B TECH in BIOMEDICAL ENGINEERING

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2152	Engineering Mathematics – III	2	1	0	3	MAT 2253	Engineering Mathematics – IV	2	1	0	3
	BME 2151	Analog Electronics	3	1	0	4	BME 2251	Biomechanics	4	0	0	4
	BME 2152	Anatomy & Physiology	4	0	0	4	BME 2252	Biomedical Instrumentation – I	3	0	0	3
	BME 2153	Digital Electronics	2	1	0	3	BME 2253	Digital System Design	4	0	0	4
	BME 2154	Network Analysis	3	1	0	4	BME 2254	Integrated Circuit Systems	4	0	0	4
	BME 2155	Signals & Systems	3	0	0	3	****	Open Elective – I				3
	BME 2161	Circuit Simulation Lab	0	0	3	1	BME 2261	IC Systems Lab	0	0	6	2
	BME 2162	Electronics Lab	0	0	6	2	BME 2262	MATLAB & Simulink	0	0	3	1
			17	**4**	**9**	**24**			**17**	**1**	**9**	**24**
	Total Contact Hours (L + T + P)		**30**				**Total Contact Hours (L + T + P) + OE**		**27 + 3 = 30**			
III	**FIFTH SEMESTER**						**SIXTH SEMESTER**					
	HUM 3151	Engg Economics and Financial Management	2	1	0	3	HUM 3152	Essentials of Management	2	1	0	3
	BME 3151	Basic Clinical Science I	4	0	0	4	BME 3251	Basic Clinical Sciences II	4	0	0	4
	BME 3152	Biomedical Instrumentation – II	3	0	0	3	BME 3252	Digital Image Processing	4	0	0	4
	BME 3153	Digital Signal Processing	3	1	0	4	BME ****	Program Elective – I	3	0	0	3
	BME 3154	Microcontroller Based Systems	4	0	0	4	BME ****	Program Elective – II	3	0	0	3
	****	Open Elective – II				3	****	Open Elective – III				3
	BME 3161	Biomedical Instrumentation Lab – 1	0	0	3	1	BME 3261	Biomedical Instrumentation Lab – 2	0	0	3	1
	BME 3162	Microcontroller Lab	0	0	6	2	BME 3262	Signal and Image Processing Lab	0	0	6	2
			16	**2**	**9**	**24**			**16**	**1**	**9**	**23**
	Total Contact Hours (L + T + P) + OE		**27 + 3 = 30**				**Total Contact Hours (L + T + P) + OE**		**26 + 3 = 29**			
IV	**SEVENTH SEMESTER**						**EIGHTH SEMESTER**					
	BME ****	Program Elective – III	3	0	0	3	BME 4298	Industrial Training				1
	BME ****	Program Elective – IV	3	0	0	3	BME 4299	Project Work/Practice School				12
	BME ****	Program Elective – V	3	0	0	3	BME 4296	Project Work (Only for B.Tech honour Students)				20
	BME ****	Program Elective – VI	3	0	0	3						
	BME ****	Program Elective – VII	3	0	0	3						
	****	Open Elective – IV				3						
			15	**0**	**0**	**18**						**13**
	Total Contact Hours (L + T + P) +OE		**15 + 3 = 18**									

Minor Specialization

I. Biomaterials

BME 4051: Biomaterials
BME 4052: Biomaterial-characterization Techniques
BME 4053: Introduction to Biomedical Nanotechnology
BME 4054: Material Science for Biomedical Engineers

II. Signal & Image Processing

BME 4055: Advanced Biomedical Signal Processing
BME 4056: Biometrics
BME 4057: Machine Learning
BME 4058: Medical Imaging

III. Material Science

PHY 4051: Physics of Low Dimensional Materials
PHY 4052: Physics of Photonic & Energy Storage Devices
CHM 4051: Chemical Bonding
CHM 4052: Chemistry of Carbon Compound

IV. Business Management

HUM 4051: Financial Management
HUM 4052: Human Resource Management
HUM 4053: Marketing Management
HUM 4054: Operation Management

V. Computational Mathematics

MAT 4051: Applied Statistics and Time Series Analysis
MAT 4052: Computational Linear Algebra
MAT 4053: Computational Probability and Design of Experiments
MAT 4054: Graphs and Matrices

Program Electives

BME 4059: Artificial Neural Networks
BME 4060: Biophotonics
BME 4061: Bio-statistics
BME 4062: Control Systems
BME 4063: Drug Delivery
BME 4064: Embedded Systems
BME 4065: Fuzzy Logic Systems
BME 4066: Gait Analysis
BME 4067: Object Oriented Programming
BME 4068: Pattern Recognition
BME 4069: Physiological Control Systems
BME 4070: Telemedicine
BME 4071: Tissue Engineering

Open Electives

BME 4301: Bio-medical Instrumentation
BME 4302: Bio-Mechanics
BME 4303: Rehabilitation Engineering

THIRD SEMESTER

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

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.

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.

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.

References:

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 (5e) - 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]

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”, (2e), John Wiley and Sons, 2013
2. A. S. Sedra, K. C. Smith, “Microelectronic circuits”, (6e), Oxford University Press, 2009.
3. R. L. Boylestad, L. Nashelsky, “Electronic Devices and Circuit Theory”, (11e), Pearson India education services, 2015.
4. J. Millman, C. C. Halkias, Chetan. D. Parekh, “Integrated Electronics”, (2e), McGraw Hill, 2010.

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

References:

1. Sampath Madhyastha, "Manipal Manual of Anatomy", CBS Publishers & Distributors, (3e), 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, (8e), 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]

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, (3e), 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, (5e), 2007.
5. Morris Mano, Digital logic and computer design, Pearson, New Delhi, 2013.
6. Ronald J. Tocci, Digital Systems - Principles & Applications, Pearson, Delhi, (8e), 2005.

BME 2154: NETWORK ANALYSIS [3 1 0 4]

Review: network equations, principles of duality & network transformation, KVL and KCL equations for DC and AC networks, network reduction using Y- transformations and network theorems. Coupled circuits, series and parallel resonant circuits, transient behavior and Initial conditions in networks, switching condition and their representation, evaluation of initial and final conditions. Continuous time signals and Systems; Laplace transforms, Inverse Laplace transform and applications, one and two port networks, driving point admittance and transfer function, Open circuit impedance parameters, Short circuit admittance parameters, transmission parameters, h-parameters. Linear wave-shaping using low pass and high pass RC circuits.

References:

1 M E Van Valkenburg, "*Network Analysis*", Prentice Hall of India, New Delhi, (3e), 2007.
2 Joseph A Edminister, "*Theory and Problems of Electric circuits*", McGraw Hill, (5e), 2001.
3 C.L.Wadhwa, "Network Analysis and Synthesis", New Age International (P)Limited, Publishers, New Delhi, (3e), 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]

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; (2e), (2015).
2. M. J. Roberts, Signals and Systems - Analysis using Transform methods and MATLAB, McGraw-Hill Education, (2e), 2011.
3. Hwei Hsu, Schaum's Outline of Signals and Systems**,** McGraw-Hill Education; (3e), 2013.

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

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:

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

BME 2162: ELECTRONICS LAB [0 0 6 2]

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", (11e), Pearson India education services, 2015.
2. Behzad Razavi, "Fundamental of Microelectronics", Wiley, 2013.
3. Roth C. H., Fundamentals of logic design, Thomson Brooks, Australia, (5e), 2007.
4. Morris Mano, Digital logic and computer design, Pearson, New Delhi, 2013.

FOURTH SEMESTER

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

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]

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 Bio fluid Mechanics, McGraw-Hill Education, (2e), 2017, USA.
2. C. Ross Ethier, Craig A. Simmons, Introductory Biomechanics, Cambridge University Press, (1e), 2009, New York, USA.
3. W. Mark Saltzman, Biomedical Engineering: Bridging Medicine and Technology, Cambridge University Press, (2e), 2015, USA.
4. Joseph Hamill and Kathleen M. Knutzen, Biomechanical Basis of Human Movement, Lippincott Williams & Wilkins, (3e), 2008, Philadelphia, USA.
5. Susan J. Hall, Basic Biomechanics, McGraw-Hill International Editions, (7e), 2014, Singapore.

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

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, (3e), 2011.
2. R S Khandpur, "Handbook of Biomedical Instrumentation", McGraw Hill, Delhi, (3e), 2014.
3. L A Geddes, L E Baker, "Principles of Applied Medical Instrumentation", Wiley India, New Delhi, (3e), 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, (4e), 2003.

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

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", (3e), 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", (3e), Addison Wesley Longman Singapore Pvt Ltd., 2005.
5. M. Morris Mano and Michael D. Cilleti, "Digital Design with Introduction to Verilog HDL", (5e), Pearson, New Delhi, 2013.

BME 2254: INTEGRATED CIRCUIT SYSTEMS [4 0 0 4]

Operational amplifiers, characteristics, frequency response, differential amplifiers, offset voltages and currents, linear applications of OP-AMP, instrumentation amplifier, active filters, integrators and differentiators, non- linear applications of Op-Amp such as multi-vibrators, Schmitt trigger circuits and function generators. 555 Timer IC and its applications such as multi-vibrators, voltage to frequency converters tone burst generators etc. phase locked loops and applications, PLL IC 565, VCO IC 566, Fixed, adjustable and variable power supplies using voltage regulator ICs, switching regulators, data converters, ADC and DAC.

References:

1. Jacob Milliman, Christors C Halkias and Chatan D Parikh "Integrated Electronics", (2e), Mcgraw Hill, 2009.
2. Ramakanth A Gayakwad, "OPAMPS and Linear Integrated Circuits", Prentice Hall, (4e), 2000.
3. Sergio F, Design with Op amps and Analog Integrated Circuits, McGraw Hill, 2002.
4. Roy D. C. and Jain S., Linear Integrated Circuits, Wiley Eastern
5. William D. Stanley, Operational Amplifiers with Linear Integrated Circuits,(4e), Pearson Education 2007

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

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. Active filters Low pass, high pass and band pass filters, 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", (2e), Mcgraw Hill, 2009
2. Ramakanth A Gayakwad, "OPAMPS and Linear Integrated Circuits", Prentice Hall, (4e), 2000.
3. William D. Stanley, Operational Amplifiers with Linear Integrated Circuits, (4e), Pearson Education 2007

BME 2262: MATLAB and SIMULINK LAB [0 0 3 1]

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, (1e), 2017.

FIFTH SEMESTER

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

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., *Fundamentals of Financial Management*, Tata Mc-Graw Hill Companies, New Delhi, 2005.
2. James L Riggs, David D Bedworth and Sabah U Randhawa., *Engineering Economics*, Tata McGraw – Hill Publishing Company Ltd, New Delhi, 2004.
3. T. Ramachandran., *Accounting and Financial Management*, Scitech Publications Pvt. Ltd. India, 2001.
4. Eugene F. B. & Joel F. H., *Fundamentals of Financial Management*, 12th ed., Cengage Learning Publisher, 2009.
5. M. Y. Khan & P. K. Jain., *Financial Management*, 5th edition Tata McGraw Hill Publication, New Delhi, 2008.
6. Thuesen G.J., *Engineering Economics* Prentice Hall of India, New Delhi, 2005.
7. Blank Leland T. Tarquin Anthony J. *Engineering Economy*, McGraw Hill, Delhi, 2002.
8. Chan S. Park, *Fundamentals of Engineering Economics*, 3rd edition, Pearson Publication, 2013.

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

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, (24e), 2012.
2. C. C. Chatterjee S, "Human Physiology", CBS Publisher, (11e), 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. Victor H Frankel and Margareta Nordin, "Basic Biomechanics of the skeletal system". Lea and Febiger, 1980.
2. M. Dena Gardiner, "The principles of exercise therapy", CBS press(4e), 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", (9e), 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, (3e), 1977.
2. Johns H E, Cunningham John Robert, The Physics of Radiology, Charle C Thomas, (4e), 1983.
3. Ramesh Chandra, "Introductory Physics of Nuclear Medicine", Lea and Febiger, 1992

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

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

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

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 (3e), 2014.
2. Dimitris G Manolakis, John G. Proakis, Digital Signal Processing: Principles, Algorithms, and Applications, PEARSON, (4e), 2007.
3. Sanjit K. Mitra, Digital Signal Processing: A Computer - Based Approach, McGraw Hill Education; (4e), 2013.

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

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

BME 3161: BIOMEDICAL INSTRUMENTATION LAB- I [0 0 3 1]

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, (4e), 2015.
2. John G Webster, "Medical Instrumentation Applications and Design", John Wiley and Sons, New York, (3e), 2011.
3. Richard Aston, "Principles of biomedical Instrumentation and measurement", Merrill, New York, 1991.

BME 3162: MICROCONTROLLER LAB [0 0 6 2]

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

SIXTH SEMESTER

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

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., *Essentials of Management*, McGraw Hill, New Delhi, 2012.
2. Peter Drucker., *Management: Tasks, Responsibilities and Practices*, Harper and Row, New York, 1993.
3. Peter Drucker., *The Practice of Management*, Harper and Row, New York 2004.

BME 3251: BASIC CLINICAL SCIENCES – II [4 0 0 4]
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; Electroencephalography; 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. Daroff, R.B. and Bradley, W.G, Bradley's Neurology in Clinical Practice, Philadelphis, PA: Elsevier/Saunders, 2016.
2. Kandel, E. R., Schwartz, J. H., and Jessell, T. M., Principles of neural science (5e). New York: McGraw-Hill, Health Professions Division, 2013.

3. Snell, Richard S., Clinical neuroanatomy. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins, 2010.

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 nebulizers. Humidifiers, Baby Incubators, Central oxygen supply. Principles of operation theatre tables and lights, phototherapy, surgical diathermy.

References:

1. M.K. Bykes and M.D. Vickers, "Measurements in Anesthesia", Blackwell, 1981.
2. Mushin, "Automatic ventilation of lung", Blackwell, 1970.

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. Malcolm Peat, "Community based Rehabilitation", Saunders, London, 1997.

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, (21e), 2010.
2. Duke Elder, System of Ophthalmology, Vol. VII, Mosby, St. Louis, 1965.

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

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*, (4e), 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]

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, (4e), 2002.
2. John G Webster, "Medical Instrumentation Applications and Design", John Wiley and Sons, New York, (3e), 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]

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; (2e) (2015).
2. Ronald W. Schafer, Alan V. Oppenheim, Discrete-Time Signal Processing, PEARSON (3e), 2014.
3. Rafael C. Gonzalez, Richard Eugene Woods, Digital Image Processing using MATLAB, (2e), Tata McGraw-Hill Education 2010.
4. A.K. Jain, *Fundamentals of Digital Image Processing*, Prentice-Hall, 1989, Fourth Indian Reprint.

SEVENTH SEMESTER

There are five program electives and one open elective with total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

BME 4298: INDUSTRIAL TRAINING

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

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.

PROGRAM ELECTIVES

BME 4051: BIOMATERIALS [3 0 0 3]

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 bio inert bio ceramics. 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”, (3e), 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”, (3e), Academic Press, Canada, 2012.
4. L.L.Hench & E.C.Ethridge, “Biomaterials, an Interfacial Approach”, Academic Press, New York, 1982.
5. David Williams, Essentials Biomaterials Science, Cambridge university press, 2013.
6. Lisa A Pruitt and A M Chakravartula, Mechanics of Biomaterials, Cambridge, 2011.

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

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]

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 Nano systems-structural and chemical characterization techniques. Properties of nanomaterials: - mechanical properties, optical properties, surface Plasmon resonance, quantum size effects, introduction to Nano electronics. 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, (1e), 2008.
5 Jun Li, Nianqiang Wu, Biosensors based on Nanomaterials and nanodevices, CRC Press, (1e), 2014.
6 T. Pradeep, A Textbook of Nanoscience and Nanotechnology, McGraw Hill Education, (1e), 2017.
7 Challa S. S. R. Kumar, Josef Horms, Csrola Leuschner, Nanofabrication Towards Biomedical Application: Techniques, Tools, Applications and impact, Wiley- VCH, (1e), 2015.

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

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.

References1.William D. Callister, Jr., David G. Rethwisch, *Materials Science and Engineering: An Introduction*, (9e), Wiley, 2014.2.Dekker A.J., *Solid state physics*, Macmillan publishers India, 2012.3.James F. Shackelford, *Introduction to Materials Science for Engineers*, (8e), 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*, (3e), 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.

BME 4055: ADVANCED BIOMEDICAL SIGNAL PROCESSING [3 0 0 3]

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, (4e), 2007
2. Simon Haykin, “Adaptive Filter Theory”, Pearson, (5e), 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]

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 App**lications to Biometrics (Premier Reference Source), Medical Information Science Reference; (1e), 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*. (2e), New York, NY: Wiley-Interscience, 2007.
6. Rafael C. Gonzalez, Richard Eugene Woods, Digital Image Processing using MATLAB, (2e), Tata McGraw-Hill Education, 2010.

BME 4057: MACHINE LEARNING [3 0 0 3]

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.

References:

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

BME 4058: MEDICAL IMAGING [3 0 0 3]

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 back projection (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*, (4e), 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, (5e), Elsevier, 2017.

6. Thomas L. Szabo, Diagnostic Ultrasound Imaging: Inside Out, (2e), Elsevier, 2014.
7. James A Zagzebski, Essentials Of Ultrasound Physics, (2e), Mosby, 2010.
8. Barbara S. Hertzberg, William D. Middleton, Ultrasound: The Requisites, EBook (Requisites in Radiology), 2015.
9. HH Schild, "MRI made easy", Schering AG, Berlin, 1990.

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

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" , (3e), Pearson, 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]

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: BIO-STATISTICS [3 0 0 3]

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.

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

BME 4062: CONTROL SYSTEMS [3 0 0 3]

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]

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, (6e), 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]

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]

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; (2e), 2017.
2. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley, (3e), 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]

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, (2e), 2010.
2. Michael Whittle, An Introduction to Gait Analysis, Butterworth-Heinemann Ltd, (4e), 2006.

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

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

BME 4068: PATTERN RECOGNITION [3 0 0 3]

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 neighborhood 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", (2e), 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", (2e), 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", (2e), Academic Press, 2014.

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

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]

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., (5e), 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]

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]

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, (3e), 2011.
2. R S Khandpur, "Handbook of Biomedical Instrumentation", McGraw Hill, Delhi, (3e), 2014.
3. L A Geddes, L E Baker, "Principles of Applied Medical Instrumentation", Wiley India, New Delhi, (3e), 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, (4e), 2003.

BME 4302: BIO-MECHANICS [3 0 0 3]

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, (4e), 2014, Philadelphia, USA.
2. Susan J. Hall, Basic Biomechanics, McGraw-Hill International Editions, (7e), 2014, Singapore.
3. Peter M. McGinnis, Biomechanics of Sport and Exercise, Human Kinetics, (3e), 2013, USA.
4. P. Grimshaw and A. Burden, Sport & Exercise Biomechanics, Taylor & Francis Group, (1e), 2007, UK.
5. Ellen Kreighbaum, Katharine M Barthels, Biomechanics-A Qualitative Approach for studying Human Movement, Allyn and Bacon Publishers, (4e), 1995, USA.

BME 4303: REHABILITATION ENGINEERING [3 0 0 3]

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(4e), 2015.
2. John G. Webster, Albert M. Cook, Willis J. Tompkins, Gregg C. Vanderheiden, "Electronic devices for Rehabilitation", John Wiley & Sons Inc., (2e), 1989.
3. John Enderle and Joseph Bronzino, "Introduction to Biomedical Engineering", academic press, (3e), 2011.
4. Rory A. Cooper, "An introduction to Rehabilitation Engineering", Taylor and Francis Inc., (1e), 2007.

OPEN ELECTIVES

MCA 4301: INTRODUCTION TO DATABASE SYSTEMS WITH MYSQL [3 0 0 3]

Modeling and Designing Databases, Database Design Process, Entity-Relationship Model, Basic Concepts, Constraints, Design of ER database schema, Reduction of ER to schema, Relational model, Super, candidate, primary ,foreign key, Schema Diagram, Relational Database design, Functional dependencies, Normal forms, Creating a MySQL Database, Table, Modifying table, constraints, indexes, Basic SQL, Inserting Data, Selecting Data, Updating Data, Deleting Data, MySQL Functions, Numeric, String, Date /Time, Advanced Queries, Sorting, Multiple tables, Inner Join, Left Join, Right Join, Natural Join, Nested queries, Generating summaries, COUNT(), MIN(), MAX(), SUM(), AVG(), Group By, Statistical techniques, Calculating Descriptive statistics, Per-Group Descriptive Statistics, Generating frequency distribution, Calculating correlation coefficients, assigning ranks, Stored routines, stored procedure, stored function, Triggers, Events to schedule Database actions, Managing users and privileges, Importing and Exporting data, importing data with LOAD data and mysql import, importing csv files, exporting query results, tables, importing XML.

References:

1. Paul Dubois, MySQL Cookbook, O'REILLY, First Edition, 2007.
2. Larry Ullman, Visual Quick Start guide MySQL, Pearson Education, 2nd Edition, 2007.
3. Seyed M. M, Saied Tahaghoghi and Hugh Williams, Learning MySQL, O'Reilly, 2006.
4. Russell J.T. Dyer, MySQL in a Nutshell, O'REILLY, 2nd Edition, 2008.

MCA 4302: INTRODUCTION TO VR AND AR TECHNOLOGIES [3 0 0 3]

Introduction: Input Devices, Output Devices, Displays, Computing Architectures for VR, The Rendering Pipeline, PC Graphics Architecture, Workstation-Based Architectures, Distributed VR Architectures, Modeling, Geometric Modeling, Physical Modeling, Behavior Modeling, Model Management, VR Programming and other Toolkits. Introduction to Unity 3D Engine, 2D Game concepts and basic scripting, 3D Game concepts and environment creation, Advanced game concepts. Introduction to Unity AR: Foundation and Vuforia, working with Vuforia in Unity, ARCore in unity, Mini project on AR. Introduction to VR, Unity for Google cardboard, Basic VR app development for Cardboard, Develop for a specific VR platform.

References:

1. Jonathan Linowers, Krystian Banbilinski, Augmented Reality for Developers,Packt Publishers, 2017.
2. Edward Lavieri, Getting started with Unity 5, Packt publishing, 2015.
3. Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, Wiley-IEEE Press, 2003.
4. Sherman, W.R. & A. Craig, Understanding, Virtual Reality: Interface, Application and Design, Morgan Kaufmann, San Francisco, CA, 2003.
5. Philippe Fuchs, Guillaume Moreau, Pascal Guitton, Virtual Reality: Concepts and Technologies, CRC, Taylor and Francis, 2011.

MCA 4303: INTRODUCTION TO LINUX AND SHELL SCRIPTING [3 0 0 3]

Introduction to UNIX/LINUX Operating System: OS concepts, Linux overview, key features of Linux, pros and cons of Linux. Processes: Processes and Files, I/O redirection and pipes, process creation, process attributes standard process file descriptors. File and Process commands. File systems: Files and directories, file naming and wildcards, file attributes, file permissions. Regular Expressions & filters: find, grep, cut, sort, grep patterns. AWK and SED. Shell and Shell Scripting: The need for shell, types of shells, interactive uses of shell, using shell for creating user commands, functions. Bash shell features: Statements, data structure, built-in commands, environment customization primitives. Linux Editors.

References:

1. Richard Blum and Christine Bresnahan, Linux Command Line Shell Scripting BIBLE, 3rd Edition, Wiley, 2015.
2. Mark Sobel. A Practical Guide to Linux commands Editor and shell programming, Prentice Hall, 2nd Edition, 2010.
3. Stephen G. Kochan. Unix Shell Programming, 3rd Edition, SAMS Publications, 2003.
4. Bash Reference Manual Download able from GNU Project.
5. Brian W Kerningham and Rob Pike. The Unix Programming Environment, PHI Learning Pvt. Ltd., 2009.

MCA 4304: INTRODUCTION TO DATA ANALYTICS [3 0 0 3]

Introduction - data science, need for analytics, steps in data analysis projects, Data- sources of data, data sets, data warehouses, data types, privacy and confidentiality, samples vs. population. Data summarization and visualization – tables and graphs. Data Preprocessing- cleaning, transformation, dimensionality reduction. Data Analysis and Visualization – descriptive, inferential statistics, uni-variate and multi-variate analysis. Grouping – Cluster Analysis- distance measures, partitioning, hierarchical, density based methods. Market Basket Analysis, Association Analysis, Market Basket Analysis. Classifiers-Bayesian, k-nearest neighbor, neural network, Support Vector Machine, Decision Trees. Prediction- Regression models, Evaluating Classification and Predictive performance, ensemble methods. Anomaly Detection. Forecasting models.

References:

1. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining, 2nd Edition, John Wiley & Sons Publication, 2014.
2. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications, John Wiley & Sons Publication, 2009.
3. Galit Shmueli, Nitin R. Patel, and Peter C. Bruce, Data Mining for Business Intelligence, John Wiley & Sons, 2014.
4. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 2011.
5. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Addison Wesley, 2005.

Minor Specialization: Computational Mathematics

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

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.

References:

1. G.E.P. Box, G. M. Jenkins, G. C. Reinsel and G M Ljung, *Time Series Analysis-Forecasting and Control*, (5e), 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, (4e), 2004
5. David Ruppert, *Statistics in Finance*, Springer Publications, 2004

MAT 4052: COMPUTATIONAL LINEAR ALGEBRA [2 1 0 3]

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*, (4e), Johns Hopkins University Press, 2013.
2. Gilbert Strang, *Linear Algebra and its applications*, (4e), Wellesley Cambridge press, 2009.
3. David S. Watkins, *Fundamentals of Matrix Computations*,(3e), Wiley, New York, 2010.
4. Roger a Horn, *Matrix Analysis*, (2e), Cambridge University Press, 2013.

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

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*, (4e), Macmillan
2. M N Murthy, *Sampling Theory and Methods*, Statistical Publishing Society, 1967
3. C Radhakrishna Rao, *Linear Statitical Inference and its applications*, (2e), Wiley Series.
4. Douglas C Montgomery, *Design and Analysis of Experiments*, (8e), 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]

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.

References:

1. F. Harary, *Graph Theory*, Narosa Publishers, 1988.
2. J.A Bondy and U.S.R Murthy, *Graph Theory with Applications*, (5e), 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.

OPEN ELECTIVES

MAT 5301: APPLIED GRAPH THEORY [2 1 0 3]

Graphs and applications of the theorems by Havel and Hakimi, Erdos and Gallai. Cut points, bridges and blocks, block graphs and cut point graphs. Trees and their characterizations, centre and centroids, block-cut points trees, spanning trees, independent cycles and cocycles, connectivity and line connectivity, Whitney's theorem. Traversability-Eulerian, Hamiltonian, line graphs and total graphs. Traversability, coverings and independence, theorem of Gallai, critical points and lines. Planarity, genus, thickness, crossing number. Colorability, chromatic number and its bounds, Nordhaus Gaddum theorems, the four and five colour theorems, chromatic polynomial. Matrix Representation -Incident matrix, Adjacency matrix, cycle matrix, cutset matrix, path matrix, Digraphs, Matrix - tree theorem on number of spanning trees. Tournament. Graph theoretic Algorithms: Computer representation of graphs-Input and output, Algorithms for connectedness, Spanning Tree, Fundamental Circuits, Directed Circuits and Shortest paths.

References:

1. F. Harary, *Graph theory*, Narosa Publishers
2. Narsingh Deo, *Graph theory with applications to Engineering and Computer Science*, Prentice Hall.
3. Robin J.Wilson, *Introduction to Graph theory*, Logman

MAT 5302: APPLIED LINEAR ALGEBRA [2 1 0 3]

Finite dimensional vector spaces, subspaces, linear independence, basis and dimension. Sum and intersection of subspaces. Algebra of linear transformations, range and null space of a linear transformation, Inner-product spaces, metric spaces and banach spaces, Gram Schmidt orthogonalization, linear operators and their adjoint, self adjoint, unitary and normal transformations, polar decomposition. Matrix algebra, simultaneous equations, Eigen values, characteristic vectors, Cayley-Hamilton theorem, minimal polynomial, Application of eigen values to solve simultaneous difference and differential equations. Quadratic forms and their classification, constrained optimization. Somecomputational methods of linear algebra.

References:

1. Gantmocher F.R., *The Theory of Matrices*, Cheisea.
2. Gilbert Strang , *Linear Algebra and its applications*, Thomson learning
3. David C. Lay, *Linear Algebra and its applications*, Pearson Education

MAT 5303:APPLIED NUMERICAL METHODS [2 1 0 3]

Matrix Algebra : Solution for linear system of equations – Direct methods: Gauss elimination method, Gauss Jordon method, Crouts (LU decomposition) method. Iterative methods, Jacobi Gauss Seidal and successive over relaxation methods. Computation of inverse of a matrix: Jordan method, Triangularization method, Choleski's method, partition method. Eigen value & Eigen vectors: Given's method for real symmetric matrices, Jocobi's method for real symmetric matrices, Power method. Numerical Solution of Ordinary Differential Equations: Single step methods, Runge- Kutta method, Adam Bashforth's predictor corrector method, Milne's predictor and corrector method. Numerical Solution of Partial Differential Equations: Finite difference approximation to derivatives of Parabolic, Elliptic. Explicit finite difference method, implicit method.

References:

1. Jain, Iyengar and Jain: *Numerical methods for Scientific and Engineering Computations*, New Age Publishers
2. Carnahan, Luther and Wikes: *Applied Numerical Methods*, John Willey
3. Conte S.D and Be Door, *Introduction to Numerical analysis*, McGraw Hill.

MAT 5304:MATHEMATICAL MODELLING [2 1 0 3]

Introduction, Techniques, classification and characteristics of mathematical models, mathematical modeling through algebra, ordinary differential equations of first order. Mathematical modeling through systems of ordinary differential equations of first order, Prey- Predator model Mathematical modeling through systems of ordinary differential equations, modeling in medicine A model for diabetic mellitus. Modelling on population dynamics Mathematical modelling through difference equations. Some simple models. Modelling of economics and finance through difference equations, population dynamics and generation of models through difference equations, modeling in probability theory, examples. Optimization models: Mathematical modeling through linear programming. Mathematical modelling through graphs: elements of graphs, digraphs. Mathematical models for blood flow. Mathematical model for Peristaltic transport of two layered.

References:

1. J N Kapur, *Mathematical Modelling*, New age international publishers,(2e), 2015.
2. J N Kapur *Mathematical Models in biology and medicine*, East- West press.
3. J N Kapur *Mathematical models of environment*, INS Academy, New Delhi

MAT 5305:OPTIMIZATION TECHNIQUES [2 1 0 3]

Formulation, Linear programming-simplex method, Penalty coase methods, 2-phase method. Dual Simplex method. Duality theory .Transportation problem-Volgel's approximation method, MODI method, Assignment problem-Hungarian method.Project Management - Networks, Project planning and control using PERT and CPM. Project crashing. Game theory - 2persons zero sum games, Minimax principle, games with mixed strategies. Dominance theory, solution using Linear programming.

References:

1. Bronson Richard - *Theory and Problems of Operations Research*- Schaum series- MGH
2. P.K.Gupta& Man Mohan - *Operations Research* - Sultan Chand & Sons
3. HamdyA.Taha - *Operations Research* PHI

MAT 5306: STOCHASTIC PROCESSES AND RELIABILITY [2 1 0 3]

Static probabilities: Review and prerequisites generating functions, difference equations.Dynamic probability: definition and description with examples. Markov chains, transition probabilities, Chapmen Kolmogrov equations. Classification of states, chains of Markov process. Stability of Markov systems, limiting behaviour, random walk. Poisson Processes : assumptions and derivations, related distributions, birth and death processes. Queueing System, general concepts, Model M/M/1 and M/M/S, steady state behaviour, transient behaviour. Wiener processes and Gaussian processes. Differential equations of a wiener process, Kolmogrov equations, Ornstein – Unlenbeck Process. White note. Reliability Theory : Definition of Reliability, types of failure, Hazard rate, Laws of failure - normal, exponential & Weibull failure laws - System reliability - in series, in parallel series - parallel system, Paralled - series system & related problems.

References:

1. Medhi. J., *Stochastic Processes*, Wiley Eastern.
2. Bhat U R, *Elements of Applied Stochastic Processes*, John Wiley.
3. A Papoulis, *Probability, Random Variables and Stochastic Procesess*, McGraw Hill.

Minor Specialization: Business Management

HUM 4051: FINANCIAL MANAGEMENT [2 1 0 3]

Introduction and objectives of financial management, Evolution of corporate finance, 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, Dividend decisions.

References:

1. Prasanna Chandra., Fundamentals of Financial Management, Tata McGraw Hill Education Pvt Ltd., New Delhi, 2006.
2. I M Pandey, Financial Management, Vikas Publishing House Pvt Ltd.,, New Delhi, 2015.
3. N Ramachandran & Ram Kumar Kakani, Financial Accounting for Management, 3/e, Tata McGraw Hill Education Pvt Ltd., New Delhi, 2011.
4. Eugene F Brigham & Michael C E, Financial Management: Theory and Practice. 12e, Cengage Learning, India, 2008.
5. Maheshwari S.N., Financial Management, Sultan Chand & Co., New Delhi, 2002.

HUM 4052: HUMAN RESOURCE MANAGEMENT [2 1 0 3]

Introduction, Scope of HRM, Objectives of HRM, Functions, Activities, Roles, HRD organization and responsibilities. Evolution of HRM, Influence of various factors on HRM. Human resource planning: Introduction, Strategic considerations, Nature and scope, Human Resources Inventory, Job analysis, Job design, Job description, Job specification and Job evaluation. Employee Recruitment & Selection: Policy, Process, Tests, modern methods, Interview, Provisional selection, Medical/Physical examinations, Placement, Induction programs and socialization. Training and development: Basic concepts, Employees training Process, Planning, Preparation of trainees, Implementation, Performance evaluation and Follow-up training. Competency Mapping and Career development programmes. Performance appraisal and Merit rating, Promotion, transfers and separations, Wages and salaries administration, Discipline and grievances. Industrial and labour relations and Trade Unionism Overview: Collective bargaining and maintaining Industrial health.

References:

1. Michael Armstrong ., A Handbook of Human Resource Management Practice: 10th Edition, New Delhi, Kogan Page India,2006
2. Gary Dessler& BijuVarkey .,Human Resource Management:12th Edition Dorling Kindersley(India),Noida,2011
3. T.V. Rao and Pereira D F., Recent experiences in Human Resources Development, Oxford and IBH Publishing, 1986.
4. Subbrao A., Essentials of Human Resource Management and industrial Relations, Himalaya Publishing House, 1999.
5. Aswathappa K,Human ResourceManagement,Text&Cases McGrawHill 7th Edition,2006
6. N G Nair and Latha Nair., Personnel Management and Industrial Relations, S. Chand Company, 1995.

HUM 4053: MARKETING MANAGEMENT [2 1 0 3]

Marketing definition, scope and concepts, Adapting marketing to the New Economy, Marketing strategic planning. Market Demand, Marketing Environment, Marketing Information System, Marketing Research. Segmentation, Targeting and Positioning, Buying Behaviour: Consumer Markets and Business Markets, Competition: Identifying competitors, analysing competitors. Product Life Cycle: Product life-cycle marketing strategies. New Market Offerings: New product development and challenges, Branding. Designing and Managing Services, Price Strategies, Retailing, Wholesaling, Integrated Marketing Communications, Digital Marketing and Trends, International Marketing

References:

1. Philip Kotler, Kevil Keller, Abraham Koshy & Mithileshwar Jha, Marketing Management – A South Asian Perspective, Pearson Education Inc, New Delhi, 2012.
2. Arun Kumar & N Meenakshi, Marketing Management, Vikas Publishing House Pvt Ltd, New Delhi, 2011.
3. Varshney R L and Gupta S L., Marketing Management, Sultan Chand & Sons, New Delhi, 2004.
4. Adrian Palmer., Principles of Marketing, Oxford University Press, New York, 2000.

HUM 4054: OPERATIONS MANAGEMENT [2 1 0 3]

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, judgement 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 inoperations 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., *Operations Management*, 11th edition, Pearson Education (Singapore) Pvt. Ltd., Delhi, 2016.
2. Heizer J. and Render B., *Operations Management*, 11th edition. Pearson Education India, 2016.
3. Khanna R. B., *Production and Operations Management*, 2nd edition, PHI Learning Private Limited, 2015.

OPEN ELECTIVES

HUM 4301: COMMUNICATIVE ENGLISH [3 0 0 3]

(Offered for Lateral Entry Students only)

Common Errors in English: Subject Verb Agreement; Uses of Tenses / Sequence of Tense; Prepositions; Articles; Special Usages; Creative Writing Essay: Types of Essays, Argumentative Essay, Descriptive/ Expository/Narrative Essays; Reading Comprehension; Dynamic text; Critical Evaluation; Group Discussions; Presentation Skills; Essay writing.; Audio texts/speeches -Practice listening skills- summary, commentary, listening exercises. Video Speeches -Theme based speeches - motivational, informative, technical, and persuasive, discussions. Speech - Elements of a good speech, types of speeches, model speech, Speech exercises, individual presentations, peer and facilitator feedback. Formal/Informal communication. Communication Styles- formal and informal, standard English and variations in usages, examples and analysis of faulty usages; Correspondence: formal/informal letters and emails .

References:

1. Green David., *Contemporary English Grammar, Structures and Composition* Chennai: Macmillan Publications.
2. Thompson AJ & Martinet AB., *A Practical English Grammar*, OUP.
3. Turton N D , Heaton J B., *Longman Dictionary of Common Errors*, 1998.
4. Meenakshi Raman & Sangita Sharma., *Technical Communication; Principles and Practice*, Oxford University Press, 2011.

HUM 4302: FILM STUDIES [2 1 0 3]

History of invention of motion pictures - Daguerre, Muybridge, Edison, SkaldanowskyBrothers,Lumieres; Evolution of film – Lumieres, Melies, Porter, Griffith, Basic techniques – Mise-en-scene, Mise-en-shot, Deepfocus Photography, Longtake, Continuity, Editing, Montage, German Expressionism; French Impressionism; Soviet Montage cinema; Hollywood cinema, Italian Neo-realism; French Nouvelle Vague, Documentary, Directors – Eisenstein, Kurosawa, Godard, Chaplin, Bergman; Mohsen Makmalbakf, Majid Majidi, Keislowski, Zhang Yimou, Kim Ki Duk, "New Wave" Cinema in India - Bengali; Malayalam; Kannada; Hindi, To be screened- Bicycle Thieves, The 400 blows, Rashomon, Wild strawberries, Battleship Potemkin, Cabinet of Dr.Caligari, The kid, Children of heaven, Hero, Ghatashraddha, PatherPanchali, Mathilukal.

References:

1. Bordwell, David and Thompson, Kristin., *Film Art: an Introduction, 7th ed*. New York: McGraw-Hill Co., 2004.
2. Kawin, Bruce., *How Movies Work*. Berkeley and Los Angeles: University of California Press, 1992.
3. Cook, David A., *A History of Narrative Film*, 4th ed. New York: W.W. Norton & Co., 2004.

HUM 4303:GERMAN FOR BEGINNERS [3 0 0 3]

Text selections, dialogue and exercises which have been designed to give the absolute beginner grounding in the rudiments of the German language, as well as providing background information about the history, life and culture in Germany.Introduction to the German alphabet and the German language – dialogues & conversations – pronunciation, basic vocabulary lists - key points of grammar - background information about the history and culture of Germany - exercises on vocabulary, grammar and German culture - reading & listening comprehension.

References:

1. Sally Johnson, Natalie Braber., *Exploring the German Language*, (2E), Cambridge University Press. 2008.
2. Charles Russ., *The German Language Today: A Linguistic Introduction*, Routledge. 1994.

HUM 4304: BUILDING BRIDGES: INDO-EUROPEAN INTERCULTURAL DYNAMICS [3 0 0 3]

The challenges of Intercultural communication - interacting in a diverse world, understanding cultures, alternative views of reality, cultural stereotyping. Foundational Theories in Intercultural Communication - Edward Hall, Samovar, G Hofstede, Understanding cultural Dimensions and Cultural Stereotyping- collectivism/ individualism, power distance, masculine/feminine, cultural metaphors, Intercultural Business Communication Competence - The Role of Language in Intercultural Business Communication , Nonverbal Language in Intercultural Communication, Cultural influence on interpersonal communication, Intercultural Dynamics in the multicultural organizations.

References:

1. Dodd, Carley H. *Dynamics of Intercultural Communication*, McGraw-Hill, Boston. 1998.
2. Gannon M J and Pillai R. *Understanding Global Cultures*, Sage Publications, California. 2010.
3. Hall, E. T. *The dance of life: The other dimension of time*, Random House, New York. 1983.
4. Hofstede, Geert., *Cultures' Consequences, Comparing Values, Behaviors, Institutions, and Organizations across Nations*, Sage Publications, Thousand Oaks, CA. 2001.
5. Martin, J.N. & Nakayama, T.K., *Intercultural communication in contexts*. 4th Edition. Mountain View, CA: Mayfield. 2007.
6. Samovar, L A and Porter, R., *Communication between Cultures*, Cengage Learning, Wadsworth, CA. 2007.

HUM 4305: INTERPRETATION OF LITERARY TEXTS [3 0 0 3]

Texts-static, dynamic, cryptic and delphic ; Language of literature; Form and structure; Literature verses popular fiction; Text and discourse; Authors and critics; Theories and approaches to literary texts; Formalism, Structuralism, Marxism, Feminism, Deconstruction; Ideational functions and textual Functions; Class, gender and texuality; Race and nationality; Genre, phonological deviations –sound patterns and figures of speech ; Pragmatic approach to literature; Understanding syntax, Lexical and syntactic analysis of literary texts; Point of view in literary texts and foregrounding; Prediction and making sense of a text; Stylistic analysis of a novel; Kinds of meaning, Rhetorical structure; Pragmatics and discourse analysis; Interpreting cohesive devices and complex functional values; Stylistic approach to literature ; Elements of literary style; Stylistic analysis of selected short stories, Poems, Novels and Plays; Genre, the plot setting, characterization, tone and themes; Stylistics and its implications on narrative techniques; Intertextuality and conceptual blending; Identifying patterns in the texts; Meaning making process in literature; Imagery, metaphor as a mode of thought; Coherence and Cohesion; Context, turn taking and Adjacency Pair; Pro-forms, Discourse markers, Lexical cohesion and presupposition; Recognizing text organization; Critical texts, Shared assumptions on critical texts; The role of schema and the concept of speech acts in literary texts.

References:

1. Austin, J.L., *How to do Things with Words*, Longman, London, 1992.
2. Barthes. R., *Introduction to the Structural Analysis of Narratives*, Fontana, London, 1977.
3. Blake.N.F., *An Introduction to the Language of Literature*, Macmillan, London. .1990.
4. Carter, R. (ed.)., *Language and Literature: An introductory Reader in Stylistics*, Allen and Unwin, London, 1982.
5. Cook, G., *Discourse and Literature*, Oxford University Press, London, 1994.
6. Harold, C.M.(ed.)., *Style in Prose Fiction*, Columbia University Press, New York.
7. Leech, G.N., *A Linguistic Guide to English Poetry*, Longman, London, 1969.

HUM 4306: PUBLIC SPEAKING [3 0 0 3]

Public Speaking -Introduction to Public speaking- Voice modulation, Sounds/accent (basics), Articulation, Anxiety management, Logical arguments, Concept of purpose, Audience, Smart use of Body language. Types of speech-Informative speeches - designing and delivery-Persuasive speeches – designing and delivery- Impromptu speeches – designing and delivery -Special occasion speeches- designing and delivery, Presentations - planning and execution -Types of presentation - Informative-Planning and delivery - Persuasive - Planning and delivery - Motivational - Planning and delivery, Other forms of speaking – Debates, Seminars, Panel Discussion, Group Discussion, Tall Tales, Turn Coat, Art of Evaluation-Providing feedback- planning, designing and delivering constructive feedback - Receiving feedback – making use of relevant feedback -Techniques of providing feedback- Speech analysis –Role of the Evaluator.

References:

1. Duarte Nancy., *Resonate: Present Visual Stories that Transform Audiences*, John John Wiley and Sons, 2010.
2. Minto Barbara., *The Pyramid Principle: Logic in writing, thinking and Problem Solving*, Financial Times Prentice Hall, 2002.
3. Berkun Scott., *Confessions of a Public Speaker*, O'Reily Media, 2009.
4. Goodale Malcolm., *Professional Presentations*, Cambridge University Press, 2005.
5. Carnegie Dale., *The Art of Public Speaking*, 1905.

HUM 4307: INTRODUCTION TO PSYCHOLOGY [3 0 0 3]

Psychology - Meaning, Nature and Scope, Defining Psychology, Meaning of the term Behavior, Nature of Psychology, Scope of Psychology: Branches and fields of Psychology. Development of Psychology - Historic Sketch of Psychology, Modern Age of Psychology, Gestalt Psychology, Psycho Analysis, Contemporary Psychology. Systems of Psychology- The Nervous System, Nature V/s Nurture, Sensation and perception, States of Consciousness. Methods of Psychology - Classical Conditioning, Introspection Method, Naturalistic Method, Experimental Method, Differential Method, Clinical Method, Psycho Physical Method. Personality- Personality types, Personality Disorders, Abnormal psychology, Treatment of personality disorders. Thinking - Nature of Thinking, Types of Thinking, Language and Intelligence. Discussion, Presentation and Assignments.

References:

1. Boring, E.G., Langfield,H.S. &Weld,H.P., *Foundations of Psychology, Asia* Publishing House, Calcutta, 1963.
2. Carson, R.C., Butcher, J.N. & Coleman, J.C., *Abnormal Psychology & Modern Life*, (8th ed) Scoff, Foresman& Co. 1988.
3. Lahey, B.B.,Psychology: *An Introduction*, 6th Ed., Tata McGraw Hill, New York, 1965.
4. Olson, M.; Hergenhahn, B.R., *Introduction to the Theories of Learning*, Prentice-Hall India, 2009.

HUM 4308: INTRODUCTION TO PHILOSOPHY, RELIGION AND CULTURE [3 0 0 3]

Notions of Philosophy; The Origin and Development of Philosophy; Ancient Philosophy; Medieval Philosophy; Modern Philosophy; Contemporary Philosophy; Indian Philosophy; Comparative Religion; Western Philosophy; The Relevance of Philosophy; Branches of Philosophy; Methods of Philosophy; Philosophy and other Branches of Study; Some Problems of Philosophy; Themes of Philosophy; Mind and Body, and the Problem of Universal; Change/Movement time and place; Existence of God and Evolution; Indian Culture; Social Ethics; Logic and Scientific Methods; Philosophy of Language.

References:

1. Aquinas, Thomas., *On Being and Essence. Trans. Armand Maurer*. Canada: Pontifical Institute of Mediaeval Studies, 1968.
2. John-Terry, Chris., *For the Love of Wisdom: An Explanation of the meaning and Purpose of Philosophy*. New York: Alba House, 1994.
3. Maritain, Jacques., *An Introduction to Philosophy*, London: Sheed and Ward. 1979.
4. Radhakrishnan, S. (Ed)., *History of Philosophy Eastern and Western Vol.II* George Allen and Unwin Ltd., London, 1953.
5. Wallace, William., *The Elements of Philosophy*. New York: Alba House, 1990.

HUM 4309: CREATIVE WRITING [3 0 0 3]

Various literary/prose forms and their characteristics; techniques and strategies for reading; nuances of language and meaning in reading and writing; Writing Exercises - techniques and strategies of writing creatively; Critical Concepts and Terms in Literary Writing; Writing Exercises; creative writing output.

References:

1. Milan Kundera ., *The Art of the Novel*.
2. The Art of Fiction: Illustrated from Classic and Modern Texts, David Lodge

HUM 4310: GRAPHIC NOVELS: HISTORY, FORM AND CULTURE [3 0 0 3]

Part I:The History of Comic Books, Part 1: Developing a Medium Defining comic books as a medium-Relationships between comic books and other forms of sequential art-The (continental) roots of comics as an art form -The ways in which comic strips and pulps contributed to the emergence of the comic book. The History of Comic Books, Part 2: The Maturation of the Medium-Influence of underground movement, ways in which mainstream publishers began to address more relevant topics, proliferation of independent comics, the increase in the profile and prominence of the medium due to ambitious projects. Part II: Creating the Story: Graphic Storytelling and Visual Narrative-Some narrative structures commonly found in comic books -The types and techniques of encapsulation-The nature of the relationship between the pictorial and linguistic elements of comic books Experiencing the Story: The Power of Comics - About diegetic images that show the world of the story-About interpretive images that comment on the story-The impact art style has on the emotional reactions of the reader; and how the meaning of each image is affected by the relationship to other images in that particular book, in other texts, and in the reader's personal experience-Part III: Comic Book Genres-the definition of genre and the role it plays in shaping the creation of comics products- the characteristics of genres, including character types, narrative patterns, themes, and other conventions-how the example genres of teen humor, romance, funny animals, horror, and memoir developed in comics, and what characterizes each-how the hybridization of genres helps experimentation and expansion of narrative possibilities.

References:

1. Roger Sabin., *Comics, Comix and Graphic Novels*.
2. Robert Petersen, Allan Moore., *Comics, Manga and Graphic Novels: A History of Graphic Narrative3. Comics as Performance*, Fiction as Scalpel.
3. JeetHeer, Kent Worcester., *Arguing Comics: Studies in Popular culture*.

HUM 4311: MANAGEMENT INFORMATION SYSTEMS [3 0 0 3]

Management information system: Introduction to management, information and system. System concepts, general model of a system and types of systems. Evolution of MIS , models and resources used in the MIS model. Structure of MIS, operating elements of an information system, synthesis of the structure. Information systems for different applications: Transaction processing systems, Human resource management systems and Marketing-application areas. Production planning and Office automation systems. Role of management information in decision making: Concepts of decision making, Decision making process and information needs at different levels of management. Herbert. A. Simon model. Phases in the decision making process, Programmed vs non-programmed decisions, General model of human as an information processor, Allen Newell Simon model. Decision support systems -structure, elements and working. Information as a strategic resource. MIS as a technique for making programmed decisions: Behavioral models of the decision maker and methods. MIS support for decision making. Role of MIS in Organizations -recent trends and e-commerce applications. Development of customized management information system approaches: SDLC -phases in SDLC, Strategic and project planning for MIS, conceptual design and detailed design phases: general business planning and MIS response. MIS Planning and planning cycle. Conceptual system design and Detailed System design. MIS System Implementation, and Pit falls: Pit Falls in MIS development, Fundamental weaknesses, soft spots in planning, design problems and review.

References:

1. Gordon B. D. and Margrethe H. O., (2005), "Management Information Systems", McGraw-Hill, New York.
2. Kenneth L. and Price J. P., (2003), "Management Information Systems", Macmillan.
3. Jawadekar W. S., (2000) "Management Information System", Tata McGraw Hill.
4. Senn J. A., (2003), "Analysis & Design of Information System", McGraw Hill International Student Edition.
5. Mudrick; Ross (1997) "Information Systems for Modern Management " Prentice Hall of India.
6. James A. O.Brien (1995)"Management Information Systems, Galgotia Publications.

HUM 4312: ENTREPRENEURSHIP [3 0 0 3]

Entrepreneur: Meaning of entrepreneur, evolution of the concept, functions of an entrepreneur, types of entrepreneur, and intrapreneur. Concept of entrepreneurship - evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development, entrepreneurship in India, barriers for entrepreneurship. Small scale industry: Definition, characteristics, need and rationale. Objectives, scope, role of Small Scale Industries (SSI) in economic development, advantages of SSI, steps to start an SSI - government policy towards SSI, different policies of SSI, impact of liberalization, privatization, and Globalization. Effect of WTO/GATT and supporting agencies of government for SSI. Institutional support: Different Schemes: TECKSOK, KIADB; KSSIDC; KSIMC; DIC Single Window Agency: SISI, NSIC, SIDBI, and KSFC, New schemes and support for start-ups and new venture under Govt. of India. Preparation of Business plan and project report: components of a successful plan. Meaning of project, project identification, project selection, project report, need and significance of report, contents, formulation, guidelines by planning commission for project report. Network analysis, errors in project report, project appraisal. Identification of business opportunities, market feasibility study, technical feasibility study, financial feasibility study and social feasibility study and documentation and evaluation.

References:

1. Vasant Desai., Dynamics of Entrepreneurial Development & Management, Himalaya Publishing House, 2007.
2. David H. Holt Entrepreneurship: New Venture Creation, Published by prentice Hall,1991.
3. Poornima. M. Charantimath., Entrepreneurship Development, Pearson Education, 2006.
4. S.S. Khanka., Entrepreneurship Development, S.Chand& Co, 2007.

Minor Specialization: Material Science

PHY 4051: PHYSICS OF LOW DIMENSIONAL MATERIALS [3 0 0 3]

Thin films: Thick and Thin Film Materials, preparation by physical and chemical methods. Thickness measurement techniques. Theories of nucleation - Capillarity and atomistic theory, effect of deposition parameters on nucleation and growth of thin films. Epitaxial growth. Reflection and Transmission at interface between isotropic transparent media. Reflectance and Transmittance in thin films. Antireflection coatings. Electrical conduction in discontinuous metal films - Quantum mechanical tunneling model. Conduction in continuous metal and semiconducting films. Thermoelectric power in metal films. thin film resistors, thermopiles. Quantum well devices.

Nanomaterials: Chemical Synthesis of Nanoparticles: Bottom up approach. Functionalized nanoparticles in different medium. Size control. Self assembly. Nanoparticle arrays. Semiconductor nanoparticles- synthesis, characterization and applications of quantum dots. Magnetic nanoparticles- assembly and nanoastructures. Manipulation of nanoscale biological assemblies. Carbon nanotubes and fullerene as nanoclustures. Nanostructured films. Physical Methods of Nanostructure Fabrication: Top down approach. Nanopatterning-Lithography- Optical, X-ray and Electron beam lithography. Ion- beam lithography.

References:

1. Chopra K. L., *Thin Film Phenomena*, Mc Graw Hill, 1969
2. Milton Ohring, *Materials Science of Thin Films*, Elsevier, 2001
3. Heavens O. S., *Optical Properties of Thin Solid Films*, Dover, 1955
4. Liz-Marzan L. M. and Kamat P. V. (Eds), *Nanoscale Materials*, Kluwer, 2003
5. Nalwa H. S. (Ed), *Nanostructured Materials and Nanotechnology*, Academic, 2002

PHY 4052: PHYSICS OF PHOTONIC AND ENERGY STORAGE DEVICES [3 0 0 3]

Semiconductors: Direct and indirect band gaps. Carrier concentrations at thermal equilibrium. Fermi level. Degenerate and non-degenerate semiconductors. Semiconductor Crystal growth techniques Contact phenomenon- semiconductor-semiconductor, metal-semiconductor contacts. Schottky and Ohmic contacts. Preparation of semiconductor devices. IC technology, elements of lithography.

Photonic Devices: LED and semiconductor lasers: Radiative and non-radiative transitions, diode laser, population inversion, laser operating characteristics, efficiency, photoconductor, photodiode, avalanche photodiode, phototransistor, material requirement for solar cells, theory and types of solar cells.

Fuel cells: Hydrogen energy – merits as a fuel – production of hydrogen, Hydrogen Fuel cells – introduction – difference between batteries and fuel cells, components of fuel cells, principle of working of fuel cell, fuel cell stack, fuel cell power plant: fuel processor, fuel cell power section, power conditioner, Advantages and disadvantages of fuel cell power plant. Types of fuel cells. Application of fuel cells – commercially available fuel cells.

References:

1. Neamen Donald A., *Semiconductor Physics and Devices, basic principles*, Tata McGraw-Hill, 2002
2. Sze S. M., *Physics of Semiconductor Devices*, John Wiley & Sons, 2007
3. Larminie J. and Dicks A., *Fuel Cell Systems Explained*, Wiley, 2003
4. Xianguo Li, *Principles of Fuel Cells*, Taylor and Francis, 2005
5. S. Srinivasan, *Fuel Cells*: From Fundamentals to Applications, Springer, 2006

OPEN ELECTIVES

PHY 4301: FUNDAMENTALS OF ASTRONOMY AND ASTROPHYSICS [3 0 0 3]

Introduction to astronomy and astrophysics. Properties of ordinary stars: Brightness of starlight; the electromagnetic spectrum; Colours of stars; stellar distances; absolute magnitudes; HR diagram. Stellar evolution: Formation of star; the main sequence; stellar structure; evolution off the main sequence; planetary nebulae; white dwarfs. The death of high mass stars: Supernovae; neutron stars; pulsars; stellar black holes. Normal Galaxies: Types of galaxies; Dark matter in galaxies. Cosmology: The scale of universe; expansion of the universe; open or closed universe; the big bang; the cosmic background radiation; big bang nucleosynthesis. Astronomical instruments.

References:

1. Marc L Kutner, *Astronomy: A physical Perspective (2e)* Cambridge University Press,2003
2. BaidyanathBasu, *An Introduction to Astrophysics (2e)*, PHI Learning Pvt. Ltd, 2011.
3. Michael Zeilik, *Introductory Astronomy and Astrophysics (4e)*, Saunders College Pub. 1992.

PHY 4302: PHYSICS OF ENGINEERING MATERIALS [3 0 0 3]

Types of magnetism, ferromagnetic domains, soft and hard magnetic materials, ferrites, magnetic storage, Superconducting materials, Applications of superconductors, Nano-materials, bottom-up and top-down methods, Quantum dots and nano-carbon tubes, Composite materials, micromechanics of composites - Density, Mechanical and Thermal properties, Semiconductors, Metals, semiconductors and insulators, Direct and indirect band-gap semiconductors, Intrinsic and extrinsic semiconductors, Diffusion and drift processes, Crystal growth techniques, Preparation of semiconductor devices.

References:

1. William F. Smith, *Principles of Materials Science and Engineering (2e)*, McGraw-Hill International Edition, 1990.
2. Nalwa H.S., *Nanostructured Materials and Nanotechnology (2e)*, Academic, 2002.
3. Chawla K. K. *Composite Materials- Science & Engineering (3e)*, Springer-Verlag, 2012.
4. Streetman Ben G. and Banerjee Sanjay Kumar, *Solid State Electronic Devices (6e)* PHI learning Private Limited, 2012.

PHY 4303: RADIATION PHYSICS [3 0 0 3]

Radiation Sources: Fast electron sources-Heavy charged particle sources-Sources of electromagnetic radiation-Neutron sources. Radiation Interaction: Photoelectric and Compton process -pair production. Interaction of heavy charged particles-stopping power-Energy loss characteristics- Bragg curve-Particle range-range straggling- stopping time-energy loss in thin absorbers-Interaction of fast electrons-absorption of beta particles-interaction of gamma rays-gamma ray attenuation-Interaction of neutrons-neutron cross section-neutron induced nuclear reactions. Radiation Detectors and Instrumentation: Semiconductors diodes-JFET-MOSFET-Integrated Circuits-OPAMP and their characteristics-Differential Amplifier-Operational amplifier systems-Pulse Amplifiers. Principles of radiation detection and measurements-Gas filled detectors-Ionisation chambers-Proportional counters-GM counters-Scintillation detectors-Semiconductor detectors-Thermo luminescent Dosimeters-Radiation spectroscopy with scintillators-Gamma spectroscopy-Multichannel pulse analyzer-Slow neutron detection methods-Reactor instrumentation. Industrial uses of nuclear measurements: Radiation detection in industrial environments-Measuring systems for industrial problems-Determination of physical material characteristics by nuclear measurements-Level height determination-Density measurements-Quantity measurements-Thickness measurement-coating thickness measurement.

References:

1. Knoll G. F., *Radiation Detection and Measurement (3e)*, Wiley 2010
2. Boylestad R. L., *Electronic Devices and Circuit theory (11e)*, Pearson Education 2016
3. Malvino A. P., *Electronic Principles (7e)*, TMH 2010
4. Foldiak G., *Industrial Applications of Radioisotopes*, Elsevier Science Ltd 1986

PHY 4304: SOLID STATE PHYSICS [3 0 0 3]

Review of Crystal structure: Lattice, basis and unit cell, crystal system, symmetry, crystal planes and miller indices, reciprocal lattice, Bragg's law, experimental methods of x-raydiffraction, types of crystal binding, analysis of stress and strain in crysals. Electrical conduction: Free electron gas model, Sommerfield quantum theory, Fermi energy, parameters of free electron gas at absolute zero, electrical conductivity, Drude-Lorentz theory and Sommerfield theory of electrical conductivity, Band theory of solids, electrical conduction in metals, insulators and semiconductorsDielectrics: Static dielectric constant, polarization and polarizability, local field, ferro electricity, piezo electricity, frequency dependence of polarizability (electronic, ionic and dipolar), dielectric losses, requirements of insulating materials, applications of dielectric materialsMagnetism: Classification of magnetic materials, classical theory of diamagnetism and paramagnetism, Weiss theory of ferromagnetism, ferrites, hard and soft magnetic materials, garnets, magnetic bubbles, ceramic magnets, applications of magnetic materials

References:

1. Kittel C., *Introduction to Solid State Physics (7e)*, Wiley 1996.
2. Rao A., *A first course Solid State Physics*, Asiatech publications 2000.
3. Pillai S.O., *Solid State Physics (6e)*, New age international publications 2006.
4. Wahab M. A., *Numerical problems in Solid State Physics*, Alpha science international publications 2011.
5. Gupta H. C., *Solid State Physics*, Vikas publishing house Pvt. Ltd. 1996.

PHY 4305: MODERN OPTICS [3 0 0 3]

Optics: Review of geometrical and physical optics, Dual nature of light, Electromagnetic spectrum, Optical devices, mirrors, lenses, prisms, grating, beam splitters, zone plate, polaroids. Light sources, emission profile. Elements of lasers: Basic requirements in a laser, characteristic properties of lasers. Q-switched and mode locked lasers. CO2, Nd: YAG lasers. Applications. Introduction to Non-linear optics. Optoelectronic devices and its application: Photo diodes, solar cells, LED, and diode lasers. DBR and DFB lasers, CCD. Optical Communication: Conceptual picture of the optical communication system, Modulation and Detection Schemes, properties of optical fibers, discussion on device requirements, OEICS. Optical storage devices: Data recording and read out from optical discs. Holographic data storage systems.

References:

1. Ghatak A., *OPTICS (4e)*, Tata McGraw Hill Publishing Company Ltd. 2009.
2. Singh J., *Optoelectronics: An Introduction to Materials and Devices*, TATA McGraw- Hill Companies, Inc. 2014.
3. Wilson & Hawkes, *LASERS*, Prentice-Hall of India Pvt. Ltd. 1987.
4. Hugh Bennett, *Understanding Recordable & Rewritable DVD*, OSTA.org.
5. Hugh Bennett, *Understanding CD-R & CD-RW*, OSTA.org.

PHY 4306: INTRODUCTORY QUANTUM MECHANICS [3 0 0 3]

Review of certain basics : Limitations of classical physics, wave-particle duality, De Broglie's hypothesis, matter as wavepacket, Heisenberg's uncertainty principle, Mathematical Formalism : operators; commutation relation; orthonormal functions; eigenvalues and eigenfunctions; the Dirac notation; the postulates of quantum mechanics.The Schrödinger Equation : Introduction, wavefunctions , time dependent Schrödinger equation, conservation of probability, expectation values, Ehrenfest's theorem, time independent Schroedinger equation, stationary states, Schroedinger equation in one dimension : the infinite square potential well; the finite square potential well; the potential barrier; tunneling; the harmonic oscillator.Quantum mechanics in three dimensions: Schrödinger equation in spherical coordinates, separation of variables, the angular equation, the radial equation, Applications (energy eigenvalues and eigenfunctions): the rigid rotator; the hydrogen atom; angular momentum. Identical Particles.Some applications of quantum mechanics in nuclear physics, condensed matter physics, and spectroscopy: alpha decay, nanostructures, STM, vibrational and rotational spectra of molecules etc.

References:

1. Verma H.C., *Quantum Physics (2e)*, Surya Publications. 2016.
2. Gasiorowicz S., *Quantum Physics (3e)*, Wiley India Pvt Limited. 2007.
3. Jain M. C., *Quantum Mechanics: A Textbook for Undergraduates*, PHI Learning Private Limited 2012.
4. Griffiths D. J., *Introduction to Quantum Mechanics (2e)*, Pearson Education.
5. Eisberg R. and Resnick R., *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles (2e)*, Wiley-India Pvt Limited. 2009.

Minor Specialization: Material Science

CHM 4051: CHEMICAL BONDING [3 0 0 3]

Introduction to bonding, Classification. Ionic bond- Lattice energy, Born Haber cycle, Radius-ratio rules, Properties of ionic compounds, Covalent character in ionic bonds. Covalent bond-Covalency, Valence bond theory, Sigma and pi bond, Hybridization, VSEPR Theory, Molecular orbital theory, Bond order, Properties of covalent compounds. Coordination bond - Primary and Secondary valencies, ligands, Valence bond theory of complexes, Crystal field theory of octahedral and tetrahedral complexes, Low and high spin complexes. Metallic bond-Band theory of metals, Conductors, semiconductors and insulators. Secondary bonding- Hydrogen bonding, London forces and dipole-dipole interactions.

References:

1. J D Lee, "Concise Inorganic chemistry", Wiley India, 2012
2. B R Puri , L R sharma and K C Kalia, "Principle of Inorganic chemistry", Vishal Publishing Co., Punjab, 2017.
3. D F Shriver, P W Atkins, "Inorganic chemistry", Oxford India, 2014
4. A F Cotton, "Basic Inorganic chemistry", Wiley Publishers, 2007

CHM 4052: CHEMISTRY OF CARBON COMPOUNDS [3 0 0 3]

Introduction to Organic Compounds: Classification, Nomenclature; Alkanes: Homologous series, Preparation; Cycloalkanes: Ring size and strain, Applications; Alkenes: Markovnikov and anti-Markovnikov addition reactions, Reduction, applications; Alkynes: Acidity, preparation, Reduction of alkynes, applications; Alkyl halides: SN1, SN2, E1 and E2 reaction mechanisms; Alcohols: Classification, Acidity, organo-metallic reagents; Aromatic compounds: Electrophilic and nucleophilic substitution reactions; Mechanism of some named reactions; Carbonyl compounds: aldehydes and ketones, carboxylic acids and carboxylic acid derivatives; Heterocyclic compounds: Nomenclature, synthesis and reactivity of thiophene, pyrrole and furan; Carbon materials: Fullerenes, carbon thin films, nanotubes and carbon fibers; Carbon nanotubes: SWNT, MWNT, synthesis, properties and applications; Carbon nanomaterials applications.

References:

1. B S Bahl and Arun Bahl, "Advanced Organic Chemistry", S Chand, New Delhi, 2012.
2. Robert T. Morrison and Robert N. Boyd, "Organic Chemistry", Pearson, New Delhi, 2016.
3. P.S. Kalsi, "Organic Reactions and Their Mechanisms", New Age International Private Limited, New Delhi, 2017.
4. Ashutosh Tiwari and S. K. Shukla, "Advanced Carbon Materials and Technology", John Wiley & Sons, 2013.

B. Bhushan ed., "Springer Handbook of Nanotechnology", Springer Publishers, Berlin, 2004.

OPEN ELECTIVES

CHM 4301: ANALYTICAL METHODS AND INSTRUMENTATION [3 0 0 3]

Spectroscopic methods of analysis: Properties of EMR, General features of spectroscopy, Types of molecular spectra, Interaction of EMR with matter, Instrumentation, Applications, Theory, Instrumentation and applications of Microwave, Raman, Infrared, UV-Visible, NMR spectroscopic techniques. Chromatographic Techniques: General concepts, Classification, Principles, Experimental techniques of CC, HPLC, TLC, GC and their applications. Electroanalytical methods: Basic principles and applications of conductometric, potentiometric titrations.

References:

1. D.A. Skoog, J. Holler, F.T.A. Nieman, *Principles of Instrumental Analysis*, 5thEdn, Saunders, Philadelphia, 1992
2. D. A. Skoog, D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, 5thEdn, Saunders College Publishing, Philadelphia, 1988
3. *Vogel's Textbook of Quantitative Chemical Analysis*, GH Jeffery, John Wiley & Sons Inc, 5thEdn, 1989

CHM 4302: FUNDAMENTALS OF INDUSTRIAL CATALYTIC PROCESSES [3 0 0 3]

Adsorption & Catalysis: Physisorption and chemisorption, Adsorption isotherms, Factors influencing adsorption, Adsorption of gases by solids, Adsorption from solution, Introduction to catalysis, Energetics, Catalytic cycles Solutions & Solubility: Ideal and non-ideal solutions, Raoult's law, Thermodynamics of ideal solutions, Vapor pressure and boiling point composition curves, Distillation behaviour of completely miscible & immiscible liquid systems, Azeotropes Colligative Properties: Determination of molar masses from vapor pressure lowering, Osmotic pressure, Boiling point elevation and Depression of freezing point, Vant Hoff's factor Colloids: Types, Preparation and purification of sols, General properties, Optical, Electrical & Kinetic properties of sols, stability of sols, Application of colloids, Emulsions & Gels- Types, Preparation, Properties and their applications.

References:

1. *Principles of Physical Chemistry*, B.R. Puri, L.R. Sharma, M.S. Pathania, Vishal Publications, New Delhi, (23e), 2008
2. *Principles of Physical Chemistry*, S.H. Maron, C.F. Prutton, IBH Publishing co. New Delhi, (4e), 1985
3. *Fundamentals of Analytical Chemistry*, D.A. Skoog, D.M. West, F.J. Holler, R. Crouch, (4e),Thomson-Brooks, 2007

CHM 4303: SUSTAINABLE CHEMICAL PROCESSES AND PRODUCTS [3 0 0 3]

Introduction and principles of green chemistry, Examples, Atom economy, carbon efficiency, life cycle analysis, sustainable products, process and synthesis catalysis and green chemistry, examples of fine and bulk chemicals production, catalysts for clean technology. Application of ecofriendly approach to waste treatment. Cleaner production processes, clean synthesis in lab Scale, industrial examples, use of ecofriendly energies. Bio-pesticides, polymers & pharmaceutical products. Electrochemical synthesis, Alternate reaction media using water and other green solvents, ionic liquids & supercritical fluids; phase transfer catalysis.

References:

1. P.T. Anastas, J. C. Warner, *Green Chemistry: Theory and Practice*, Oxford Univ. Press, Oxford, 2008
2. A.S. Matlack, *Introduction to Green Chemistry*, Marcel Dekker, New York, 2001
3. P. T. Anastas, R. H. Crabtree, *Handbook of Green Chemistry and Catalysis*, Wiely-VCH, Weinheim, 2009

Inter Institute Open Electives

Centre for Creative and Cultural Studies (CCCS), Manipal

IIE 4301: ART APPRECIATION [3 0 0 3]

How to read a visual, how to enjoy or feel an art form, what is Creative Thinking? Indian Art: Heritage & Culture; Art Appreciation: Western Art, Artist & Art Movements: Raja Ravi Verma, Tagore, Da Vinci, Van Gogh; Aesthetics: Beauty, Feel & Expression; Art & Science; Art & Film; Art: Freedom & Society, to be an art literate. A journey to immerse in the world of Art.

IIE 4302: INDIAN CULTURE AND CINEMA - AN INTRODUCTION [3 0 0 3]

Introduction to Idea of Culture, Identity and tradition, Indian Cultural History, Indian cultural history, Time and space, Indian Art and heritage, Indus valley civilization – Indian Independence, Post-colonial India, Modern India, Indian Cinema, Body, language and feel, Film and culture, Evolution, Interpretation and Reflection, Indian Cinema, Media and the medium, Pioneers and classical films, Culture and art of cinema, Culture, Cinema and Society, Revolutions, ideas, innovations, Culture, Cinema and Peace, Message, purpose and the challenge.

Manipal Institute of Management, Manipal

IIE 4304: CORPORATE FINANCE [3 0 0 3]

Introduction to Corporate Finance, Financial Goal, Agency Problems, Managers vs Shareholders Goals, Concepts of Value and Return, Capital Budgeting Decisions, Cost of Capital, Calculation of the Cost of Capital in Practice, Financial and Operating Leverage, Capital Structure, Relevance of Capital Structure, Irrelevance of Capital Structure, Relevance of Capital Structure, Dividend Theory, Dividend Relevance, Dividend Relevance, Dividend and Uncertainty, Dividend Irrelevance, Principles of Working Capital Management.

References:

1. Brealey, R., Myers, S., Allen, F., & Mohanty, P. (2014). Principles of Corporate Finance (11e). New Delhi : Mc Graw Hill Education (India) Private Limited,.
2. Pandey, I. M. (2014). Financial Management (10e). New Delhi: Vikas publishers.
3. Ross, S. A., Westerfield, R. W., Jaffe, J., & Kakani, R. K. (2014). Corporate Finance (10e). New Delhi: Mc Graw Hill Education (India) Private Limited.
4. Parasuraman, N. R. (2014). Financial Management - A Step-by-Step Approach (1e.). New Delhi: Cengage Learning India Private Limited.

IIE 4305: INTERNATIONAL BUSINESS MANAGEMENT [3 0 0 3]

Historical perspective of international business, International business environment, Modes of entering international business, Cross-Culture and dynamic market understanding, Differences in Culture, Theories of international business, World Bank, World trade organization, Multinational Corporations and their involvement in International Business, Tariffs and quotas, Balance of Payment Account.

References:

1. Hill Charles, W. L., & Jain Arun, K. (2011). International Business: Competing in the Global Marketplace. (8e), Tata McGraw Hill.
2. Kumar, S. P., & Sanchari, S. (2012). International Business Management-AGlobal Perspective. New Delhi: Excel Books.

IIE 4306: BRAND MANAGEMENT [3 0 0 3]

Introduction to brand management, Developing a brand strategy, Brand resonance and brand value chain, Designing and implementing brand marketing programs to build brand equity, Measuring and interpreting brand performance, Designing and implementing brand architecture strategies, Managing brands.

References:

1. Keller, K. L., Parameswaran, M. G., Jacob, I. (2015). Strategic Brand Management (4e). Noida, India: Pearson Prentice Hall Publication.
2. Rowles, D., (2014). Digital Branding (1e.). UK: Kogan Page Limited.
3. Kapferer, J. N., (2012). The New Strategic Brand Management: Advanced Insights and Strategic Thinking (5e). UK: Kogan Page Limited

Centre for Integrative Medicine & Research (CIMR)

IIE 4307: YOGA [3 0 0 3]

Aim, Obiectives, Meanings and Definitions of Yoga, History of Yoga, Concepts and misconcepts of Yoga, Schools of Yoga, Ashtanga Yoga

Subjects by Industry Experts

IIE 4308: HEALTH ECONOMICS [3 0 0 3]

Economics: Understanding Economics, Efficiency, Rational decision making, Opportunity costs, Supply and demand, Price discovery, Health economics: Defining health, Human capital, what does supply and demand mean in the context of health? Arrow on the uncertainty and welfare economics, The Moral hazard, DALY and QALY, Efficiency: The Production possibility frontiers. The production function for health care. Health policy, Defining equity, Standards of healthcare provision Epidemiology, The Healthcare sector, The demand for health, Disease prevalence, The pharmaceuticals market, Cross country case studies.

References:

1. Sloan, Frank A., and Chee-Ruey Hsieh. Health economics. MIT Press, 2012
2. Annemans, L. Health economics for non-economists. An introduction to the concepts, methods and pitfalls of health economic evaluations. Academia Press, 2008
3. Jeffery, Roger. The politics of health in India. University of California Press, 1988.

IIE 4309: DIGITAL MEDICINE [3 0 0 3]

Present day practice of medicine. Limitations of scalability in the present framework. Introduction to computing, algorithms, big data, semantic web, mobility. Communication-WAN/LAN, 3G/4G and 5G. Patient/Electronic Health records. Experience with these records elsewhere Wearables, the physics of data capture. Practical demonstration of wearables Genomics, an introduction. Computational genomics including the software. Imaging –an introduction-ionizing and non-ionizing. Imaging software and science of diagnosis. How all the four 4 pillars-PHR/EHR, Wearables, Genomics and Imaging come together with software as the glue to change the world of medicine.

References:

1. David Mount. Bioinformatics: Sequence and Genome Analysis. CSHL, 2001
2. Durbin, Richard, Sean Eddy, Anders Krogh, and Graeme. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press, 1999

Manipal College of Nursing Manipal

IIE 4310: MEDICAL EMERGENCY AND FIRST AID [3 0 0 3]

Principles of First Aid, First aid kit and equipment, emergency drugs, scene assessment, safety and identifying hazards, patient assessment, Basic Life Support and AED, triage, extrication/stretchers, ambulance. Describe the causes, signs and symptoms and management of respiratory emergencies, acute gastro-intestinal emergencies, musculoskeletal emergencies, dental, ENT and eye emergencies, renal emergencies, nervous system emergencies, hematological emergencies, endocrine emergencies, toxicological emergencies, environmental emergencies, pediatric emergencies, psychiatric emergencies, obstetrical emergencies

References:

1. Pollak, A.N. (2005). Emergency care and transportation of the sick and injured. Massachusetts: Jones and Bartlett publishers.
2. Keen, J. H. (1996). Mosby's Critical Care and Emergency Drug Reference. Missouri: Mosby's year book.
3. Walsh, M. (1990). Accident and emergency nursing. A new approach. Oxford: Butterworth Heinemann Ltd.
4. Sbaih, L. (1992). Accident and emergency Nursing. A nursing model. London: Chapman and Hall.
5. Sbaih, L. (1994). Issues in accident and emergency Nursing. London: Chapman and Hall.
6. Bourg, P., & Rosen, S. P. (1986). Standardized nursing care plans for emergency departments. Missouri: The C. V. Mosby Company.
7. Howard, P.K., &Steinmann, R. A. (2010). Sheehy's Emergency Nursing principles and practice. Missouri: Mosby Elsevier.
8. Sira.S, (2017). First Aid Manual for Nurses (First ed.), New Delhi: CBS Publishers & Distributors Pvt. Ltd.

IIE 4311: LIFE STYLE MODIFICATION AND COMPLEMENTARY AND ALTERNATIVE THERAPIES [3 0 0 3]

Principles and concepts of life style modification and various complementary and alternative therapies, Demonstrate skill in performing different yoga aasanas, guided imagery/Progressive muscle relaxation, meditation & Pranayama, reflexology, massage therapy, aerobics, laughter therapy

References:

1. Bhat Krishna K. The power of yoga. Suyoga publications; DK, 2006
2. M.M.Gore. Anatomy & Physiology of yogic practices; (5e), New age book.
3. K N Udupa. Stress and its management by yoga. (2e). Motilal Banarsidas publishers Pvt. Ltd, Delhi, 2007.
4. Yoga and total health. A monthly journal on the yoga a way of life.
5. Swami Satyananda Saraswati. Dynamics of yoga. (2e), Bihar school of yoga, Bihar 1997.

Welcomegroup Graduate School of Hotel Administration, Manipal

IIE 4312: INDIAN CUISINE AND CULTURE PRACTICAL [3 0 0 3]

Introduction to Indian cuisine, Basic Indian gravies, Rice cooking, Preparation of various rice products, Tandoor Cooking, Indian sweets, Comfort Food, Regional and sub-regional cuisine.

IIE 4313: FOUNDATION COURSE IN BAKING AND PATISSERIE PRACTICAL [3 0 0 3]

Introduction to Patisserie and Baking Principles, Special emphasis placed on the study of ingredient functions, Students will have the opportunity to apply basic baking techniques, Understanding fundamentals of yeast dough production, Emphasis on the application of ingredient functions, product identification and recipe interpretation occurs throughout the course, Pastry Basics and Pie dough, The fundamental production of classical European pastry based desserts are included, Techniques of Cake Making, Techniques of Cookie making, The course emphasizes the preparation and makeup techniques of various cookies.

References:

1. Wayne Gisslen – Professional Baking, (5e), John Wiley USA.
2. Haneman L.J. Bakery: Flour Confectionery HEINMAN.
3. Mermaid Books The Book Of Ingredients DOWELL PHILIP.
4. John Wiley Understanding Baking AMENDOLA JOSEPH.
5. New Age International, A Professional Text to Bakery and Confectionery, KINGSLEE JOHN.
6. Virtue And Company Ltd., The New International Confectioner: WILFRED J. FRANCE.
7. Charrette Jacques, Great Cakes and Pastries, TEUBNER CHRISTIAN.
8. Joseph Amendola, Baker's Manual, (5e), NICOLE REES.
9. Joseph Amendola, Understanding Baking, (3e), NICOLE REES.
10. Culinary Institute Of America, Baking and Pastry: Mastering the Art and Craft, JOHN WILEY.

IIE 4314: GLOBAL CUISINE & CULTURE- PRACTICAL [3 0 0 3]

European Cuisine: Familiarization of ingredients, recipes and preparation of different countries. North American Cuisine: Familiarization of ingredients, recipes and preparation of different countries. South American Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Asian Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Australian Cuisine: Familiarization of ingredients, recipes and preparation of different countries. African Cuisine: Familiarization of ingredients, recipes and preparation of different countries. Molecular Gastronomy: Additives, Tools, and Recipes. Processed Food: Comparison and Critiquing. Mediterranean and European cuisine: Familiarization of ingredients, recipes and preparation of different countries.

References:

1. The Professional Chef - The Culinary Institute of America
2. Practical Cookery - Kinton, Ceserani and Foskett
3. Food Production Operation - Parvinder S. Bali
4. Professional Cooking - Wayne Gisslen
5. Cookery for the Hospitality Industry - Dodgshun Peters
6. Modern Cookery - Thangam E Phillips

School of Communication, Manipal

IIE 4315: REPORTING AND WRITING [3 0 0 3]

Introduction to news writing news in different media, news, definition of news, news values; types of news other theoretical issues relating to news writing. News Reporting Basic of news writing: structure of news reports; writing the lead; the changes in the composition of the lead; techniques of news gathering; sources of news. Reporting various types of reporting (Objective, Interpretative, Investigative,) General assignment reporting/working on a beat. Reporting for news agency, periodicals and magazines. Interviewing: doing the research, conducting the interview, types and formats of interviews, writing interviews

References:

1. Mencher, Melvin (2006): News Reporting and Writing, Mac-Graw Hill, Boston.
2. Scalnan, Christopher (2000): Reporting and Writing: Basics for the 21st Century, Harcourt College Publishers.
3. Harrington Walt (1997) Intimate Journalism: The Art and Craft of Reporting Everyday Life, Sage Publications.
4. Carole, Rich (2007), Writing and Reporting News: A Coaching Method, Thomson Learning Inc.Kamath, K.V. (1993): Journalists' Handbook, Vikas Publishing House.
5. Aggarwal, Vir Bala (2006): Essentials of Practical Journalism, Concept Publishing Company.

IIE 4316: INTRODUCTION TO ADVERTISING & PUBLIC RELATIONS [3 0 0 3]

Introduction to advertising; Evolution and history of advertising; Influence of advertising on society and ethics. Advertising as part of marketing mix; Structure and types of ad agencies; Advertising planning; creative strategy and implementation (media strategy). The essentials of advertising on different media platforms – print, broadcast, internet and new media; discuss the difference in planning and execution using examples or campaign case studies. Public Relations-scope; definition; evolution; establish difference between PR and advertising; Identifying stakeholders and various Public Relation tools. Steps in developing a PR program/campaign-stating the problem, planning and programming, action and evaluation; Crisis communication; Ethical issues in Public Relations.

References:

1. Butterick, K (2012): Introducing Public Relations: Theory and Practice. New Delhi: SAGE Publications India Pvt. Ltd.
2. Cutlip, Center & Broom, (2000): Effective Public Relations.USA: Prentice Hall International.
3. Jaishri Jethwaney and Shruti Jain, (2012): Advertising Management. New Delhi: Oxford University Press
4. Reddi, C.V.N. (2009): Effective Public Relations and Media Strategy. New Delhi: PHI Learning Pvt. Ltd.
5. Sharma, S. & Singh, R. (2009): Advertising Planning and Implementation. New Delhi: PHI Learning Pvt. Ltd.

IIE 4317: BASIC PHOTOGRAPHY [3 0 0 3]

Photo Journalism: History of Photography and Photo Journalism. Photo Journalism: Definition, Nature, Scope and Functions of Photo Journalism – Qualification and Responsibilities of Photo Journalists, News Photographers and News Value, Types and Sources. Selection, Criteria for News Photographs – Channels of News Pictures – viz., Wire, Satellite, Agency, Stock, Picture Library, Freelancer, Photo Editing, Caption Writing, Photo – Presentation. Legal and Ethical aspects of Photography – Professional Organizations – Camera – Components and Types of Camera – Types of Lens, Types of Films, Types of Filters – Importance of Light and Lighting Equipments – Camera Accessories – Picture appreciation. Digital Camera – Digital Technology and its future – Darkroom Infrastructure – Film developing and Printing

References:

1. Basic Photography – Newnes
2. The Hamlyn Basic Guide to Photography – Hamlyn
3. Hamlyn Encyclopedia of Photography – Hamlyn
4. Photographing People – Guglielmezei
5. History of Photography – Cyernshem G R
6. Photo Journalism – Rothsteline
7. Techniques of Photo Journalism – Milten Feinberg
8. Freelance Photography – Jechsend Gedsey
9. Picture Editing – Stanley E Kalish and Clifton C Edom
10. News Photography – Jack Price
11. 1000 Ideas for better News Picture – High Sidley and Rodney Fox

IIE 4318: MEDIA PRODUCTION TECHNIQUES [3 0 0 3]

Print design elements – typography, colours, spacing, pictures, logos, graphics, principles of layout and design – basic writing skills. Photography – SLR camera, Lenses, Apertures and Shutter speeds, Exposure, Understanding light, Filters and assessories, composing a picture, developing and printing, creating special effects. Digital photography – digital camera – digital technology and its future. Television – Introduction to AV Media-pre-production, production, post-production. Show packaging-Camera-characteristics, parts and functions; Mounting accessories and movements. Shots-Types and Uses; Basic composition. Practical video recording process. Radio – Introduction to Radio-Microphone types, characteristics and uses; Cables and Connectors. Recording device-Types and Characters, Audio editing, Programme formats-news, drama, feature and PSA's and Advertising.

References:

1. Gerald Millerson, “Effective TV production”
2. Peter Jarvis, “The Essential TV director's Handbook
3. Hamlyn “Basic guide to photography”
4. Ralph Milton “Radio programming – a basic training manual”
5. Tomlinson Holman “Sound for film and television”
6. Reporting and writing by Melwin Mencher

IIE 4319: GRAPHIC & SKETCHING [3 0 0 3]

Basic Art Principles: Element of Art & Design, Contour Drawing, Composition Principles, Pencil shading, creating geometry model and shading. Basic Perspective: Still life sketching & Drawing, Styles of shading, Introduction to colors, color still life painting, Layout Design, Creating concepts for Design. Skeleton System, Body Proportions, Upper Body, Lower Body, Back, Hands and Legs. Text: Human Anatomy by Victor Perard, Dynamic Anatomy by Burne Hogarth. Gesture Drawing Tips, Line of Action, Dynamic Poses, Body Weight and Gravity, Clothing. Text: Figure Drawing by Anthony Ryder.

List of Practical's:

- 10 Drawings of Human Anatomy Study In Pencil
- 50 Drawings of Gesture Drawing In Pencil
- 5 Contour Drawing
- 2 Still Life Pencil Shading
- 2 Color Still Life
- 2 Layout Design

References:

1. Mastering Composition: Techniques and Principles to Dramatically Improve Your Painting (Mastering (North Light Books)) Hardcover – 25 Jan 2008 by Ian Roberts
2. Layout Essentials: 100 Design Principles for Using Grids (Design Essentials) Paperback – 1 by Beth Tondreau
3. Pencil Drawing: Learn how to develp drawings from start to finish with techniques for shading, contrast, texture, and detail (Artist's Library) Paperback – 1 Jan 1988 by Gene Franks
4. Drawing the Head and Figure – Jack Hamm
5. Dynamic Anatomy – Burne Hogarth
6. The artists complete guide to Human figure Drawing – Anthony Ryder
7. Human Anatomy – Victor Perard