their functions, spinal cord-reflex mechanism sympathetic and parasympathetic nervous system.

Special senses: Organs of vision, hearing, taste & smell. Mechanism of vision, color vision, mechanism of hearing, sense of taste, sense of smell, tests of hearing, audiometry.

TEXT BOOKS

1. Guyton and Hall, *Textbook of Medical Physiology Book*, Elsevier Health Science, 1994.
2. W.F Ganong, *Review of Medical Physiology*, McGraw Hill, 2012.

REFERENCES

1. Chappel Michael, *Physiology for Engineers*, Springer, 2015.

Biomedical Engineering
BM 75202: Rehabilitation and Prosthetics
Syllabus

Course Outcomes:-

CO1: To develop a strong "systems" understanding of the continuum of care for clinical rehabilitation, including from the context of optimizing outcomes.

CO2: To understand key aspects of sensorimotor systems as related to human performance and design/evaluation of human-technology interfaces.

CO3: To gain significant conceptual understanding of approaches for breaking down access barriers, and hands-on experience in using modern telecommunications technologies, especially in the context of access technologies, tele-rehabilitation and the roles of consensus standards.

CO4: To understand some basic principles and applications of biomechanics to rehab devices and interfaces.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75202	Rehabilitation and Prosthetics	4	-	-	4	-	4	70	30		-	100

Unit. 1 Clinical Rehabilitation Science & Engineering: Principles, Terminology & Models

Rehabilitative science foundations: healing biodynamic at the cell-tissue-organ-person levels, and understanding effects of interventions, existing infrastructure for the field of clinical rehabilitation and physical medicine, consensus terminology and models for the rehabilitation/disability field, clinical rehab engineering and the human activity / assistive technology (HAAT) model, rehabilitative continuum of care as a optimization problem, concepts in tele-access within the context of continuum of care**.**

Unit. 2 Sensorimotor Systems and Human Performance Assessment

Conceptual models of human performance and interface design, terminology and approaches in rehabilitation and ergonomics, basics of sensorimotor control (feed-back, feed-forward), components of sensory performance and relation to technology, vision, gaze and video codes, resolution and sampling, hearing, speaking and audio codecs, frequency content, volume, reflexes, spasticity, positioning and measurement sampling, arms, reaching, tracking and robotic manipulators, hands, grasping, manipulation and computer interface devices, example: virtual reality/environments. Tools for integrative task analysis: approaches to task analysis in rehabilitation, relation to fields of ergonomics and usability engineering.

Unit. 3 Access Engineering: Accessible Interfaces and Tele-rehabilitation

Foundations: access to information and services through accessible interfaces and telecommunications, accessible design regulations related to section 508 of rehab act, accessible design and universal design, universal access concepts, accessibility guidance for medical devices, models for tele-rehabilitation, optimization modeling framework.

Unit. 4 Rehab Biomechanics of Devices and Interfaces

Brief overview of biomechanics behind mobility and manipulation technologies, statics, solids, materials, kinematics, dynamics, principles of bi-causal mechanical interfaces, seated mobility devices, wheelchair considerations, seating considerations, device assisting manipulation tasks, concept of extended physiological proprioception (EPP), upper extremity prosthetics: body-powered, upper extremity prosthetics: externally-powered.

Unit. 5 Neuro-rehabilitation: Innovation in Therapeutic Strategies

Model of rehabilitation plan of care (e.g. neurorehab from traumatic event), conceptual framework: diagnosis, prognosis, intervention, assessment, outcomes. conventional approaches to diagnosis, intervention and outcomes assessment, patient records (paper, electronic), scales ("instruments" "forms" "measures") - by trained observer and/or self-report, objective (sensor-

based) measures (not common, but examples from PT, speech, gait), innovative approaches in neurorehab, classification: assessment, intervention/therapy, activity monitoring (e.g., wearable)**.**

TEXT BOOKS

1. Rory A Cooper, Hisaichi Ohnabe, Douglas A. Hobson, *An Introduction to Rehabilitation Engineering***,** CRC, 2006.

REFERENCE BOOKS

1. Raymond V. Smith, John H. Leslie Jr, *Rehabilitation Engineering*, CRC press, 1990.

Biomedical Engineering
BM 75452: Virtual Instrumentation

Course Outcomes:-

CO1: To review background information required for studying virtual instrumentation.
CO2: To study the basic building blocks of virtual instrumentation
CO3: To study the various techniques of interfacing of external instruments of PC.
CO4: To study the various graphical programming environment in virtual instrumentation.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-75452	Virtual Instrumentation	-	-	4	-	4	4	-	-	40	60	100

Unit. 1 Introduction to Virtual Instrumentation

Virtual instrumentation, history of VI, architecture of virtual instrumentation, conventional and graphical programming, distrubuted systems, and advantage of PC based medical instruments. Introduction to bioelectric signals.

Unit. 2 Application Development Software

Basics of LabVIEW, for and while loops, structures, arrays and clusters, graphs and charts, file i/o- sample VI's to demonstrate file i/o- string handling, configuring external instrument with PC.

Unit. 3 Basics of Data Acquisition

Hardware/Analog interfacing, practical vs ideal interfacing. Building GUI for use in data acquisition.

Unit. 4 Signal Sampling Fundamentals for Data acquisition

Acquisition of general waveforms and bio-signals, Fourier and Fast Fourier transform, wavelet transform, correlation (windowing and filtering tools).

Unit. 5 Medical Applications of VI

Data acquisition with Lab View, VI based temperature monitoring system, cardiac monitor (ECG), Biobench - A virtual instrument application for data acquisition and analysis of physiological signal (ECG).

TEXT BOOKS

1. Gary Johnson, *Lab-VIEW Graphical Programming*, Second edition, McGraw Hill.
2. Lisa K. wells & Jeffrey Travis, *LabVIEW for everyone*, Prentice Hall, 1997.
3. Kevin James, *PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control*, Newnes, 2000.

REFERENCE BOOKS

1. Robert H. Bishop, *Learning with Lab-view*, Prentice Hall, 2003.
2. Peter W. Gofton, *Understanding Serial Communications*, Sybex International, 1994.