Session 2018-19
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 the 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: 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

Cell membrane, Nernst equation, resting and action potential, electrical activity of muscles, electrical activity of the heart and brain. 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.

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 2018-19
Semester A- Syllabus

Biomedical Engineering

B.E. IInd Year

BM- 29003: Human Anatomy and Physiology

Course Outcomes:-

CO1: Introduction to cell cytology & physiology of human skeletal systems
CO2: Introduction to blood along with its properties & functions, determination of blood groups.
CO3: Introduction to cardiovascular system & associated diseases.
CO4: Introduction to nervous system along with its functioning and anatomical features.
CO5: Study of human respiratory and renal system & its mechanism.

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 Special Organs and Endocrine Glands

Eyes-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 2018-19
Semester A- Syllabus

Biomedical Engineering

B.E. IInd Year

MA- 29024: Mathematics- III

Course Outcomes:-

CO1: Modeling 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.	CW	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 2018-19
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 2018-19
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 2018-19
Semester A- Syllabus

Biomedical Engineering

B.E. IInd Year

OC-I: Health Care technology

Course Outcomes:-

CO1: Introduction of various aspects of healthcare.
CO2: Knowledge of various factors affecting healthcare.
CO3: Knowledge of various practices used in healthcare.
CO4: Introduction to medical terms.
CO5: Understanding of medical ethics and hygiene.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
OC-I	Open Category (Audit Only)	-	-	-	-	-	-	-	-	-	-	-

Unit. 1 Introduction

Health care technology and human history, meaning of technology, benefits of modern health and medical technology, technology and population health, evidence of the impact of health care technology on health.

Unit. 2 Creation, Diffusion and Evaluation of Technology

Sources of technology, development of new technology in health care, factors that influence the uptake of new technology, controlling the uptake of technology, evaluating technology.

Unit. 3 Introduction to Common Medical Tests

Types of tests, risks and results, the "laboratory testing cycle", questions to ask before ordering a laboratory test, reasons for ordering a laboratory test, CBC, BMP, CMP, serum iron tests, serum vitamin assays, liver function tests, kidney function tests, thyroid function tests, sexually transmitted disease (STD) blood tests, various vaccination schedules.

Unit. 4 Health Care Technology Assessment

Purposes of HCTA, basic HCTA orientations, types of organizations that conduct HCTA, expertise for conducting HCTA, selected issues in HCTA, quality of care and HCTA, outcomes research and HCTA, decentralization of HCTA, barriers to HCTA, underused technologies, and ten basic steps of HCTA.

Unit. 5 Ethical, Legal, Social, and Political Issues

Ethical, Legal, Social, and Political Issues, various aspects of public health and hygiene, personal hygiene, definition of health, code of conduct in clinics, information of epidemiology.

TEXT BOOKS

1. Louise M Simmers, *Introduction to healthcare technology*, 2nd ed., Cenage Publications, 2008.
2. Mark Revels, Mark D. Clampa, *Introduction to Healthcare Information Technology*, Cengage Learning, 2012.

REFERENCES

1. B.M. Sakharkar, *Principles of Hospital administration and Planning*, 2nd ed., JPB, 2009.

Session 2018-19
Semester B- Syllabus

Biomedical Engineering

B.E. IInd Year

EI 27002: 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 BOOKS

1. A.K. Sawhney, *Electrical & Electronic Measurement & Instrumentation*, Dhanpat Rai, 2015.

REFERENCES

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

Session 2018-19
Semester B- Syllabus

Biomedical Engineering

B.E. IInd Year

EC- 29562: 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	Digital Electronics	3	1	2	4	1	5	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 2018-19
Semester B- Syllabus

Biomedical Engineering

B.E. IInd Year

BM- 29551: Analog Electronics

Course Outcomes:-

CO1: Basic knowledge of BJT, small signal amplifiers.
CO2: To understand concept of power amplifiers, and regulated power supplies.
CO3: Knowledge of tuned amplifier circuits for audio & video.
CO4: To understand basic concept of feedback and circuit utilizing the same.
CO5: Knowledge of OP-AMP and different application circuits.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-29551	Analog Electronics	3	-	2	3	1	5	70	30	40	60	200

Unit. 1 Frequency Response of BJT Amplifiers

Review of analysis of single stage amplifiers using BJT and FET. Small-signal high-frequency hybrid-π model of a BJT, amplifier transfer function – low-frequency, mid, and high-frequency bands. General expressions for the low frequency and high frequency responses, power supplies.

Unit. 2 Power Amplifiers and Regulated Power Supplies

Classification of power amplifiers, transfer characteristics, power dissipation, power conversion efficiency of class A and B output stages. Cross-over distortion and its reduction. Class AB output stage – transfer characteristics, biasing circuits. Short-circuit protection of output stages. 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, current regulators.

Unit. 3 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. Analysis & design of class C amplifiers.

Unit. 4 Feedback Amplifiers

Feedback concept, characteristics of negative and positive feedback. Effect of negative and positive feedback on input impedance, output impedance, gain, and noise and frequency response. Different negative feedback topologies: series- shunt, series-series, shunt-shunt and shunt-series configurations. Derivation of input resistance, output resistance and closed-loop gain of the above for both the ideal and practical amplifiers. Gain and Phase-margins. Frequency compensation. Oscillators: classification of oscillators, frequency and oscillatory circuits, RC phase shift oscillator, Wein bridge oscillator, Hartley oscillator, Colpitt oscillators, crystal oscillator.

Unit. 5 Operational Amplifiers

General configuration and basic stages of an operational amplifier (Op-Amp). Differential amplifier, analysis of differential amplifiers, cascading of differential amplifiers, op- Amp parameters – ideal and practical. Compensated and un-compensated op- amps, application of op-amps in linear and nonlinear circuits.

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.

TEXT BOOKS

1. J. Millman & A. Grabel, *Microelectronics*, Tata McGraw-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 2018-19
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 2018-19
Semester B- Syllabus

Biomedical Engineering

B.E. IInd Year

HU 2X015/2X515: Humanities and Engineering Economics

Course Outcomes:-

CO1: To develop the optimising skills of technology-use in engineering profession through fostering economic and humanitarian analytical skills among engineering students

CO2: To explore the potential of students in economic perspective of engineering professional goals.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
HU – 2X015	Humanities and Engineering Economics	3	-	-	3	-	3	70	30	-	-	100

Unit 1 Role of Humanities in Engineering education, social and ethical values , social institutions and association, social stratification in India, social change, Government –function and organs, parliamentary and presidential system, Democracy Vs dictatorship.

Unit 2 Nature and scope of economics, Economic cyclic flow, Central Economic problems, macro and micro economics, concept, determinants and law of demand and supply, Elasticity of demand.

Unit 3. Production, cost and Revenue: Equilibrium price, Production function, laws of return to variable proportion, Laws of return to scale, cost concepts, cost functions and their inter relations, Revenue Concepts and functions, break-even analysis.

Unit 4. Pricing and Market: Equilibrium of firm and industry. Price determination under perfect competition, monopolistic competition and monopoly. Time value of money and Investment analysis- NPV, IRR, ARR and payback period method.

Unit 5. Environment and economic development: concepts and determinants of economic growth and development, Rostou's stages of economic growth. Sustainable development Environment development relations (Kuznet's Curve)

TEXT BOOKS

1. Pradhan, shekapure and Hiray*, Humanities and social sciences*, Wiley India Pvt. Ltd (2010/latest Ed)

2. Jhingal M.l., *Economics of development and Planning*, Vrinda Publication (40th Ed. /latest).

3. Ahuja H. L., *Advance economic theory*, S Chand Publication, (21st Ed. /Latest)

4. Agrawal R.C., *Principal of Political Science*, S. Chand Publication (5th Ed. /Latest).

Session 2018-19
Semester B- Syllabus

Biomedical Engineering

B.E. IInd Year

OC-II: Yoga for Fitness

Course Outcomes:-

CO1: Understanding the origin and importance of yoga.
CO2: Understanding and practising various types of yoga.
CO3: Understanding and practising naturopathy and mesopathy.
CO4: Practising of various mudras.
CO5: Practising of various mantras.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
OC-II	Open Category (Audit Only)	-	-	-	-	-	-	-	-	-	-	-

Unit. 1 Introduction
Origin of yoga & its brief development, meaning of yoga & its importance, yoga as a science of art (Yoga Philosophy).

Unit. 2 Classification of Yoga
Types of yoga, hatha yoga, raja yoga, laya yoga, bhakti yoga, gyan yoga, karma yoga, asthang yoga.

Unit. 3 Principles of Yogic Practices
Meaning of asana, its types and principles, meaning of pranayama, its types and principles. Meaning of kriya its types and principles.

Unit. 4 Yogic Therapies and Modern Concept of Yoga
Naturopathy, hydrotherapy, electrotherapy, messotherapy, acupressure, acupuncture.

Unit. 5 Meaning and Importance of Prayer
Meaning of meditation and its types and principles, psychology of mantras. Different mudras during prayers.

TEXT BOOKS

1. B. K. S. Iyengar, *The Illustrated Light on Yoga*, Aquarian/Thorsons, 1993.
2. Leslie Kaminoff, *Yoga Anatomy*, 2nd ed., Human Kinetics, 2011.

REFERENCES

1. Erich Schiffmann, *Yoga: The Spirit and Practice of Moving into Stillness,* 1st ed., Pocket Books, 1996.

Session 2018-19
Semester B- Syllabus

Biomedical Engineering

B.E. IInd Year

HU 29499: Skill Development, Innovation and Entrepreneurship

Course Outcomes:-

CO1: Understand innovation, entrepreneurship and its process
CO2: Explain initiatives required for business plan
CO3: Explain myths, values, attitude and competencies of an entrepreneur
CO4: Distinguish between different types of entrepreneurs
CO5: Understand reasons behind success and failure of a business

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
HU 29499	Skill Development, Innovation and Entrepreneurship	-	1	2	1	1	2	-	-	-	50	50

Unit. 1 Entrepreneurship

Entrepreneurship: concept, function and need, Myths about entrepreneurship, Generation of idea and Self-assessment of skills, resources and dreams, Feasibility study and Opportunity assessment, entrepreneurship as a problem solving profession, Risk taking: concept and types of business risks, Barriers to entrepreneurship.

Unit. 2 Entrepreneur

Concept and types of entrepreneur, Mindsets of an entrepreneur and an employee, characteristics and competencies of an entrepreneur, Entrepreneurial values: values, attitude and motivation, Entrepreneurial traits, Gender and entrepreneurship.

Unit. 3 Innovation

Nature of Ideas and Innovation, Incentives for Innovators: Contracting and Control Rights; Secrecy; and Procurement, Innovation Environment, Diffusion of Ideas, Diffusion of Innovations.

Unit. 4 Skill Development

Meaning, Nature of Skill Development, objectives of Skill Development, Importance of Skill Development, Skill Development Initiative Scheme, skill development in context to Creativity, innovation and opportunity finding.

Unit. 5 Entrepreneurship Development

Factors of development of entrepreneurship, Entrepreneurial Motivation, Concept, New forms of business organisation, small cottage and large scale enterprises, social entrepreneurship, start-ups. Resource mobilisation, business ethics and positive value system.

Note: The syllabus will be discussed trough tutorial classes in form of general orientation of the students in order to sensitise the students about entrepreneurship. For this, the students will also be assigned to prepare five case studies. The guidance, monitoring, and evaluation of the progress will be done through practical classes.

Reference books:

1. Nandan H, *Fundamentals of Entrepreneurship*, PHI Publishing house.
2. Raichaudhary Anjan, *Managing New Ventures: Concepts and Cases in Entrepreneurship*, PHI Publishing house.

Session 2018-19
Semester A-Syllabus

Biomedical Engineering

B.E. IIIrd Year

BM-39004: Programming Tools & Techniques

Course Outcomes:-

CO1: Basic knowledge of OOPS principle.
CO2: Introduction to programming and architecture of java.
CO3: To implement database connectivity with GUI.
CO4: To understand various classes in java.
CO5: Introduction to programming in MATLAB & SIMULINK.

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.

Unit. 2 Concept of Objects
State, behavior & identity of an object, classes: identifying classes and candidates for classes, attributes and services, access modifiers, static members of a class, instances, message, construction and destruction of objects, introduction to inheritance, polymorphism, and encapsulation.

Unit. 3 The Evolution of Java
Object-oriented programming concepts and evolution of java, differences between C++ and Java, the primary characteristics of java, architecture, programming with Java, Case studies for medical application.

Unit. 4 JAVA Fundamentals I
Tokens, expressions, data types, declarations, and control flow. Introduction to classes in java, working with objects, packages, inheritance, interfaces. Case studies for medical application.

Unit. 5 Introduction to MATLAB and Simulink
Need of MATLAB, operations and working in MATLAB and its interface to other languages, GUI, standalone files in MATLAB, other compatible tools. Introduction to Simulink and its applications.

PRACTICALS

List of Experiments

1. Java program to define class and instantiate its object
2. Java program to demonstrate casting in Java.
3. Java program to implement single and multidimensions array in java.
4. Java program to define class, define instance methods for setting and retrieving values of instance variable and instantiate its object
5. Java program to define class and its constructor.
6. Java program to define instance method and demonstrate method overloading.
7. Java program to demonstrate use of subclass and nested class.

8. Java program to practice String class and its method.
9. Java program to implement inheritance and demonstrate method overriding.
10. Java program to demonstrate exception handling in java.

TEXT BOOKS

1. Timothy Budd, *An Introduction to Object-Oriented Programming*, 3rd ed., Addison-Wesley Publication, 2002.
2. C.S. Horstmann & C Gary, *Core Java: Volume I, Fundamentals,* 8th ed., Prentice Hall Publication, 2007.
3. Rudra Pratap, *Getting Started with MATLAB*, Oxford University Press, 2002.

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.

Session 2018-19
Semester A-Syllabus

Biomedical Engineering

B.E. III[rd] Year

BM- 39001: Signal and Systems

Course Outcomes:-

CO1: Basic knowledge of different types of signals & systems.
CO2: To understand linear time invariant systems and their mathematical representations.
CO3: To understand Fourier series.
CO4: Knowledge of Fourier transforms of continuous & discrete systems.
CO5: Basic idea of different 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	-	2	3	1	4	70	30	40	60	200

Unit. 1 Introduction to Signals & Systems

Continuous-time and discrete-time signals, transformations of the independent variable, exponential and sinusoidal signals, the unit impulse and unit step functions, continuous-time and discrete-time systems, and basic system properties.

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.

A historical perspective, the response of LTI systems to complex exponentials, Fourier series representation of continuous-time periodic signals, convergence of the Fourier series, 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 The Continuous-Time and Discrete- Time Fourier Transform

Representation of Aperiodic Signals: The continuous-time Fourier transform**,** the Fourier transform for periodic signals, properties of the continuous-time Fourier transform, the convolution property, the multiplication property, tables of Fourier properties and basic Fourier transform pairs, systems characterized by linear constant-coefficient differential equations. The Discrete-Time Fourier Transform**:** The Fourier transform for periodic signals, properties of the discrete-time Fourier transform, the convolution property, the multiplication property, tables of Fourier transform properties and basic Fourier transform pairs, duality, systems characterized by linear constant-coefficient difference equations.

Unit. 5 Laplace and Z - Transform

The Laplace Transform: The region of convergence for Laplace transforms, the inverse Laplace transform, properties of the Laplace transform, some Laplace transform pairs, system function algebra and block diagram representations, the unilateral Laplace transform.
Z-Transform: The region of convergence for the z-transform, the inverse z-transform, properties of the z-transform, some common z-transform pairs.

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

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 2018-19
Semester A-Syllabus

Biomedical Engineering

B.E. III[rd] Year

BM-39003: Biomedical Instrumentation I

Course Outcomes:-

CO1: Introduction of various sources of bioelectric signal & their processing.
CO2: Basic understanding of principles & design of monitoring instruments like ECG, EEG, EMG.
CO3: To describe various fundamentals of recording & diagnostic instruments.
CO4: To study various body chemicals measuring instruments & their calibration.
CO5: To design wearable therapeutic and diagnostic instruments.

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

Unit. 1 Bio-electrodes and Bio-chemical Sensors

Introduction to medical instruments: sources of biomedical signals, general constraints in design of medical instruments, signal conditioning and processing circuits for medical recording systems, recording system for biomedical signals. Electrodes tissue interface, skin contact impedance. Half-cell potential, skin electrode interface, bio-electrodes.

Unit. 2 Bio Amplifier

Bio amplifiers, carrier amplifier, isolation amplifier, differential amplifier, chopper amplifier, instrumentation amplifier, bioelectric signals (ECG, EMG, EEG, EOG & ERG) and their characteristics, Einthoven triangle, ECG machine, EMG machine, EEG machine, heart sound and characteristics, PCG.

Unit. 3 Patient Monitoring Systems and Biotelemetry

Measurement of blood pressure – direct methods and indirect methods, temperature measurement, respiration rate, heart rate measurement, apnea detectors, oximetry- pulse oximeter, ear oximeter, computerized patient monitoring system, biotelemetry.

Unit. 4 Cardiac Measurements and Devices

Cardiac output measuring techniques – Dye dilution method, Thermo dilution method, BP method, blood flow measuring techniques- electromagnetic, ultrasound blood flow meter, laser doppler blood flow meter, cardiac arrhythmias, plethysmography, cardiac pacemakers and defibrillator: AC, and DC types, heart lung machine (HLM), oxygenators.

Unit. 5 Analytical Equipments

Chemical fibro sensors, fluorescence sensors, glucose sensor, blood cell counters, coulter counter, electrical impedance method, optical method, colorimeter, spectro photometer, flame photometer, chromatography, mass spectrometer, electrical hazard – micro and macro- shock, patient safety procedures, pH meter, blood gas analyser.

PRACTICALS

List of Experiments

1. To observe ECG wave forms generated by ECG simulator in different leads configuration.
2. To observe Phonocardiogram waveforms (PCG) of subject (Human body).
3. To measure the systolic and diastolic blood pressure of human heart.
4. To study abnormalities (Tachycardia, Bradycardia) present in Human cardiovascular system using ECG simulator.

5. To study EEG waveforms in unipolar recording and average recording mode.
6. To study EMG waveform generated by built-in EMG Simulator.
7. To measure the respiration-rate of subject (Human body).
8. To understand the transmission and reception of biological signal using a telemetry system.
9. To study 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 2018-19
Semester A-Syllabus

Biomedical Engineering

B.E. III[rd] Year

BM-39005: System Designing with Microcontroller

Course Outcomes:-

CO1: Introduction of various microprocessor families.
CO2: To study various feature of interfacing & peripheral devices.
CO3: Introduction to various data communication schemes.
CO4: Introduction to system architecture of 8051 with its addressing modes.
CO5: Study of operational features of microcontroller for designing monitoring systems for healthcare.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-39005	System Designing with Microcontroller	3	1	2	4	1	5	70	30	40	60	200

Unit. 1 Introduction

Evolution of microprocessor, organization of microcomputer, computers & micro controllers. Different microprocessor families– a comparative study. Architecture: architecture & programming of Intel 8085, addressing modes, instruction set.

Unit. 2 Interfacing Memory and I/O Devices

Memory mapped i/o and i/o mapped i/o, address space partitioning, data transfer-synchronous, asynchronous, interrupt driven etc. Direct memory access data transfer (DMA), serial data transfer.

Unit. 3 The 8051 Architecture

Hardware- oscillator and clock, program counter, data pointer-registers-stack and stack pointer, special function registers, instruction set, addressing modes, memory organization-program memory-data memory, i/o ports, external memory, counter and timer, serial data i/o, interrupts.

Unit. 4 8051 Assembly Language Programming

Structure of assembly language, assembling and running an 8051 program, single bit instructions, timer and counter, serial programming, interrupt programming.

Unit. 5 Programming 8051 Timers using C

Introduction to software IDE, serial port programming, interrupts programming, LCD & keyboard interfacing, ADC, DAC & sensor interfacing, external memory interface, stepper motor and waveform generation.

Application of Microprocessor and Microcontroller in Biomedical:

a. ECG monitoring, EEG monitoring.
b. Temperature, respiratory rate, pulse monitoring etc.

PRACTICALS

List of Experiments

1. Study of 8085 microprocessor kit and its peripherals.
2. Addition of 2 8 bit numbers stored at various memory locations.
3. Subtraction of 2 8 bit numbers stored at various memory locations.
4. Addition of two 16 bit numbers stored at various location.
5. Exchange contents of 2000 and 2001 memory location.

6. Compute 1s complement and 2s complement of given no.
7. To write a program to sort given 'n' numbers in ascending order.
8. To write a program in Keil for 8051 assembly language to ON and OFF LED using switch on port-1.
9. To write a program in Keil for 8051 assembly language to toggle LEDs on port-1.
10. To write a program in Keil for 8051 assembly language for displaying LED patterns on port-1.

TEXT BOOKS

1. R. S. Gaonkar, *Microprocessor Architecture Programming and Application with the 8085/8088*, 6th ed., Penram International Publishing, 2013.
2. Douglas Hall, *Microprocessor & Interfacing*, 2nd ed., Tata McGraw Hill, 1974.

REFERENCES

1. *Microprocessor & Peripheral Handbook*, by Intel Corporation.

Session 2018-19
Semester A-Syllabus

Biomedical Engineering

B.E. IIIrd Year

BM-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	4	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 BOOKS

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 2018-19
Semester A-Syllabus

Biomedical Engineering

B.E. IIIrd Year

OC-III- : Hospital Engineering

Course Outcomes:-

CO1: Introduction to concept of hospital designing.
CO2: To study various factors affecting hospitals architecture and planning.
CO3: Laws and regulations in medical field.
CO4: Introduction to medical jurisprudence.
CO5: Maintenance of biomedical equipments.

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

Unit. 1 Concept of Hospitals

Planning and design of hospital, types of hospitals, various requirements of hospitals, difference between hospital and general office, factors affecting architecture and planning of hospitals, mechanical electrical HVAC design of hospitals, introduction to hierarchy of staff in hospitals, introduction to various departments.

Unit. 2 Design of a Hospital

Mechanical design of hospitals, mechanical system issues, codes issues, architectural constraints, patient care, design of wards, labs and facilities.

Unit. 3 Design of Electrical Systems

Basic electric requirement of hospital, load requirements for healthcare facilities, preliminary design phase (planning) for health care facilities, general electrical distribution systems for health care facilities. The varying need of different departments and power sources in health care facilities.

Unit. 4 Heating, Ventilation and Air Conditioning

HVAC, and air handling systems in general, understanding psychometrics, the dynamics of moist air, chilled beams, testing, balancing and adjusting the HVAC, ductwork, terminal units, room air distribution, dehumidification, room pressurization controls, operating room controls.

Unit. 5 Definition of Biomedical Engineering and Clinical Engineering

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 staff for medical equipment's 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.

TEXT BOOKS

1. Harold E. Smalley, *Hospital Management Engineering – A guide to the improvement of hospital management system*, Prentice Hall, 1982.
2. L. G. Redstone, *Hospital and Health Care Facilities*, McGraw Hill, 2002.

REFERENCES

1. *Maintenance of medical Equipment's*- MP Government guidelines.

Session 2018-19
Semester B -Syllabus

Biomedical Engineering

B.E. IIIrd Year

BM-39503: Biomedical Statistical Signal Processing

Course Outcomes:-

CO1: Introduction to data collection and sampling.
CO2: Define and understand the concept of random variable.
CO3: To understand various distribution and density functions.
CO4: Study of probability theory principle component analysis & independent component analysis.
CO5: Introduction to MATLAB & SIMULINK.

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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	1	-	4	-	4	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, 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. 3 Distributions of Function of Random Variables

Distribution of sum, product and quotient of two variables, reproductive property of standard distributions, $\chi 2$ (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. 4 Statistical Filtering Process

Adaptive filtering: principle and application, steepest descent algorithm convergence characteristics, LMS algorithm, convergence, excess mean square error, application of adaptive filters, RLS algorithm, derivation, matrix inversion, initialization. Finite time estimation of mean value, correlation, synchronous averaging, regression, multiple and partial correlation, one-way and two-way analysis of variance (ANOVA**).**

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 artifacts (low frequency) and power line interference in ECG**,** cancellation of ECG from EMG signal. Introduction to principal component analysis (PCA), Covariance matrix, residuals from PCA, PCA estimations from raw data matrix.

TEXT BOOKS

1. Krzanowski, W.J., *Principles of Multivariate Analysis*, Oxford Univ. Press, 1988.
2. *Statistics Tool Box* with MATLAB.

REFERENCES

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

Session 2018-19
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	-	2	3	1	4	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 Filer
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 Filer
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 2018-19
Semester B-Syllabus

Biomedical Engineering

B.E. IIIrd Year

BM-39504: Biomedical Instrumentation II

Course Outcomes:-

CO1: Study of various types of ventilators and anaesthetic machine.
CO2: To study electrical stimulators as means of therapy and principle of surgical diathermy.
CO3: To study and perform mathematical analysis of techniques used in BMD.
CO4: To study 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 Instrumentation II	3	-	2	3	1	4	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 Equipment's

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, and 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 2018-19
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 2018-19
Semester B-Syllabus

Biomedical Engineering

B.E. IIIrd Year

BM-39502: Analog and Digital Communication

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.	
BM-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 2018-19
Semester B -Syllabus

Biomedical Engineering

B.E. IIIrd Year

OC-IV: Biomaterials

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 bio compatibility 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-IV	Biomaterial	-	-	-	-	-	-	-	-	-	-	-

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 2018-19
Semester A- Syllabus

Biomedical Engineering

B.E. IVth Year

BM-49006: Modeling and Simulation of Physiological Systems

Course Outcomes:-

CO1: Introduction to physiological control system and develop understanding of physiological system.
CO2: Study of cardio vascular and pulmonary system, its mechanics, modeling and simulation.
CO3: To understand the interaction of pulmonary and cardio vascular model. Software based model development.
CO4: Study of steady state analysis of muscle stretch reflex action.
CO5: Study the physiological activities taking place in controlling specific physiological parameter.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-49006	Modelling and Simulation of Physiological Systems	4	-	2	3	1	4	70	30	40	60	200

Unit. 1 Introduction to Physiological Control Systems

Difference between engineering and physiological control systems, modeling of physiological systems, linear models - distributed parameters versus lumped parameter models. Linear muscle model. Simple models of muscle stretch reflex action, steady state analysis of muscle stretch reflex action.

Unit. 2 Lung Tissue Viscoelastance

Chest wall, airways- complete model of respiratory mechanics-pulmonary system software development, computational flow diagram, interaction of pulmonary and cardiovascular models. Transient response analysis of neuromuscular reflex model action, ventilatory action.

Unit. 3 Cardiovascular System Modeling and Simulation

Theoretical basis- model development-heart & circulatory model-computational flow diagram of the cardiac system, pulmonary mechanics modeling and simulation-the role of kidney in Blood pressure regulation.

Unit. 4 Anatomy and Physiology of Nerves Action Potentials

Model of neuronal dynamics- the Hodgkin-Huxley model. Biological receptors: introduction, receptor characteristics, transfer function models of receptors, receptor and perceived intensity, baro receptor reflex. Eye movement system and Wetheimer's Saccade eye model. Oculomotor.

Unit. 5 Art of Modeling

Compartmental models- derivation of the mathematical description compartmental systems-modeling compartmental models-examples compartmental use in biology and medicine-identification of physiological control systems- parametric and nonparametric identification methods: numerical deconvolution-least square estimation. Problems in parameter estimation.

PRACTICALS

List of Experiments

1. Study of SIMULINK library and implementation following model in it.
   i) A model for capacitive electrical circuit.
   ii) A model for inductive electrical circuit.
2. Implement a model for first order system with SIMULINK.
3. To examine the negative feedback associated with the reflex system using goniometer and EMG.
4. SIMULINK model for the steady state analysis of the muscle stretch reflex model.
5. Implement a linearized lung mechanics model with SIMULINK.

i) Direct transfer function method.
ii) Differential equation method.

6. Implement a model for neuromuscular reflex in SIMULINK.
7. SIMULINK model to determine the steady state operating point of the ventilatory control system.
8. Study of transient response analysis of linearized lung mechanics model.
9. Determination of frequency response of linearized lung mechanics model using SIMULINK.
10. Simulation of blood glucose-insulin regulation model with the help of SIMULINK.
11. Study and simulation of saccadic eye movement model (Westheimer's model).

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, *Modeling and Simulation in Medicine and the Life Sciences*, Springer, 2002.

REFERENCE

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

Session 2018-19
Semester A- Syllabus

Biomedical Engineering

B.E. IVth Year

BM-49002 : Biomechanics

Course Outcomes:-

CO1: Introduction to force & moments, mechanical behavior of fibers & study of mechanics behind human motion and performance

CO2: Study of architectural features and mechanical properties of musculoskeletal and soft tissues and knowledge of implant used for repair hard tissues

CO3: To study structure, function of cartilages, tendons, ligaments and identify the major factors involved in the kinematics of human movement.

CO4: To study Mechanics of prosthesis and apply the concept of engineering for better advancement

CO5: Study of biomechanics of spines.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-49002	Biomechanics	4	1	2	4	1	5	70	30	40	60	200

Unit. 1 The Concepts of Force and Moments

Static equilibrium, mechanical behaviour of fibers. Fibers: time-dependent behaviour.

Unit. 2 Bone Structure and Composition

Mechanical properties of bone, viscoelastic properties- Maxwell and Voight models, anisotropy-electrical properties of bone, fracture mechanism and crack propagation in bones, fractures fixators and repairing of bones, mechanical properties of collagen rich tissues, teeth.

Unit. 3 Structure and Function of Cartilages, Tendons, Ligaments

Biomechanics of joints, human locomotion, gait analysis, foot pressure measurements, pedobarograph, force platform, mechanics of foot, mechanics of plantar ulcers arthritis, biomechanical treatment.

Unit. 4 Artificial Valves and Prosthetics

Biological mechanical valves developments, heterograft, testing of valves. Total hip prosthesis requirements, components, stress analysis and instrumentation, knee prosthesis.

Unit. 5 Biomechanics of Spines

Scoliosis- biomechanical treatment and instrumentation, muscle mechanics. Exo-skeletal system for paraplegics, powered wheel chairs, crutches and canes.

PRACTICALS

List of Experiments

1. To investigate the characteristics of electromyography (EMG) signals as they relate to muscle function.
2. Assess a joint's range of motion and evaluate the range.
3. Analysis of Push-Pull Motions.
4. To determine centre of gravity by graphical method.
5. To design simple lever and torque problems involving the human body and the implements it uses.
6. To design work-energy relationship problems as it applies to a body experiencing linear motion.
7. To implement kelvin voight model for visoelastic behaviour of fibres.

TEXT BOOKS

1. Alexander & R Mc Neil, *Biomechanics*, Chapman and Hall, 1975.
2. D. N. Ghista, *Biomechanics of Medical Devices*, CRC, 1982.

REFERENCES

1. A. Z. Tohen, *Manual of Mechanical Orthopedics*, Thomas, 1973.
2. D. N. Ghista and Roaf, *Orthopedic Mechanics: Procedure and Devices*, Academic Press, 1978.

Session 2018-19
Semester A- Syllabus

Biomedical Engineering

B.E. IVth Year

BM-49025 : Embedded Systems

Course Outcomes:-

CO1: To understand basics of embedded systems.
CO2: To understand and design different architectures of embedded systems.
CO3: To integrat I/P & O/P peripheral devices with other components of embedded systems.
CO4: To study of memory system architecture.
CO5: To apply knowledge of embedded system to design solution 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	4	-	2	3	1	4	70	30	40	60	200

Unit. 1 Introduction to Embedded Systems:
Definition of embedded system, embedded systems vs. general computing systems, history of embedded systems, classification, major application areas, purpose of embedded systems, characteristics and quality attributes of embedded systems, common design metrics, and processor technology: general purpose processor, application specific processor, single purpose processor.

Unit. 2 Embedded System Architecture:
Von Neumann v/s Harvard architecture, instruction set architecture, CISC and RISC instructions set architecture, basic embedded processor, microcontroller architecture, CISC & RISC examples: 8051, ARM, DSP processors.

Unit. 3 Input Output and Peripheral Devices
Timers and counters, watchdog timers, interrupt controllers, PWM, keyboard controller, analog to digital converters, real time clock. Introduction to communication protocols: basic terminologies, concepts, serial protocol: I2C, CAN, firewire, USB. Parallel protocols: PCI bus, IrDA, bluetooth, IEEE 802.11, wireless protocols.

Unit. 4 Memory System Architecture
Caches, virtual memory, MMU, address translation, memory and interfacing, memory write ability and storage performance. Memory types, composing memory – advance RAM interfacing, microprocessor interfacing I/O addressing, interrupts, direct memory access, arbitration multilevel bus architecture.

Unit. 5 Embedded System Supporting Technologies
Difference between normal OS and RTOS, scheduling algorithms. Case study: Tiny OS, VxWorks, QNX. Overview of VLSI technology, introduction to device drivers. Case studies: washing machine, air-conditioning, auto focus camera.

PRACTICALS

List of Experiments

1. Introduction to various development environment: 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.

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.

REFERENCES

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

Session 2017-18
Semester A- Syllabus

Biomedical Engineering

B.E. IVth Year

BM- 4708/BM 47001: Biomedical Instrumentation and Analytical Methods

Course Outcomes:-

CO1: Introduction to general human physiology.
CO2: Illustration of measurement of physiological signals from detection to display.
CO3: Understand theory and design aspects of different therapeutic equipment.
CO4: Gain knowledge about advanced microprocessor and PC based biomedical instruments.
CO5: Perform the analytical experiments; improve analytical skills and attitude which help them to apply these skills in their field of engineering.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-4708/BM 47001	Biomedical Instrumentation and Analytical Methods	4	-	2	3	1	4	70	30	40	60	200

Unit. 1 Introduction to Human Physiology

Review: general human physiology, generation and transmission of action potential, depolarization and repolarization, evoked potentials. Physiology of heart: heart as pump. Various types of electrodes and their construction, performance and application, bioelectrical signals and their recording. Physiological transducers.

Unit. 2 Measurement and Recording of Physiology Signals

Signal condition and processing circuits for medical recording system. Bedside monitor, ECG machine and cardio scope blood flow meters, blood pressure and cardiac output measurement, measurement of heart sounds, plethysmography. Patient care and monitoring .central monitoring systems. Electrical safety of medical equipments.

Unit. 3 Therapeutic Equipments

Pacemakers – theory and design aspects, defibrillators, laser applications in biomedical field. Artificial kidney and dialyzers, X-ray machines and competent tomography, magnetic resonance and ultrasonic imaging systems, ultrasound in medicines. Introduction to thermography.

Unit. 4 PC Based Biomedical Instruments

Advanced microprocessor and PC based biomedical instruments. Biomedical telemetry. Introduction about body area network.

Unit. 5 Analytical Techniques

Electromagnetic radiation and its interaction with matter. Various components of optical spectroscopic instruments. Laws of spectroscopy. Absorption spectroscopy for UV, visible and IR region. Various sources and detectors and instrument designs. FTIR and its distinct applications. NMR spectroscopy and X- ray analysis, ion sensitive electrodes and their measurement chemistry analyzers. Introduction to Chromatography: Gas & Liquid.

PRACTICALS

List of Experiments

1. To observe ECG wave forms generated by ECG simulator in different leads configuration.
2. To observe Phonocardiogram waveforms (PCG) of subject (Human body).
3. To measure the systolic and diastolic blood pressure of human heart.
4. To study abnormalities (Tachycardia, Bradycardia) present in human cardiovascular system using ECG simulator.
5. To study EEG waveforms in unipolar recording and average recording mode.

6. To study EMG waveform generated by built-in EMG Simulator.
7. To measure the respiration-rate of subject (Human body).
8. To understand the transmission and reception of biological signal using a telemetry system.
9. To study 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 2018-19
Semester A- Syllabus

Biomedical Engineering

B.E. IVth Year

BM-49222 : Rehabilitation Engineering

Elective I.1

Course Outcomes:-

CO1: Introduction to physical impairment & principles of rehabilitation in orthotics and orthoprosthetic.
CO2: Introduction to the concept of mobility and funtioning details of various appliances i.e. Laser cane.
CO3: Study of sensory augmentation classification, prevention and cure of visual impairment.
CO4: Study of subjective and objective measurement tools in rehabilitation characterizing human system.
CO5: Application of computer application in rehabilitation.
CO6: Study of interfaces in compensation of visual perception for mobility and orientation.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-49222	Rehabilitation Engineering	4	-	-	3	-	3	70	30	-	-	100

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 Engineering Concepts in 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 Artificial Larynx (pneumatic & electronic)

Analysing artificial electronic larynx, augmentative communication, control and computer access (AAC): user interface, outputs, acceleration techniques, intervention and other issues.

Unit. 4 Orthopedic Prosthetics and Orthotics in Rehabilitation

Engineering concepts in motor rehabilitation. Computer aided engineering in customized component design. Intelligent prosthetic knee. Hierarchically controlled prosthetic hand, Self-aligning orthotic knee joint. Externally powered and controlled orthotics and prosthetics. FES systems-restoration of hand function, restoration of standing and walking, HAS.

Unit. 5 Active Prostheses

Active above knee prostheses. Myoelectric hand and arm prostheses- different types, block diagram, signal flow diagram and functions. The MARCUS intelligent hand prostheses.

TEXT BOOKS

1. Bronzino, Joseph, *Handbook of Biomedical Engineering*, 2nd ed., CRC Press, 2000.
2. Robinson C.J, *Rehabilitation Engineering*, CRC press, 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 2018-19
Semester A- Syllabus

Biomedical Engineering

B.E. IVth Year

BM- XXXXX: Hospital Technology Systems

Elective I.2

Course Outcomes:-

CO1: Introduction to basic 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: Maintenance protocols of hospital equipments.
CO5: To understand hospital information system.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-XXXXX	Hospital Technology Systems	4	-	-	3	-	3	70	30	-	-	100

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. Deodorization, disinfection, dehumidification and cryogenic systems. Centralized supply of air, 6L oxygen, nitrous oxide & vacuum, principle of production of liquid oxygen. Management of lifts, firefighting equipment's.

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 staff 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*, Prentice Hall, 1982.
2. L. G. Redstone, *Hospital and Health Care Facilities*, McGraw Hill, 2002.
3. C. A. Caceras, *Clinical Engineering*, Academic Press, 1977.
4. J Davey and D Ali, *Ward's Anaesthetics Equipment's,* 6th ed., Elsevier Health-UK, 2011.

REFERENCES

1. BIS, ISO *Certification details*.
2. Alexander Kusko, *Emergency and Standby Power Systems*, McGraw Hill, 1989.

Session 2018-19
Semester A- Syllabus

Biomedical Engineering

B.E. IVth Year

BM-49305 : Medical Imaging Systems

Elective II.1

Course Outcomes:-

CO1: To impart basic knowledge of ultrasound physics, the instrumentation involved and modes of operation.
CO2: To introduce principles of sectional imaging in X-Ray, CT scanner configuration and 2D image reconstruction techniques.
CO3: To make students aware of the basic physics of MRI, its instrumentation and areas of application.
CO4: To give an overview of Emission Computed Tomography with emphasis on SPECT and PET imaging.
CO5: To give knowledge of IR imaging, its advantages and application.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-49305	Medical Imaging Systems	4	-	-	3	-	3	70	30	-	-	100

Unit. 1 Ultrasound in Medicine

Introduction, production of ultrasonics - 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. 2 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. 3 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. 4 Radio Isotope Imaging

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

Unit. 5 Infra-Red Imaging

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

TEXT BOOKS

1. P. Allisy-Roberts, J. Williams and R. Farr, *Farr's physics for medical imaging*. Edinburgh: Saunders Elsevier, 2008.
2. W. Hendee and E. Ritenour, *Medical Imaging Physics*. Hoboken: Wiley, 2003.

REFERENCES

1. S. Webb, *The Physics of Medical Imaging*, 2nd ed. CRC Press, 1999.
2. A. C. Kak, *Principle of Computed Tomographic Imaging*, IEEE Press New York, 1988.
3. G. A. Hay, *Medical Image Formation Perception and Measurement*, John Wiley & Sons, 1977.

Session 2018-19
Semester A- Syllabus

Biomedical Engineering

B.E. IVth Year

BM-XXXXX: Bioinformatics

Elective II.2

Course Outcomes:-

CO1: Introduction to bioinformatics its databases, tool and application.
CO2: Study of structures and properties of nucleic acids i.e. DNA and RNA along with the DNA sequencing techniques
CO3: Introduction to sequence alignment methods, algorithm and tools used for alignment.
CO4: Introduction to gene mapping, DNA micro array and tools used for gene prediction.
CO5: Study of proteomics prediction techniques for protein structures, introduction to phylogenetic trees and its algorithms like UPGNA.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-XXXXX	Bioinformatics	4	-	-	3	-	3	70	30	-	-	100

Unit. 1 Introduction to Bioinformatics
Objectives of bio-informatics, data integration, data analysis, bio-informatics databases and tools. Overview of bio-informatics application.

Unit. 2 Molecular Biology and Information
Basic chemistry of nucleic acids, structure of DNA. Genes: - The functional elements in DNA, DNA sequencing and polymeric chain reaction, cloning methodology. Amino acids, protein structure.

Unit. 3 Sequence Alignment
Introduction to sequence analysis, models for sequence analysis and their biological motivation. Methods of alignment, usage of gap penalties and scoring matrices. Tools for sequence alignment, multiple sequence alignment. Applications of multiple alignment.

Unit. 4 Gene Mapping and Gene expression
Applications of Gene mapping, DNA sequencing, DNA micro arrays, algorithms for gene alignment, genetic code.

Unit. 5 Proteomics
Protein structure visualization, protein structure prediction, methods of protein structure for known folds, methods of protein structure for unknown folds. Methods for structure prediction. Phylogenetic trees: rooted and unrooted trees; UPGMA and Fitch- Margoliash method.

TEXT BOOKS

1. Dan E Krane Michael L Raymer, *Fundamentals Concept of Bioinformatics*, Pearson, 2003.
2. S. C. T. Rastogi, *Bio- informatics: Concepts, Skills and Applications*, CBS Publication.
3. S. Ignacimuthu, *Basic Bioinformatics*, Alpha Science International, 2004.

REFERENCES

1. David B Allison Grier P Page, *DNA Microarrays and Related Genomics Techniques*, Chapman & Hall/CRC, 1 ed., 2005.
2. Baxevanis, *Bio-informatics: A practical guide to the Analysis of Genes and Proteins*, Wiley, 3 ed., 2004.

Session 2018-19
Semester A- Syllabus

Biomedical Engineering

B.E. IVth Year

OC-V : Computer Vision and Machine Learning

Course Outcomes:-

CO1: To introduce concept of 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.	
OC-V	Computer Vision and Machine Learning	-	-	-	-	-	-	-	-	-	-	-

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**)**, 3D 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, multi resolution 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, spacio-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.

Session 2018-19
Semester B- Syllabus

Biomedical Engineering

B.E. IVth Year

BM-XXXXX : Artificial Neural Networks

Elective III.1

Course Outcomes:-

CO1: To understand the biological neuron, comparison with ANN, structure and learning of ANN.
CO2: To understand and apply feed forward networks, delta learning rules, back propagation algorithm.
CO3: Study of feedback networks, dynamic networks: Hopefied nets.
CO4: Study of associative memory, bidirectional associative memory.
CO5: Understanding basics of matching and self associating networks, counted propagation networks.

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

Unit. 1 Structure and Function of a Single Neuron
Biological neuron, artificial neuron, definition of ANN, single layer network. Learning and adaptation, Neural network learning rules-Perceptron training algorithm, linear separability, Widro & Hebb's learning rule/Delta rule, ADALINE, MADALINE, AI v/s ANN.

Unit. 2 Multilayer Feed Forward Networks
Linearly non separable pattern classification. Generalized delta learning rule. Delta learning rule for multi perceptron layer, back propagation algorithm.

Unit. 3 Single Layer Feed Back Networks
Basic concept of dynamic networks, the hopfield network both discrete and gradient forms.

Unit. 4 Associative Memory
Linear associator, recurrent associative memory, bidirectional associative memory.

Unit. 5 Matching and Self Associating Networks
Hamming net and Maxnet, unsupervised learning of clusters, counter propagation network, feature mapping, self organizing feature maps, ART 1.

PRACTICALS

List of Experiments

1. To study some basic neuron models and learning algorithms by using Matlab's neural network toolbox.
2. Write a program to understand how weights and output effect output of neuron.
3. How the choice of activation function (or transfer function) affects the output of a neuron. Experiment with the following functions: identity (purelin), binary threshold (hardlim, hardlims) and sigmoid (logsig, tansig).
4. To observe how the weights and bias values are able to represent a decision boundary in the feature space.
5. Write a program to demonstrate effects of decision boundary changes during training with the perceptron learning rule.
6. Write a program of perceptron learning rule for linearly separable problems.
7. Write a program of perceptron learning rule for non-linearly separable problems.

8. Write a program for adaptive filtering of speech signals using Adaline.

TEXT BOOK

1. Jacek M. Zurada , *Introduction to Artificial Neural Networks* , West Publishing Company , 1992.

REFERENCES

1. Philip D. Wasserman, *Neural Computing*, Van Nostrand Reinhold, 1989.
2. Satish Kumar , *Neural Networks A Classroom Approach*, 2nd ed., Mc Graw Hill, 2017.
3. Judith E. Dayhoff , *Neural Network Architecture*, Van Nostrand Reinhold, 1989.

Session 2018-19
Semester B- Syllabus

Biomedical Engineering

B.E. IVth Year

BM-XXXXX: Medical Image Processing

Elective III.2

Course Outcomes:-

CO1: Study of fundamentals of image processing and image perception.
CO2: Introduction to image enhancement spatial domain techniques.
CO3: Introduction to image restoration: noise degradation model.
CO4: Introduction to different image transforms.
CO5: Concepts of image analysis, feature extraction etc.

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

Unit. 1 Fundamentals of Image Processing and Image Perception

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 Spatial Domain Techniques

Image negative, contrast stretching, gray level and bit plane slicing, power law transformation, histogram equalization and histogram specification, local enhancement techniques, image subtraction, averaging and logical operations. Spatial filtering: low pass, high pass and derivative filters, median filtering. Frequency domain filters: low pass, high pass and Butterworth filters.

Unit. 3 Image Restoration

Noise degradation model, estimation of degradation model. Restoration in presence of noise-spatial filtering, frequency domain filtering, inverse filter and least mean square error (Wiener) filtering.

Unit. 4 Image Transforms

2D FFT and its properties. Walsh transform, Hadamard transform, discrete cosine transform, Haar transform, Slant transform, K L transform.

Unit. 5 Image Analysis

Feature extraction, spatial features, amplitude and histogram features, transform features, edge detection: gradient, compass Laplace, Sobel, Prewitt operators, stochastic gradients. Line and spot detection. Boundary extraction: connectivity and contour following.

PRACTICALS

List of Experiments

1. To implement point processing and pixel operations.
2. To implement image arithmetic operations.
3. To implement logical operations on image.
4. To implement histogram calculation and equalization.

5. To implement geometric transformations.
6. To implement image restoration.
7. To implement spatial filters.
8. To implement frequency domain filtering.
9. To implement morphological operations.
10. To implement wavelet transform.

TEXT BOOKS

1. Jain Anil K, *Fundamentals of Digital Image Processing*, Prentice Hall, 1996.
2. B. Chanda, D. Majumder, *Digital Image Processing and Analysis*, PHI, 2011.

REFERENCES

1. Gonzalez Rafel C, Wintz Paul, *Digital Image Processing*, Addison Wesley, 1987.
2. Pratt William K, *Digital Image Processing*, John Wiley and Sons, 2006.

Session 2018-19
Semester B - Syllabus

Biomedical Engineering

B.E. IVth Year

BM-XXXXX: Hospital Management and Information Systems

Elective III.3

Course Outcomes:-

CO1: To impart basic concepts of data structures & their application.
CO2: To understand basic concepts of database system.
CO3: To understand the features of database system & relational databases.
CO4: Design of HIS and its integration in a networked hospital scenario.
CO5: Concepts of AI and development of experts systems for medical data analysis.

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

Unit. 1 Introduction to Data Structures
Elements, arrays, records, sets, tables etc. Singly and doubly linked data, stacks, queues, trees etc.

Unit. 2 Introduction to Database Models
Relational databases, data indexing and structuring - data independence- data definition language and data manipulation language E-R diagram with examples relational model structures of relational databases.

Unit. 3 Relational Database Design- Normalization
1NF, 2NF and 3NF indexing and hashing. Security of database design example on a popular RDBMS package. Miniaturized data storage and retrieval system like CD-ROM, magneto optical discs, optical juke boxes, write many read many devices and miniature magnetic tape devices. Interfacing and retrieval details.

Unit. 4 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).

Unit. 5 Introduction to AI and Experts System
Knowledge components, knowledge representation schemes- production system. Expert's system tools- language.

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 "CT scan" 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. Remez Elmasri, Shamkant B. Navathe, *Fundamentals of Database Systems*, 7th ed., Pearson, 2017.

Session 2018-19
Semester B- Syllabus

Biomedical Engineering

B.E. IVth Year

BM-XXXXX : Biomaterials

Elective IV.1

Course Outcomes:-

CO1: To understand biomaterials and classification.
CO2: To study various methods to test surface and bulk properties of biomaterials.
CO3: To study evaluation of biocompatibility of biomaterials though in-Vitro and in-vivo testing
CO4: To understand practical applications of biomaterials.
CO5: To understand host reaction on the application of biomaterials

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-XXXXX	Biomaterials	4	1	-	4	-	4	70	30	-	-	100

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, sterilization of implants. Degradation of materials in biological environment.

Unit. 2 Mechanical Behaviour of Materials

Stress-Strain curve characteristics, viscoelasticity, mechanical properties & remodeling 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 and 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 2018-19
Semester B- Syllabus

Biomedical Engineering

B.E. IVth Year

BM-XXXXX: Telemedicine

Elective IV.2

Course Outcomes:-

CO1: General concepts of telemedicine, its application with reference to network topologies and models.
CO2: Understanding of wireless communication technologies, standards and data handling.
CO3: Clinical applications of telemedicine, selected case studies of various disciplines.
CO4: Design of integrated telemedicine architecture with sub systems like network devices, workstation.
CO5: Knowledge of ethical practices, data security. International and National rules, regulations and laws.

Subject-Code	Subject Name	L	T	P	Theory Credits	Practical Credits	Total Credits	Maximum Marks				
								Theory		Practical		Total
								Th.	CW	SW	Pr.	
BM-XXXXX	Telemedicine	4	1	-	4	-	4	70	30	-	-	100

Unit. 1 History, Definitions and Current Applications

General introduction to the telemedicine applications, advantages/disadvantages & scope. 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.

Unit. 2 ATM Technology

IDN, ISDN, telephone telemedicine (PSTN), switching techniques, telemetry, data compression, wireless transmission, wireless technologies, 802.11, 802.16, satellite communication.

Unit. 3 Clinical Applications

Clinical parameters, cardiology, dermatology, tele-radiology, ENT, emergency medicine (CDMA, GSM), gastroenterology, homecare, neurology, oncology, ophthalmology, tele-rehabilition, tele-pathology & tele-surgery.

Unit. 4 Telemedicine Equipments

IP video and audio – video conferencing hardware/software. Video hardware (Cameras, Monitors, recorders etc.), video production, editing, broadcasting, voice over IP/audio systems. Network equipments – Telemedicine workstations, DSL, ADSL, SDSL, cable modems, VoIP modem, Fast switched ethernet, routers, switches, hubs, multipoint 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

Licensure and accreditation, security and confidentiality, government regulations, International and National protocols- HL7, HIPAA, DICOM, and Indian IT act.

TEXT BOOKS

1. Tenenbaum, *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.

Biomedical Engineering
BM 75201: Adaptive Signal Processing

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, 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 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-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-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 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.

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: 2018-19

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 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

Unit. 1 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. 2 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

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Session: 2018-19

Biomedical Engineering
BM 75851: Finite Element Method
Syllabus

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.

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 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.