

**B TECH in MECHATRONICS ENGINEERING**

Year	THIRD SEMESTER										FOURTH SEMESTER									
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C								
II	MAT 2151	Engineering Mathematics – III	2	1	0	3	MAT 2261	Engineering Mathematics – IV	2	1	0	3								
	MTE 2151	Data Structures and Algorithms	2	1	0	3	MTE 2251	Automated Manufacturing Systems	3	0	0	3								
	MTE 2152	Digital System Design	3	1	0	4	MTE 2252	Design of Machine Elements	3	1	0	4								
	MTE 2153	Microcontroller based System Design	4	0	0	4	MTE 2253	Linear Control Theory	3	1	0	4								
	MTE 2154	Robotics I	2	1	0	3	MTE 2254	Linear Integrated Circuits and Applications.	3	1	0	4								
	MTE 2155	Sensors and Instrumentation	4	0	0	4	**** ****	Open Elective – I				3								
	MTE 2161	Microcontroller Lab	0	0	3	1	MTE 2261	CAD and Kinematics' Simulation Lab	0	0	3	1								
	MTE 2162	Robotics Lab I	0	0	3	1	MTE 2262	Integrated Electronics Lab	0	0	3	1								
MTE 2163	Sensors and PLC lab	0	0	3	1	MTE 2263	Manufacturing Processes Lab	0	0	3	1									
			17	4	9	24		14	4	9	24									
	<b>Total Contact Hours (L + T + P)</b>						30	<b>Total Contact Hours (L + T + P) + OE</b>						27 + 3 = 30						
	<b>FIFTH SEMESTER</b>										<b>SIXTH SEMESTER</b>									
III	HUM 3151	Engg Economics and Financial Management	2	1	0	3	HUM 3152	Essentials of Management	2	1	0	3								
	MTE 3151	Digital Signal Processing	3	1	0	4	MTE 3251	Automobile Engineering	2	1	0	3								
	MTE 3152	Electric Drives	3	1	0	4	MTE 3252	Energy and Heat Transfer	3	1	0	4								
	MTE 3153	Hydraulics and Pneumatics Systems	2	1	0	3	MTE ****	Program Elective – I	3	0	0	3								
	MTE 3154	Theory of Machines	3	1	0	4	MTE ****	Program Elective – II	3	0	0	3								
	**** ****	Open Elective – II				3	**** ****	Open Elective – III				3								
	MTE 3161	Drives, Controls and Modelling Lab	0	0	6	2	MTE 3261	Hydraulics Lab	0	0	3	1								
	MTE 3162	Robotics Lab II	0	0	3	1	MTE 3262	IIoT Lab	0	0	6	2								
						MTE 3263	Pneumatics Lab	0	0	3	1									
			13	5	9	24		13	3	12	23									
	<b>Total Contact Hours (L + T + P) + OE</b>						27 + 3 = 30	<b>Total Contact Hours (L + T + P) + OE</b>						28 + 3 = 31						
	<b>SEVENTH SEMESTER</b>										<b>EIGHTH SEMESTER</b>									
IV	MTE ****	Program Elective – III	3	0	0	3	MTE 4298	Industrial Training				1								
	MTE ****	Program Elective – IV	3	0	0	3	MTE 4299	Project Work/Practice School				12								
	MTE ****	Program Elective – V	3	0	0	3	MTE 4296	Project Work (Only for B.Tech honour Students)				20								
	MTE ****	Program Elective – VI	3	0	0	3														
	MTE ****	Program Elective – VII	3	0	0	3														
	**** ****	Open Elective – IV				3														
			15	0	0	18					13									
	<b>Total Contact Hours (L + T + P) + OE</b>						15 + 3 = 18	<b>Total Contact Hours (L + T + P) + OE</b>												

## Minor Specializations

### I. Electric Vehicle Technology

MTE 4051: Automotive Control Systems  
MTE 4052: Battery and Fuel Cell Technology  
MTE 4053: Mechatronics modelling of Hybrid Vehicles  
MTE 4054: Vehicle Dynamics

### II. Industrial IoT Systems

MTE 4055: Database Management Systems  
MTE 4056: Information Security for Industrial Automation  
MTE 4057: Internetworking for Industries  
MTE 4058: Principles of Cryptography

### III. Robotics and Automation

MTE 4059: Artificial Intelligence  
MTE 4060: Robot Dynamics and Control  
MTE 4061: Robot Path Planning and Mobile Robots  
MTE 4062: Soft Robotics

### IV. 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

### V. Business Management

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

### VI. 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

MTE 4063: Big Data Analytics  
MTE 4064: Building Automation  
MTE 4065: Computer Architecture and Real time Systems  
MTE 4066: Computer Networks and Communication Protocols  
MTE 4067: Design of Mechanical Drives  
MTE 4068: Dynamics and Controls of Mechatronics Systems  
MTE 4069: Electric Vehicle Machines and Drives  
MTE 4070: Embedded Systems and RTOS  
MTE 4071: Engineering Materials  
MTE 4072: Hybrid Vehicle Technology  
MTE 4073: Machine Learning  
MTE 4074: Machine Tool Technology  
MTE 4075: Machine Vision and Image Processing  
MTE 4076: Mechanical Vibrations  
MTE 4077: Micro Electro Mechanical Systems  
MTE 4078: Micro-manufacturing Systems  
MTE 4079: Nanotechnology  
MTE 4080: Production Operations and Management  
MTE 4081: Robotics II  
MTE 4082: Systems Modelling and Simulation  
MTE 4083: Wireless Sensor Networks

### Open Electives

MTE 4301: Autonomous Robots  
MTE 4302: Electric Vehicle Technology  
MTE 4303: Hydraulics and Pneumatics Systems  
MTE 4304: Industrial IoT  
MTE 4305: Introduction to Robotics  
MTE 4306: Mechatronics Systems

## THIRD SEMESTER

### MAT 2151: ENGINEERING MATHEMATICS - III [2 1 0 3]

Vector Calculus: Gradient, divergence and curl, their physical meaning and identities. Line, surface and volume integrals. Green's theorem, statements of divergence and Stoke's theorems, applications. Fourier series: Fourier series of periodic functions, Euler's formulae. Fourier series of odd and even functions and functions with arbitrary period. Half range expansions. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Harmonic analysis. Partial differential equations: Basic concepts, solutions of equations involving derivatives with respect to one variable only. solutions by indicated transformations and separation of variables. Derivation of one-dimensional wave equation (vibrating string) and its solution by using the method of separation of variables. D'Alembert's solution of wave equation. Derivation of one dimensional heat equation using Gauss divergence theorem and solution of one dimensional heat equation. Solution by separation of variables. Numerical Methods: Finite difference expressions for first and second order derivatives (ordinary and partial). Solution of boundary valued problems, Classification of second order partial differential equations. Numerical solutions of Laplace and Poisson equations by standard five point formula and heat and wave equations by explicit methods.

#### References:

1. Kreyszig, Erwin, Advanced Engineering Mathematics, John Wiley & Sons, (5e), 2010.
2. S. S. Sastry, Introductory Methods of Numerical Analysis, (2e), 1990, Prentice Hall.
3. B. S. Grewal, Higher Engineering Mathematics, 1989, Khanna Publishers
4. Murray R. Spiegel, Vector Analysis, 1959, Schaum Publishing Co.

### MTE 2151: DATA STRUCTURES AND ALGORITHMS [2 1 0 3]

Accessing variables through pointers, Pointers arithmetic and arrays, Pointers and Functions, Recursion- definition, Recursive programs, Stacks, Queues, Evaluation of expressions, Linked lists-singly, doubly, header node, circular along with application. Trees- Binary trees, In-order, Preorder and Post order traversal of Trees. Creation, Insertion and Deletion operations on Binary search tree. Sorting – Bubble sort, Selection sort, Merge sort, Quick sort, Heap sort. Searching – Linear search, Binary search. Horspool algorithm, Open Hash table, Floyd's algorithm, Warshall's algorithm, Prim's algorithm, Kruskal's algorithm, Dijkstra's algorithm.

#### References:

1. Behrouz A. Forouzan, Richard F. Gilberg, A Structured Programming Approach Using C, (3e), Centage Learning India Pvt. Ltd. India, 2007.
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson and Freed, Fundamentals of Data Structures in C, (2e), Silicon Press, 2007.
3. Richard F. Gillberg, Behrouz A. Forouzan, Data Structures, A Pseudo code Approach with C, (2e). Centage Learning India Pvt. Ltd. India, 2009.
4. Tenenbaum Aaron M., Langsam Yedidyah, Augenstein Moshe J., Data Structures using C, (1e), Pearson Prentice Hall of India Ltd., 2007.
5. Debasis Samanta, Classic Data Structures, (2e), PHI Learning Pvt. Ltd., India, 2010.

### MTE 2152: DIGITAL SYSTEM DESIGN [3 1 0 4]

Design of combinational circuits by using principles of minimization of Boolean equations: Adder, Subtractor, Encoder, Decoder, Multiplexer, Demultiplexer. Concept of K-Maps reduction, Design sequential circuits by using memory elements like latches and flip-flops, FPGA Architectures- ACTEL, XILINX and ALTERA logic families, logic module,

switching technology, I/O cells, Programmable interconnect, Modeling of circuits at structural, dataflow, behavioral abstraction levels using Verilog HDL modeling language.

**References:**

1. Morris Mano, Digital design, (3e), Prentice Hall of India, 2002.
2. A. Anand Kumar, Switching Theory and Logic Design, (2e), Prentice Hall of India, 2009.
3. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, (2e), Prentice Hall PTR, 2003.
4. David J Comer, Digital Logic State Machine Design, (3e), Oxford University Press, 2012.
5. Neil H.E Weste and Kamran Eshraghian, Principles of CMOS VLSI Design, (2e), Wesley, 1998.

**MTE 2153: MICROCONTROLLER BASED SYSTEM DESIGN [4 0 0 4]**

Introduction to 8051: Introduction to embedded controllers, Harvard vs. Von Neumann architecture, commercial microcontroller devices. Architecture of 8051: Registers, Register Banks, PSW, CPU, PC, DPTR, SFRs, RAM, ROM, Stack; Programming model of 8051, Pin diagram & details, I/O Ports & details. 8051 Assembly Language Programming: Assembler Directives, Addressing Modes of 8051, Instruction set, calculation of delay, delay programs. Timers, Counters, Serial Communication, Interrupts, Programming examples. 8051 Programming in Embedded C: Data types in embedded C, arithmetic & logic operators, control statements and loops in embedded C, functions & arrays, I/O port programming, programming timers & counters, Interrupts & Serial communication program. Hardware Interfacing : Programmable I/O (8255); Memory Interfacing, Stepper Motor, DAC, ADC, Seven Segment Display, LCD, Relays & Optoisolators. Design of Microcontroller based systems: Emergency Alarm System, Temperature Control System, Traffic Light Control System, SCR Firing Circuit. Introduction to other Microcontroller families (PIC, AVR, ARM).

**References:**

1. Muhammad Ali Mazidi, Janice Gillipse Mazidi, Rolin D. Mckinlay, 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education, 2010.
2. Myke Predko, Programming and Customizing the 8051 Microcontroller, Tata McGraw Hill, 2007.
3. Kenneth J. Ayala, 8051 Microcontroller and Embedded Systems using Assembly and C, Cengage Learning, 2010.
4. Ajay V. Deshmukh, Micro controllers- Theory and Applications, TMH, New Delhi, 2008.
5. Krishna Kant, Microprocessors and Micro controllers, PHI, India, 2007.

**MTE 2154: ROBOTICS I [2 1 0 3]**

Introduction: Definition of robots, definition and factors affecting the control resolution, spatial resolution, accuracy and repeatability, specification of a robot, actuators and sensors, drives and transmission systems used in robotics. Spatial descriptions and transformations: Descriptions, operators, transform equations. Introduction to Lie algebra and Rodrigues's rotation formula and Quaternions. Manipulator kinematics: Link description, manipulator kinematics, actuator space, joint space, and Cartesian space, kinematics of two industrial robots, frames with standard names. Introduction to kinematics of parallel manipulators, Closed loop constraints, four bar mechanism, Stewart platform. Inverse manipulator kinematics: Pieper's solution when three axes intersect. Manipulator dynamics: Introduction, acceleration of a rigid body, mass distribution, Newton's equation, Euler's equation iterative Newton-Euler dynamic formulation. Trajectory generation: Path description and generation, joint-space schemes Cartesian-space schemes. Linear control of manipulators: Introduction, feedback and closed-loop control, second-order linear systems, control of second-

order systems, trajectory-following control, continuous vs. discrete time control, modeling and control of a single joint.

**References**

1. John J. Craig, Introduction to Robotics: Mechanics and Control, (3e), PHI, 2005.
2. C. Peter., Robotics, Vision and Control: Fundamental Algorithms in MATLAB. Vol. 73. Springer, 2011.
3. G. Ashitava, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2006.
4. Murray, Richard M., Zexiang Li, S. Shankar Sastry, and S. Shankara Sastry, A Mathematical Introduction to Robotic Manipulation, CRC press, 1994.
5. S. Bruno and O. Khatib, EDS: Springer handbook of Robotics, Springer, 2016.

**MTE 2155: SENSORS AND INSTRUMENTATION [4 0 0 4]**

Units and standards, calibration, static and dynamic characteristics of an instrument, error analysis, electromechanical indicating instruments. Material science concepts: materials used as sensors and transducers. analog and digital voltmeters, ammeters, multimeters, DC bridges, AC bridges, fault detection- short circuit, open circuit, shielding and grounding methods, introduction to sensors and transducers, potentiometers, physical quantities and their measurements- strain, force, speed, velocity, acceleration, proximity and range, temperature, pressure, flow, level, O2 sensors, breathalyzers, display device- digital CRO, data storage, introduction to data acquisition, elements of data acquisition system, concept of signal conditioning. PLC: Programming formats using contacts and coils, latching etc. Converting simple relay logic diagram to PLC ladder diagram, Digital logic implementation in ladder programming, Timer and counter functions, Arithmetic functions, R-trig / F- trig pulses, shift registers, sequence functions, PID principles and functional block, position indicator with PID control. Communication: Industrial Process Automation, Networks and Protocols: AS-i, CAN, MODBUS, PROFIBUS-DP, Wi-Fi, WiMAX, Connectors.

**References:**

1. A.K. Sawhney, A course in Electrical and Electronic Measurements and Instrumentation, (19e), Dhanpat Rai & Co. Publishers, 2012.
2. A. K. Sawhney, A course in Mechanical Measurement and Instrumentation, (9e), Dhanpat Rai & Co. Publishers, 2012.
3. R.K. Rajput, Electrical & Electronic Measurements & Instrumentation, (2e), S.Chand Publishers, 2010.
4. Bela G. Liptak, Process Measurement and Analysis, (4e), CRC press, 2003.
5. Liptak, B.G. (Ed.), Instrument engineers' handbook, Vol. 3: Process software and digital networks, (1e) CRC Press, Boca Raton, London, 2002.

**MTE 2161: MICROCONTROLLER LAB [0 0 3 1]**

Microcontroller: Introduction to 8051, arithmetic instructions, array handling and code conversions, bit manipulations and logic instructions, timer/counter programming, serial communication and interrupts, interfacing ADC with 8051, interfacing stepper motor with 8051, interfacing DAC with 8051, interfacing logic controller with 8051, interfacing seven segment display with 8051, interfacing LCD with 8051, implementing a traffic light controller using 8051.

**References:**

1. Muhammad Ali Mazidi, Janice Gillipse Mazidi, Rolin D. Mckinlay, 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education, 2010.
2. Myke Predko, Programming and Customizing the 8051 Microcontroller, Tata McGraw Hill, 2007.

3. Kenneth J. Ayala, 8051 Microcontroller and Embedded Systems Using Assembly and C, Cengage Learning, 2010.
4. Ajay V. Deshmukh, Microcontrollers- Theory and Applications, Tata McGraw Hill, 2008.
5. Krishna Kant, Microprocessors and Microcontrollers, PHI, 2007.

#### **MTE 2162: ROBOTICS LAB I [0 0 3 1]**

Robotics: Simulation of forward and inverse kinematics in computational software, Preliminary idea of master-slave control including hardware interfacing, Concept of Daisy Chain Network to control multiple actuators simultaneously. Introduction to Robot Studio an offline Programming Tool. Defining Targets and Path Generation. Creating a Custom Tool and Defining a Work object. Conveyor Tracking using Robot Studio. Control of Stepper Motor Actuators using Raspberry PI. PID Control of Lego Line Following Robot. Robot Vision- Part Shape Detection using Sherlock –Image Processing Software. Food Quality Inspection. Colour Detection using Sherlock- Image Processing Software.

##### **References:**

1. John J. Craig, Introduction to Robotics: Mechanics and Control, (3e), PHI, 2005.
2. C. Peter., Robotics, Vision and Control: Fundamental Algorithms in MATLAB. Vol. 73, Springer, 2011.

#### **MTE 2163: SENSORICS AND PLC LAB [0 0 3 1]**

Behavior of inductive, magnetic, reflection light scanner, and one way barriers, reflection light barrier OBS and an ultrasonic sensor. Path power characteristic curve of inductive analog encoder, reduction factor of reflection light scanner OJ, fitted with an optical waveguide. Response curve of inductive sensor, capacitive sensor, magnetic field sensors. Switching frequency and switching distance and hysteresis of NBN, CJ, MB, OJ. Calculation of maximum admissible velocity of an object using ultrasonic sensor.

Introduction of PLC, study basic components, networking and different programming technique. Of PLC. Study NO, NC and holding circuit programs, Implement of Simple Ladder program, to study basic functions of timers, counters, math, logical and program control instructions. Study different applications using ladder logic.

##### **References:**

1. Siemens PLC manual, Siemens.
2. PLC training practice module, BOSCH REXROTH manual Germany 2011.
3. John W. Webb and Ronald A. Reiss, Programmable logic controllers- Principle and applications, (5e), PHI, 2005.
4. Sensorics training system practice module, BOSCH REXROTH manual, Germany 2011.
5. Sensors in theory and practice, BOSCH REXROTH AG Germany 2007.

## **FOURTH SEMESTER**

#### **MAT 2261: ENGINEERING MATHEMATICS IV [2 1 0 3]**

Probability: Introduction, finite sample spaces, conditional probability and independence, Baye's theorem, one dimensional random variable, mean, variance. Two and higher dimensional random variables: mean, variance, correlation coefficient. Distributions: Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential distributions, simple problems. Moment generating function, Functions of one dimensional and two dimensional random variables, Sampling theory, Central limit theorem and applications. Finite difference expressions for first and second order derivatives (ordinary and partial): Solution of boundary value problems, Numerical solutions of Laplace and Poisson equations by standard five point formula and heat and wave equations by

explicit methods. Difference equations: Difference equations representing physical systems, difference operator, the z transforms, properties of z transforms, initial and final value theorems, solution of difference equations by the method of z transforms.

##### **References:**

1. P. L. Meyer, Introduction to Probability and Statistical Applications, (2e), American Publishing Co., 1979.
2. Kreyszig Erwin, Advanced Engineering Mathematics, John Wiley & Sons, 2010.
3. Duffy Dean G, Advanced Engineering Mathematics with MATLAB, CRC Press, 2016.
4. Jeffrey Alan, Advanced Engineering Mathematics, Academic Press, 2001.

#### **MTE 2251: AUTOMATED MANUFACTURING SYSTEMS [3 0 0 3]**

Overview of Manufacturing and Automation: Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Additive Manufacturing : Process Chain for Additive Manufacturing Processes, Rapid Prototyping Data Formats, Liquid Based Process, Rapid Freeze Prototyping, Solid Based Process, Powder Based Process, Rapid Tooling Application in design, engineering, analysis and planning, Applications. Subtractive Manufacturing: Computer numerically controlled machining, Numerical control in Non-Traditional Machining, Adoptive control Machining system. Basics of CNC programming (Simulation). Flexible Manufacturing System: Group Technology, Cellular Manufacturing, Quantitative Analysis of Cellular Manufacturing (Rank order Clustering), Flexible Manufacturing system (FMS), Quantitative analysis of FMS (Bottleneck model), Computer Aided Process Planning (CAPP). Product Life Cycle and Data Management (PLDM): Components of PLM, phases of PLM, PLM feasibility study, PLM visioning. PLM Strategies, Strategies for recovery at end of life, recycling. Product Data Management systems and importance, barriers to PDM implementation.

##### **References:**

1. C.K. Chua, K.F. Leong, C.S. Lim, Rapid Prototyping: Principles and Applications, (3e), 2010.
2. Gibson, I, Rosen, D W., and Stucker, B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2014.
3. Groover Mikell P, Automation, Production Systems, and Computer Integrated manufacturing, (4e), Prentice Hall of India. New Delhi, 2016.
4. Kalpakajain, Manufacturing Engineering and Technology, (4e), Addison Wesley, New York, 2014.
5. Saaksvuori, Antti, Immonen, Anselmi, Product Lifecycle Management, (2e), Springer-Verlag Berlin Heidelberg, 2005.

#### **MTE 2252: DESIGN OF MACHINE ELEMENTS [3 1 0 4]**

Stresses and strains, bending moments, uniaxial, biaxial and complex loading systems, principal planes and stresses, Theory of pure bending, stress distribution in beams, stresses in shafts, stepped and hollow shafts, theories of failure, deflection of beams by double integration method and Macaulay's method, stress concentration, fatigue loading, S-N diagram, design of transmission shafts, ASME code for shaft design, design of helical springs, terminologies of springs, static and fatigue load on springs, concentric springs, design of power screws, stresses in different components of power screws, torque calculations, efficiency of power screws, design of spur gears, dynamic and wear load based gear design, beam strength and Lewis equation, selection of bearings, lubrication of bearings, specification and selection of ball bearings, sensing and measurement of mechanical motion, computer programs to calculate stresses and deflection in simple machine members.

**References:**

1. Timoshenko and Young, Elements of Strength of Materials, Tata McGraw Hill, New Delhi, 2003.
2. Popov E.P., Engineering Mechanics of Solids, Prentice Hall India, New Delhi, 2001.
3. Beer F. P. and Johnston R., Mechanics of Materials, (3e), MacGraw Hill Book Company, 2002
4. Shigley J. E. and Mischke C. R., Mechanical Engineering Design, (5e), McGraw Hill Inc, New York. 2004
5. Bhandari V B., Design of Machine Elements, (2e), Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.

**MTE 2253: LINEAR CONTROL THEORY [3 1 0 4]**

Feedback control systems terminologies, control system design process. differential equation of physical systems, linear approximation, frequency domain representation, Time domain analysis and design, first and second order system response analysis, time domain and Steady State Error (SSE), stability, RH criteria, root locus technique. Introduction to compensator design, design of lag, lead, and lag-lead compensating network. Frequency domain analysis- frequency response, Bode plot construction and interpretation of system behaviour, gain margin & phase margin, relation between time domain & frequency domain specification, SSE characteristics from frequency response, control system design simulation analysis.

**References:**

1. Norman S. Nise, Control Systems Engineering, (6e), Wiley India.
2. R.C Dorf, R. H. Bishop, Modern Control Systems, (8e), Wesley Longman Inc.
3. B.C. Kuo, F. Golnaraghi, Automatic Control Systems, (8e), Wiley India.
4. K. Ogata, Modern Control Engineering, (5e), PHI.
5. M. Gopal, Control System: Principles and Practices, (4e), TMH.

**MTE 2254: LINEAR INTEGRATED CIRCUITS AND APPLICATIONS [3 1 0 4]**

Introduction to op-amp using 741IC, linear applications of Op-amp, Operational amplifier and block diagram representation, characteristics of ideal operational amplifier, Open loop and closed loop operation of operational amplifier, non-linear applications, precision half wave and full wave rectifiers, peak detector, sample and hold circuit, log and antilog amplifiers, analog multipliers and dividers, comparators, designing of filters, design of analog to digital and digital to analog converters, designing of a stable and monostable multivibrator and its applications using 555 timer IC. Operating principle of PLL using 565 IC, and its applications, analysis, design of fixed and adjustable voltage regulators, and its applications.

**References:**

1. Stanley William D., Operational Amplifiers with Linear Integrated Circuits, Prentice Hall, (2e), 2004.
2. Franco Sergio, Design with Op-amps and Analog Integrated Circuits, McGraw Hill, (3e), 2002.
3. David L. Terrell and Butterworth – Heinemann, Op Amps Design, Application, and Troubleshooting, (2e), 1996.
4. Ramakant A. Gaikwad, Op-Amps and Linear Integrated Circuits, Prentice Hall of India, (4e), 2009.
5. Choudhury Roy D and Shail B. Jain, Linear Integrated Circuits, Wiley Eastern, (4e), 2011.

**MTE 2261: CAD AND KINEMATICS' SIMULATION LAB [0 0 3 1]**

2D sketcher exercises of simple machine components, solid modeling and assembly exercise of machine components like 6 axis robot, CPU fan, bench vice, screw jack etc... Kinematic analysis of simple

mechanisms like slider crank mechanism, 4 bar mechanism, cam and follower mechanism.

**References:**

1. Gopalkrishna K. R., Machine Drawing, Subhas Publications, Bangalore, 2002.
2. Bhat N.D., Machine Drawing, Charotar Publishing House, Anand, 2002.
3. Venugopal K., Engineering drawing and graphics + Auto CAD, Newage International publishers, Delhi 2002.
4. Narayana K.L. and Kannaiah P, Text Book on Engineering drawing, Scitech Publications, Chennai 2002.
5. Sham Tickoo, CATIA – for Engineers and Designers, Dreamtech Press, New Delhi 2005.

**MTE 2262: INTEGRATED ELECTRONICS LAB [0 0 3 1]**

Introduction to PSpice, Analog circuit designs using 741 IC linear applications of Op-amps, design of rectifiers, design of DACs and ADCs, design of filters, astable, monostable multivibrators & Schmitt trigger, using 555 IC design and study of astable and monostable multivibrators, using 78xx and LM 317 IC, design and study of regulators. Digital circuit designs- design of combinational circuits implementation of Boolean functions and arithmetic circuits, multiplexers, decoders, code converters, display driver interfaces, design of sequential circuits- design of ripple counters, shift registers and ring counters, design of synchronous counters, design of sequence detectors.

**References:**

1. Franco Sergio, Design with Op amps & Analog Integrated Circuits, McGraw Hill 1997.
2. J. Millman and H. Taub, Pulse, Digital and Switching Waveforms, TMH 2002.
3. Morris Mano, Digital design, (3e), Prentice Hall of India.
4. Ananda Kumar, Switching Theory and Logic Design, Prentice Hall of India, 2009.
5. Vladimirescu, The PSpice Book, J. Wiley & Sons, New York, 1994.

**MTE 2263: MANUFACTURING PROCESS LAB [0 0 3 1]**

Foundry shop: Introduction to molding and pattern materials; use of cores; exercises involving preparation of small sand mould and castings. Forging practice: Introduction to forging tools; exercises on simple smithy; metal cutting machine: preparing the turning models by using lathe; thread cutting; preparing models which includes milling, shaping and grinding (surface); spur gear cutting; CNC demonstration: vertical milling center and turning center.

**References:**

1. Chaudhury S. K. Hajara & Others, Elements of Workshop Technology vol 1 & 2, (5e), Media Promoters & publishers Pvt. Ltd., Mumbai, 2004.
2. R.K. Jain, Production Technology, (2e), Khanna Publishers, New Delhi, 2002.
3. Raghuvanshi, B.S., A course in Workshop technology, Vol 1 & II, Dhanpat Rai & Sons, New Delhi.

**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, Costing and its types – Job costing and Process costing, 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, (12e), Cengage Learning Publisher, 2009.
5. M. Y. Khan & P.K. Jain., Financial Management, (5e), 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, (3e), Pearson Publication, 2013.

**MTE 3151: DIGITAL SIGNAL PROCESSING [3 1 0 4]**

Introduction to Signal Processing, operations on signals, Properties of signals and systems, Impulse Response and convolution, Sampling, Aliasing, Transform domain analysis of discrete-time systems: Z Transform and application of Z transforms to discrete time systems, Computation of DFT, Fast Fourier Transform. Digital Filter Characteristics and structures, IIR Filter Design using Butterworth and Chebyshev approximations, Impulse invariant and bilinear transformation methods. FIR Filter Design using Window method and Frequency sampling method. Architectural features of Digital signal processors and Case study of TMS320C24x processor. Case study: Sensing, measurement and analysis of mechanical motion, fault analysis.

**References:**

1. Oppenheim A.V, Willsky A.S, Signals and Systems, (2e), PHI, 2011
2. Oppenheim A.V. and R.W. Schafer, Discrete time signal processing, (2e), Prentice-Hall, 2001.
3. Proakis J.G. and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, (3e), PHI, 2007.
4. Rabiner L.R and Gold D.J, Theory and Applications of Digital Signal Processing, (2e), Prentice Hall, 2007.
5. TMS320F/C24x DSP Controllers, Reference Guide, June 1999.

**MTE 3152: ELECTRIC DRIVES [3 1 0 4]**

Introduction to power electronics, switching characteristics, BJT, SCR, MOSFET, triggering methods, PWM methods, controlled rectifiers, loads, freewheeling diodes. DC motors, operating principles, torque speed characteristics, speed control concepts, solid state motor drivers choppers buck, boost, buck-boost, thyristor controlled rectifiers. AC motors, three phase induction motors, operating principles, torque speed characteristics, speed control, solid state motor drivers, ac voltage regulators, inverters, VSI, CSI, single phase induction motors, synchronous motors, linear induction motors, PM synchronous motors, servo motors, switched reluctance motors, BLDC motors, stepper motors. Fundamentals of electric drives, basic components, advantages, closed loop control, speed, torque conventions, steady state equilibrium, and determination of motor power rating.

**References:**

1. Gopal K. Dubbey, Fundamentals of Electric Drives, (2e), Narosa Publishers, 2010.
2. Nagrath I.J. and Kothari D.P., Electric machines, (3e), Tata McGraw Hill, 2011.
3. Bimbra P.S., Power electronics, (3e), Khanna Publishers, 2010.
4. R. Krishnan, Electric Motor Drives Modeling, Analysis, and Control, (2e), Prentice Hall, 2012.

**MTE 3153: HYDRAULICS AND PNEUMATICS SYSTEMS [2 1 0 3]**

Pneumatic systems, structure and signal flow, compressors, actuators and control valves, single acting and double acting cylinders, manual pneumatics, single and multiple actuators, limit switches, proximity sensors, electro pneumatics and design of electro pneumatic circuits, direction control valves, relay control systems, timers, counters, pressure control valves, closed loop pneumatics and Flow control valves. Hydraulic systems, physical principles of oil hydraulics, hydraulic actuators, valves and accessories, hydraulic power pack, types of hydraulic pumps, accumulator, Filters, hydraulic circuits, regenerative, meter in, meter out, bleed off, sequencing, pressure reducing circuits, electro hydraulic circuits, proportional hydraulics and servo hydraulics.

**References:**

1. Anthony Esposito, Fluid power with applications, Pearson Education, 2003.
2. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science & Technology Books, (3e) 2011.
3. Scholz D., Proportional Hydraulics, Festo Didactic GMBH & Co, Germany, 2002.
4. Majumdar S.R., Pneumatic Systems - Principles and Maintenance, Tata McGraw Hill, 2000.
5. Merkle D., Rupp K. and Scholz D., Electrohydraulics Basic Level TP 601, Festo Didactic GMBH & Co, Germany, 1994.

**MTE 3154: THEORY OF MACHINES [3 1 0 4]**

Kinematics and Dynamics, Mechanisms and Machines, Plane and Space Mechanisms, Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion Four Link Planar Mechanisms and their Inversions. Mobility and range of movement. Dynamics of Rotating Bodies- Balancing. Turning Moment Diagram for Engines, Flywheel and Governors. Gears and Gear Trains. Straight line mechanisms, steering mechanisms and universal joint. Dimensional synthesis of mechanism; motion, path and function generation. Advanced synthesis solutions, branch and order defects.

**References:**

1. John J. Uicker Jr., Gordon R. Pennock, Joseph E. Shigley, Theory of Machines and Mechanisms, (5e) OUP USA, 2017.
2. Rattan. S. S, Theory of Machines, (4e), Tata Mc Graw Hill, New Delhi, 2017.
3. Bevan. T, Theory of Machines, (4e), Laxmi Publications, New Delhi, 2016.
4. Ghosh and Mallick. A. K, Theory of Machines and Mechanisms, (3e), Affiliated East West Private Limited New Delhi, 2008.
5. Ballaney P. L, Theory of Machines and Mechanisms, Khanna Publishers, New Delhi, 2005

**MTE 3161: DRIVES, CONTROLS AND MODELLING LAB [0 0 6 2]**

Automation motors and their drivers and controls: Stepper motors, servo motors, linear motors etc.

**References:**

1. Drives and Control training system- Practice module, BOSCH REXROTH manual, Germany 2011.

### **MTE 3162: ROBOTICS LAB II [0 0 3 1]**

Robot dynamic simulation, Implementation of model based controller, ROS based system for path planning, Intelligent control system for multi-body system, Basic of swarm robotics, Integration of machine vision and robotics, Virtual reality and augmented reality, Simulation of soft robots. Online Programming using IRB2600 and Teach Pendant- Jogging Operation, Creating Targets and Tracing a Square and Circle using Pen Tool. Conveyor tracking using IRB robot. Control of Digital Inputs and Outputs through Rapid and IRB2600 Robot. EMU Robotek II ARM.

#### **References:**

1. IRC5, Robotware 6.02, R15.2, User Documentation Rev C
2. Sherlock Machine Vision Software User's Reference Manual, for Software versions 7.1.x and 7.2.x.
3. John J. Craig, Introduction to Robotics- Mechanics and Control, (3e), Pearson Education International, 2005.
4. Yoram Koren, Robotics for Engineers, McGraw Hill, 1992.

## **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 departmentalization, 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. Koontz D. Essentials of Management, Mc Graw Hill, New York, 2004.
2. Peter Drucker. Management, Task and Responsibility, Allied Publishers, 2006.
3. Peter Drucker. The practice of management, Butterworth Hein Mann, 2003.

### **MTE 3251: AUTOMOBILE ENGINEERING [2 1 0 3]**

Introduction to automobile engineering: vehicle construction and layouts, chassis, frame and body, IC engines. Engine auxiliary systems. Transmission systems, clutch types & construction, gear boxes- Hydrodynamic Clutches Torque Converter. Hybrid and Electric Drive-trains: Basic concept of hybrid traction, hybrid drive-train architecture -Traction Motor Characteristics, Tractive Effort and Transmission Requirement, Vehicle Performance, Fuel efficiency analysis. Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems, pneumatic and hydraulic braking systems. Desirable tyre properties, conventional tubed & tubeless tyre. Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Control and Regenerative braking, Electronic control Unit, Energy Management Strategies used in hybrid and electric vehicles, Fundamentals of regenerative braking.

#### **References:**

1. Gisbert Lechner, Harald Naunheimer, Automotive Transmissions: Fundamentals, Selection, Design and Application, Springer- Verlag Berlin Heidelberg, New York, 1999.
2. Robert Fischer, Ferit Küçükay, Gunter Jürgens, Rolf Najork, Burkhard Pollak, "Automotive transmission book, Springer International Publishing Switzerland 2015

3. Mehrdad Ehsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, (2e), CRC Press, 2010.
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, (2e), CRC Press, 2010
5. Kripal Singh, Automobile Engineering Vol-1 and 2, Standard Publishers, Delhi, 2007

### **MTE 3252: ENERGY AND HEAT TRANSFER [3 1 0 4]**

Properties of pure substances and ideal gases, First and second laws of thermodynamics, Energy conversion by cycles, Power-absorbing and power producing cycles. Fluids and Their Properties, Fluid Pressure and Its Measurement, Hydrostatics, Buoyancy and Floatation, Kinematics of Fluid Flow, Venturimeter and Pitot Tube, Small and Large Orifices, Applications of the Momentum equation, Flow Through pipes, Heat Transfer: Introduction to heat transfer, General Law of Heat Conduction, Steady state one dimensional heat conduction with and without heat generation, Heat Transfer from Extended Surfaces, Heat Transfer by Forced convection and Free convection, Radiation, Heat Exchangers, Cooling of Electronic equipment.

#### **References:**

1. Cengel Y Al and Boles M A, Thermodynamics, An Engineering Approach, Tata Mc Graw Hill, 2003.
2. Michael J Moran, Fundamentals of Engineering Thermodynamics, Wiley India Pvt. Ltd., 2010.
3. Munson B R, Young D F and Okiishi T H, Fundamentals of Fluid Mechanics, John Wiley & Sons., Singapore, 2006
4. Kumar D. S, Fluid Mechanics and Fluid Power Engineering, Kataria S K and Sons, New Delhi, 2010.
5. Yunus A. Cengel, Heat Transfer: A Practical Approach, Tata McGraw Hill Inc., New Delhi, 2005.

### **MTE 3261: HYDRAULICS LAB [0 0 3 1]**

Working principles of hydraulic pumps, hydraulic motors, pressure switch, pressure reducing valve, accumulator, proximity switch, throttle valves, pressure compensated flow control valves and direction control valves. Rigging of manual and electro hydraulic circuits using above components.

#### **References:**

1. Industrial Hydraulics Trainee's manual, BOSCH REXROTH manual, Germany 2011.

### **MTE 3262: I/O LAB [0 0 6 2]**

Operation of TwinCAT software, tools and usage. I/O accessing: Analog and Digital detection of sensors. Actuation on sensor detection using TwinCAT. HMI programming using TwinCAT. ADS communication in LAN. Actuation and programming of stepper and servo motors using TwinCAT. Communication using OPCUA with remote server. Creation of apps for usage and remote control of factory floor.

#### **References:**

1. Beckhoff: New Automation Technology: Main Catalog, Volume 1, IPC, Motion, Automation, Germany, 2018.
2. Beckhoff: New Automation Technology: Main Catalog, Volume 2, I/O, Germany, 2018.

### **MTE 3263: PNEUMATICS LAB [0 0 3 1]**

Operations of various valves like directional control valves, flow control valves, pressure control valves and switches like pressure switches, proximity switches. Operations of timers and counters. Rigging of manual pneumatic and electro-pneumatic circuits using above valves and switches.

#### **References:**

1. Practice for Professional Pneumatics Trainee's manual, BOSCH REXROTH manual, Germany 2011.
2. Practice for Professional Electro-Pneumatics Trainee's manual, BOSCH REXROTH manual, Germany 2011.

## SEVENTH SEMESTER

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

## EIGHTH SEMESTER

### MTE 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.

### MTE 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-voce 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

#### MTE 4051: AUTOMOTIVE CONTROL SYSTEMS [2 1 0 3]

Overview of Automotive Control Systems, Automotive Control-System Design Process, Identifying the Control Requirements, Review of Engine Modeling, Engine Operations, Engine Control Loops, Control-Oriented Engine Modeling, Vehicle Dynamics, Coordinates and Notation for Vehicle Dynamics, Longitudinal Vehicle Motion, Lateral Vehicle Motion, Vertical Vehicle Motion, Human Factors in Vehicle Automation, Driver Modeling, Design, Modeling, and Control of Automotive Transmission Systems, Powertrain Control Systems, Air-Fuel Ratio Control, Control of Spark Timing, Idle-Speed Control, Transmission Control, Design, Modeling, and Control of Hybrid Systems: Control of Hybrid Vehicles, Series, Parallel, and Split Hybrid Configurations, Hybrid Vehicle-Control Hierarchy, Control Concepts for Series Hybrids, Control Concepts for Parallel Hybrids, Control Concept for Split Hybrids, Feedback-Based Supervisory Controller for PHEVs, Modeling and Control of Fuel Cells for Vehicles: Modeling of Fuel-Cell Systems, Control of Fuel-Cell Systems, Control of Fuel-Cell Vehicles, Parametric Design Considerations, Cruise and Headway Control, Antilock Brake and Traction-Control Systems, Vehicle Stability Control, Four-Wheel Steering, Active Suspensions, Overview of Intelligent Transportation Systems, Preventing Collisions, Longitudinal Motion Control and Platoons, Automated Steering and Lateral Control.

#### References:

1. Zong Xuan, Automotive propulsion systems, CRC press, 2015.
2. A. Galip Ulsoy, Ann Arbor, Automotive Control Systems, Cambridge university press, 2012.
3. M. Thoma, F. Allgöwer, M. Morari, Identification for automotive systems, Springer, 2012.
4. B.T. Fijalkowski, Automotive Mechatronics: Operational and Practical Issues, Springer, 2011.

#### MTE 4052: BATTERY AND FUEL CELL TECHNOLOGY [3 0 0 3]

Introduction to Functional Safety Following ISO 26262, Description of Automotive Battery System Architecture, Classification and Application of Safety Measures for Automotive Battery Systems, Organizational and

Technical Safety Measures, Application of Measures at Battery System Units, Considering non-E/E Measures in the Concept Phase. Specific Hazards of Electric Vehicles, Applicable Design Approach for Batteries, Automotive Battery Design, Modularity and Battery Components, Safety-Relevant Design Parameters, Structural Vehicle Design Process Including Batteries, Standard Approach and Requirements, Batteries in Crash Tests and Crash Simulation, Finite Elements Model of the Battery, Modelling of Mechanical Deformation, Modelling of Material and Joint Failure, Modelling of Electrical Contact and Leakage, Experimental (Brief Description of the Test Rig, Testing Method, Gas Analysis, Cell-Components Identification, Lithium-Ion Cells, Electrical Characterization), Typical Course of a Thermal Runaway Experiment, Thermal-Runaway Experiments, Gas Analysis, Empirical Models, Equivalent Circuit Modelling, Parametrization, Mechanistic Models, Charge Transfer, Ion Transport, Electron Transport, Porous Electrodes, Intercalation, Heat Generation, Cell Ageing, Large-Scale Modelling, Thermal Behaviour, Electrical Behaviour, Distributed-Micro-Structure Modelling, Mobility Demands and Primary Energy Resources, Internal Combustion Engines and Their Impact on Air Quality, Climate Change and Carbon-Free Fuel Chance, Hydrogen Production, Hydrogen Distribution, Hydrogen Storage, Basic Concepts of Electrochemistry, Proton Exchange Membrane Fuel Cells, Sensitivity of PEM Stacks to Operating Conditions, Durability of PEM Fuel Cells, Design of Hydrogen Fuel Cell Systems for Road Vehicles, Hydrogen Fuel Cell Systems: Preliminary Remarks, Hydrogen Feeding System, Air Feeding Systems, Thermal Management System, Integrated Fuel Cell System: Efficiency, Dynamics, Costs

#### References:

1. Pasquale Corbo, Fortunato Migliardini, Ottorino Veneri, Hydrogen Fuel Cells for Road Vehicles, Springer London Dordrecht Heidelberg New York, 2011.
2. Michael H. Westbrook, The Electric Car Development and future of battery, hybrid and fuel-cell cars, Co-published by The Institution of Engineering and Technology, London, United Kingdom, and Society of Automotive Engineers, Warrendale, PA 15096-0001, USA, 2007.
3. Alexander Thaler, Daniel Watzenig, Automotive Battery Technology, Springer Cham Heidelberg New York Dordrecht London, 2009.
4. Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Press, 2009.

#### MTE 4053: MECHATRONICS MODELLING OF HYBRID VEHICLES [2 1 0 3]

Introduction to Vehicle Propulsion and Powertrain Technologies: Objectives of vehicle propulsion control. Powertrain architecture and technologies. Importance of Powertrain Modeling and Models - Drivetrain. Engine Management systems (EMS): Basic engine operation-EMS building block, Effective work, Engine control structure and components, Automatic Code Generation and Information Exchange - Calibration and Parameter Representation - Engine Maps - Model-Based Development. Fuel management and control: Stoichiometry and air-fuel ratio - Engine concepts and its geometry, Engine control - Power, torque and mean effective pressure - Feed-forward and Feedback Control Structure, Fuel Dynamics and Injector Compensation Driveline modeling Driveline control: General Modeling Methodology - Graphical Scheme of a Driveline - A Basic Complete Model and Rigid Driveline - Reflected Mass and Inertias - Modeling of Neutral Gear and Open Clutch -Torque Converter - Control Design and Validating Simulations- Driveline control - goals of driveline control - State-space formulation - Controller formulation - Driveline control with LQG/LTR. Miscellaneous - Vehicle control systems and performance measures: ABS control systems -ABS cycle detection - control of the Yaw dynamics - derivation of simplified control law - derivation of reference values

**References:**

1. Lars Eriksson, Lars Nielsen, Modeling and Control of Engines and Drivelines, (1e), Wiley, 2014.
2. Georg Rill, Road Vehicle Dynamics: Fundamentals and Modeling, CRC press- Taylor and Francis group, 2011.
3. Uwe Kiencke, Lars Nielsen, Automotive Control Systems: For Engine, Driveline and Vehicle, (2e), Springer, 2005.
4. Rolf Isermann, Engine Modeling and Control: Modeling and Electronic Management of Internal Combustion Engines, Springer, 2014.

**MTE 4054: VEHICLE DYNAMICS [2 1 0 3]**

Introduction to Vehicle System Dynamics: Theoretical background on Vehicle Dynamics and control, Fundamental approach to Vehicle modelling. Longitudinal dynamics: Vehicle Load Distribution – Acceleration, Brake Force Distribution, Braking Efficiency and Braking Distance, Braking, Semi-Trailer. Tire Mechanics: Introduction, Mechanical Properties of Rubber, Slip, Grip and Rolling Resistance, Tire Construction and Force Development, Contact Patch and Contact Pressure Distribution, Tire Brush Model, Lateral Force Generation – Ply Steer and Conicity, Tire Models – Magic Formula, Classification of Tyre Models, and Combined Slip. Lateral Dynamics: Introduction, Bicycle Model, Stability, and Steering Conditions, Effect of road loads on Dynamics of Vehicle – Aerodynamics, rolling resistance, Total road load, Under-steer Gradient and State Space Approach, Parameters affecting vehicle handling characteristics, Subjective and Objective Evaluation of Vehicle Handling and Rollover Prevention. Vertical Dynamics: Introduction, Quarter Car Model. Noise, Vibration, and Harshness: Random Process and Conclusion, Traction control system, Anti-lock Braking system, Hydraulic unit for ABS and EPS. Overview on effect of safety system on Dynamics of Vehicle.

**References:**

1. Reza N. Jazar, Vehicle dynamics: theory and application, Springer, 2017.
2. Hans B. Pacejka, Tire and Vehicle Dynamics, Elsevier, 2012.
3. Rajesh Rajamani, Vehicle Dynamics and Control, Springer, 2011.
4. Alexander F., Driveline systems of Ground Vehicles: Theory and design, CRC Publishers 2010.
5. Thomas D. Gillespie, Fundamentals of Vehicle Dynamics, SAE International 1997.

**MTE 4055: DATABASE MANGEMENT SYSTEMS [2 1 0 3]**

Introduction: Database-System Applications, Relational Databases, Data Storage and Querying, Transaction Management, Database Architecture, Database Users and Administrators. Relational Model: Structure of Relational Databases, Database Schemas, Keys, Relational Query Languages, Relational Operations. Database Design and The E-R Model: SQL: SQL Data Definition, SQL Data Types and Schemas, Integrity Constraints, Basic Structure of SQL Queries, Set Operations, Aggregate Functions, Nested Subqueries, Additional Basic Operations Null Values, Atomic Domains and First Normal Form, Decomposition Using Functional Dependencies, Functional Dependency Theory, Algorithms for Decomposition, Decomposition Using Multivalued Dependencies. Transaction Management: Transaction Concept. Data mining: Introduction, Association rules mining, market based analysis, Apriori Algorithm, Partition Algorithm, Pincer – Search Algorithm, Dynamic item set counting algorithm, FP-tree growth Algorithm, PC Tree, Multilevel association rules, Clustering Techniques: Introduction, Clustering paradigms, Partitioning Algorithms, k – Medoid & k- means Algorithms, CLARA, CLARANS, Hierarchical Clustering, DBSCAN.

**References:**

1. Silberschatz, Korth, Sudarshan, Database System Concepts, (6e), McGrawHill, New York, 2011.
2. Ramez Elmasri and Shamkant Navathe, Durvasula V L N Somayajulu, Shyam K Gupta, Fundamentals of Database Systems, (6e), Pearson Education, United States of America, 2011.
3. Thomas Connolly, Carolyn Begg, Database Systems – A Practical Approach to Design, Implementation and Management, (4e), Pearson Education, England, 2005.
4. Peter Rob, Carlos Coronel, Database Systems-Design, Implementation and Management, (10e), Course Technology, Boston, 2013.
5. Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, Morgan Kauffmann Publishers, (2e), 2008

**MTE 4056: INFORMATION SECURITY FOR INDUSTRIAL AUTOMATION [2 1 0 3]**

Introduction to security, Characteristics of Information, Components of an Information system, Security System Development Lifecycle, The Need for Security- Business Needs first, Threats, Attacks, Intruders, Intrusion detection, Malicious Software – Types, Viruses, Viruses countermeasures, Worms, Introduction to Database security, SQL injection, Reliability and Integrity, Sensitive Data, Inference, Multilevel Databases, Proposals for Multilevel Security, Designs of Multilevel Secure Databases, Transport-level Security- Web security issues, SSL, TLS, Pretty Good Privacy (PGP), S/MIME, IP security policy, Encapsulating Security payload, Internet Key Exchange, The need for Firewalls, Firewall characteristics, Types of Firewalls, Cyber Crimes and Hackers- Cybercrimes, Cyber criminals, Hackers Hacking topologies, Types of Attacks, Dealing with the rising tide of cybercrimes, Indian Cyber Law offences.

**References:**

1. William Stallings, Cryptography and Network Security: Principles and Practice, (5e), Prentice Hall, 2010.
2. Michael E. Whitman and Herber J. Mattord, Principles of Information Security, (4e), Centage Learning India Publication, 2011.
3. Charles P Pfleeger and Shari Lawrence Pfleeger, Security in Computation, (4e), PHI, 2009.
4. Joseph Migga Kizza, A Guide to Computer Network Security, Springer Intertnation edition, 2009.

**MTE 4057: INTERNETWORKING FOR INDUSTRIES [2 1 0 3]**

Introduction to Computer Networks: Types of networks, Types of transmission media, Concept and types of Multiplexing, Concept and types of Multiple Access techniques, Principles and types of Analog and Digital Modulation. ISO/OSI model: Physical layer: Types of cables, Types of connectors, Communication standards, Data-Link layer, Network Layer: IPv4, IPv6, Routing and Subnetting, Transport Layer: TCP, UDP. Networks in Industrial Process Automation: Introduction to networks in Industrial Process Automation, Networks and Protocols: AS-i, CAN, DeviceNet, Interbus, LON, Foundation Fieldbus, HART, PROFIBUS-PA, BACnet, ControlNet, Industrial Ethernet, Ethernet/IP, MODBUS, PROFIBUS-DP. Fiber Optic Communication: Principles of Fiber-Optic networks, Types of Fiber-Optic cables, Fiber-Optic Network design, Fiber cable installation and setup, Splices and Connectors, Inspection and testing. Radio, Satellite and Infrared Communication: Radio systems, Spread Spectrum techniques, Satellite LANs, Communication bands in satellite communication, Infrared Systems, Very fast Infrared.

**References:**

1. Liptak, B.G. (Ed.), Instrument engineers' handbook, Vol. 3: Process software and digital networks, (1e) CRC Press, Boca Raton, London, 2002.

- Andrew S. Tanenbaum, Computer Networks, (5e), Prentice Hall of India Pvt. Ltd., 2010.
- William Stallings, Data and Computer Communications, (7e), Prentice Hall of India Pvt. Ltd., 2004.
- James F. Kurose, Keith W. Ross, Computer Networking (A Top-Down Approach Featuring the Internet), (3e), Pearson Education, 2005.
- Todd Lammle, Cisco Certified Network Associate-Study Guide, (2e), Sybex Inc. Publishing. 2000.

#### **MTE 4058: PRINCIPLES OF CRYPTOGRAPHY [2 1 0 3]**

Introduction- Security goals, Attacks, Services and Mechanisms, Classical Encryption Techniques, Symmetric Cipher model, Transposition Techniques, The Data Encryption Standard, Block Cipher Operation, Multiple Encryption and Triple DES, Modes of operation, Mathematics of Cryptography- Modular Arithmetic, Fermat's and Euler's theorems, The Chinese Remainder Theorem, AES- structure, Round Functions, Key Expansion, Pseudorandom Number generators, Stream ciphers, RC4, Public-key Cryptosystems, RSA algorithm, Diffie-Hellman Key exchange, El Gamal Cryptosystem, Cryptographic Hash functions- Applications, Hash functions based on Cipher Block Chaining, Secure Hash Algorithm, Message Authentication Function, Message Authentication codes, Digital Signatures.

#### **References:**

- William Stallings, Cryptography and Network Security: Principles and Practice, (5e), Prentice Hall, 2010.
- Behrouz A. Forouzan and Debdeep Mukhopadhyay, Cryptography and Network Security, (2e), McGraw Hill, 2008.
- Atul Kahate, Cryptography and Network Security, Tata McGraw-Hill Publishing, 2008.
- Bruce Schneier, Applied Cryptography, (2e), John Wiley and Sons, Inc., 1996.

#### **MTE 4059: ARTIFICIAL INTELLIGENCE [2 1 0 3]**

Fundamentals: McCulloch - Pitts model, Activation functions, Feed forward and feedback networks, Learning rules. Single layer feed forward networks: Introduction, Perceptron Models, Training Algorithms, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications. Multi layer feed forward networks: Generalized Delta Rule, Derivation of Back propagation (BP) Training, Summary of Back propagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements. Application of neural networks: Control applications, Character recognition. Fuzzy control: Classical sets & fuzzy sets, fuzzy set operations, Fuzzy relations, membership function, extension principles. Fuzzy Logic System Components: Fuzzification, Membership Value assignment, development of rule base and decision making system, Defuzzification to crisp sets. Application of fuzzy logic. Introduction to Genetic Algorithm (GA): Principles, Working operation, Design, Applications in control system. Hybrid system: fuzzy-neural systems, Familiarization with MATLAB Fuzzy logic & neural network Toolbox.

#### **References:**

- Jacek M. Zurada, Introduction to artificial neural networks, Jaico, 2006.
- Timothy J. Ross, Fuzzy logic with engineering applications, MGH, 2010.
- Chin-Teng-Lin, C. S. George Lee, Neural fuzzy systems, PHI, 1996.
- Rajasekharan and Rai, Neural networks, fuzzy logic, genetic algorithms: synthesis and applications, PHI Publication, 2017.

#### **MTE 4060: ROBOT DYNAMICS AND CONTROL [2 1 0 3]**

Review of Robot Kinematics- Transformations: Joint/Task space, Forward Kinematics, Inverse Kinematics, Jacobians, Trajectory Generation, Serial and Parallel Kinematics. Robot Dynamics- Lagrange-Euler Dynamics, Force, Inertia, and Energy, Lagrange's Equations of Motion, Newton's equations of motion, Formulation of robot dynamics,

State-Variable Representations, Dynamics of robots with actuators. Robot control problems – Regulator problem, tracking problem, controllers. Set point Tracking, Actuator Saturation, Integrator Anti-windup Compensation, Quadratic Optimal control problem. Nonlinear dynamics and control - Lyapunov stability theorem, Robust control, Feedback-Linearization Controllers, Lyapunov Designs, Variable-Structure Controllers, Saturation-Type Controllers. Inverse dynamics controllers, Force control, Stiffness control, Impedance control, Hybrid Position/Force Control, Reduced state modeling and control, Impedance Control, Stiffness and Compliance, Under-actuated System.

#### **References:**

- Mark W. Spong, Seth Hutchinson, M. Vidyasagar, Robot Modeling and Control, (2e), John Wiley and sons, 2009.
- Frank L. Lewis, Robot Manipulator Control- Theory and Practice, (2e), CRC Press, 2003.
- Mark W. Spong, Robot Dynamics and Control, (2e), John Wiley and sons, 2009.
- Yoshikawa, Foundations of Robotics: Analysis & Control, (1e), Prentice Hall India, 2009.

#### **MTE 4061: ROBOT PATH PLANNING AND MOBILE ROBOTS [2 0 3 3]**

Autonomous mobile robots - Locomotion - Wheeled locomotion- Robot kinematics models & constraints, Mobile robot workspace. Configuration Space – Obstacles space, dimensions of configuration space, topology of configuration space, parameterization, transformations, Potential Functions, Gradient descent. Implementation in plane- computation, local minima problem. Algorithms – Analysis and complexity, running time, complexity, completeness. Visibility graph, Graph Search A\*, Weighted A\*, Anytime & Incremental Search D\*, Road Maps - Generalized Voronoi Graph (GVG), GVG – transversality, connectivity, opportunist path planning. Cell Decomposition - Trapezoidal decomposition, Morse cell decomposition, Visibility based decomposition. Sampling Based Algorithms, Rapidly Exploring Random Trees (ERT), Control based planning, Manipulation planning, Optimal motion planning, Feedback motion planning. Motion Planning – Motion planning under kinematics and dynamic constraints, Trajectory planning, Non-holonomic constraints, Path planning, Combined path planning and control.

#### **List of Experiments:**

- Implement Dijkstra's algorithm for a mobile robot
- Implement A\* algorithm for a mobile robot
- Extend A\* algorithm to a C-space for 2 degree planar manipulator
- Implement Probabilistic Road Maps for more than 3 degree of freedom manipulator
- Implement Artificial Potential Functions for path planning.
- Executing any one of the above mentioned algorithms for planning a path and then control a Lego robot to follow the path generated.

#### **References:**

- Fahimi, Farbod, Autonomous robots: modeling, path planning, and control. Vol. 107. Springer Science & Business Media, 2008.
- H. Choset, K. M. Lynch, S. Hutchinson, G. A. Kantor, W. Burgard, L. E. Kavraki, S. Thrun Principles of Robot Motion: Theory, Algorithms, and Implementations, MIT Press, Cambridge, MA, 2005.
- S. M. LaValle, Planning Algorithms, Cambridge University Press, Cambridge, UK, 2006.

#### **MTE 4062: SOFT ROBOTICS [2 1 0 3]**

Review of Robot Kinematics and Dynamics: Spatial Representation of Rigid Body in Space, Forward Kinematics, Inverse Kinematics, Trajectory Generation, Robot Dynamics and Control, Mathematical Modelling of Flexible Manipulator, Introduction to Euler Cauchy Elasticity Problem, Modeling soft mechanics (numerical, computational, analytical): Hyper-redundant kinematic structures, Resolution of inverse kinematics, Mathematical formulation for animating flexible structure, Bio-mimetics (modelling of snake/earthworm, caterpillar etc), Continuum Mechanics, Eigenvalues and Eigenvectors, Geometric interpretation of eigenvectors, Cayley-Hamilton theorem, Principal Component Analysis, Singular Value Decomposition, ISO-Map Dimensional Reduction technique. Sensors and Actuators: Soft Actuators, Soft Sensors, Electroactive Polymer, Ionic Polymer Metal

Composites, Shape Memory Alloy, Artificial Muscles based on Electric/Pneumatics, Thermal/Chemical Actuation. Rapid digital manufacturing of multifunctional soft materials: Introduction to 3D Printing, 3D printing of Soft Materials, Hyper-elasticity, Finite Element Analysis, Stretchable Electronics, Soft Electrical Materials, Soft Mechanical Composite Materials, Gradient of Material Stiffness, Mechanical Soft Materials, Pneumatic Artificial Muscles. Applications: Case Studies on Wearable Robotics, Space Robotics, Deep-Sea Robotics, Healthcare Systems, Under-Actuated Robots

**References:**

1. Jog, C.S., Foundations and applications of mechanics: Volume I: Continuum mechanics, Narosa Publishing House, 2007.
2. Alexander Verl, Alin Abu-Schaffer, Oliver Brock, Annika Raatz, Soft Robotics Transferring Theory to Application, Springer, 2015.
3. Jaeyoun (Jay) Kim, Microscale Soft Robotics: Motivations, Progress, and Outlook, Springer International Publishing, 2017.
4. Cecilia Laschi, Jonathan Rossiter, Fumiya Iida, Matteo Cianchetti, Laura Margheri, Soft Robotics: Trends, Applications and Challenges, Springer International Publishing, 2016.

**MTE 4063: BIG DATA ANALYTICS [2 1 0 3]**

Big Data, Characteristics of Big Data, Data in a warehouse and data in Hadoop, Importance of Big Data, Big data use cases, Map Reduce, Distributed File System, Algorithms using Map Reduce, Communication Cost model, Complexity Theory, Meet Hadoop, Comparison with other systems, The Hadoop Distributed File System, Hadoop I/O, File Based Data structures, Developing a Map Reduce Application, Inverted Index for Text Retrieval, Graph Algorithms, Page Rank, Stream Data Model: A Datastream Management system, Sampling Data in a Stream, Filtering Streams, Distinct Elements in a Stream, NOSQL Models, Understanding Storage Architecture, Performing CRUD operations, Querying NOSQL Stores.

**References:**

1. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, (1e) Cambridge University Press, 2011.
2. Tom White, Hadoop: The definitive guide, (3e), O'reilly, Yahoo Press, 2012.
3. Shashank Tiwari, Professional NOSQL, (2e), Wiley India Pvt. Ltd., 2012.
4. Jimmy Line, Chris Dyer, Data Intensive Text Processing with MapReduce, (1e), Morgan and Claypool Publishers, 2010.
5. Paul C Zikopoulos, Chris Eaton, Dirk Deroos, Thomas Deutch, George Lapis, Understanding Big Data, (1e) McGraw Hill, 2012.

**MTE 4064: BUILDING AUTOMATION [2 1 0 3]**

Overview of Digital Controller: Data Form used in computers, Microcomputer, Input / Output Unit, Processor Operation and Software, Sensors, Actuator, I/O devices, Field Controllers. Network and Communication protocols: Networking basics, Types of Networks-Serial and Parallel Communication, RS232 and RS 485 Interfaces, MODBUS protocol overview, BACnet protocol overview. Introduction to Building Management Systems: Buildings and Energy Management, Different systems in a building. Introduction to HVAC, StruxureWare for Building Operation. General BMS architecture: Introduction to HVAC and Optimal control methods for HVAC Systems: Important components of HVAC, HVAC Control systems and Direct Digital Control, AHU, Chillers, Zones, Air Distribution Systems, Field Devices, Schneider Controllers (PLC's). Lighting control systems: Strategies for energy management and lighting. Security and Safety Control Systems: Access Control-Introduction, Basic Components, Controller / Panel, Credentials, Reader, Locking Device, How it works / Operations, Type of Card/Readers, Anti-Pass back, Power Requirements, Videos (Digital Video Recorder), Types

of Camera, Fire Alarm Systems - Sprinklers. System integration and convergence: Need for integration, interoperability and protocols, BMS integration case studies, iBMS, Compatibility of different internet technologies and its application in BMS. Application of internet for Automation and Management: Web Based Automation, General Architecture, Web Enablement, Data Communication Energy Management: Overview on EMS, Energy Analysis/Audit. Green Buildings (LEED): Green Buildings Approach, Benefits of Green Buildings, Elements of Green Building Design, Leadership in Energy and Environmental Design (LEED), LEED Case Study.

**References:**

1. V. K. Jain, Automation Systems in Smart and Green Buildings, published by Khanna Publishers, 2009.
2. Reinhold A, Understanding Building Automation Systems: Direct Digital Control, Energy Management, Life Safety, Security/access Control, Lighting, Building Management Programs, 2009.
3. Ronnie J. Auvil, HVAC Control Systems, (2e), 2007.
4. Thomas L. Norman, Integrated Security Systems Design: Concepts, Specifications, and Implementation (1e) by CPP PSP CSC 2007.
5. Benantar, Messaoud, Access Control Systems: Security, Identity Management and Trust Models, Springer publication, 2005.

**MTE 4065: COMPUTER ARCHITECTURE AND REAL TIME SYSTEMS [2 1 0 3]**

Organization and Architecture, Processor Organization, The Instruction Cycle, Introduction to Parallel processing, Parallel Computer Structures, Architectural Classification schemes, Pipelining, Instruction Level Parallelism, SIMD Computer Organizations, SIMD Interconnection networks, Parallel Algorithms for Array processors, Symmetric Multiprocessor Organization, Cache Coherence and the MESI protocol, Multithreading and Chip Multiprocessors, Synchronization, Models of Memory Consistency, Clusters, Operation System Design Issues, Cluster Computer Architecture, Blade servers, Clusters compared to SMP, Multicore computers, Hardware Performance issues: Increase in Parallelism, Power consumption, Software performance issues: Software on multicore, Multicore organization, Intel x86 Multicore organization: Intel Core Duo, Intel Core i7.

**References:**

1. William Stalling, Computer Organization and Architecture: Designing for Performance, (8e), Pearson Prentice Hall, 2010.
2. Kai Hwan and Faye A. Briggs, Computer Architecture and Parallel Processing, TMH Private Ltd., 2012.
3. John L. Hennessy and David A. Patterson, Computer Architecture, A Quantitative Approach, (5e), Morgan Kaufmann, 2014.
4. Rajiv Chopra, Advanced Computer Architecture (A Practical Approach), S. Chand and Company Ltd. 2011.

**MTE 4066: COMPUTER NETWORKS AND COMMUNICATION PROTOCOLS [3 0 0 3]**

Introduction to reference models, data communication, network architecture, basics of OSI, and TCP/IP reference models. Transmission media, FDM, TDM and CDMA, Frame relay and ATM switching, ISDN, local area network protocols, IEEE standards for LAN. Data link layer design, functions and protocols, link layer, error detection and correction techniques, multiple access protocol, Ethernet, hubs and switches, PPP. Network layer, Transport layer: connectionless transport-UDP, FTP, Electronic Mail in the Internet, P2P file sharing, HTTP, quality of services: ATM, Differentiated services Model, flow identification, scheduling, factors affecting QOS parameters and service categories, network management, protocol, SNMP, CMIP, concept of traffic and service. Voice and video data, ATM Traffic, Traffic contracting.

**References:**

1. James F. Kurose, Keith W. Ross, Computer Networking (A Top-Down Approach) Featuring the Internet, (3e), Pearson Education, 2005.
2. Andrew S. Tanenbaum, Computer Networks, (5e), PHI, 2010.
3. Charle Kaufman, Radia Perlman, Mike Specines, Uyles Black, Computer Networks: Protocols Standards and Interfaces, Prentice Hall of India Pvt. Ltd. 2010.
4. William Stallings, Data and Computer Communications, (7e), 2004, Prentice Hall of India Pvt. Ltd.

**MTE 4067: DESIGN OF MECHANICAL DRIVES [2 1 0 3]**

Introduction, bevel gear and worm gear, beam strength, dynamic load and wear load, heat dissipation and efficiency of worm gear, sliding contact bearings, lubricants, viscosity, bearing modulus, Sommerfield number, coefficient of friction, mechanism of film lubrication, eccentricity and minimum oil film thickness. Belt drives, power transmission, flat and V belts, power rating, V-flat drives, selection of belts and pulleys. Wire and rope drives - types & construction of wire ropes, loads & stresses in ropes, selection of wire ropes. Chain drives, chordal action, sprocket size and teeth, chain speed, selection of roller chains. Mechanical brakes - block brakes, band brakes, pivoted Shoe brakes, disc brake, torque capacity, heat dissipation, clutches, friction clutches, disc clutch, cone clutch, design projects.

**References:**

1. Shigley J. E. and Mischke C. R., Mechanical Engineering Design, (5e), McGraw Hill Inc, New York, 2004.
2. Bhandari V. B., Design of Machine Elements, (2e), Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.
3. Norton R. L., Machine Design - An Integrated Approach, (2e), Prentice Hall Inc. New Jersey, 2004.
4. Juvenile R. C. and Marshek K. M., Fundamentals of Machine Component Design, (3e), John Wiley and Sons, Inc, New York, 2000.
5. Mahadevan K. and Balaveera Reddy K., Machine Design Data Hand Book, (4e), CBS Publishers and Distributors, New Delhi, 2014.

**MTE 4068: DYNAMICS AND CONTROL OF MECHATRONICS SYSTEMS [3 0 0 3]**

Industrial feedback controllers, PID controllers, tuning methods, frequency response approach, computational optimization, modified PID scheme. Introduction to state space analysis - state space representations, eigen vectors and eigen values, transfer functions, state space modeling. Control system design in state space, solution of LTI state equation, controllability and observability, state feedback controllers, state observers Lyapunov stability analysis, quadratic optimal control. Types of nonlinearity, describing functions phase plane method, linearization techniques, MATLAB simulation, state space modeling, feedback controllers, observers, regulator problems.

**References:**

1. Ogata K., Modern Control Engineering, (5e), Pearson Prentice Hall, 2005.
2. Karl J. Astrom, Feedback systems- An Introduction for Scientists and Engineers, Princeton University Press, 2008.
3. Norman S. Nise, Control Systems Engineering, (6e), John Wiley & Sons, Inc, 2011.
4. Stanley M. Shinnars, Modern Control Systems, Theory and Design, John Wiley & Sons, Inc, 2009.
5. Gopal M., Modern Control System Theory, (2e), New Age International Ltd, 2005.

**MTE 4069: ELECTRIC VEHICLE MACHINES AND DRIVES [3003]**

Overview of EV Technologies-Motor Drive Technology, Energy Source Technology, Battery Charging Technology, Vehicle-to-Grid Technology, Pure Electric Vehicle, Hybrid Electric Vehicle, Gridable Hybrid Electric Vehicle, Fuel-Cell Electric Vehicle. DC Motor Drives - System Configurations, DC Machines, DC-DC Converters, Soft-Switching DC-DC Converter Topologies, DC Motor Control, Regenerative Braking, Design Criteria of DC Motor Drives for EVs. Induction Motor Drives- System Configurations, Induction Machines, Inverters for Induction Motors, Induction Motor Control, Design Criteria of Induction Motor Drives for EVs. Permanent Magnet Brushless Motor Drives- System Configurations, PM Brushless Machines, PM Brushless Motor Control, Design Criteria of PM Brushless Motor Drives for EVs, Switched Reluctance Motor Drives- SRM Machines, SR Converters, Comparison of SR Converters for EVs, SR Motor Control, Design Criteria of SR Motor Drives for EVs, Machine Initialization, Planetary-Geared SR Motor Drive, Outer-Rotor In-Wheel SR Motor Drive. Integrated-Starter-Generator Systems -System Configurations, ISG Machines, ISG Operations, Cranking, Electricity Generation, Idle Stop-Start, Power Assistance. Planetary-Geared Electric Variable Transmission Systems: Input-Split PG EVT Systems, Compound-Split PG EVT Systems, Design Criteria of PG EVT Systems, PM Synchronous PG EVT System Configuration. Double-Rotor Electric Variable Transmission Systems- Double-Rotor Machines, Basic Double-Rotor EVT Systems, Advanced Double-Rotor EVT Systems, Axial-Flux DR EVT System, Magnetless DR EVT System, Design Criteria of DR EVT Systems, Design Example of DR EVT Systems. Potential Applications of DR EVT Systems in HEVs.

**References:**

1. K T Chau, Electric Vehicle Machines and Drives- Design, Analysis And Application, (1e) John Wiley & Sons, 2015.

**MTE 4070: EMBEDDED SYSTEMS AND RTOS [2 1 0 3]**

Introduction to embedded system, attributes and major application areas of ES, Processor and memory organization, Communication networks, ARM processor introduction, architectural inheritance, Architectural features of ARM Processor, instruction set, Pipelined architecture in ARM, THUMB instruction format, memory mapped peripherals, architectural features of ARM Cortex M3 and programming examples. Introduction To Real-Time Operating Systems, Tasks and Task states, Semaphores, Message queues, Mail boxes and pipes, Hard and Soft real time systems, scheduling considerations, Multicore real time systems. Case studies.

**References:**

1. Wolf, Wayne, Computers as Components- Principles of Embedded Computing System Design, Morgan-Kaufmann, 2000.
2. Steve Furber, ARM System-on-chip Architecture, Pearson Education, 2000.
3. Andrew Sloss, Dominic Symes, Chris Wright, ARM system Developer's Guide, 1st edition.

**MTE 4071: ENGINEERING MATERIALS [3 0 0 3]**

Crystal structures, Miller indices, crystal imperfections, mechanism of solidification, nucleation and crystal growth, phases in solids, equilibrium diagrams, iron-Carbon systems, principle and objectives of heat treatment, TTT diagrams, electronic materials, deposition of thin films, insulators and dielectric properties, polarization in dielectrics, electrostriction, piezoelectricity, ferroelectricity, magnetic materials, magnetic dipole and moments, magnetization, super paramagnetic materials, applications of magnetic materials, photonic materials, refraction, reflection, absorption, emission phenomena.

**References:**

1. Donald R. Askeland and Pradeep P. Fulay, The Science and Engineering of Materials, Cengage learning publishers, (6e), 2011.
2. Lakhtin Yu., Engineering Physical metallurgy and heat treatment, MIR Publishers, Moscow, 1985.
3. Higgins R.A., Engineering Metallurgy, (5e), ELBS, London, 1983.
4. Avner S.H., Introduction to Physical Metallurgy, (3e), McGraw Hill, Delhi, 2004.
5. Arzamasov, Material Science, MIR Publishers, Moscow. 1989.

**MTE 4072: HYBRID VEHICLE TECHNOLOGY [2 1 0 3]**

Vehicle dynamics-vehicle resistance, dynamic equation, tire ground adhesion, maximum tractive effort, vehicle speed, transmission characteristics, vehicle performance, hybrid and electric drive trains-configurations of electric vehicles, traction motor characteristics, basic concept of hybrid traction, hybrid drive train architecture – series, parallel torque and speed coupling, electric propulsion unit, different motors, configuration and control of dc motor drives, introduction to power modulators, control and regenerative braking, classification of different energy management strategies, fundamentals of regenerative braking, sizing the drive system- propulsion motor, sizing the power electronics, selecting the energy storage technology, communications, supporting subsystems, design of series hybrid drive train.

**References:**

1. Mehrdad Ehsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles- Fundamentals, Theory and Design, (2e), CRC Press, 2010.
2. Iqbal Hussein, Electric and Hybrid Vehicles-Design Fundamentals, (2e), CRC Press, 2010.
3. Gianfranco Pistoia, Electric and Hybrid Vehicles - Power Sources, Models, Sustainability, Infrastructure and the Market, (1e), Elsevier, 2010

**MTE 4073: MACHINE LEARNING [2 1 0 3]**

Introduction to Machine Learning, Review of Linear Algebra, Review of Probability theory, Overview of Convex optimization, Hidden Markov models, Multivariate Gaussian distribution, Gaussian Processes. Bayesian decision theory, Maximum likelihood ratio, P a r a m e t r i c classification, Regression, Multivariate methods, K-nearest neighbor classification, Supervised learning: Setup, LMS, Logistic regression, Perceptron, Exponential family, Generative learning algorithms, Gaussian discriminant analysis, Naïve Bayes, Support vector machines, Model selection and feature selection, Evaluation and debugging learning algorithms. Unsupervised learning: Clustering, K-means, Hierarchical clustering, Competitive learning, Radial basis functions. EM, Mixture of Gaussians, Factor analysis, Principal Component Analysis, Independent Component Analysis, Naïve Bayes classifier, Hidden Markov model, Linear Regression, Belief Propagation, Generating diverse learners, Voting, Error correction output codes, Bagging, Boosting. Applications of Machine Learning in Robotics: Developmental Robotics, Cognitive Robotics, Evolutionary Robotics.

**References:**

1. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, (1e), MIT Press, 2012.
2. Ethem Alpaydin, Introduction to Machine Learning, (2e), MIT Press, 2010.
3. Mehryar Mohri, Afshin Rostamizadeh and Amel Talwalkar, Foundation of Machine Learning, (1e), MIT Press 2012.
4. Daphne Koller and Nir Friedman, Probabilistic Graphical Models: Principles and Techniques, (1e), MIT Press, 2009.
5. Christopher M. Bishop, Pattern Recognition and Machine Learning, (1e), Springer, 2007.

**MTE 4074: MACHINE TOOL TECHNOLOGY [3 0 0 3]**

Types of motion in cutting, cutting speed, feed, depths of cut in machining, cutting tools classification, nomenclature of single point cutting tool, difference between orthogonal and oblique cutting, mechanism of metal cutting, types of chips, chip breakers, forces acting on a tool, merchant circle diagram, velocity relations, specific energy in cutting, tool wear, tool life factors, Taylor's tool life equation, tool wear mechanisms, heat distribution in metal cutting, measurement of temperature in metal cutting, lathe tool dynamometer, cutting fluids selection and applications, cutting tool materials, specifications for inserts and tool holders. CNC tooling, tool presetting, automated tool & pallet changing, work holding, cutting process parameter selection, jigs and fixtures, types of clamping devices, principles of clamping.

**References:**

1. Milton C. Shaw, Metal Cutting Principles, (2e), Oxford University Press, 2000.
2. Kempster, Jigs and Fixtures, (3e), Mark Howard Publications, 2004.
3. Steve Krar, Arthur Gill and Peter Smid, Machine Tool Technology Basics, (2e), Industrial Press Inc., U.S, 2012.
4. Sharma. P. C, A Text Book of Production Engineering, (7e), SChand Publishers, New Delhi, 2008.

**MTE 4075: MACHINE VISION AND IMAGE PROCESSING [3 0 0 3]**

Image Acquisition and Analysis: Vision system components, Image acquisition and analysis, Image digitization, Image enhancement, restoration, Segmentation, Morphological Operations, image representation and analysis, color image processing. 3D Vision: Camera and optics, Perspective Projection Geometry Rotation and translation matrix, Pinhole camera model, Calibration methods, Intrinsic and Extrinsic Camera Parameters, Stereovision, Stereo correspondence Algorithms, Epipolar Geometry, Essential and fundamental matrix, 3D Reconstruction. Motion Estimation and Tracking: Optical flow estimation, Object tracking with Kalman filtering. Basic idea of localization employing passive markers. Case Studies/Application: Basic color detection, Face recognition, Vehicle tracking, applications using computer vision toolbox and image processing toolbox of MATLAB.

**References:**

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, (3e), Pearson Education, 2008.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, Image Processing, Analysis and Machine Vision, (2e), 1998.
3. Boguslaw Cyganek & J. Paul Siebert, An Introduction to 3D Computer Vision Techniques and Algorithms, (1e), Wiley, 2009
4. David A. Forsyth Jean Ponce, Computer vision: A modern approach, Pearson Education Limited.
5. E.R. Davies, Royal Holloway, Machine Vision: Theory, Algorithms and Practicalities, (3e), University of London, 2004.
6. Juneja and Nitin Seth, Fundamental of Metal Cutting and Machine Tools, (2e), New Age International Publishers, 2003.

**MTE 4076: MECHANICAL VIBRATIONS [2 1 0 3]**

Introduction to mechanical vibration, vibration system and types, vibration analysis - degrees of freedom, mathematical modeling, equations of motion, SHM, natural frequency of single degree of freedom system – mathematical modeling, derivation of governing differential equation of motion for free undamped and damped systems, forced vibration – single degree of freedom system under harmonic excitation, steady state, reciprocating and rotating unbalance, transmissibility and isolation, base excitation with harmonic input. Two degree of freedom systems - natural frequencies and mode shapes, forced vibration. Natural frequency of multi-degree of freedom systems, vibration control, vibration testing and measurement.

**References:**

1. Groover G.K., Mechanical Vibrations, Nemchand and Bros, Roorkee, 2012.
2. Singirisu Rao S, Mechanical Vibration, Pearson Education, Delhi, 2004.
3. Dukkappatti Rao V., Text Book of Mechanical Vibration. Prentice Hall of India Ltd, 2004.
4. Daniel Imnan J. Engineering Vibration, Prentice Hall, New Delhi, 2001.
5. Thomson W.T., Theory of Vibrations with Applications, Chapman and Hall, 4th Edition, 1993.

**MTE 4077: MICRO ELECTRO MECHANICAL SYSTEMS [2 1 0 3]**

Introduction to MEMS and microsystems - products, evolution of micro-fabrication, microelectronics, miniaturization, applications in automotive and other industries, micro sensors, micro actuation, micro accelerometers, microfluidics. Scaling laws in miniaturization, scaling laws – geometry, electrostatic forces, electromagnetic forces, electricity, heat transfer and fluid mechanics. Materials for MEMS and microsystems. Microsystems fabrication processes, photo lithography, ion implantation, diffusion, oxidation, chemical vapor deposition, physical vapor deposition, deposition by epitaxy, etching, bulk manufacturing, surface micromachining, LIGA process. Microsystems – design and packaging, mechanical packaging of microelectronics, assembly of microsystems, packaging materials.

**References:**

1. Tai Ran Hsu, MEMS and Microsystems - Design and Manufacturing, Tata McGraw Hill, 2010.
2. Marc J. Madou, Fundamentals of Micro Fabrication - The Science of Miniaturization, CRC Press, 2002.
3. Wolfgang Menz, J. Mohr and Oliver Paul, Microsystem Technology, Wiley-VCH, 2001.
4. Mohamed Gad-el-Hak, The MEMS Handbook, CRC Press 2002.
5. S.D. Senturia, Microsystem Design, Kluwer Academic Publishers, 2001.

**MTE 4078: MICRO - MANUFACTURING SYSTEMS [3 0 0 3]**

Introduction, working principles and process parameters, machine tools, applications of the micro manufacturing processes, challenges in meso, micro, and nanomanufacturing, industrial applications and future scope of micro-manufacturing processes. Different instruments related to micro manufacturing such as microsensors, microactuators, microsystems. Working principles, machine construction, and applications of micromachining, nanofinishing, microjoining, microforming, microcasting, micromolding, LIGA for micro/nano products and features, the diversified industrial applications of the micro-manufactured processes, and recent research trends in this area.

**References:**

1. Jain V. K., Introduction to Micromachining, Narosa Publishing house Pvt. Ltd., 2010.
2. Jain V. K., Micromanufacturing, CRC Press, 2012.
3. Jain V. K., Advanced Machining Processes, Allied Publishers Pvt. Ltd., 2014.
4. Mahalik N. P., Micromanufacturing & Nanotechnology, Springer Berlin Heidelberg, 2006.
5. Jackson J. M., Microfabrication & Nanomanufacturing, CRC Press, 2005.

**MTE 4079: NANOTECHNOLOGY [3 0 0 3]**

Introduction to nanotechnology, bottom-up and top-down approaches, physical and chemical properties, methods of preparation of nanoparticles, carbon nanostructures and their applications, physical chemistry of nanosystems, micro electro mechanical devices and technologies - microsensors, MEMS fabrication processes and applications, microscale and nanoscale heat conduction, nanofluids preparation and characterization, nanomaterials used in energy and environmental applications and their properties, future development of micro actuators, nano-lithography, photoresist patterning,

photolithography, electron beam lithography, production of polygon mirrors, optic fibers, future trends in nanotechnology.

**References:**

1. Charles P. Poole, Introduction to Nanotechnology, Wiley-Interscience, 2003.
2. Guozhong Cao, Nanostructures & Nanomaterials, Imperial College Press, 2004.
3. C B Sobhan, Microscale and Nanoscale Heat Transfer, Taylor and Francis, 2008.
4. Norio Taniguchi, Nanotechnology, Oxford University Press, 2008.
5. James J Allen, MEMS Design, Taylor and Francis, 2005.

**MTE 4080: PRODUCTION AND OPERATIONS MANAGEMENT [2 1 0 3]**

Introduction, production consumption cycle, forecasting- quantitative and qualitative methods, Forecast control, measures of forecast accuracy product development and design, product life cycle, process design, process charts, flow diagrams and man machine charts capacity planning, breakeven analysis, single and multi-product P-V charts, aggregate planning, trial and error approach, use of transportation algorithm, job shop scheduling, Sequencing of “n” jobs through 2 machines, “n” jobs through 3 machines and 2 jobs through “n” machines inventory management and line balancing, resource conversion and concepts, planning models and behavioural applications, case studies.

**References:**

1. Adam Everett E. Jr. and Ebert Ronald J., Production and Operations Management, Prentice Hall of India Pvt. Ltd., 2002.
2. Chase Richard B., Aquilano Nicholas J. and Jacobs F. Roberts, Production and Operations Management, Tata McGraw-Hill publishing Co. Ltd., 1999.
3. Eilon Samuel, Elements of Production Planning and Control, Universal Publishing Corporation, 1991.
4. Monks Joseph G., Operations Management, Tata McGraw-Hill

**MTE 4081: ROBOTICS II [2 1 0 3]**

Autonomous mobile robots:- Introduction, locomotion legged mobile robots. Wheeled locomotion. Robot kinematics models & constraints, Mobile robot maneuverability. Mobile robot workspace-degree of freedom, homomorphic robots, path & trajectory considerations. Motion control - open loop control Feedback control. Robot control problems, controllers -PD, PID compensation, closed loop control, gain tuning, performance analysis, simulation analysis. Set point Tracking. Nonlinear dynamics and control - Lyapunov stability theorem, Robust control, Feedback-Linearization Controllers, Lyapunov Designs, Variable-Structure Controllers, Saturation-Type Controllers. Inverse dynamics controllers, Force control, stiffness control, Impedance control, Hybrid Position/Force Control, Reduced state modeling and control. Modeling soft mechanics (numerical, computational, analytical): Hyper-redundant kinematic structures, Resolution of inverse kinematics, Mathematical formulation for animating flexible structure, Bio-mimetics, Continuum Mechanics, Eigenvalues and Eigenvectors, Geometric interpretation of eigenvectors, Cayley-Hamilton theorem, Principal Component Analysis, Singular Value Decomposition, ISO-Map Dimensional Reduction technique. Sensors and Actuators: Soft Actuators, Soft Sensors, Electroactive Polymer, Ionic Polymer Metal Composites, Shape Memory Alloy, Artificial Muscles based on Electric/Pneumatics, Thermal/Chemical Actuation

**References:**

1. Jog, C.S., Foundations and applications of mechanics: Volume I: Continuum mechanics, 2007, Narosa Publishing House.
2. Alexander Verl, Alin Albu-Schaffer, Oliver Brock, Annika Raatz, Soft Robotics Transferring Theory to Application, Springer, 2015.
3. Jaeyoun (Jay) Kim, Microscale Soft Robotics: Motivations, Progress, and Outlook, Springer International Publishing, 2017.
4. Cecilia Laschi, Jonathan Rossiter, Fumiya Iida, Matteo Cianchetti,

Laura Margheri, *Soft Robotics: Trends, Applications and Challenges*, Springer International Publishing, 2016.

5. Fahimi, Farbod. *Autonomous robots: modeling, path planning, and control*. Vol. 107. Springer Science & Business Media, 2008.

#### **MTE 4082: SYSTEMS MODELING AND SIMULATION [3 0 0 3]**

Principles of modeling and simulation, modeling and simulation of mixed systems, transfer function, block diagram, state space representation of SISO, MIMO, modeling of dynamic systems, construction, analysis, practical applications, linear systems, methods of model order determination, impulse and frequency response methods, system identification, algorithms for parameter estimation, gradient algorithm, least square algorithm, ARX, ARMAX applications of LS and ARMA methods, regression methods, introduction to nonlinear modeling, identification NARMAX model, case studies UAV quad-rotor, hard discs, maglev systems, ball and beam systems.

##### **References:**

1. George Pelz, *Mechatronic Systems Modeling and Simulation with HDLs*, Wiley, 2003.
2. Devdas Shetty, Richard Kolk, *Mechatronics System Design*, (2e), Cengage Learning, 2010.
3. Benjamin C. Kuo, Farid Golnarghi, *Automatic Control Systems*, (8e), Wiley, 2009.
4. Jack W. Lewis, *Modeling of Engineering Systems PC-Based Techniques and DesignTools*, High Text Publications, 2000.
5. Ioan D. Landau, Gianluca Zito, *Digital Control Systems Design, Identification and Implementation*, Springer, 2006.

#### **MTE 4083: WIRELESS SENSOR NETWORKS [3 0 0 3]**

Challenges for wireless sensor networks, single node architecture, hardware components, energy consumption of sensor nodes, network architecture, types of sources and sinks, single hop versus multi-hop networks, multiple sinks and sources, wireless channel and communication fundamentals, frequency allocation, modulation and demodulation, MAC protocols, contention-based protocols, SMAC – BMAC, TRAMA, IEEE 802.15.4 MAC protocol, Q-MAC (Query MAC), Q-MAC (QoS MAC). Routing challenges and design, SPIN COUGAR, ACQUIRE, LEACH, PEGASIS, GF, GAF, GEAR, Aggregation techniques – TAG, Tiny DB traditional transport control protocols. Wireless LANs: 802.11, 802.11a/b/g, 802.16-WiMAX, UWB communications, wireless personal area networks, BlueTooth. Healthcare monitoring system using wireless sensor networks, remote home lighting and appliance control system, automatic speed control and vehicle tracking using GSM and GPS technologies.

##### **References:**

1. Kazem Sohraby, Daniel Minoli and Taieb Znati, *Wireless Sensor Networks Technology-Protocols and Applications*, John Wiley & Sons, 2007.
2. Holger Karl and Andreas Willig, *Protocols and Architectures for Wireless Sensor Networks*, John Wiley & Sons, Ltd, 2005.
3. Ananthram Swami, Qing Zhao, Yao-Win Hong, Lang Tong Pub, *Wireless Sensor Networks Signal Processing and Communications*, John Wiley & Sons.
4. Murthy, Ad Hoc Wireless Networks: Architectures and Protocols, Pearson Education.
5. Sridhar S. Iyengar, Nandan Parameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye, *Fundamentals of Sensor Network Programming: Applications and Technology*, John Wiley & Sons

#### **OPEN ELECTIVES**

##### **MTE 4301: AUTONOMOUS ROBOTS [2 1 0 3]**

Locomotion, Legged Mobile Robots, Leg configurations and stability, Examples of legged robot locomotion, Wheeled Mobile Robots, Wheeled locomotion, Mobile Robot Kinematics: Kinematic Models and Constraints, Representing robot position, Forward kinematic models, Wheel kinematic, Robot kinematic constraints, Examples. Perception: Sensors for Mobile Robots, Sensor classification, Characterizing sensor performance, Wheel/motor sensors, Heading sensors, Ground-based beacons, Active ranging, Motion/speed sensors, Vision-based sensors.

Mobile Robot Localization: The Challenge of Localization: Noise and Aliasing, Sensor noise, Sensor aliasing, To Localize or Not to Localize: Localization-Based Navigation versus Programmed Solutions, Map Representation, Continuous representations, Decomposition strategies, Probabilistic Map-Based Localization, Markov localization, Kalman filter localization. Planning and Navigation: Competences for Navigation: Planning and Reacting, Path planning, Obstacle avoidance.

##### **References:**

1. Roland Siegwart, Illah R. Nourbaksh, *Introduction to Autonomous Robots*, MIT Press, 2004.
2. Howie Choset, Kevin M Lynch, *Principles of Robot Motion*, MIT Press, 2005 King Sun Fu
3. Gonzalez, *Robotics- control, sensing, vision, and intelligence*, McGraw-Hill, 1987.

##### **MTE 4302: ELECTRIC VEHICLE TECHNOLOGY [3 0 0 3]**

Vehicle dynamics-vehicle resistance, dynamic equation, tire ground adhesion, maximum tractive effort, vehicle speed, transmission characteristics, vehicle performance, hybrid and electric drive trains-configurations of electric vehicles, traction motor characteristics, basic concept of hybrid traction, hybrid drive train architecture – series, parallel torque and speed coupling, electric propulsion unit, different motors, configuration and control of dc motor drives, introduction to power modulators, control and regenerative braking, classification of different energy management strategies, fundamentals of regenerative braking, sizing the drive system- propulsion motor, sizing the power electronics, selecting the energy storage technology, communications, supporting subsystems, design of series hybrid drive train.

##### **References:**

1. Mehrdad Ehsani, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles- Fundamentals, Theory and Design*, (2e), CRC Press, 2010.
2. Iqbal Hussein, *Electric and Hybrid Vehicles-Design Fundamentals*, (2e), CRC Press, 2010.
3. Gianfranco Pistoia, *Electric and Hybrid Vehicles - Power Sources, Models, Sustainability, Infrastructure and the Market*, (1e), Elsevier, 2010.

##### **MTE 4303: HYDRAULICS AND PNEUMATICS SYSTEMS [2 1 0 3]**

Pneumatic systems, structure and signal flow, compressors, actuators and control valves, single acting and double acting cylinders, manual pneumatics, single and multiple actuators, limit switches, proximity sensors, electro pneumatics and design of electro pneumatic circuits, direction control valves, relay control systems, timers, counters, pressure control valves, closed loop pneumatics and Flow control valves. Hydraulic systems, physical principles of oil hydraulics, hydraulic actuators, valves and accessories, hydraulic power pack, types of hydraulic pumps, accumulator, Filters, hydraulic circuits, regenerative, meter in, meter out, bleed off, sequencing, pressure reducing circuits, electro hydraulic circuits, proportional hydraulics and servo hydraulics.

##### **References:**

1. Anthony Esposito, *Fluid power with applications*, Pearson Education, 2003.
2. Andrew A. Parr, *Hydraulics and Pneumatics*, Elsevier Science & Technology Books, 1999.
3. Scholz D., *Proportional Hydraulics*, Festo Didactic GMBH & Co, Germany, 2002.
4. Majumdar S.R., *Pneumatic Systems - Principles and Maintenance*, Tata McGraw Hill, 2000.
5. Merkle D., Rupp K. and Scholz D., *Electrohydraulics Basic Level TP 601*, Festo Didactic GMBH & Co, Germany, 1994.

##### **MTE 4304: INDUSTRIAL IoT [2 1 0 3]**

Introduction to Industrial IoT, Components of IoT. Sensors, Acceleration: Accelerometers (Piezoelectric, Capacitive); Proximity & Range: Proximity Switches, Ultrasonic Sensor, Hall Effect Sensor, Eddy Current Sensor, Temperature: Bimetallic, RTD, Thermocouple, Thermistor, Optical Pyrometer; Pressure: Electric Transducers, Pressure

Transmitters, Pressure Gauges - McLeod, Knudsen, Pirani, Vacuum; Flow: Ultrasonic, V Cone, Laser Doppler, Mass flowmeters. Introduction to PLC: Advantage of PLC, and Chronological Evolution of a PLC, Type of PLC, Parts of PLC and Block diagram PLC, I/O modules and interfacing, networking of PLC, Input-Output System Sinking and Sourcing, power supply module, Programming Equipments. Programming formats using contacts and coils, latching etc. Converting simple relay logic diagram to PLC ladder diagram, Digital logic implementation in ladder programming, Timer and counter functions, Arithmetic functions, R-trig / F- trig pulses, shift registers, sequence functions, PID principles and functional block, position indicator with PID control. Industrial Process Automation, Networks and Protocols: AS-i, CAN, DeviceNet, Interbus, LON, Foundation Fieldbus, HART, PROFIBUS-PA, BACnet, ControlNet, IndustrialEthernet, Ethernet/IP, MODBUS, PROFIBUS-DP. Database-System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases. Introduction to security, Characteristics of Information, Components of an Information system, Security System Development Lifecycle, The Need for Security-Business Needs first, Threats, Attacks, Intruders, Intrusion detection.

**References:**

1. Liptak, B.G. (Ed.), Instrument engineers' handbook, Vol. 3: Process software and digital networks, (1e), CRC Press, Boca Raton, London, 2002.
2. Silberschatz, Korth, Sudarshan, Database System Concepts, (6e), McGraw Hill, New York, 2011.
3. William Stallings, Cryptography and Network Security: Principles and Practice, (5e), Prentice Hall, 2010.

**MTE 4305: INTRODUCTION TO ROBOTICS [2 1 0 3]**

Introduction: Definition of robots, definition and factors affecting the control resolution, spatial resolution, accuracy and repeatability, specification of a robot, actuators and sensors, drives and transmission systems used in robotics. Spatial descriptions and transformations: Descriptions, operators, transform equations. Introduction to Lie algebra and Rodrigues's rotation formula and Quaternions. Manipulator kinematics: Link description, manipulator kinematics, actuator space, joint space, and Cartesian space, kinematics of two industrial robots, frames with standard names. Introduction to kinematics of parallel manipulators, Closed loop constraints, four bar mechanism, Stewart platform. Inverse manipulator kinematics: Pieper's solution when three axes intersect. Manipulator dynamics: Introduction, acceleration of a rigid body, mass distribution, Newton's equation, Euler's equation iterative Newton-Euler dynamic formulation. Trajectory generation: Path description and generation, joint-space schemes Cartesian-space

schemes. Linear control of manipulators: Introduction, feedback and closed-loop control, second-order linear systems, control of second-order systems, trajectory-following control, continuous vs. discrete time control, modeling and control of a single joint.

**References:**

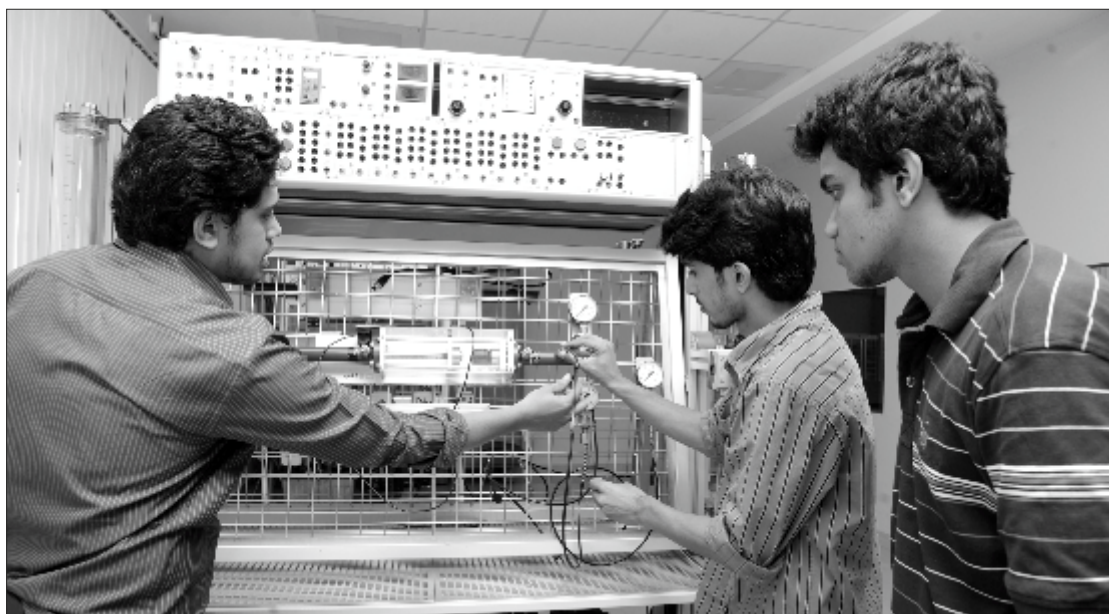
1. John J. Craig, Introduction to Robotics: Mechanics and Control, (3e), PHI, 2005.
2. C. Peter. Robotics, Vision and Control: Fundamental Algorithms in MATLAB. Vol. 73. Springer, 2011.
3. G. Ashitava, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2006.
4. Murray, Richard M., Zexiang Li, S. Shankar Sastry, and S. Shankara Sastry, A Mathematical Introduction to Robotic Manipulation, CRC press, 1994.
5. S. Bruno and O. Khatib, EDS: Springer handbook of Robotics, Springer, 2016.

**MTE 4306: MECHATRONICS SYSTEMS [2 1 0 3]**

Mechatronic Engineering: Introduction, Mechatronic Systems, Modelling, and Design - Coupled Design, Mechatronic Design Quotient, Design Evolution, Evolution of Mechatronics, Application Areas. Basic Elements and Components: Mechanical Elements: Mass, Spring, and Damper. Fluid Elements: Fluid Capacitor, resistor. Thermal Elements: Thermal capacitor, and resistor. Mechanical Components: transmission, lead screw and nut, and harmonic drives. Passive Electrical Elements and Materials, Active Electronic Components, Light Emitters and Displays and Light Sensors. Modelling of Mechatronic Systems: Dynamic Systems and Models, Transfer Functions and Frequency-Domain Models, Equivalent Circuits and Linear Graph Reduction, Block Diagrams, Response Analysis, Computer Simulation. Signal Conditioning: Impedance Characteristics, Amplifiers, filters, Modulators and Demodulators, Analog-to-Digital Conversion. Sensors and Actuators: Potentiometer, Resolver, Encoders, Proximity Sensors, Tactile Sensors. Hydraulic, Pneumatic and Electrical Actuators. Microcontrollers: Microcontroller Architecture, Input / Output Hardware, and Programming. Case Studies in Mechatronics Robotics Case Study, Hydraulics Based Case Study, Electrical Based Case Study, Pneumatics Based Case Study.

**References:**

1. Clarence W. de Silva, Mechatronics: A Foundation Course, CRC Press, 2010.
2. Ganesh S. Hegde, Mechatronics, Laxmi Publications Pvt Ltd., 2011.



## **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 Gaussian 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 Statistical 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. Some computational methods of linear algebra.

**References:**

1. Gantmacher F.R., *The Theory of Matrices*, Chelsea.
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 Jordan method, Crout's (LU decomposition) method. Iterative methods, Jacobi Gauss Seidel 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, Jacobi'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 Wiley
3. Conte S.D and Boor, *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 coarse methods, 2-phase method. Dual Simplex method. Duality theory. Transportation problem-Vogel's approximation method, MODI method, Assignment problem-Hungarian method. Project Management - Networks, Project planning and control using PERT and CPM. Project crashing. Game theory - 2 persons 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. Hamdy A. 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, Chapman Kolmogorov 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, Kolmogorov equations, Ornstein – Ulmer Process. White noise. 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, Parallel - 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 Processes*, 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 & Biju Varkey ., 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 Resource Management, Text & Cases McGraw Hill 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, Kevin 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 in operations planning and scheduling across the organization, sales and operation planning strategies- chase strategy, level strategy, operations planning using linear programming technique, scheduling job and facility scheduling, and work for scheduling. Theory of constraints, managing bottle necks in manufacturing and service processes, identifying bottle necks, relieving bottle necks, drum buffer rope system, and managing constraints in a line system. Supply chain design across the organization, supply chains for services and manufacturing, measures of supply chain performance - inventory measures, financial measures, inventory and supply chains - pressures for small inventories, pressures for large inventories, types of inventory, inventory reduction tactics, and inventory placement. Costs of quality, total quality management, acceptance sampling, statistical process control - control charts, and process capability. Continuous improvement using lean systems, different types of wastes, strategic characteristics of a lean system, designing lean system layout, and Kanban system.

#### **References:**

1. Krajewski L. J., Ritzman L. P., Malhotra M., and Srivastava S. K., *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, Skaldanowsky Brothers, 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 Makmalbaf, Majid Majidi, Keislowksi, 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, Pather Panchali, Mathilukal.

#### **References:**

1. Bordwell, David and Thompson, Kristin., *Film Art: an Introduction*, 7th ed. New York: McGraw-Hill Co., 2004.
2. Kavin, 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 sexuality; 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/accents (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 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'Reilly 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 Narrative*3. *Comics as Performance, Fiction as Scalpel.*
3. Jeet Heer, 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 nanostructures. Manipulation of nanoscale biological assemblies. Carbon nanotubes and fullerene as nanoclusters. 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. Baidyanath Basu, *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-ray diffraction, types of crystal binding, analysis of stress and strain in crystals. Electrical conduction: Free electron gas model, Sommerfeld quantum theory, Fermi energy, parameters of free electron gas at absolute zero, electrical conductivity, Drude-Lorentz theory and Sommerfeld theory of electrical conductivity, Band theory of solids, electrical conduction in metals, insulators and semiconductors. Dielectrics: Static dielectric constant, polarization and polarizability, local field, ferroelectricity, piezoelectricity, frequency dependence of polarizability (electronic, ionic and dipolar), dielectric losses, requirements of insulating materials, applications of dielectric materials. Magnetism: 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. CO<sub>2</sub>, 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 Schrödinger equation, stationary states, Schrödinger 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.
5. 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*, Wiley-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, Objectives, Meanings and Definitions of Yoga, History of Yoga, Concepts and misconceptions 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 asanas, 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 Foscett
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 accessories, 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 develop 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
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