MAT 2152: ENGINEERING MATHEMATICS III [2 1 0 3]

COs:

1. Understand and apply the concepts of Fourier Series, Fourier transforms & their properties
2. Understand and apply analyticity of a complex functions and its properties.
3. Understand and apply the concepts of contour integration
4. Understand the concept of vector differential and integral calculus & their properties
5. Apply the concepts of linear PDEs, to solve one dimension Heat and Wave equation by different methods.

Syllabus:

Complex Variable: Functions of complex variable. Analytic function, C-R equations, differentiation, Integration of complex function, Cauchy's integral formula. Taylor's and Laurent Series, Singular points, Residues, Cauchy's residue theorem. **12 Hrs.**

Partial Differential Equations: Solution by method of separation of variables. Solution by indicated transformations. One dimensional wave equation D'almbert's solution and solution by separation of variables. One dimensional heat equation and solution by separation of variables.

06Hrs.

Fourier representations for signals: Introduction, Discrete-time periodic signals (Textbook 2): The discrete-time Fourier series, continuous-time periodic signals: The Fourier series, Discrete-time non-periodic signals: The discrete-time Fourier transform, continuous-time non-periodic signals: The Fourier transform, properties of Fourier representations. Fourier transform representations for periodic signals, convolution and modulation with mixed signal classes, Fourier transform representation for discrete-time signals. **18 hrs**

Reference Books:

1. Grewal B.S, Higher Engineering Mathematics, Khanna Publishers.
2. Haykin Simon, Veen Barry Van, *Signals and Systems*, John Wiley &Sons, New Delhi, 2008
3. Erwin Kreyszig: Advanced Engg. Mathematics-, Wiley Eastern.
4. Applied Numerical Analysis (5^{th} Edition) - Gerald and Wheatley.
5. Murray R. Spiegel: Vector Analysis. 1959, Schaum Publishing Co.
6. Advanced Engineering Mathematics, Vol 3, by Narayanan, Ramaniah and Manicavachagom Pillay.

BME 2151: ANALOG ELECTRONICS [3-1-0-4]

COs:

1. Bias BJT, FET and MOSFETs in different configurations.
2. Analyze and design BJT, JFET and MOSFET amplifiers using appropriate small signal models.
3. Describe the concept of feedback and analyze different types of feedback amplifiers
4. Design different types of oscillators.
5. Design and analyze power amplifiers using BJT and compare different types.

Syllabus:
Review of BJT operation, biasing and stability, Transistor at low frequencies and high frequencies, Metal Oxide Semiconductor Field Effect Transistors and their Applications. Bipolar Transistor Large-Signal and Small-Signal Model. BJT Amplifiers: Input and Output Impedances, Biasing, Bipolar Amplifier Topologies. MOS Amplifier: Amplifier Topologies, Relationship between Transfer Function and Frequency Response, Input and Output Impedances. Properties of Negative Feedback: Gain Desensitization, Bandwidth Extension. Oscillators: LC Oscillators, Parallel LC Tanks, Cross-Coupled Oscillator. Power Amplifier: Emitter Follower as Power Amplifier, Push-Pull Stage, Improved Push-Pull Stage, Power Amplifier Classes.

References:

1. Behzad Razavi, "Fundamental of Microelectronics", 2nd Edition, John Wiley and Sons, 2013
2. A. S. Sedra, K. C. Smith, "Microelectronic circuits", 6th Edition, Oxford University Press, 2009.
3. R. L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", 11th Edition, Pearson India education services, 2015.
4. J. Millman, C. C. Halkias, Chetan. D. Parekh, "Integrated Electronics", 2nd Edition, McGraw Hill, 2010.

BME 2152: ANATOMY & PHYSIOLOGY [4 0 0 4]

COs:

1. A good knowledge of the essentials of human anatomical structures
2. Ability to connect to engineering applications.
3. A good understanding of the human physiology.
4. Appreciation of the scope for engineering-solutions involving measurement, interpretation and diagnosis of physiological dysfunctions

Syllabus:

PARTA: ANATOMY

Skeletal System: Types of bone, classification, Structure of bone, Blood supply, Cartilage: Type, Structure in brief, Joints: Classification, Structure of synovial joint, Major joints of the body. Muscle tissue: Types, Structure of skeletal muscle, Types of muscles, Brain: Parts, Brain stem, Ventricles, CSF, Meninges, Cranial nerves (names and functions only). Spinal cord: Gross features and structures, Spinal nerve, Nerve endings and receptors, Autonomic nervous system. Sensory system: Eye, Ear, Skin. Heart: Pericardium, Chambers, Blood supply Organs. Respiratory system: Parts, Trachea, Lungs. G I Tract: Parts, Stomach, Intestine, Liver, and Pancreas. Urinary system, Male and Female reproductive organs, and Endocrine glands.

Reference:

Sampath Madhyastha, Manipal Manual of Anatomy, CBS Publishers & Distributors, Edition 3, 2016.

PART-B PHYSIOLOGY

Introductory lecture pertaining basic functional concept of the human body as a whole and contribution of the individual system for achieving the goal. Haemetology; Leverage system i.e. bone and muscle physiology in general. Nerve action potential and its ionic basis. Body temperature regulation; Biophysical aspects of blood pressure (Bop) and its recording technique. Electrocardiograph and its gross normal features and alterations, Optics of the eye. Fundamental tonal analysis, determination of pitch, loudness and quality of sound. Sensorium - general role of receptors as transducers, generation of potential in the

receptors. Motor control of skilled voluntary movements: Mechanism of abnormal oscillatory movements Electroencephalogram and electrocorticogram.

References:

1. Charles E Tobin, Manual of Human Dissection, McGraw Hill, Edition 4, 1961.
2. J Gibson, Modern Physiology and Anatomy of Nurses, Black Well, 1981.
3. A J Vander, J H Sherman, D S Luciano, Human Physiology, McGraw Hill, Edition 8, 2000.
4. Cyril A Keele, Eric Neil, Neil Norman Joels, Samson's Wright's Applied Physiology, Oxford University Press, 1993.

BME 2153: DIGITAL ELECTRONICS [2 1 0 3]

COs:

1. Perform arithmetic operations & conversions in different number systems and gain knowledge of logic families.
2. Understand the Boolean algebraic theorems & different logic optimization techniques and minimize logic functions so as to realize digital circuits.
3. Apply digital design principles in designing combinational logic circuits.
4. Analyze & design sequential logic circuits.

Syllabus:

Combinational logic circuits: Overview of Algebraic simplification of Boolean expressions and realization using logic gates, minimization using Karnaugh map; Minimization using variable entered maps, Quine-McCluskey algorithm; Combinational circuit design using MSI chips: Multiplexers, demultiplexers, encoders, decoders, parity generators, parity checkers; Arithmetic circuits: Half adder, full adder, adder-subtractor, ripple carry and carry look ahead adders, ALU; Logic families and their characteristics: TTL families, CMOS families, CMOS logic; Sequential logic circuits: Overview of flipflops and ripple counter; Counters: Pre-settable counter (binary and modulo *n*); Shift registers: shift register counters, ring counter, twisted ring counter; Analysis and design of synchronous sequential finite state machines: Classification of FSM, state assignment, state minimization, design of next state decoder and output decoder, synthesis using D-FF and JK-FF, MSI devices as state machines, ASM charts.

References:

1. Wakerly, Digital Design Principles & Practices, Pearson, Delhi, Edition 3, 2003.
2. Givone, Digital Principles & Design, TMH, New Delhi, 2011.
3. Leach D. P. & A. P. Malvino, Digital Principles and Applications, MGH, 2008.
4. Roth C. H., Fundamentals of logic design, Thomson Brooks, Australia, Edition 5, 2007.
5. Morris Mano, Digital logic and computer design, Pearson, New Delhi, 2013.
6. Ronald J. Tocci, Digital Systems - Principles & Applications, Pearson, Delhi, Edition 8, 2005.

BME 2154 NETWORK ANALYSIS [3 1 0 4]

COs:

1. Understanding of various network theorems and their applications to problem solving.
2. Ability to study resonant circuits and to evaluate the initial and final conditions of passive circuits for AC and DC excitations
3. An appreciation of the utility of the Laplace transform in the analysis of passive networks.
4. Ability to analyze network functions, network parameters and linear wave shaping.

Syllabus:

Network equations:

Nodal and loop analysis of networks, source transformation, Methods of analysis of DC and AC networks, Star delta transformations, Coupled circuits. Resonant circuits, Property of duality in networks.

Network Theorems:

Superposition, Reciprocity, Millman's theorems, Thevinin's and Norton's theorems, Maximum Power transfer theorem, Tellegan's Theorem

Laplace transformation and its application:

Definition, Basic theorems in Laplace transformation, properties of Laplace transforms, inverse Laplace transforms, partial fraction expansion, initial and final value theorems, shifting theorems, step, ramp and delayed functions. Solution of RL, RC, RLC networks using Laplace transformation method, Laplace transform of periodic and non-periodic signal.

Transient behaviour and Initial conditions in networks:

Behaviour of circuit elements under switching condition and their representation. Evaluation of initial and final conditions in RL, RC and RLC circuits for AC and DC excitations.

Linear wave shaping:

Response of RC & RL circuits to step, pulse, square wave, ramp and exponential inputs, compensated attenuators.

Two port network and network functions:

Open circuit impedance parameters, short circuit admittance parameters, Transmission parameters, Hybrid parameters, relationship between two port parameters, Parallel connection of two port networks, series connection of two port networks, cascade connection of two port networks, driving point impedance and admittance functions, Transfer functions.

References:

1). M E Van Valkenburg, "*Network Analysis*", Prentice Hall of India, New Delhi, Edition 3, 2007.
2). Joseph A Edminister, "*Theory and Problems of Electric circuits*", McGraw Hill, Edition 5, 2001.
3). C.L. Wadhwa, "Network Analysis and Synthesis", New Age International (P)Limited, Publishers, New Delhi, Edition 3, 2007.
4) Jacob Millman and Herbert Taub, "Pulse, Digital and Switching Waveforms" Mcgraw-Hill Book Company, New Delhi, 1992.

BME 2155 SIGNALS AND SYSTEMS [3-0-0-3]

COs:

1. Perform various mathematical operations on signals and identify system properties.
2. Characterize & analyze LSI systems in time domain.
3. Understand the Fourier representations & its properties and appreciate its significance in frequency domain signal/system analysis.
4. Understand the Laplace/Z-transform & its properties and appreciate its significance in signal/system analysis.

Syllabus:

Introduction to signals; Representations of continuous and discrete-time signals, Some special signals; Introduction to systems, system properties, Continuous time and discrete time Linear shift-invariant (LSI) systems, Frequency analysis of signals and systems, Fourier series representation, the Fourier Transform, The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT), The Laplace Transform for continuous time signals and systems, The z-Transform for discrete time signals and systems, Sampling Theorem and its implications. Spectrum of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems.

References:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Pearson Education India; 2nd Edition, (2015).
2. Simon Haykin and Van Veen, "Signals and Systems", John Wiley, 2014.
3. M. J. Roberts, Signals and Systems - Analysis using Transform methods and MATLAB, McGraw-Hill Education, 2nd Edition, 2011.
4. Hwei Hsu, Schaum's Outline of Signals and Systems**,** McGraw-Hill Education; 3 edition, 2013.

BME 2161: CIRCUIT SIMULATION LAB [0-0-3-1]

COs:

1. Build circuit simulation skills in PSpice.
2. Analyze and interpret the Simulations in PSpice
3. Adapt the circuit designing concepts and PSpice Simulator to design applications such as Amplifiers, oscillators.

Syllabus:

Study of Simulation software using simple circuits. Rectifier circuits (Half wave, Full wave, and Bridge rectifier with filters). Power Supply design with regulators. Waveform generator using BC147 Transistors (Astable Multivibrator). Waveform generator using BC147 Transistors (Monostable Multivibrator). Clipper and Clampers (Positive edge and Negative edge). Op-Amp Application-I (Inverter amplifier, integrated amplifier, difference amplifier). Op-Amp applications-II (Phase shift Oscillators, sine wave generator, square wave generator). Filters. (Passive Low Pass Filter, Inverting Active High Pass Filter, Inverting Band Pass Filter, Second Order Low Pass Filter). Light Detector Circuit.

References:

David M. Buchla, Lab Manual (MultiSIM Emphasis) for Electronic Devices and Circuit Theory, Prentice Hall; 9th Edition, 2005.
Fawwaz Ulaby, CIRCUITS, National Technology & Science Press, 3rd Edition, 2015.

BME 2162 ELECTRONICS LAB [0-0-6-2]

COs:

1. Design and interpret basic analog circuits.
2. Analyze, design & implement combinational and sequential logic circuits.
3. Develop skill to apply the knowledge, by working on specific problems.

Syllabus:

Analog Electronics: To conduct the experiments related to the characteristics of Transistor, FET and other special devices; Design of power supplies: rectifier (capacitor filter), voltage-doublers, quadruples, and series voltage regulator; Design of amplifiers: Transistor amplifiers with and without feedback, and FET Amplifiers; Design of oscillators: RC phase shift oscillator, Wein bridge oscillator, Hartley and Colpitt's /Crystal oscillator (using BJT's FET's), UJT oscillator.

Digital Electronics: Design of simple combinational circuits using logic gates (Implementing using NOR/NAND); Code converters and magnitude comparators; Simple combinational circuits using multiplexers; Simple combinational circuits using decoders; Arithmetic circuits; Asynchronous sequential

circuits (up-down counters); Synchronous sequential circuits (up-down counters); Shift registers; Sequence detectors and sequence generators.

References:

1. R. L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", 11th Edition, Pearson India education services, 2015.
2. Behzad Razavi, "Fundamental of Microelectronics", Wiley, 2013.
3. Roth C. H., Fundamentals of logic design, Thomson Brooks, Australia, Edition 5, 2007.
4. Morris Mano, Digital logic and computer design, Pearson, New Delhi, 2013.

MAT 2253: ENGINEERING MATHEMATICS IV [2-1-0-3]

Cos:

1. Apply optimization methods in various engineering problems for making best decisions and planning.
2. Understand classical and axiomatic approach of probability, Baye's theorem and its application. Explain one dimensional random variables, its properties and applications.
3. Explain two dimensional random variables, its properties and applications. Obtain the regression lines and fit a curve by the method of least square.
4. Understand the concept of distributions.
5. Understand concept of special functions and their applications.

Syllabus:

Optimization

Basic concepts, classification of optimization problems. Linear programming, Graphical and Simplex methods, penalty cost and two phase methods.

Probability, Random Variables & Stochastic Processes

Introduction; conditional probability and independence, Bayes' theorem; random variables, probability distribution and density functions, specific random variables; functions of a random variable – distribution and density functions; Mean and Variance; Chebyshev's inequality.

Random vectors – two random variables, joint statistics; covariance, correlation coefficient, independence; regression, least squares principles of curve fitting.

Introduction to stochastic processes; statistics; stationarity; Autocorrelation and Power Spectrum, Wiener-Khinchin Theorem.

References:

1. Kreyszig E - *Advanced Engineering Mathematics*, Wiley Eastern.
2. Papoulis - *Probability, Random Processes and Stochastic Process*, McGraw Hill.
3. Peebles Jr. - *Probability, Random variables and random signal principles*, McGraw Hill.
4. Grewal B.S. - *Higher Engineering Mathematics*, Khanna Publishers.

BME 2251 BIOMECHANICS [4-0-0-4]

COs:

1. Understanding of the dynamics of fluid flow in the human body.
2. Be aware of the mechanical properties of soft and hard tissues
3. Have the knowledge of mechanical aspects of the human movement

Syllabus:

Bio-fluid mechanics: Viscosity, classification of fluids, blood rheology, fundamental method for measuring viscosity, rheology of blood in micro-vessels, mechanical model of cardiovascular system, relationship among blood velocity, blood pressure and blood vessel diameter in the vascular tree, resistance against blood flow, types of blood flow, prosthesis-related complications attributable to valve fluid dynamics. Mechanics of breathing, physical aspects of alveoli, diffusion, airway resistance. Connective tissue mechanics: structure and biomechanical properties of collagen, tendon, ligament & cartilage; composition, structure and biomechanical properties of bone, bone fracture and failure mechanics, skeletal muscle tissue properties and functions, skeletal muscle architecture, force generation in the muscle, role of skeletal muscle, force-velocity relationship in skeletal muscle, joint flexibility. Human movement mechanics: linear kinematics- kinematic parameters, fundamental concepts of gait, projectile motion, linear kinematics of walking & running, angular kinematics- types of angles, lower extremity joint angles, angular motion relationships, relationship between linear and angular motion, angle-angle diagrams, linear kinetics- laws of motion, types of forces, representation of forces acting on a system, angular kinetics- Newton's laws of motion (angular analogs), center of mass calculation, Rotation and Leverage, Pulley systems, Analysis using Newton's laws of motion.

References:

1. Lee Waite and Jerry Fine, Applied Biofluid Mechanics, McGraw-Hill Education, Second Edition, 2017, USA.
2. C. Ross Ethier, Craig A. Simmons, Introductory Biomechanics, Cambridge University Press, First Edition, 2009, New York, USA.
3. W. Mark Saltzman, Biomedical Engineering: Bridging Medicine and Technology, Cambridge University Press, Second Edition, 2015, USA.
4. Joseph Hamill and Kathleen M. Knutzen, Biomechanical Basis of Human Movement, Lippincott Williams & Wilkins, Third Edition, 2008, Philadelphia, USA.
5. Susan J. Hall, Basic Biomechanics, McGraw-Hill International Editions, Seventh Edition, 2014, Singapore.

BME 2252 BIOMEDICAL INSTRUMENTATION- I [3-0-0-3]

COs:

1. Comprehension of the concepts of transduction, and a good knowledge of their applications.
2. Familiarity with different types of electrodes used in the acquisition of physiological signals along with their specific applications.
3. An insight into the origin of physiological signals, and the instrumentation relevant to certain diagnostic measures.
4. Knowledge of basic instrumentation relevant to certain therapeutic measures and awareness of the elements of risk in the use of medical instruments, and the precautionary measures required for basic electrical safety

Syllabus:

Biomedical transducers: Classification and Selection; Pressure Transducers: Resistive, capacitive, Inductive & Piezo-electric transducers, Photoelectric transducers & its types; Thermal transducers & its types; Electrodes & Amplifiers: Principles of working and their characteristics, Half- cell potential, Types of electrodes, Electrode-Electrolyte model, Amplifiers for biomedical instrumentation; Physiological Signals & Measurements: Basics of ECG, EMG, EEG, PCG, blood pressure & blood flow and the instrumentation for measuring these signals; Cardiac Pacemakers: Types of pacemakers, Modes of triggering, Pacemaker power supplies, pacemaker codes; Defibrillators: AC and DC defibrillators, Types of electrodes and their features, cardioverters; Lasers: Basic principles, types of lasers and their medical applications; X-ray systems, Fluoroscopic system, principles of tomography; Electrical Hazards & Safety: Safety code standards, Micro and Macro shock and its physiological effects, Methods of electrical safety.

References:

1. John G Webster, "Medical Instrumentation Applications and Design", John Wiley and Sons, New York, 3rd Edition, 2011.

2. R S Khandpur, "Handbook of Biomedical Instrumentation", McGraw Hill, Delhi, 3rd Edition, 2014.

3. L A Geddes, L E Baker, "Principles of Applied Medical Instrumentation", Wiley India, New Delhi, 3rd Edition, 2008.

4. Richard Aston, "Principles of Biomedical Instrumentation and Measurement", Merrill, New York, 1991.

5. Joseph J Carr, John M Brown, "Introduction to Biomedical Equipment technology", Prentice Hall, New Jersey, 4Th Edition, 2003.

BME 2253 DIGITAL SYSTEM DESIGN [4-0-0-4]

COs:

1. Understand the basics of CMOS technology and CMOS circuit design.
2. Acquire a knowledge of ASIC (Application Specific Integrated Circuit) design and development skills for designing a digital system
3. Understand basics of Programmable Logic Devices (PLD) and to develop ability to solve problems using PLDs
4. Understand the Hardware Description Language (HDL) and develop skills required for designing digital systems using Verilog HDL

Syllabus:

Introduction to Digital System Design, Design flow, Design styles: Full-custom IC, Semi-custom IC, ASIC (Application Specific Integrated Circuit), Types of ASICs, Y chart. Introduction to CMOS, CMOS gates and circuits. CMOS based combinational logic cells, Transmission Gates, Sequential Logic Cells, Data path logic cells, Data path elements, Examples (Adders/ multiplication). Combinational Circuits Design, Shannon's expansion theorem, design of Sequential circuit. Programmable ASICs and logic cells, Programmable Logic Devices (PLD's) and applications, Programmable Array Logic, Complex

Programmable Logic Devices (CPLD's), elements of CPLD, Example, Mask-programmable Gate Array (MPGA's), FPGA's architectures, Example and applications. Introduction Verilog, Verilog module styles: Data flow, Behavioral and Structural, Verilog modules for Flip-flop, adder, Multiplexer. Verilog based System Design: Sequential Circuits (Registers / counters), combinational circuits (Adder, multipliers, LUTs).

References:

1. Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", 3rd Edition, McGraw Hill Education(India) Pvt. Ltd., New Delhi, 2014.
2. Charles Roth, Lizy Kurian John, Byeong Kil Lee, "Digital System Design Using Verilog", Cengage Learning US, 2016.
3. M.J.S. Smith, "Application Specific Integrated Circuits", Pearson, New Delhi, 2002.
4. J. Bhaskar "Verilog Primer", 3rd Edition, Addison Wesley Longman Singapore Pvt Ltd., 2005.
5. M. Morris Mano and Michael D. Cilleti, "Digital Design with Introduction to Verilog HDL", 5th Edition, Perason, New Delhi, 2013.

BME 2254 INTEGRATED CIRCUIT SYSTEMS [4 0 0 4]

COs:

1. An understanding of basic theory of Integrated circuits.
2. An understanding of building blocks of analog computation using Op-Amp.
3. Ability to design circuits using timer IC in different applications
4. Ability to design IC based regulated power supplies.

Syllabus:

Operational Amplifier

Introduction: Basic block diagram of OPAMP.

Differential Amplifier:

Differential amplifier circuit, characteristics of differential amplifier, analysis of emitter coupled differential amplifier using small signal hybrid model, methods of improving common mode rejection ratio using constant current source, transfer characteristics of differential amplifier, block diagram of OP-Amp, offset error voltages and currents, Temperature drift of input offset voltage and current, Measurement of OPAMP parameters, Frequency response of OPAMP.

Linear analog systems: Basic OPAMP applications, differential DC amplifier, summing, scaling, Averaging and Instrumentation amplifier, stable AC coupled amplifier, Analog Integration and Differentiation, Voltage to current and current to voltage converter, Active filters, active resonant and RC band pass filters, Delay equalizer.

Non-linear applications of operational amplifier:

Precision half wave and full wave rectifiers, peak detector, sample and hold circuit, log and antilog amplifiers, comparators, Schmitt trigger, square wave, triangular wave generators and pulse generator.

Timer IC:

Introduction, pin details of 555 IC, functional diagram of 555 IC, astable multivibrator, positive and negative edge triggered monostable multivibrator, linear ramp generator, voltage to frequency converter, tone burst generator and other applications.

IC Voltage Regulators:
Regulator IC's, 78xx series and 79xx series, Adjustable voltage regulator IC LM 317, Power supply design using these IC's, Switching regulators.

Data converters:
Principles of digital to analog converter (DAC) and analog to digital converters (ADC), binary weighted, R-2R digital to analog converters, flash type ADC, successive approximation type ADC, counter ramp type ADC and dual slope analog to digital converters, specifications of ADC and DAC.

Phase-locked loops:
Functional diagram of voltage controlled oscillator 566 IC and its analysis. Operating principle of PLL, study of IC 565, circuit analysis of phase detector. Definition and derivation for free running frequency, lock range and capture range. Applications of PLL as frequency multiplier, AM demodulation and FSK etc.

References:

1. Jacob Milliman, Christors C Halkias, "*Intergrated Electronics*", Mcgraw Hill, 2002.
2. Jacob Millman, Irvin Grabel, "*Microelectronics*", McGraw Hill, Edition 2, 1988.
3. Ramakanth A Gayakwad, "*OPAMPS and Linear Integrated Circuits*", Prentice Hall, Edition 4, 2000.
4. J Nagrath, "*Electronics (Analog and Digital)*", Prentice Hall.
5 Franco Sergio "Design with Op amps & Analog Integrated Circuits*" McGraw Hill, 1997.*

BME 2261 IC SYSTEMS LAB [0-0-6-2]

COs:

1. Practical knowledge towards designing the circuits based on Op-Amps in various applications.
2. Practical knowledge to design the circuits based on timer ICs in different applications.
3. Skill to design regulated power supplies with ICs.

Syllabus:
Op-amp linear applications, adders, subtractors, integrator, differentiator, voltage to current converters. Op-Amp non-linear applications, Comparators, square wave generator, multi-vibrators, function generators, oscillators, precision rectifiers. Binary weighted and ladder type DAC, IC Voltage regulators and power supplies, timer IC applications such as multi-vibrators etc. Mini project.

References:

1. Jacob Milliman, Christors C Halkias and Chatan D Parikh "*Intergrated Electronics*", 2nd Edition, Mcgraw Hill, 2009

2. Ramakanth A Gayakwad, "*OPAMPS and Linear Integrated Circuits*", Prentice Hall, Edition 4, 2000.

3. William D. Stanley, Operational Amplifiers with Linear Integrated Circuits, 4th Edition, Pearson Education *2007*

BME 2262: MATLAB and Simulink LAB [0-0-3-1]

COs:

1. Build programming skills in MATLAB.
2. Build Simulating skills in SIMULINK.
3. Analyze and interpret the results of the implemented program.
4. Adapt the Conceptual and Mathematical modeling skills to program and design MATLAB & SIMULINK programs for different applications

Syllabus:
Introduction to MATLAB; Array operations: Arithmetic, Relational and logical operations, MATLAB scripts, functions, Control flow and operators, Debugging M-files. Introduction to Simulink, creating new models, writing techniques, Help window usage, Data driven modeling, Hybrid systems (continuous and Discrete), Embedded Algorithms.

References:

1. Sulaymon L. Eshkavilov**,** MATLAB & Simulink Essentials: MATLAB & Simulink for Engineering Problem Solving and Numerical Analysis, Lulu Publishing Services, 2016.
2. William Bober, MATLAB® Essentials: A First Course for Engineers and Scientists, CRC Press, 1st edition, 2017.

HUM 3151: ENGG ECONOMICS AND FINANCIAL MANAGEMENT [2-1-0-3]

COs

1. Define the concepts of demand and supply
2. Apply the appropriate engineering economics analysis method(s) for problem solving
3. Compute the depreciation of an asset using standard depreciation techniques
4. Describe and apply the basic techniques of financial statement analysis
5. Apply all mathematical approach models covered in solving engineering economics problems

Syllabus:
Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, Declining balance method of depreciation, Sum-of-the-years digits method of depreciation, Sinking fund and service output methods, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios.

References:

1. **Prasanna Chandra (2005),** "Fundamentals of Financial Management", Tata Mc-Graw Hill Companies, New Delhi.
2. **James L Riggs, David D Bedworth and Sabah U Randhawa**, **(2004),** "Engineering Economics", Tata McGraw – Hill Publishing Company Ltd, New Delhi

3. **T. Ramachandran (2001),** "Accounting and Financial Management", Scitech Publications Pvt. Ltd. India.
4. **Eugene F. B. & Joel F. H. (2009),** "Fundamentals of Financial Management", 12th ed., Cengage Learning Publisher.
5. **M. Y. Khan & P. K. Jain (2008),** "Financial Management", 5th edition Tata McGraw Hill Publication, New Delhi.
6. **Thuesen G.J (2005)**, "Engineering Economics" Prentice Hall of India, New Delhi.
7. **Blank Leland T. Tarquin Anthony J**. **(2002)**, "Engineering Economy", McGraw Hill, Delhi.
8. **Chan S. Park, (2013),** "Fundamentals of Engineering Economics", 3rd edition, Pearson Publication.

BME 3151: BASIC CLINICAL SCIENCES – I [4-0-0-4]

COs:

1. An understanding of cardiovascular system, and of its functioning.
2. A good knowledge of clinical aspects of orthopedics and rehabilitation.
3. A knowledge of the essentials of radiation physics in the field of radio-diagnosis and imaging.
4. Understanding the knowledge of radiation biology and related therapeutic tools.

Syllabus:

PART-A: CARDIOLOGY

Heart structure and function – overview, Details of cardiovascular physiology – blood flow (circulation), Detail anatomy of human heart, principles of cardiovascular measurements-blood pressure, cardiac output, etc. Heart valves, Prosthetic heart valves – evolution, detail structure, functions and applications, Open heart surgery and Heart lung machines, Basics of 12-lead Electrocardiography – Einthoven's triangle, ECG potentials – generation and conduction, conduction system, Applications of ECG in cardiac clinics, Normal and abnormal ECGs, Diagnostic applications, Interpretation of ECG, Cardiac pacing. Assisted cardiac devices-concepts and applications from biomedical engineering perspective, Holter monitor.

References:

1. Kim E. Barrett, "Ganong's Review of Medical Physiology", McGraw Hill, Edition 24, 2012.
2. C. C. Chatterjee S, "Human Physiology", CBS Publisher, Edition 11, 2016.

PART-B: ORTHOPAEDICS

Bioengineering aspects of fracture management: Structure of bone-gross, Microscopic biochemical fractures: Types, Mechanism of injury, Normal Healing of Fractures, Treatment of fractures: General principles, Closed methods, External fixation and Internal fixation, Biomechanics of internal fixation and description of external fixators, Bioengineering principles of internal fixation, Intramedullary nails, Plates, and Screws.

The concepts of load bearing, load sharing and stress shielding by implants, Piezo electricity and electrical stimulation for bone healing, Bioengineering aspects of joint diseases, Structure of joints: Fibrous, Cartilaginous, Synovial, Lubrication of joints and the functions of articular cartilage, Degeneration of cartilage, Degenerative arthritis and Rheumatoid arthritis, Joint replacement, hip, knee, shoulder, small joints.

Biomaterials: Requirements of implant materials and biocompatibility, Material implants: Materials in external appliances, Materials in prosthetics, Materials in Orthotics, Bioengineering principles of management of paralytic problems, Gait analysis, Orthotics, Principles of tendon transfer, Bioengineering principles of amputation and prosthetics, Upper limb prosthesis, Lower limb prosthesis.

References:

1. Wilton H Bunch and Robert D Keagy, Principles of Orthotic treatment.
2. Adams John Cranfield and Xchurchill living stone, Outline of orthopedics and outline of fractures.
3. Frankel, Lea, Febiger , Nordin,,Basic Biomechanics of the skeletal system.
4. M. Dena Gardiner, The principles of exercise therapy, CBS press, Edition 4, 1985.

PART-C: RADIOLOGY

X-ray tube, Target material, focal spot, size, shape of filament rotating anode, cooling of target tube, Interaction of X-ray with matter, Use of filters, scattered rays, quality of X-rays, HVL, CONES, Grids, Photographic effects on X-ray film, density, contrast, distortion, Speed of X-ray film, Fluorescent & Intensifying screen, Computed Tomography; Image Intensifier, Digital Subtraction Angiography, Radiation hazards & protective measures; X-Ray Exposure Parameters; Ultrasonography, Principles of Magnetic Resonance Imaging; Brachy Therapy.

References:

1. Thomas S. Curry, James E. Dowdey, Robert C. Murray, "Christensen's Physics of Diagnostic Radiology", Illustrated Edition, Lippincott Williams and Wilkins, 1990.
2. Joseph Selman", The fundamentals of Imaging Physics and Radiobiology", 9th Edition, Charles C. Thomas, 2000.
3. Penelope Allisy-Roberts, Jerry R Williams, "Farr's Physics of Medical Imaging", Illustrated Edition, Elsevier Health Sciences, 2007.

PART-D: RADIOTHERAPY

Principles of radiation oncology and cancer radio therapy, LET and RBE, Radio sensitivity and Radio resistance tumors and tissues, Clinical definition of tumor radiosensitivity, Classification of tumors according to cell Radiosensitivity, Cell survival theory, Cell cyclekinetics and age response function, Cell survival curves, Oxygen effect, OER,Cell repair- sublethal and potentially damage repair. Radio curability of tumors, Therapeutic ratio, Normal tissue tolerance dose, Modification of radiation response, Physical, Chemical and Biomedical modifiers, Radiation biology stages of radiation actions, Physical stage LEI-RBE, Physiochemical reactions, Chemical stage. Radioactive effect of important Biological macromolecules, Radiation on cell site in cells, DNA repair process, Effects of radiation on cell cycle process, Cell death survival curves, Oxygen effect, Fractionation, Biological effects of Radiation, Radioactive protection, Acute Radiation syndromes, Somatic effects LD-50, Cause of radiation death - skin - blood and blood forming organs, Reproductive organs, Embryo-Late effects of Radiation, Radiation carcinogenesis, Leukemogenesis, Cataract, Genetic effects, Hazards and permissible exposures, maximum permissible occupational doses, Hazards in various branches of radiation, Protective lines of defense, Protective measures, Physical measurements and medical investigations.

References:

1. Meredith W J , Massey J B, Fundamental Physics of Radiology, John Wright, Edition 3, 1977.
2. Johns H E, Cunningham John Robert, The Physics of Radiology, Charle C Thomas, Edition 4, 1983.
3. Romesh Chandra, Introduction to Nuclear Medicine.

BME 3152 BIOMEDICAL INSTRUMENTATION II [3-0-0-3]

COs

1. Awareness of the main parts and the applications of the equipments concerned with respiration.
2. Familiarity with the operation/working principles of the specific diagnostic and therapeutic equipments and clinical laboratory instrumentation.
3. Knowledge of the working principles of specific equipments concerned with blood circulation & dialysis.
4. An understanding of the concepts and applications of blood cell counter, thermographic and ultrasonic imaging modalities

Syllabus:

Respiratory measurements and aids: Principle of Impedance Pneumography & Pneumotachograph; Ventilators, Impulse Oscillometry, Body plethysmograph; Clinical Laboratory Instrumentation: Spectrophotometry, Auto analysers, Electrosurgical units: Principle of working, modes of operation, Risks and the safety measures associated with ESU. Ultrasonography: Interaction of ultrasound with tissues, scanning modules, echocardiograph, Endoscopes, Neonatal instrumentation: Incubators, Apnea monitors and neonatal ventilators (High frequency ventilators (HFO); Anaesthesia equipment, Lithotripsy, Heart-Lung Machine: Qualitative requirements, Functional details of the types of blood oxygenators, IABP Machine. Hemodialysers: Type of exchangers, Hemodialysis machine; Principles and applications of Thermograph, Infusion pump, Blood cell counter.

References:

1. John G Webster, "Medical Instrumentation Applications and Design", John Wiley and Sons, New York, 3rd Edition, 2011.
2. R S Khandpur, "Handbook of Biomedical Instrumentation", McGraw Hill, Delhi, 3rd Edition, 2014.
3. L A Geddes, L E Baker, "Principles of Applied Medical Instrumentation", Wiley India, New Delhi, 3rd Edition, 2008.
4. Joseph J. Carr, John M Brown, "Introduction to Biomedical Equipment Technology", Prentice Hall, New Jersey, 4Th Edition, 2003.
5. Richard Aston, "Principles of biomedical Instrumentation and measurement", Merrill, New York, 1991.

BME 3153: DIGITAL SIGNAL PROCESSING [3-1-0-4]

COs:

1. Explain the fundamentals of signals and systems with basic operation and their properties.
2. Identify different Transforms, their properties, and their significance in signal & system analysis.
3. Build the realization of FIR and IIR filters
4. Design the simple FIR and IIR filters, Linear Phase FIR filters, Analog filters, Digital IIR and FIR filters.

Syllabus:

Introduction to Discrete time signal and systems. Z Transform: Definition and properties, region of convergence, inverse Z transform, transfer function, poles and zeros, application of Z transforms to

discrete-time systems, representation of systems – signal flow graph, realization of a z-domain transfer function; relation between s-plane and z-plane. Discrete Fourier Transform: properties, linear convolution using the DFT, Divide and Conquer algorithm to implement DFT, The fast Fourier transform: radix 2. Discrete Time Systems in Frequency Domain, Simple Digital Filters, All Pass filters, Linear phase filters. Analog Filter Design: Chebyshev and Butterworth filter design, Analog frequency transformations. Digital Filter Structure: FIR & IIR Realizations and Lattice Synthesis; IIR Filter Design: IIR filter Design by Bilinear Transformation; FIR Filter Design: FIR Digital Filter Design by Windowing, Minimum Phase filter design.

References:

1. Ronald W. Schafer, Alan V. Oppenheim, Discrete-Time Signal Processing, PEARSON 3rd Edition, 2014.
2. Dimitris G Manolakis, John G. Proakis, Digital Signal Processing: Principles, Algorithms, and Applications, PEARSON, 4th Edition, 2007.
3. Sanjit K. Mitra, Digital Signal Processing: A Computer - Based Approach, McGraw Hill Education; 4th Edition, 2013.

BME 3154: MICROCONTROLLER BASED SYSTEMS [4-0-0-4]

COs:

1. Describe the internal architecture of the Intel 8051, and the ARM Cortex-M3 microcontrollers including counters, timers, ports, and memory.
2. Develop logics for arithmetic and logical operations, memory and array handling, bit manipulations, and I/O port programming.
3. Write assembly language and C Programs for the Intel 8051 and the ARM CORTEX M3 microcontroller based systems.
4. Interface peripherals to the microcontroller and design microcontroller Based Systems.
5. Design microcontroller Based Systems.

Syllabus:

Introduction Microprocessors and microcontrollers: Microprocessor and Microcontroller structure, Microcontroller families. The 8051 Architecture: Hardware, I/O pins, Ports, external memory, Counters and timers, serial I/O, and Interrupts. The 8051 programming: Addressing modes, Data move, Arithmetic, Logical, Jump & Call Instructions; programming examples in assembly language and in "C". The ARM Cortex M3 Microcontroller: Hardware Architecture, Programming model and Registers, operating modes, Memory System, stack and interrupts. The ARM CortexM3 programming: ARM and THUMB instruction sets, addressing modes, Data processing, Call & Branching instructions. Interfacing: External memory, UART, Keyboard and Display interfaces; Pulse measurement, D/A and A/D conversions, Multiple interrupts, Temperature monitoring system, Stepper motor control system, and Real-time Clock interface.

References:

1. Kenneth J. Ayala, "8051 Microcontroller and Embedded Systems Using Assembly and C" 2nd Edition, Cengage Learning, New Delhi, 2009.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, "8051 Microcontroller and Embedded Systems Using Assembly and C", 2nd Edition, Pearson Education, New Delhi, 2013.
3. Joseph Yiu, "The Definitive Guide to the ARM® Cortex-M3", 2nd Edition, Elsevier, 2010.
4. Steve Furber, "ARM System-On-Chip Architecture", 2nd Edition, Pearson Education, New Delhi, 2012.

BME 3161 BIOMEDICALINSTRUMENTATION LAB- I [0-0-3-1]

COs:

1. Ability to experimentally deduce the characteristics of the various transducers.
2. Ability to use different types of electrodes used in the acquisition of physiological signals along with their specific applications.
3. Familiarization of certain diagnostic and therapeutic equipments.

Syllabus:

Bioelectric amplifier, Thermal sensors- RTD, Thermocouple and Thermistor, Characteristics of Inductive and Capacitive transducers, Optical sensors- LDR, Photodiode and Phototransistor, bio-signal acquisition using Physiography, Familiarization of Audiometer, Defibrillator, Pacemaker circuit, Recording of ECG using Electrocardiograph.

References:

1. Ramakanth A Gayakwad, "OPAMPS and Linear Integrated Circuits", Prentice Hall, 4Th Edition, 2015.
2. John G Webster, "Medical Instrumentation Applications and Design", John Wiley and Sons, New York, 3rd Edition, 2011.
3. Richard Aston, "Principles of biomedical Instrumentation and measurement", Merrill, New York, 1991.

BME 3162: MICROCONTROLLER LAB [0-0-6-2]

COs:

1. Develop logics and write programs for arithmetic & logical operations, Memory handling, code conversion, and bit manipulation.
2. Write and verify the programs written for the 8051 and ARM Cortex-M3 microcontroller using the assembler and Hardware kits.
3. Interface peripherals to the microcontroller and program the microcontroller for the functioning of the interface.
4. Design and implement microcontroller based systems.
5. Document and Communicate the microcontroller based design.

Syllabus:

Module I: Familiarization of the 8051 simulation tool and trainer kits, and experiments based on the Intel 8051 Microcontroller.

Module II: Interfacing Experiments based on the Intel 8051 Microcontroller.

Module III:Familiarization of ARM programming tools and ARM kits and Experiments Based on ARM Cortex M3 Microcontroller.

Module IV: Mini Project (Design, construct and demonstrate a microcontroller based system using the microcontrollers such as the Intel 8051, the ARM, ATMEL, AVR, PIC etc.).

References:

1. Kenneth J. Ayala, "8051 Microcontroller and Embedded Systems Using Assembly and C" 2nd Edition, Cengage Learning, New Delhi, 2009.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, "8051 Microcontroller and Embedded Systems Using Assembly and C", 2nd Edition, Pearson Education, New Delhi, 2013.
3. Joseph Yiu, "The Definitive Guide to the ARM® Cortex-M3", 2nd Edition, Elsevier, 2010.

HUM 3152: ESSENTIALS OF MANAGEMENT [2 1 0 3]

COs:

1. Understand the roles of managers, principles of management, managerial skills, and strategies required to run a business successfully with social and ethical responsibilities.
2. Develop an organizational structure and plan for manpower in a given business organization
3. Apply leadership and motivational theories in the organizational contexts
4. Acquire budgetary skills through process and techniques of controlling
5. Differentiate the managerial practices internationally; prepare a business plan by identifying business opportunities, conducting market analysis and preparing feasibility reports

Syllabus:

Definition of management and systems approach, Nature & scope. The functions of managers. Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, How to set objectives, Strategies, Policies & planning premises. Strategic planning process and tools. Nature & purpose of organising, Span of management, Factors determining the span, Basic departmentation, Line & staff concepts, Functional authority, Art of delegation, Decentralisation of authority. HR planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership- leadership behaviour & styles, Managerial grid. Basic control process, Critical control points & standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA, Application of Theory Z. The nature & purpose of international business & multinational corporations, Unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections.

References:

1. **Harold Koontz & Heinz Weihrich (2012)**, "Essentials of Management", McGraw Hill, New Delhi.
2. **Peter Drucker (1993**), "Management: Tasks, Responsibilities and Practices", Harper and Row, New York.
3. **Peter Drucker (2004),** "The Practice of Management", Harper and Row, New

BME 3251 BASIC CLINICAL SCIENCES – II [4 0 0 4]

COs:

1. An understanding of the central nervous system, and diagnostic tools used in clinical practice.
2. A good knowledge of life-support-devices and the anesthesia machine.
3. A knowledge of normal ocular structure, the diseases of the eye and the related diagnostic and therapeutic equipment.
4. An understanding of the clinical aspects of speech & hearing and related diagnostic and therapeutic tools.

Syllabus:

PART-A: NEUROLOGY

Introduction to neurology; Review of the structure, development, and function of the nervous system: Central, peripheral and autonomic nervous system, Part of the brain structure, The motor system, Sensation, Cranial nerves. Functional topography of brain. Spinal cord, Consciousness, Higher functions, somatosensations, Neurons and glia, membrane potential, postsynaptic potential, action potential, signal transductions, neurotransmitters, synaptic transmissions, neural plasticity- LTP and LTD, Motor spinal

control, cortical and subcortical motor control, Sleep and its disorders, Diagnostic investigations, Electroencephalography, Computerized Axial Tomography, Radioactive brain scanning, Angiography, Pnuemoencephalography, The motor unit recording, The methods of Electro diagnosis, Neuromuscular stimulation, Electromyography, Clinical Applications, Diseases of muscle, Motor neuron disorders, The electrical study of reflexes, The silent period, The F Response, The H Reflex, The Axon reflexes, Disorders of neuromuscular transmission.

References:

1. Victor Maurice, Adams Raymond D, Principles of Neurology, McGraw Hill, Edition 5, 1993.
2. Erodal, Neuroanatomy.
3. Lance and Moleod, Physiological approach to Clinical Neurology

PART-B: ANAESTHESIOLOGY

This course will provide an overview of basic physical principles and their applications in anaesthesia and intensive care. It will begin with the description of general and regional anaesthetic techniques fundamental to the practice of anaesthesia before going on to describe the anaesthesia machine, medical gas supply systems and intravenous drug delivery systems. The principles of equipment used in pain therapy will be discussed. Finally, students will learn about mechanical ventilation with special emphasis on mechanical ventilators and nebulisers. Humidifiers, Baby Incubators, Central oxygen supply. Principles of operation theatre tables and lights, phototherapy, surgical diathermy.

References:

1. Ganong, Review of Medical Physiology [available at MIT and KMC libraries]
2. Cyril and Neil, Samson Wright's applied physiology [available at MIT and KMC libraries]
3. C.C. Chatterjee, Human Physiology [available at MIT and KMC libraries
4. M.K. Bykes and M.D. Vickers, Measurements in Anaesthesia, Blackwell 1981.
5. Mushin, Automatic ventilation of lung, Blackwell 1970.
6. R.D. Millor, Text Book of Anaesthesia, some chapters.

PART – C: SPEECH & HEARING

Introductory Lectures on Anatomy of the vocal tract and the ear; Audiometers, Middle ear analyzer, Evoked potentials, OAE, hearing aids, Cochlear implants, ALD, Hearing aid analyzer, Electro Glottography, AAC, Introduction to speech assessment, DSP, Assessment of voice and fluency, Voice and fluency therapy assessment, Artificial larynx, Spirometry, Speech synthesis, Practical demonstration.

References:

1. Community based Rehabilitation, ISBNO 0-7020-1941-0, Saunders, London, 1997.
2. A Nenfeldt and A Albrigt, Disability and Self- directed employment, 1998.

PART-D: OPHTHALMOLOGY

Physiology of Eye: Structure of eye, function, Generation of signals and transmission to brain Electrophysiology, Aqueous humor production: Intraocular pressure fluctuations.

Equipment Used: Vision testing equipment (Computerized & Manual.), Snellens's Chart, Keratometer, Refractometer, Colour Vision, Eye Examination equipment: Slit lamp biomicroscope & Camera, Fundus Camera, Opthalmoscope – Direct & Indirect, Retinoscope, Tonometers - contact & Noncontact, Perimeters – Listers, Bjerrums, Octopus, and Goldmann, Ophthalmodynamometers, Ultrasound Scanners, Synoptophore + Hesschart, Electromagnet, Lathes, Specialized equipment used in treatment:Argon laser, Nd-YAG Laser, Contact Lenses, Intraocular Lenses, Operating Microscope, Cryosurgical equipment, Vitrectomy instrument.

References:

1. Tandon, Radhika, Parson Diseases of the Eye, Elsevier, Edition 21, 2010.
2. Duke Elder, System of Ophthalmology, Vol. VII, Mosby, St. Louis, 1965.

BME 3252: DIGITAL IMAGE PROCESSING [4-0-0-4]

COs:

1. Acquire the basic mathematical concepts required to understanding digital image processing techniques taught in this course
2. Develop a basic understanding of the human vision system.
3. Acquire a knowledge of the image processing techniques taught in this course.
4. Develop an ability to write pseudo-codes on selected algorithms taught in this course

Syllabus:

Review of signals, systems & transforms; 2D signals & systems, 2D DFT and its computation. Image perception – the human vision system, psycho-visual experiments, monochrome vision model, temporal properties. Image compression – the discrete cosine transform (DCT), properties, computation, practical compression algorithm. Image Enhancement: Point operations – Histogram modification, Histogram equalization; Spatial filtering: linear filters & the median filter. Edge Detection, Hough transform – detection of straight lines and curves in images; Invariant descriptors: Fourier Descriptor, Moment-based invariants; Morphological Image Processing techniques, Thresholding, Connected Component Labeling.

References:

1) R.C. Gonzalez and R.E. Woods, *Digital Image Processing*, 4Th Edition, Pearson Education Inc., 2017.
2) Jae S. Lim, *Two-dimensional Signal and Image Processing*, Prentice-Hall, Englewood Cliffs, New Jersey, 1990.
3) A.K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989, Fourth Indian Reprint.

BME 3261 BIOMEDICAL INSTRUMENTATION LAB- II [0-0-3-1]

COs

1. Ability to implement and test filters and amplifier circuits.
2. Ability to simulate and condition physiological signals
3. Familiarisation of clinical laboratory equipments and its safety practices.

Syllabus:

Basic laboratory equipments and safety practices, Spectrophotometer based experiments, Patient isolation circuit using opto-coupler, Strain sensors, Bio-signal acquisition and conditioning circuits.

References

1. Ramakanth A Gayakwad, "Op-Amps and Linear Integrated Circuits", Prentice Hall, 4th Edition, 2002.
2. John G Webster, "Medical Instrumentation Applications and Design", John Wiley and Sons, New York, 3rd Edition, 2011.
3. Richard Aston, "Principles of biomedical Instrumentation and measurement", Merrill, New York, 1991.

BME 3262: SIGNAL AND IMAGE PROCESSING LAB [0-0-6-2]

COs:

1. Implement signal processing concepts using MATLAB, and interpret the results.

2. Implement image processing concepts using MATLAB, and interpret the results.

3. Appreciate the use of MATLAB as a research tool in the area of signal & image processing.

Syllabus:

Signal Processing: Introduction; Discrete Time System and its properties, Convolution, DTFT, Transfer functions & pole-zero plots; DFT/FFT and their properties, FIR and IIR filters, design & implementation. Biomedical

Image Processing: Display and simple manipulations, Contrast enhancement; the DCT and its applications on compression; Computation of the 2D DFT; 2D Filtering, Edge Detection; Hough Transform; Moment-based invariants; Morphological Operations; Connected Component Labelling; Color Models.

References:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Pearson Education India; 2 edition (2015).
2. Ronald W. Schafer, Alan V. Oppenheim, Discrete-Time Signal Processing, PEARSON 3rd Edition, 2014.
3. Rafael C. Gonzalez, Richard Eugene Woods, Digital Image Processing using MATLAB, 2nd Edition, Tata McGraw-Hill Education 2010.
4. A.K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989, Fourth Indian Reprint.

BME 4298: INDUSTRIAL TRAINING

COs:

1. An understanding of the industrial environment.
2. Improved interpersonal & leadership skills, and professional behavior.
3. Ability to relate theoretical knowledge to practical challenges.
4. Oral and written communication skills (by way of writing report on the Industrial training and discussing the experience orally).

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry

BME 4299: PROJECT WORK/PRACTICE SCHOOL

COs:

1. Ability to identify, design and implement a solution to a given problem, along with data interpretation.
2. Leadership and teamwork skills, in managing a multidisciplinary (healthcare) project, including financial and ethical responsibilities.
3. Technical writing, presentation skills.

The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

BME 4051 BIOMATERIALS [3-0-0-3]

Cos:

1. Understand the fundamentals of different class of biomaterials

2. Understand the properties pertaining to various materials and application.

3. Utilize the basic understanding of the material based approach of various implants. Discuss about procedures that are commonly used to replace the lost functions.

4. Understand the key issues related to the fabrication of scaffolds from biomaterials for regenerative medicine application.

Syllabus:

Introduction to Bio-materials: definition of biomaterials, requirements and its uses, classification of biomaterials, performance of biomaterials

Types of biomaterials: Metallic Biomaterials- introduction, types - Stainless steel, Co-Cr alloys, Ti alloys, dental metals and other metals, corrosion behavior. Ceramic Biomaterials: introduction, Classification - Non-absorbable or relatively bioinert bioceramics. Biodegradable or Resorbable ceramics. Bioactive or surface reactive ceramics. Polymeric Biomaterials: introduction, polymerization and its types, basic structure, classification solid state properties, discussion on different class of synthetic non-degradable polymers Biodegradable Polymeric Biomaterials, Biologic Biomaterials: Tissue Derived Biomaterials; Composite Biomaterials: introduction, structure, types, properties and applications.

Implantable Medical devices: (a) Orthopaedics-joint replacement, bone defects, bone fracture, cartilage defects, (b) Cardiovascular system- arteries and veins, Heart valve prostheses- introduction, causes, mechanical and bioprosthetic heart valves. (c) eyes and ears-contact lenses, IOL, cochlear implant, (d) dentistry, maxillofacial and craniofacial – dental implants, craniofacial reconstruction, (e) general soft tissue repair

Biomaterials for regenerative medicine-background, tissue engineering templates, types of template materials, fabrication route

References:

1. Joseph D Bronzino, "The Biomedical Engineering Handbook", 3rd Edition, CRC press, USA, 2006.
2. Park Joon Bu, "Biomaterials Science and Engineering", Plenum Press, University of Michigan, 1984.
3. Buddy D Ratner & Allen S Hoffman, "Biomaterials Science and Introduction to Materials in Medicine", 3rd Edition, Academic Press, Canada, 2012.
4. David Williams, Essentials Biomaterials Science, Cambridge university press, 2013.
5. Lisa A Pruitt and A M Chakravartula, Mechanics of Biomaterials, Cambridge, 2011

BME 4052 BIOMATERIAL CHARACTERIZATION TECHNIQUES [3-0-0-3]

COs:

1. understand the principle and application of chemical characterization techniques used for the study of biomaterials
2. explain different the physical characterization techniques used for the study of biomaterials.

   explain different the physical characterization techniques used for the study of biomaterials.

3. explain the application of surface characterization techniques for the analysis of biomaterials

Syllabus

Physical and chemical characterization of Biomaterials: optical microscopy, UV-Vis spectroscopy, fluorescence spectroscopy, transmission electron microscope (TEM), scanning electron microscope (SEM), scanning tunneling microscope (STM), atomic force microscope (AFM), near-field scanning optical microscope (NSOM), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FT-IR), dynamic light scattering (DLS), contact angle, gas adsorption, mass spectroscopy, chromatography. Thermal characterization of biomaterials: thermogravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC). Surface Characterization of Biomaterials: X-ray photoelectron spectroscopy (XPS), auger electron spectroscopy (AES), secondary ion mass spectroscopy (SIMS), surface matrix-assisted laser desorption ionization mass spectrometry (Surface-MALDI-MS), profilometry, light microscopy and confocal microscopy.

References

1. Amit Bandhyopadhya and Susmita Bose, *Characterization of Biomaterials*, Elsevier, 2013.
2. Douglas B. Murphy, *Fundamentals of light microscopy and electronic imaging*, Wiley-Liss, Inc. USA, 2001.
3. B.D. Cullity and S.R. Stock, *Elements of X-ray diffraction*, Prentice Hall, Inc. USA, 2001.
4. D.B. Williams and C. Barry Carter, *Transmission electron microscopy* 4 volumes, Springer, USA, 1996.
5. Gerhard Huebschen Iris Altpeter, Ralf Tschuncky Hans-Georg Herrmann, *Materials Characterization Using Nondestructive Evaluation (NDE) Methods*, Elsevier, 2016.
6. M. Jaffe, W. Hammond, P. Tolias, T. Arinzeh, *Characterization of Biomaterials*, Elsevier, 2012.

BME 4053 INTRODUCTION TO BIOMEDICAL NANOTECHNOLOGY [3-0-0-3]

Cos:

1. understand the size and shape effect on material properties and explain. Lamer's theory and stabilization.
2. explain bottom-up and top-down methods of nanomaterial preparation
3. describe the different characterization methods/instruments used in biomedical nanotechnology.
4. understand the application of nanomaterials for biomedical imaging, drug delivery systems, biosensors, and tissue engineering and describe toxicity and environmental risks of nanomaterials.

Syllabus:

Introduction nanotechnology: Nanomaterials- classifications, synthesis methods, nanostructured system by self-assembly, biomimetic and biomolecular recognition assembly, surface functionalization of nanoparticles, nanocomposites. Characterization tools for nanomaterials and nanosystems- structural and chemical characterization techniques. Properties of nanomaterials: - mechanical properties, optical properties, surface plasmon resonance, quantum size effects, introduction to nanoelectronics. Nanotechnology for drug delivery, nanotechnology for diagnosis, prognosis, and disease status: - biomedical imaging, biosensors and drug delivery. Therapeutic nanotechnology, nanotechnology for implant materials and tissue engineering, cosmetics, nanotechnology safety concerns.

References:

1. Guozhong Cao, Nanostructures and nanomaterials Synthesis, Imperial Press, 2011.
2. Neelina H. Malsch, *Biomedical nanotechnology*, CRC Press, 2005.
3. G.A. Ozin and A.C. Arsenault, *Nanochemistry: A chemical approach to Nanomaterials,* Royal Society of Chemistry, 2005
4. Kenneth E. Gonsalves, Craig R. Halberstadt, Cato T. Laurencin, Lakshmi S. Nair, Mott, *Biomedical Nanostructures,* Weily-Blackwell, 1st edition, 2008.
5. Jun Li, Nianqiang Wu, *Biosensors based on Nanomaterials and nanodevices*, CRC Press, 1st edition, 2014.
6. T. Pradeep, *A Textbook of Nanoscience and Nanotechnology*, McGraw Hill Education, 1st edition, 2017.
7. Challa S. S. R. Kumar, Josef Horms, Csrola Leuschner, Nanofabrication Towards Biomedical Application: Techniques, Tools, Applications and impact, Wiley- VCH, 1st edition, 2015.

BME 4054 MATERIAL SCIENCE FOR BIOMEDICAL ENGINEERS [3-0-0-3]

COs:

1. Describe the electrical conductivity of metallic and semiconducting materials
2. explain and classify dielectrics and dielectric breakdown mechanisms
3. understand the magnetic and optical properties of materials
4. describe piezoelectric, ferroelectric, superconducting and nano-materials

Syllabus:

Atomic structure and interatomic bonding, metals, semiconductors, insulators. Conductivity of metals and semiconductors- Drude model, dependence on temperature and composition, Matthiessen's rule. Insulating materials, Inorganic, organic, liquid and gaseous insulators. Dielectrics: Introduction to Dielectric polarization and classification – Clausius-Mossotti relation. Dielectric Breakdown: Mechanism of

breakdown in gases, liquids and solids –basic theories including Townsend's criterion, Streamer mechanism, suspended particle theory, intrinsic breakdown, electro-mechanical breakdown- Factors influencing Ageing of insulators- Application of vacuum insulation- Breakdown in high vacuum. Ferroelectricity, piezoelectricity. Magnetic Materials: Magnetization of matter, Classification of magnetic materials -Curie-Weiss law- Hard and soft magnetic materials– Ferrites. Introduction to polymers, degradation of polymers, conducting polymers, hydrogels, Dendrimers. Optical Properties: Light Interactions with Solids, Refraction, Reflection, Transmission, Absorption, Luminescence, Lasers, Photoconductivity. Introduction to nanomaterials.

References:

1. William D. Callister, Jr., David G. Rethwisch, *Materials Science and Engineering: An Introduction*, 9th Edition, Wiley, 2014.
2. Dekker A.J., *Solid state physics*, Macmillan publishers India, 2012.
3. James F. Shackelford, *Introduction to Materials Science for Engineers*, 8th edition, Pearson, 2014.
4. Marcel van Genderen, *Materials science for biomedical engineering*, Eindhoven: Technische Universiteit Eindhoven, 2011.
5. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons, *Biomaterial science- An introduction to Materials in medicine*, 3rd edition, Academic press, 2012.
6. S.O Kasap, *Principles of Electrical Engineering Materials and Devices*, International Edition, McGraw-Hill, 2000.
7. T Pradeep, *A Textbook of Nanoscience and Nanotechnology*, Tata McGraw Hill Education, 2012.

BME4055: ADVANCED BIOMEDICAL SIGNAL PROCESSING [3-0-0-3]

COs:

1. Possess basic knowledge of probability theory and signal processing techniques.
2. A knowledge of various advanced signal processing concepts.
3. Ability to analyze advanced signal processing techniques.
4. Ability to identify, develop and apply the principles of specific signal processing techniques in the field of health care.

Syllabus:

Review of Probability theory, random variables and stochastic processes; Spectral estimation techniques; Estimation of the autocorrelation and power spectrum density (PSD): Nonparametric methods of power spectrum estimation: The Periodogram & its modifications, The Welch method, Biomedical applications. Cepstrum analysis: The cepstrum, power cepstrum, complex cepstrum, Biomedical applications; Adaptive Filters: Weiner filter, Adaptive noise canceling, Principles of adaptive noise canceling with LMS and RLS adaptation algorithm. Adaptive line enhancer, principles of adaptive line enhancer using the LMS and GAL algorithm and Biomedical engineering applications. Parametric methods of power spectrum estimation: AR modeling – The Yule-Walker method and least square method of parameter-estimation; selection of AR model order; Autoregressive Moving Average (ARMA) modeling; Adaptive methods of estimating the PSD, Biomedical engineering applications.

References:

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson, 4th edition, 2007
2. Simon Haykin, "Adaptive Filter Theory", Pearson, 5th edition, 2013
3. M. Akay, "Biomedical signal processing", Academic press, 1994.
4. Rangaraj M Rangayyan, "Biomedical Signal Analysis", John Wiley and Sons, Illustrated edition, 2015.

BME 4056: BIOMETRICS [3-0-0-3]

COs:

1. Explain the fundamentals of Image processing and Computer vision.
2. Identify different Biometric system design parameters to asses the system
3. Build the Multimodal Biometric system for security.

Syllabus:

Basic image operations, Interpolation, Special filters, enhancement filter, Edge detection, thresholding, localization. Introduction of biometric traits and its aim, Biometric system, authentication, physiological and behavioral properties, Identification and verification, Threshold, Score distribution, FAR and FRR, System design issues - Expected overall error, EER, ROC curve, DET curve, FAR/FRR curve. Existing Biometric Technologies: Fingerprints, Face, Iris, Hand Geometry, Ear, Voice, Retina, Gait. Introduction to physiological and behavioral biometrics in hospitals or care units, Biometric authentication based on ECG, EMG, and Phonocardiograph (PCG) signals. Multimodal identification and Verification system, normalization strategy, Fusion methods, Biometric system security. Face and ECG Based Multimodal Biometric Authentication.

References:

1. Girija Chetty and Jucheng Yang, Advanced Biometric Technologies, InTech, 2011.
2. Jain, A.K., Ross, A., Nandakumar, K. Introduction to Biometrics. Springer; 2011.
3. David Zhang, Fengxi Song, Zhizhen Liang, Yong Xu, Advanced Pattern Recognition Technologies with Applications to Biometrics (Premier Reference Source), Medical Information Science Reference; 1st edition, 2009.
4. Ruud M. Bolle, Sharath Pankanti, Nalini K. Ratha, Andrew W. Senior, Jonathan H. Connell Guide to Biometrics, By, Springer, 2009.
5. Duda, Richard, Peter Hart, and David Stork. *Pattern Classification*. 2nd Edition, New York, NY: Wiley-Interscience, 2007.
6. Rafael C. Gonzalez, Richard Eugene Woods, Digital Image Processing using MATLAB, 2nd Edition, Tata McGraw-Hill Education, 2010.

BME 4057: MACHINE LEARNING [3-0-0-3]

COs:

1. Explain the fundamentals of Supervised, Unsupervised and Reinforcement Learning techniques
2. Identify different practical Machine Learning issues and advices.
3. Design Deep Learning Architectures.

Syllabus:

Introduction: Basic Concepts-Supervised Learning, Discriminative Algorithms. Supervised learning: Supervised learning setup, LMS, Linear Algebra, Logistic regression. Perceptron. Exponential family, Generative learning algorithms. Gaussian discriminant analysis. Naive Bayes approach, Support vector machines, Vectorization. Practice ML advice: Bias/variance tradeoff, Model selection and feature selection, Evaluating and debugging learning algorithms, Practical advice on structuring an ML project, Convex Optimization. Deep Learning: NN architecture, Forward/Back propagation, Vectorization, Other optimization tricks, Evaluation Metrics. Unsupervised learning: Clustering. K-means, EM. Mixture of Gaussians, Factor analysis, PCA (Principal components analysis), ICA (Independent components analysis). Reinforcement learning and control: MDPs. Bellman equations, Value iteration and policy iteration, Linear quadratic regulation (LQR), LQG, Q-learning. Value function approximation.

Reference:

1. Christopher Bishop, Pattern Recognition and Machine Learning (Information Science and Statistics), Springer; 1st Edition. 2006. Corr. 2nd Print, 2011.
2. Stephen Marsland, Machine Learning: An Algorithmic Perspective, Chapman and Hall/CRC, 2nd Edition, 2014.
3. Duda, Richard, Peter Hart, and David Stork. *Pattern Classification*. 2nd Edition, New York, NY: Wiley-Interscience, 2007.

BME 4058: MEDICAL IMAGING [3-0-0-3]

COs:

1. Understand the basics/mathematical preliminaries pertaining to signal/image processing
2. Understand the mathematics of image reconstruction from projections, leading to algorithms to implementing the same.
3. Understand the physics, working principles, and limitations of the imaging modalities taught in this course: CT, MRI, and ultrasound imaging systems.
4. Develop an ability to write pseudo-codes based on some of the selected (simple/straightforward) algorithms taught.

Syllabus:

Review of signals, systems & transforms; 2D signals & systems; Medical Imaging: Imaging modalities and their applications; Computed tomography (CT): mathematical basis, the Radon transform & the central slice theorem; Image reconstruction from projections: the Direct Fourier Method, convolution backprojection (CBP) algorithm, Algebraic Reconstruction Techniques (ART); reconstruction from fan-beam projections; Extension to 3D – cone-beam CT, spiral CT. Tomosynthesis; X-rays: utility, generation and detection; X-ray CT systems. Emission CT: principles, Positron emission tomography (PET); attenuation correction in ECT; Ultrasound in clinic: benefits/risks, Basics of Ultrasound - review, Ultrasound imaging; Contrast enhanced ultrasound imaging; Motion artifacts in ultrasound imaging. Clutter filtering; elastography, plane wave imaging; Magnetic resonance imaging: Principles of data-

generation, resolving the tissues, resolving the spatial locations, and extension to 2D. Resolution & Field of View; Data sampling and the concept of bandwidth.

References:

1. R.C Gonzalez and R.E. Woods, *Digital Image Processing*, 4Th Edition, Pearson Education Inc., 2017.
2. A.K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989, Fourth Indian Reprint.
3. A.C. Kak and M. Slaney, *Principles of Computerized Tomographic Imaging*, SIAM's Classics in Applied Mathematics, Philadelphia, SIAM, 2001.
4. Kline Jacob, *Handbook of Biomedical Engineering*, Academic Press, 1988.
5. Carol M. Rumack, Deborah Levine, Diagnostic Ultrasound, 5Th Edition, Elsevier, 2017.
6. Thomas L. Szabo, Diagnostic Ultrasound Imaging: Inside Out, 2nd Edition, Elsevier, 2014.
7. James A. Zagzebski, Essentials Of Ultrasound Physics, 2nd Edition, Mosby, 2010.
8. Barbara S. Hertzberg, William D. Middleton, Ultrasound: The Requisites, EBook (Requisites in Radiology), 2015.
7. HH Schild, "MRI made easy", Schering AG, Berlin, 1990.

BME 4059 ARTIFICIAL NEURAL NETWORKS [3-0-0-3]

COs:

1. Understand the basics of Artificial neural network and Learning approaches.
2. Understand and design supervised and unsupervised artificial neural networks.
3. Acquire the skills for training and testing of the artificial neural network
4. Ability to identify the necessity of appropriate Neural network and its performance in different applications

Syllabus:

Introduction; Review of Linear Algebra: projection of a vector, eigen and singular value decomposition, gradient vector and Hessian matrix of a vector function, Taylor expansion of a vector function. Pattern and data, Biological foundations of neural network, Components and topology of artificial neural network. Basic network properties: Activation functions, computational properties of nodes, learning methods, Training and Testing. Single layer networks, Feed forward neural networks, Supervised Learning networks, Multilayer neural networks, Associative memory networks, training algorithm for pattern association, pattern correction, pattern retrieval, Feedback neural networks, analysis of pattern clustering, Attractor neural network, Unsupervised learning network: Maxnet, Kohonen Self-organizing feature Map and Special networks. Functional units of ANN for object recognition, Neural network for Medical diagnosis: Bio-signal Analysis, recognition of diagnostic information from brain MRI images, ANN for digital pathology application.

References:

1. D L Hudson and M E Cohen, "Neural Networks and Artificial Intelligence for Biomedical Engineering", IEEE Press Series on Biomedical Engineering, IEEE Press, IEEE Publications, U .S, 2000.
2. S. N. Sivanandam, and S. N. Deepa, "Principles of Soft Computing", Wiley India Pvt. Ltd., New Delhi, 2011.
3. Simon O. Haykin , "Neural Networks and Learning Machines" , 3rd Edition, Perason, Prentice Hall, New Delhi, 2009
4. S. N. Sivanandam, S. Sumathi and S. N. Deepa, "Introduction to Neural Networks using MATLAB 6.0", TATA McGRAW HILL, New Delhi, 2006.
5. B Yegnanarayana, Artificial Neural Networks, Prentice Hall India, New Delhi,2001.
6. Sara Moein, "Medical Diagnosis Using Artificial Neural Networks", IGI Publications, USA,2014

7. Emmanuel C. Ifeachor, Piotr S Szczepaniak, Paulo J. G. Lisboa, "Artificial Neural Networks In Biomedicine", Springer-Verlag London, 2000.

BME 4060 BIOPHOTONICS [3-0-0-3]

COs:

1. Possess knowledge about the emerging field of biophotonics.
2. Knowledge about the optics based technologies
3. Ability to apply the bio sensing, imaging and cell manipulation techniques to life sciences

Syllabus:

Basics of Biology: Structure and types of cells, chemical building blocks, Cellular processes, Protein classification and function, Organization of cells into tissues, Types of tissue and their functions, Tumors and Cancers.
Photobiology: Interaction of light with cells, Interaction of light with tissues, Photo process in biopolymers.

Biomedical Optics with instrumentation: Photo-excitation and Spectroscopy, Molecular Spectroscopy; UV/VIS absorption, FTIR, Raman, Different types of Raman, Fluorescence, Time-resolved Photo-acoustics, Single molecule detection etc.
Bio imaging: Principles and techniques: Transmission microscopy, Fluorescence microscopy, scanning microscopy, Inverted and upright microscopy, Confocal microscopy, Multi-photon microscopy, Optical Coherence Tomography, near field optical microscopy, Spectral and time resolved imaging, Non-linear optical imaging and applications.
Optical Biosensors: Bio-recognition, Optical transduction, Fluorescence sensing, Fiber Optic Biosensors, Planar waveguide Biosensors, Evanescent-wave biosensors, Interferometric biosensors, Surface-plasmon-resonance biosensors, Recent novel sensing methods.
Tissue Engineering with light: Laser tissue contouring and restructuring, Laser tissue welding and regeneration, Femtosecond laser surgery, Future Directions, Optical Tweezers: Manipulation by light, Principle and design of laser tweezers, Optical trapping using non Gaussian beams, Raman-Optical Tweezers, Laser Scissors, Applications.
Microarray Technology for genomics and proteomics, Flow cytometry, Nano-Bio-Photonics and Biomaterials for Photonics.

References:

1. Paras N Prasad, "Introduction to Biophotonics," John Wiley & Sons, Inc, USA, 2003.
2. P. Narayanan, "Essentials of Biophysics," New Age International Ltd., New Delhi, India 2000.
3. V.B. Kartha and C. Santhosh, "Biomedical Spectroscopy", Manipal University Press 2014.

BME 4061: BIOSTATISTICS [3 0 0 3]

COs:

1. Understand the role of biostatistics in medical studies
2. Identify appropriate tests to perform hypothesis testing.
3. Interpret the outputs of the tests adequately
4. Apply appropriate statistical procedures and interpret the results.

Syllabus:

Introduction, Summarizing Quantitative Data, Summarizing Categorical Data; Prevalence, Incidence, Relative Risk, Risk Difference, Sampling Bias, Confidence Intervals, Study Design, Probability & Screening; Probability distributions: Binomial & Normal Distributions, Sampling Distributions, Confidence Intervals.

Hypothesis Test: Introduction, One-sample proportion, Chi-square test, t tests, Continued MCW, Power and Sample Size.

Correlation & Regression, Multiple Regression, Regression to the Mean MCW.

Refernces:

[1] Sullivan, L.M., Essentials of biostatistics for the health sciences, 3rd Edition, Jones & Bartlett Learning, 2018.
[2] Machin, Campbell and Walters, Medical Statistics, 4th ed., Wiley, 2007.
[3] Motulsky, H., Intuitive Biostatistics: A nonmathematical guide to statistical thinking, 3rd Edition, Oxford University Press, New York, 2014.
[4] Utts, J and Heckard, R., Mind on statistics, 5Th Edition, Cengage Learning, USA.

BME 4062 CONTROL SYSTEMS [3-0-0-3]

COs:

1. Model electrical and mechanical systems and deduce equations
2. Analyze the performance of linear time-invariant systems.
3. Determine the absolute and relative stability of linear systems from their frequency response.

Syllabus:

Introduction to feedback control systems, Mathematical modeling of electrical, mechanical and electromechanical systems, Analogous Systems Concept of transfer functions, Block diagrams and simplification, Signal flow graphs, time domain analysis, derivations of time domain specifications for second order systems. Steady State Errors, BIBO stability, Routh-Hurwitz criteria, Root Locus Techniques, construction of the root locus diagram, Interpretation of system response from these plots. Bode plots, gain margin and phase margin, polar plots, Nyquist stability criterion.

References:

1. John J.D'Azzo and Constantine H. Houpis, *Feedback control system analysis and synthesis*, McGraw Hill New-York, 2007.
2. Nagrath and Gopal, *Control Systems engineering, (2e,)* New Age International (P) Limited, 2001.
3. R.C Dorf and R.H Bishop, *Modern Control Systems, (8e),* Addison- Wesley Longman Inc.,1998.
4. K. Ogata, *Modern control engineering, (3e),* Prentice Hall India, 2002.
5. B.C. Kuo, F. Golnaraghi, *Automatic Control Systems, (8e),* Wiley India, 2003.

BME 4063 DRUG DELIVERY [3-0-0-3]

COs:

1. An ability to distinguish conventional dosage forms and controlled release system, and the importance of controlled drug release.
2. Understand the fundamental aspects of drug release, pharmacokinetics and pharmacodynamics.

3. Understand the uses of various drug delivery matrices and ability to exploit materials in designing drug delivery carriers and Vaccines.
4. Understand the key issues to deal with drug targeting

Syllabus:
Drug delivery system: overview, dosage form-tablet, capsule, parenteral etc. classification of drug delivery system, chemically controlled system, diffusion controlled system, controlled release mechanism- Membrane reservoir system, Matrix system, swelling controlled release system, biodegradable controlled release system

Fundamental aspects of drug delivery: introduction of pharmacokinetics and pharmacodynamics, diffusive transport, diffusion in heterogeneous system, passage of drug through membrane drug release kinetics from different biopolymer matrices

Pharmacokinetics: common routes of systemic drug administration, drug absorption, bioavailability, determinants of bioavailability- disintegration, dissolution, drug distribution, drug elimination.

Matrix based drug delivery system: Delivery materials, polymer based matrices; hydrogels- drug carriers, transdermal and trans-mucosal drug delivery system, measuring in vitro diffusions, measuring controlled release kinetics, drug targeting approaches, biocompatibility aspects of matrices

Immunity and immunological preparations: immunity, types, immunological preparations; bacterial vaccines, vaccines containing living viruses, vaccines containing toxoids
Fundamentals of vaccine delivery

References:

1. B. Wang, T. J. Sahaan, R. A. Soltero, Drug Delivery: Principles and applications, John Wiley & Sons Inc., 2016.
2. L Shargel, S Wu-Pong, A Yu, Applied Biopharmaceutics& Pharmacokinetics, 6Th Edition, The McGraw Hill, 2005.
3. S. Rosenbaum, Basic Pharmacokinetics and Pharmacokinetics, Wiley, 2011.
4. Juergen Siepmann, Ronald A. Siegel, Michael J. Rathbone (Editors), Fundamentals and Applications of Controlled Release Drug Delivery, Springer, 2012.
5. Eric P. Holowka, Sujata K. Bhatia, Drug Delivery-Materials Design and Clinical Perspective, Springer, 2014.
6. David Williams, Essentials of Biomaterials Science, Cambridge University press, 2014.

BME 4064 EMBEDDED SYSTEMS [3-0-0-3]

COs:
1. Understand basic requirements of an embedded system as compared to general computing systems.
2. Select processors and communication protocols and build appropriate hardware for small scale embedded systems.
3. Write embedded programs in assembly language and in embedded C for an embedded processor.
4. Appreciate RTOS and understand different real-time scheduling algorithms.
5. Manage embedded system development projects.

Syllabus:
Introduction to Embedded systems, processor and memory organization, Devices, Serial & Parallel buses for device networks, Device drivers and interrupt servicing mechanisms. Programming concepts, and embedded programming in C. Real-Time Operating systems and Task Scheduling algorithms. Hardware

Software Co-simulation: Co-simulation approaches, Embedded System Development Life Cycle (EDLC). Representative Embedded systems.

References:

1. Peckol James K, "Embedded Systems" John Wiley and Sons, New Delhi, 2013.
2. Valvano Jonathan W, "Embedded Systems", Jonathan W.V, U. K., 2014.
3. Frank Vahid and Tony Givargis, "Embedded system Design – A Unified Hardware/Software Introduction", Wiley India Pvt. Ltd, 2014.
4. Tim Wilmshurst, "An Introduction to the design of Small Scale Embedded Systems" Palgrave, New York, 2003.
5. Shibu K.V, "Introduction to Embedded Systems", TMH, New Delhi, 2010.

BME 4065: FUZZY LOGIC SYSTEMS [3-0-0-3]

COs:

1. Explain the fundamentals of Fuzzy Sets and Fuzzy Logic
2. Identify different types of Membership function for Type - I & II Fuzzy systems.
3. Design the Type - I & II Fuzzy Logic systems.

Syllabus:

Introduction to Fuzzy Sets and Fuzzy Logic: Crisp Sets, Fuzzy Sets, Linguistic variables, Membership functions, Set theory operations on Crisp and Fuzzy sets, Relations and Compositions, Hedges, Extension Principles, Crisp logic, Fuzzy logic, Sources of Uncertainty, small applications. Membership functions: Type-1 Membership functions, Type-2 Membership functions, Multivariable Membership functions, Case studies. Singleton and Non-Singleton Type-1 Fuzzy logic systems: Introduction, Rules, Fuzzy Inference Engine, Fuzzification and its effect on Inference, Defuzzification, Fuzzy basis functions, Universal approximators, Designing FLSs, Case studies. Type-2 Fuzzy Sets: Operations on and Properties of Type-2 Fuzzy Sets, Type-2 Relations and Compositions, Type reduction. Type-2 Fuzzy Logic Systems: Singleton Type-2 FLSs, Type-1 Non-singleton Type-2 FLSs, Type-2 Non-singleton Type-2 FLSs, Respective Case Studies.

References

1. Jerry M. Mendel, Uncertain Rule-based Fuzzy Logic System: Introduction and New Directions, Springer; 2nd Edition, 2017.
2. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley, 3rd Edition, 2011.
3. George J. Klir, Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, Facsimile Edition, 1995.

BME 4066: GAIT ANALYSIS [3-0-0-3]

COs:

1. Explain the fundamentals of Biomechanics of GAIT
2. Identify different Pathological gait deviations.
3. Analyze the Normal and Abnormal Gaits using Quantified Gait Analysis.

Syllabus:

Fundamentals of Human Gait: Gait cycle, Phase of Gait, Basic functions. Normal Gait Analysis: Ankle-Foot Complex, Foot support patterns, Ankle, Foot, Knee, Hip, Head, Trunk and Pelvis, Arm Gait Dynamics

and their functional Interpretation. Pathological Gait Analysis: Pathological Mechanisms, Ankle and Foot, Knee, Hip Trunk and Pelvis Gait Deviations. Clinical Considerations: Examples of Pathologic Gait, Weakness, Pain - Osteoarthritis, Stroke, Amputations. Advanced Locomotor Function: Stair Negotiation - Stair Ascent, Stair Descent; Running - Terminology and Timing of Running. Quantified Gait Analysis: Gait Analysis Systems, Motion Analysis, Muscle Control and Dynamic EMG, Kinetics of Gait Ground Reaction, Stride Analysis.

References:

1. Perry, J., Burnfield J M., Gait Analysis: Normal and Pathological Function, SLACK Incorporated, 2nd Edition, 2010.
2. Michael Whittle, An Introduction to Gait Analysis, Butterworth-Heinemann Ltd, 4th Edition, 2006.

BME 4067 OBJECT ORIENTED PROGRAMMING [3-0-0-3]

COs:

1. Understand the procedure oriented and object oriented programming paradigms
2. Develop skills to implement class, independent and reusable modules
3. Enhance problem solving skills with the concept of operator overloading and Inheritance
4. Understand the Polymorphism, and handling of files

Syllabus:

Introduction to fundamental concepts of programming language, Object Oriented Programming paradigm, Characteristics of object oriented languages. Classes and Objects: Class specification, Class objects, Accessing Class Members, Static members, Constructors and Destructors, Parameterized constructors, Multiple Constructors, Friend function. Operator Overloading & Type conversion: Defining operator overloading, Overloading Unary and Binary operators, Overloading using friend function, Type conversion: Basics to class type, class to basic type and class to another class type. Inheritance: Derived class and base class, Types of inheritance, Levels of Inheritance, Single inheritance, Multiple Inheritance, Hierarchical inheritance and Hybrid inheritance. Polymorphism: Virtual Functions: Pure function, Friend classes. Files and Exception Handling: Classes for file stream operation, Opening and closing a file, file modes, file pointers and manipulators. Exception handling mechanism: throwing, catching and re-throwing. Graphics: Text mode graphics, Graphics mode, Graphics functions, colors, Rectangles and lines, Polygons and Inheritance, sound and motion, Text in graphics mode. Object oriented system development: Introduction, Steps in object oriented design.

References:

1. E. Balagurusamy, "Object Oriented Programming with C++", 6th Edition, Tata McGraw-Hill Education Pvt. Ltd, New Delhi, 2013.
2. Robert Lafore, "Object Oriented Programming in Turbo C++", 3rd Edition, Galgotia Publications Pvt. Ltd., New Delhi, 2006.
3. Stanley B. Lippman, Josee Lajoie, Barbara E Moo, "C++ Primer", 5th Edition, Addison-Wesley Professional, 2012.
4. Herbert Schildt, "The Complete Reference C++", 4th Edition, TMH, New Delhi, 2004.

BME 4068 PATTERN RECOGNITION [3-0-0-3]

COs:

1. Understanding the principles and concepts of the basic pattern recognition system
2. Understand the design of Parametric Classifiers
3. Develop skills for finding the clusters
4. An appreciation of Artificial Neural Network as a classifier
5. Ability to identify the necessity of appropriate classifiers in different applications

Syllabus:

Introduction to Pattern Recognition (PR) system; Application domains, Feature, Feature space, Class, Feature vector, Classifier, Classification and approaches, Design cycle; Linear Regression, Logistic Regression & General Linear Model; Introduction to Statistical decision making, Bayesian Decision Theory: continuous and discrete features, Multiple features, conditionally independent features, Maximum likelihood estimation, Decision boundaries, unequal costs of error, Estimation of error rates, the leaving one-out technique. Non-Parametric Techniques: K-nearest neighbourhood estimation, clustering: Hierarchical clustering, Agglomerative clustering algorithm, Single, Average and Complete linkage algorithms, Partitional clustering, K means, Ward's algorithm, Problems. Gaussian Mixture Models – with Expectation Maximization algorithm, Principal Component Analysis; Introduction to Neural Networks; performance analysis of a classifier.

References:

1. Earl Gose, Richard, Johnson Baugh and Steve Jost, "Pattern recognition and Image analysis", Prentice Hall, New Delhi, 2002.
2. Schalkoff Robert J, "Pattern recognition", John Wiley & Sons, New York, 1992.
3. Richchard O Duda, Peter E. Hart, David G. Strok, "Pattern Classification", 2nd Edition, Wiley, Singapore, 2005.
4. S. N. Sivanandam, S. Sumathi and S. N. Deepa, "Introduction to Neural Networks using MATLAB 6.0", TATA McGRAW HILL, New Delhi, 2006
5. S. N. Sivanandam, and S. N. Deepa, "Principles of Soft Computing", 2nd Edition, Wiley India Pvt. Ltd, New Delhi, 2011
6. Sara Moein, "Medical Diagnosis Using Artificial Neural Networks", IGI Publications, USA,2014
7. Volker Schmid Anke Meyer-Baese Schmid Meyer-Baese "Pattern Recognition and Signal Analysis in Medical Imaging", 2nd Edition, Academic Press, 2014.

BME 4069: PHYSIOLOGICAL CONTROL SYSTEM [3-0-0-3]

COs:

1. Demonstrate thorough knowledge of technological control system concepts.
2. Interpret the physiological signals, to design a suitable control system model.
3. Ability to analyze physiological control systems.
4. Apply the principles of control systems to the physiological signals.

Syllabus:

Introduction to physiological modeling: Introduction; Multi-scale organization of living organisms: cell to organ Homeostasis. Examples of physiological control systems. Review of linear systems concepts, Fourier series: Modeling signals using Fourier series, Deterministic and stochastic signals and systems. **Mathematical tools:** Basic concepts of control systems; Open vs. closed loop Steady state and transient analysis of control systems. Linear models vs nonlinear models Distributed vs. lumped parameter models

Compartment models. **Cardiovascular and Respiratory system:** Circulatory system. Key events in the cardiac cycle. Blood pressure and flow, vascular impedance. Lumped parameter models, windkessel model of circulation Cardiac mechanics. Respiratory mechanics, lung models. **Nervous system:** Anatomy and physiology of nerves Action potentials, Hodgkin-Huxley model. **Musculoskeletal system:** Muscle anatomy and physiology. How muscles contract, Hill model of muscle contraction, Muscle stretch reflex**. Eye Movement Model:** Types of Eye movement, Eye movement system and Wetheimer's saccade eye model. Robinson's Model, Oculomotor muscle model, Linear Reciprocal Innervations Oculomotor Model.

References:

1. Michael C. K. Khoo, Physiological Control Systems: Analysis, Simulation and Estimation, Wiley IEEE Press, 1999.
2. John D. Enderle, "Model of Horizontal eye movements: Early models of saccades and smooth pursuit", Morgan & Claypool Publishers, 2010.

BME 4070 TELEMEDICINE [3-0-0-3]

Cos:

1. Describe the benefits of Telemedicine & the fundamentals of communication and the technology required for Telehealth services.
2. Describe the amplitude and frequency modulation techniques used for the transmission of analog signals.
3. Discuss the digital modulation techniques and the various multiplexing techniques and networks available for telecommunication.
4. Discuss the various data security issues, standards and the 'ethical & legal aspects of telemedicine, along with various applications of Telemedicine.

Syllabus:

History of Telemedicine, Block diagram of telemedicine system, origin and development of Telemedicine, Benefits and limitations of Telemedicine; Data & Signal, transmission impairments & channel capacity, Guided & Unguided transmission media, transmission of digital signal and analog signal: Analog modulation techniques: AM & FM, analog to digital conversions and digital modulation techniques like ASK, FSK, PSK and DPSK; Multiplexing techniques: TDM & FDM, Multiple access techniques: TDMA, FDMA & CDMA; Types of Network; Switching techniques: Circuit switching and Packet switching; Reference models: OSI model & TCP/IP; Types of wireless network like Bluetooth, Wi-Fi, Zig Bee, Satellite network etc.; Data Security and Standards: Encryption, Cryptography, digital signature, biometric security; Ethical and legal aspects of Telemedicine; Applications of Telemedicine: Teleradiology, telepathology, teleoncology, and other applications including videoconferencing.

References:

1. Behrouz A Forouzan, "Data Communication and Networking", McGraw Hill Education (India) Pvt. Ltd., 5th Edition, 2013.

2. Bernard Fong, A.C.M. Fong, C.K. Li, "Telemedicine technologies: Information technologies in Medicine and telehealth", John Wiley & Sons, UK, 2011.

3. Olga Ferrer-Roca, M.Sosa Ludicissa, Handbook of Telemedicine, IOS Press 2002.

4. Konstantina S.Nikita, Handbook of Biomedical Telemetry, John Wiley & Sons, 2014.

5. A.C. Norris, Essentials of Telemedicine and Telecare, John Wiley & Sons, 2002.

6. R S Khandpur, "Telemedicine technology and applications", PHI Learning Pvt. Ltd, New Delhi, 2017.

BME 4071 TISSUE ENGINEERING [3-0-0-3]

COs:

1. Understand fundamental aspects of cellular behavior and tissue engineering.
2. Basic understanding of cell signaling, homeostasis, stem cells.
3. Understand the design aspect of polymeric scaffolds.
4. Understand the key issues to deal with cell/tissue culture and correlation with matrix and cellular behavior.

Syllabus:

Introduction: Basic definition, Structural and organization of tissues: epithelial, connective tissues. Sterilization Process: Introduction, different sterilization methods: physical, chemicals; applications. Morphogenesis, Generation of Tissue in the Embryo: introduction, different germ layers, cardiac cell development, blood vessels development, skin tissue development; development of bone and cartilage, future development. Cellular Signaling: introduction, cellular signaling in skin, bone cartilage biology; understanding and implementing principles of cell signaling in tissue engineering. Stem Cell: introduction, types, self-renewal, differentiation, embryonic stem cell: isolation, properties; adult stem cells: isolation, properties, stem cell niche, future perspective. Cell and Tissue Culture: introduction, cell harvest, selection, expansion, differentiation, co-culture, source, types of tissue culture (animal), cell lines, culture media, maintenance of cell in vitro. Scaffolds: polymer, natural polymer for tissue engineering, degradable materials, various type of scaffold, cell –matrix interaction, ECM. Methods to monitor tissue re-modeling Engineering tissues (like skin, cartilage, bone).

References:

1. Satya Prakash, D.S. Tim, Stem cell bioengineering and tissue engineering microenvironment, World Scientific, 2012.
2. Endarle, Blanchard & Bronzino, Introduction to Biomedical Engineering, Academic press, 1998.
3. C.W. Patrick Jr., A. G. Mikos, L.V. Mcintire, Frontiers in tissue engineering, Pergamon, Elsevier, 1998.
4. C.V. Blitterswijk, Tissue Engineering, Academic Press, 2008.
5. B.O. Palsson and S N Bhatia, Tissue Engineering, Pearson Prentice Hall, 2004.
6. David Williams, Essentials Biomaterials Science, Cambridge University Press, 2014.
7. Julia Polak,(Ed), Advances in Tissue Engineering, Imperial College Press, 2008.

OPEN ELECTIVES:

BME 4301: BIOMEDICAL INSTRUMENTATION [3 0 0 3]

COs:

1. Comprehension of the concepts of transduction, and a good knowledge of their applications.
2. Familiarity with electrodes and amplifiers used in the acquisition of physiological signals.
3. An insight into the origin of physiological signals, and the instrumentation relevant to certain diagnostic measures.
4. Knowledge of basic instrumentation relevant to certain therapeutic measures and awareness of the elements of risk in the use of medical instruments, and the precautionary measures required for basic electrical safety.

Syllabus:

Biomedical transducers: Classification and Selection; Pressure Transducers: Resistive, capacitive, Inductive transducers & Piezo-electric, Photoelectric transducers & its types; Thermal transducers & its types; Electrodes & Amplifiers: Principles of working and their characteristics, Half- cell potential, Types of electrodes, Electrode-Electrolyte model, Amplifiers for biomedical instrumentation; Physiological Signals & Measurements: Basics of ECG, EMG, EEG, PCG, blood pressure & blood flow and the instrumentation for measuring these signals; Cardiac Pacemakers: Types of pacemakers, Modes of triggering, Pacemaker power supplies, pacemaker codes; Defibrillators: AC and DC defibrillators, Types of electrodes and their features, cardioverters; Lasers: Basic principles, types of lasers and their medical applications; X-ray systems, Fluoroscopic system, principles of tomography; Electrical Hazards & Safety: Safety code standards, Micro and Macro shock and its physiological effects, Methods of electrical safety.

References:

1. John G Webster, "Medical Instrumentation Applications and Design", John Wiley and Sons, New York, 3rd Edition, 2011.
2. R S Khandpur, "Handbook of Biomedical Instrumentation", McGraw Hill, Delhi, 3rd Edition, 2014.
3. L A Geddes, L E Baker, "Principles of Applied Medical Instrumentation", Wiley India, New Delhi, 3rd Edition, 2008.
4. Richard Aston, "Principles of biomedical Instrumentation and measurement", Merrill, New York, 1991.
5. Joseph J Carr, John M Brown, "Introduction to Biomedical Equipment technology", Prentice Hall, New Jersey, 4Th Edition, 2003.

BME 4302 BIOMECHANICS [3-0-0-3]

COs:

1. Develop a basic understanding of the biomechanics of human movement and also the skeletal considerations for human movement.
2. Develop an understanding of the biomechanics of human skeletal muscle and articulation.
3. Determine the kinematic quantities (both linear and angular form) that causes the human motion.
4. Apply the principles of aerodynamics and hydrodynamics in various sport activities

Syllabus:

Basic terminology, Anatomical movement descriptors. Skeletal considerations for movement: Composition & Structure of bone, mechanical properties of bone, bone fracture & failure mechanics. Muscular considerations for movement: Skeletal muscle tissue properties, function and structure, Force generation in the muscle, Role of muscle, Force-velocity relationships in skeletal muscle, Joint flexibility. Fundamental concepts of gait. Linear Kinematics: kinematic parameters, projectile motion, linear

kinematics of walking and running. Angular Kinematics: types of Angles, lower extremity joint angles, angular motion relationships, relationship between linear and angular motion, angle-angle diagrams. Linear Kinetics: laws of motion, types of forces, representation of forces acting on a system. Angular Kinetics: Newton's laws of motion (angular analogs), center of mass calculation, rotation and leverage, pulley system, analysis using Newton's laws of motion. Application of Aerodynamics in Sports: aerodynamic drag force - effects of drag on the body and objects in sport- activities, aerodynamic lift force - lift force acting on shapes and surfaces, effects of lift on projected objects, the Magnus effect. Application of Hydrodynamics in Aquatics: buoyancy and floatation, floating ability of the human body, types of floaters, different floating positions of the human body, resistive & propulsive forces in swimming skills, Swimming efficiency and speed.

References:

1. Joseph Hamill and Kathleen M. Knutzen, Biomechanical Basis of Human Movement, Lippincott Williams & Wilkins, Fourth Edition, 2014, Philadelphia, USA.
2. Susan J. Hall, Basic Biomechanics, McGraw-Hill International Editions, Seventh Edition, 2014, Singapore.
3. Peter M. McGinnis, Biomechanics of Sport and Exercise, Human Kinetics, Third Edition, 2013, USA.
4. P. Grimshaw and A. Burden, Sport & Exercise Biomechanics, Taylor & Francis Group, First Edition, 2007, UK.
5. Ellen Kreighbaum, Katharine M Barthels, Biomechanics-A Qualitative Approach for studying Human Movement, Allyn and Bacon Publishers, Fourth Edition, 1995, USA.

BME4303 REHABILITATION ENGINEERING [3-0-0-3]

COs:

1. Understand the need and importance of the rehabilitation engineering for the society in general.
2. Decide what are the different categories of rehabilitation needed for the society.
3. Understand different stages through which rehabilitation has to be implemented on case to case basis.
4. Develop the technical aspect of individual rehabilitation cases – to the identified cases.
5. Practical experience to this socially important field of engineering.

Syllabus:

Introduction to rehabilitation engineering and assistive technology: principles, engineering concepts in sensory rehabilitation, motor rehabilitation and communication disorders. Orthopedic prosthetics & orthosis in rehabilitation technology: fundamentals of design of upper and lower extremity prosthetic and orthotic devices, applications. Mobility aids: mobility aids for the blind, discussion of design and function of robotic aids, wheel chairs. Sensory augmentation & substitution: visual, auditory and tactile sensory augmentation & substitution. Conversion aids for non-vocal physically impaired persons: characteristics and design considerations for conversion aids, biofeedback in communicative disorders, artificial larynx. Principles and applications of electrical stimulation: artificial electrical stimulation of nerves and muscles, applications. Conceptual frameworks, education and quality assurance.

References:

1. Joseph D. Bronzino and Donald R. Peterson, "The Biomedical Engineering Handbook", volume II, CRC press, fourth edition, 2015.
2. John G. Webster, Albert M. Cook, Willis J. Tompkins, Gregg C. Vanderheiden, "Electronic devices for Rehabilitation", John Wiley & Sons Inc, second edition, 1989.

3. John Enderle and Joseph Bronzino, "Introduction to Biomedical Engineering", academic press, third edition, 2011.
4. Rory A. Cooper, "An introduction to Rehabilitation Engineering", Taylor and Francis Inc, first edition, 2007.

MAT 4051 APPLIED STATISTICS AND TIME SERIES ANALYSIS [2-1-0-3]

COs:

1. To make the students understand the mathematical and statistical tools to analyze real and experimental data
2. To develop the skills needed to do empirical research in fields operating with data sets
3. To provide students with techniques for estimation and assessment of models with time series data
4. Students should be able to critically review and evaluate time series models and choose the best modeling approach
5. Able to apply the knowledge on real world time series and forecast problems

Syllabus:

Stochastic and deterministic dynamic mathematical models – forecasting and control, transfer function models, models for discrete control systems. Basic ideas in model building- linear and multiple linear regression

Basic concepts in stochastic processes and Markov chains, Mean square distance, mean square error prediction, prediction of covariance stationary process, ergodic theory and stationary process, applications of ergodic theory, spectral analysis of covariance stationary processes, Gaussian systems, stationary point processes, level crossing problems.

ARIMA models, Autoregressive models, moving average models, duality, model properties, parameter estimates, forecasts.
Volatility models: ARCH and GARCH modelling, testing strategy for heteroscedastic models, volatility forecasts, Black Scholes model.

Reference Books:

1. G.E.P. Box, G. M. Jenkins, G. C. Reinsel and G M Ljung, *Time Series Analysis-Forecasting and Control*, 5th Edition, Wiley Series, 2016.
2. Anderson T W, *The Statistical Analysis of Time Series*, John Wiley, New York, 1994
3. Samuel Karlin, Howard M Taylor, *First Course in Stochastic process*, Academic Press, New York,
4. C. Chatfield, *The Analysis of Time Series – An Introduction*, Chapman and Hall / CRC, 4th Edition, 2004
5. David Ruppert, *Statistics in Finance*, Springer Publications, 2004

MAT 4052 – COMPUTATIONAL LINEAR ALGEBRA [2-1-0-3]

COs:

1 Gain insight into why solution of linear systems is so fundamental in applied mathematics.

2 Be able to distinguish and analyze a variety of tools that exist for solving linear systems and finding eigenvalues of these systems.

3 Be able to evaluate when a problem should be solved using a direct or iterative method and what the advantages, disadvantages, and costs are for these methods.

4 Understand the way in which error in data can corrupt the solution and, therefore, how much confidence one can place in the solution that is obtained.

Syllabus:

Matrix Analysis: Basic Ideas from Linear algebra, vector norms, matrix norms, orthogonality and SVD, Projections and CS decomposition, The sensitivity of square linear systems.

General Linear Systems: Triangular systems, The LU factorization, Round off analysis of Gausian elimination, Pivoting, Improving and estimating accuracy.

Orthogonalization and least squares: Householder and Givens matrices, The QR factorization, The full rank LS problem, Other orthogonal factorizations, The rank deficient LS problem, Weighing and iterative improvement, square and underdetermined systems.

The symmetric Eigen value problem: Eigen values properties and decompositions, Power iterations, the symmetric QR algorithm, Jacobi methods, Tridiagonal Methods, Computing the SVD, some generalized eigen value problems.

References:

1. Gene H. Golub and Charles F. Van Loan, *Matrix Computations*, 4th edition, Johns Hopkins University Press, 2013.
2. Gilbert Strang, *Linear Algebra and its applications*, 4th edition, Wellesley Cambridge press, 2009.
3. David S. Watkins, *Fundamentals of Matrix Computations*, 3rd edition Wiley, New York, 2010.
4. Roger a Horn, *Matrix Analysis*, 2nd Edition, Cambridge University Press, 2013.

MAT 4053 COMPUTATIONAL PROBABILITY AND DESIGN OF EXPERIMENTS [2-1-0-3]

COs:

1. Present theory and techniques of statistical inference in a logically integrated and practical form
2. Different aspects of statistical inference such as testing of hypothesis, experimentation and problem of identification would be discussed based on the framework of the chosen model
3. The adequacy of the proposed models would be checked based on the available facts.

Syllabus:

Sampling and sampling distributions, Most powerful tests, Uniformly most powerful tests, Likelihood ratio tests, The sequential probability ratio test, Randomized Designs, Inferences about the differences in Means, Paired Comparison Designs, Inferences about the variance of normal distributions,

Monte Carlo estimation methods

The analysis of variance, RCBD, LSD and Related Designs, The Graeco - Latin square Design, Balanced Incomplete Block Designs, PBIBD

Introduction to Factorial Designs, The Two Factor factorial design, Blocking in a factorial design, 2^k Factorial Design, Blocking and Confounding in the 2^k Factorial Design, Partial Confounding

Two level fractional factorial designs, three level and mixed level factorial and fractional factorial designs, 3^k Factorial Design, Confounding in the 3^k Factorial Design, Fractional replication of the 3^k Factorial Design, Factorials with mixed levels.

References:

1. Robert V Hogg and Allen Craig, *Introduction to Mathematical Statistics*, 4th Edition, Macmillan
2. M N Murthy, *Sampling Theory and Methods*, Statistical Publishing Society, 1967
3. C Radhakrishna Rao, *Linear Statitical Inference and its applications*, 2nd Edition, Wiley Series.
4. Douglas C Montgomery, *Design and Analysis of Experiments*, 8th Edition, Wiley Series, 2012,
5. D D Joshi, Linear Estimation and Design of Experiments, New Age International Publishers, 2009

MAT 4054: GRAPHS AND MATRICES [2-1-0-3]

COs:

1. To understand the basic concepts of graph theory, special classes of graphs, and their properties and operations
2. Analyse and characterise trees and connectivity and traversability of graphs and networks
3. Demonstrate understanding of planarity and colouring of graphs and maps, and characterise graph properties using incidence matrices
4. Determine the adjacency eigen values of graphs, and analyse basic graph properties using adjacency matrices
5. Compute the Laplacian eigen values and use these to determine connectedness and number of spanning trees of graphs.

Syllabus:

Graphs and subgraphs, walks, paths and connectedness, distance as a metric, degrees, regular graphs, cubic graphs, bipartite graphs, self-complementary graphs, operations on graphs, extremal graphs, cut points, bridges and blocks, block graphs and cut point graphs.

Trees and their characterizations, centres and centroids, block-cut point trees, spanning trees, independent cycles and cocycles, connectivity and line connectivity, graphical variations of Menger's theorem.

Traversability: Eulerian graphs and Hamiltonian graphs. Line graphs and total graphs. Line graphs and traversability, coverings and independence, critical points and lines.

Planarity: Plane and planar graphs, outer planar graphs, Kuratowski's theorem, vertex colouring.

Incidence Matrix: Rank, minors, path matrix, 0-1 incidence matrix.

Adjacency Matrix: Eigen values of some graphs, determinant, bounds, energy of a graph, antiadjacency matrix of a directed graph, non-singular trees.

Laplacian Matrix: Basic properties, computing Laplacian eigen values, matrix tree theorems, bounds for Laplacian spectral radius, edge-Laplacian of a tree.

Refernces:

1. F. Harary, *Graph Theory*, Narosa Publishers, 1988.
2. J.A Bondy and U.S.R Murthy, *Graph Theory with Applications*, Fifth Edition, Elsevier Publishing Co., 1982.
3. D.B. West, *Introduction to Graph Theory*, Pearson Education, Inc., 2001.
4. R.B Bapat, *Graphs and Matrices*, Hindustan Book Agency, 2010.
5. Lowell W Beineke and Robin J Wilson, *Topics in Algebraic Graph Theory*, Cambridge University Press, 2005.

HUM 4051 FINANCIAL MANAGEMENT [2 1 0 3]

COs:

1. Comprehend the basic functions and responsibilities of a financial department in a business/firm.
2. Apply the accounting principles and prepare financial statements.
3. Analyze the nature of various financing choices.
4. Evaluate and make decisions regarding investments and funding alternatives.
5. Estimate an optimum working capital requirement.

Syllabus:

Introduction and objectives of financial management, Evolution of corporate finance and its responsibilities. Types of accounts, Golden rules of accounting, Preparation of journal, Ledger, Trial balance and final accounts. Sources of long term finance, Characteristics of equity capital, Preference capital, Debenture capital & Term loans. Valuation of securities, Concepts, Bond valuation and related models, Bond value theorems, Yield to maturity. Equity valuation; Dividend capitalization approach, Leverage, Operating leverage, Financial leverage, Total leverage, Indifference point analysis. Working capital management, Capital budgeting: appraisal criteria, pay-back period, Average rate of return, Net present value, Benefit cost ratio and internal rate of return. Risk analysis in capital budgeting, Cost of capital: introduction, cost of debt capital, Preference capital and Equity capital, Weighted average cost of capital, Determination of proportions, Cash management, and Dividend decisions.

References:

1. Prasanna Chandra (2006), "Fundamentals of Financial Management", *Tata McGraw Hill, Delhi.*
2. I M Pandey (2007), "Financial Management", *Vikas Publishing house, Delhi.*
3. Subir Kumar Banerjee (1999), "Financial Management", *Sultan Chand & Co., Delhi.*
4. ICFAI (2003), "Corporate Financial Management", *ICFAI, Hyderabad.*
5. Maheshwari S.N (2002), "Financial Management", *Sultan Chand & Co.,*

HUM 4052 HUMAN RESOURCE MANAGEMENT [2 1 0 3]

COs:

1. Identify the need to align HR policies & practices with the organization strategy.
2. Function effectively – individually as well as in diverse team
3. Apply HR practices in resolving work place conflicts and maintain healthy employee relation.
4. Apply the HR concepts in suitably designing and developing the jobs resulting in optimal people performance.
5. Apply HR concepts in ensuring continuous development of the people in professional and ethical manner.

Syllabus:

Evolution and development: Introduction, Scope of HRM, Objectives of HRM, Functions of HRM, Activities of HRM, Managerial skills and roles, HRD organization and responsibilities; Evolution of HRM, Influence of various factors on HRM, Theories of HRM; Human resource planning- Introduction, Strategic considerations, Nature and scope, Human resources inventory, Forecast, Job analysis, Job description, Job specification, Job evaluation, Employment stability; Recruitment, Selection, Placement and induction, Scientific selection, Policy, Process, Tests, Interview, Work history, References, Provisional selection, Medical/Physical examinations, Final selection, Employment; Induction, & socialization - Placement policy, Induction programs, socialization programmes; Training and development - Basic concepts, Employees training, Training process, Planning, Preparation of trainees, Implementation, Performance evaluation, Follow-up training; Management executive development and Career development - Basic concepts, Stages of career development, Career development programmes; Promotion transfers and separations; Wages and salaries administration; Discipline and grievances, Industrial and labour relations and Trade unionism, Collective bargaining, Industrial health, Performance appraisal and Merit rating.

Reference Books:

1. T.V. Rao and Pereira D F (1986), "Recent experiences in Human Resources Development", Oxford and IBH Publishing.
2. Subbrao A. (1999), "Essentials of Human Resource Management and industrial Relations", Himalaya Publishing House.
3. N G Nair and Latha Nair (1995), "Personnel Management and Industrial Relations", S. Chand Company.
4. Virmani B R; Rao Kala (1997), "Economic restructuring technology transfer and human resource development", Response books.
5. Pareek Udai et al. (2002), "Human Resource Development in Asia: Trends and Challenges", Oxford and IBH Publishing.
6. Michael Armstrong., "A handbook of Human Resource Management Practice"Kogan Page limited, 10th edition. edition.
7. Gary Dessler & Biju Varkkey, "Human Resource Management", Pearson education, 2011.

HUM 4053 MARKETING MANAGEMENT [2-1-0-3]

COs:

1. Identify key marketing concepts, theories and the importance of customer satisfaction and retention
2. Analyze the factors influencing buying behaviour, competitive environment and strategies
3. Identify Market Segments and Positioning strategies for new product developed and explain Product Life Cycle
4. Explain the mechanisms of Pricing and Marketing Channels
5. Design Integrated Marketing Communication for a Product/Service

Syllabus:

Defining marketing for the Twenty-first Century, Scope of marketing, Marketing concepts; Adapting marketing to the New Economy: Major drivers of the new economy, how business practices are changing. Building Customer Satisfaction, Value, and Retention: Defining customer value and satisfaction, Corporate and division strategic planning, Business unit strategic planning. Market Demand: Components of a modern marketing information system. Scanning the Marketing Environment: Analysing needs and trends in the microenvironment. Consumer Markets: Factors influencing buying behaviours. Business Markets: The business market versus the consumer market, major influences on buying decisions, institutional and government markets. Dealing with the Competition: Identifying competitors, analysing competitors.

Market Segments: Patterns of market segmentation, Segmenting consumer and business markets. Product Life Cycle: Product life-cycle marketing strategies. New Market Offerings: Challenges in new-product development, Organizing new-product development, New-product development process, Consumer-adoption process. Designing and Managing Services: Characteristics of services, Managing product support services. Price Strategies: Setting the price, Adapting the price, Initiating and responding to price changes. Retailing, Wholesaling: Trends in retailing, Wholesaling, Wholesaler marketing decisions. Integrated Marketing Communications: The major modes of communication, and Marketing communications mix.

References:

1. Philip Kotler (2000), "Marketing Management – Analysis, Planning, Implementation and Control", Prentice Hall of India Private Limited, New Delhi.
2. ICFAI (2003), "Marketing Management", ICFAI, Hyderabad.
3. Varshney R L and Gupta S L (2004), "Marketing Management", Sultan Chand & Sons, New Delhi.
4. Adrian Palmer (2000), "Principles of Marketing", Oxford University Press, New

HUM 4054: OPERATION MANAGEMENT [2 1 0 3]

COs:

1. Understand and analyze the importance of operations for a firm.
2. Demonstrate decision making ability in core areas of operations such as forecasting, capacity planning, and managing bottlenecks in operations.
3. Develop operations plans to execute business operations on a short run.
4. Understand the basics concepts of supply chain management.
5. Comprehend the importance of quality and lean principles in production and service operations.

Syllabus:

Introductions to operations management – process view and supply chain view, Types of production activities, Competitive priorities and capabilities. Break-even analysis, Evaluating services or products, Evaluating processes - make or buy decision, Decision making under risk, and decision trees. Introduction to forecasting, Importance and uses of forecasting, Demand patterns, Demand management options, Judgment methods, Causal methods - linear regression, time series method – Naïve method, Moving average, Weightage moving average, and Exponential smoothing curve. Planning long-term capacity, Measures of capacity and utilization, Economies of scale, Diseconomies of scale, Capacity timing and Sizing strategies, Sizing capacity cushions, Timing and sizing expansion – Expansionist strategy, Wait and see strategy, and a Systematic approach to long term capacity decision. Levels in operations planning and scheduling across the organization, Sales and operation planning strategies- Chase strategy, Level strategy, Operations planning using linear programming technique, scheduling job and facility scheduling, and work for scheduling. Theory of constraints, managing bottle necks in manufacturing and service processes, Identifying bottle necks, Relieving bottle necks, Drum buffer rope system, and managing constraints in a line system. Supply chain design across the organization, Supply chains for services and manufacturing, Measures of supply chain performance - Inventory measures, financial measures, Inventory and supply chains - pressures for small inventories, Pressures for large inventories, Types of inventory, Inventory reduction tactics, and Inventory placement. Costs of quality, Total quality management, Acceptance sampling, Statistical process control - Control charts, and Process capability. Continuous improvement using lean systems, Different types of wastes, Strategic characteristics of a lean system, Designing lean system layout, and Kanban system.

References:

1. Krajewski L. J., Ritzman L. P., Malhotra M., and Srivastava S. K. (2016), "Operations Management", 11th edition, Pearson Education (Singapore) Pvt. Ltd., Delhi.
2. Heizer J. and Render B. (2016), "Operations Management", 11th edition. Pearson Education India.
3. Khanna R. B. (2015), "Production and Operations Management", 2nd edition, PHI Learning Private Limited.