

**B TECH in ELECTRONICS AND INSTRUMENTATION ENGINEERING**

Year	THIRD SEMESTER							FOURTH SEMESTER						
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C		
II	MAT 2152	Engineering Mathematics – III	2	1	0	3	MAT 2258	Engineering Mathematics – IV	2	1	0	3		
	ICE 2151	Analog Electronic Circuits	3	1	0	4	ICE 2251	Digital System Design	2	1	0	3		
	ICE 2152	Digital Electronic Circuits	2	1	0	3	ICE 2252	Industrial Instrumentation	3	0	0	3		
	ICE 2153	Electronic Measurements	3	0	0	3	ICE 2253	Linear control Theory	3	1	0	4		
	ICE 2154	Network Analysis and Signals	3	1	0	4	ICE 2254	Linear Integrated Circuits	3	1	0	4		
	ICE 2155	Sensors and Transducers	3	0	0	3	****	Open elective-I	3	0	0	3		
	ICE 2161	Digital Circuits Lab	0	0	3	1	ICE 2261	Analog Circuits Lab	0	1	3	2		
	ICE 2162	Measurement and Transducers lab	0	0	3	1	ICE 2262	Circuit Simulation and HDL Lab	0	0	3	1		
ICE 2163	Virtual Instrumentation Lab	0	1	3	2	ICE 2263	Instrumentation lab	0	0	3	1			
			16	5	9	24			16	5	9	24		
	<b>Total contact hour (L+T+P)</b>						30	<b>Total contact hour (L+T+P) + OE</b>						30
	<b>FIFTH SEMESTER</b>							<b>SIXTH SEMESTER</b>						
III	HUM 3152	Essentials of Management	2	1	0	3	HUM 3151	Engineering Economics and Financial Management	2	1	0	3		
	ICE 3151	Control System Components	3	0	0	3	ICE 3251	Digital Signal Processing	3	1	0	4		
	ICE 3152	Micro-controllers	4	0	0	4	ICE 3252	Industrial Automation	4	0	0	4		
	ICE 3153	Modern Control Theory	3	1	0	4	ICE ****	Program elective-I	3	0	0	3		
	ICE 3154	Process Instrumentation and Control	3	0	0	3	ICE ****	Program elective-II	3	0	0	3		
	****	Open elective-II	3	0	0	3	*** ****	Open elective-III	3	0	0	3		
	ICE 3161	Micro-controller Lab	0	1	3	2	ICE 3261	Automation Lab	0	0	3	1		
	ICE 3162	Process Control Lab	0	0	3	1	ICE 3262	Control System Lab	0	0	3	1		
			18	3	6	23	ICE 3263	DSP Lab	0	1	3	2		
			18	3	6	23	<b>Total contact hour (L+T+P) + OE</b>						30	
	<b>SEVENTH SEMESTER</b>							<b>EIGHTH SEMESTER</b>						
IV	ICE ****	Program elective - III	3	0	0	3	ICE 4298	Industrial Training				1		
	ICE ****	Program elective- IV	3	0	0	3	ICE 4299	Project and practice school				12		
	ICE ****	Program elective- V	3	0	0	3	ICE 4296	Project Work (Only for B.Tech honour Students)				20		
	ICE ****	Program elective- VI	3	0	0	3								
	ICE ****	Program elective- VII	3	0	0	3								
	***	Open elective-IV	3	0	0	3								
			18	0	0	18	<b>Total Contact Hours (L + T + P) +OE</b>						18	

## **Minor Specialization**

### **I. Computational Intelligence**

ELE 4061: Artificial Intelligence  
ECE 4051: Computer Vision  
ECE 4052: Machine Learning  
ELE 4062: Soft Computing Techniques

### **II. Control Systems**

ICE 4051: Digital Control Systems  
ICE 4052: Non-Linear Control Systems  
ICE 4053: Robust Control  
ICE 4054: System Identification

### **III. Embedded Systems**

ECE 4053: Embedded System Design  
ELE 4063: FPGA based system Design  
ECE 4054: Internet of Things  
ELE 4064: Real Time Systems

### **IV. Illumination Technology**

ELE 4065: Integrated Lighting Design  
ELE 4066: Lighting Controls: Technology & Applications  
ELE 4067: Lighting Science: Devices and Systems  
ELE 4068: Solid State Lighting

### **V. Sensor Technology**

ICE 4055: Advanced Sensor Technology  
ICE 4056: Micro Electro Mechanical Systems  
ICE 4057: Multi Sensor Data Fusion  
ICE 4058: Smart Sensor

### **VI. Signal Processing**

ECE 4055: Advanced Digital Signal Processing  
ELE 4073: Digital Image Processing  
ECE 4056: Digital Speech Processing  
ELE 4074: Linear Algebra for Signal Processing

### **VII. VLSI Design**

ECE 4061: Analog & Mixed Signal Design  
ECE 4062: Digital Design Verification  
ECE 4063: Low power VLSI Design  
ECE 4064: Semiconductor Device Theory

### **VIII. 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

### **IX. Business Management**

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

### **X. 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**

ICE 4059: Neural Network and Fuzzy Logic  
ICE 4060: Real Time Operating System  
ICE 4061: DSP algorithms and Architecture  
ICE 4062: Analytical and optical Instrumentation  
ICE 4063: Automotive Electronics  
ICE 4064: Biomedical Instrumentation and Equipment  
ICE 4065: Data Structures using C++  
ICE 4066: Cyber physical systems  
ICE 4067: Power Electronics  
ICE 4068: Robotics  
ICE 4069: Reliability and safety Engineering  
ICE 4070: Wireless Sensor Technology  
ICE 4071: Industrial Internet of Things

### **Open Electives**

ICE 4301: Feedback Control Theory  
ICE 4302: Industrial Automation  
ICE 4303: Industrial Instrumentation  
ICE 4304: Sensor Technology  
ICE 4305: Smart Sensor  
ICE 4306: Virtual Instrumentation  
ICE 4307: Farm Automation

### THIRD SEMESTER

#### **MAT 2152: ENGINEERING MATHEMATICS III [21 0 3]**

Functions of complex variable. Analytic function, C-R equations, differentiation, Integration of complex function, Cauchy's integral formula. Taylor's and Laurent Series, Singular points, Residues, Cauchy's residue theorem. Periodic function, Fourier Series expansion. even and odd functions, functions with arbitrary periods, Half range expansions Fourier transform, Parseval's identity, PDE-Solution by method of separation of variables and by indicated transformations. One dimensional wave equation, One dimensional heat equation and their solutions. Vector differential operator, gradient divergence and curl. Line, surface and volume integrals. Green's theorem, Divergence and Stoke's theorem

##### **References:**

1. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers.
2. Erwin Kreyszig: Advanced Engg. Mathematics, Wiley Eastern.
3. Murray R. Spiegel: Vector Analysis. 1959, Schaum Publishing Co.
4. Advanced Engineering Mathematics, Vol 3, by Narayanan, Ramaniah and Manicavachagom Pillay

#### **ICE 2151: ANALOG ELECTRONIC CIRCUITS [3 1 0 4]**

Structure and operation of MOSFET, I-V Characteristics, Channel-Length Modulation, Transconductance, Large-Signal and Small-Signal Model, Biasing, Amplifier topologies, Common-Source Amplifier, Common-Gate Amplifier, Source Follower, Cascode, Two stage CS Amplifiers, MOS Differential amplifier, Miller's Theorem, Frequency Response of CS, CG, CD, Cascode and differential amplifier Stage, Negative Feedback Amplifiers, Feedback Topologies, Power amplifiers, Push-Pull Stage, LC Oscillators, Hartley's and Colpitt's Oscillator, RC Phase Shift Oscillator, Ring Oscillator.

##### **References:**

1. Behzad Razavi, Fundamental of Microelectronics, Wiley, (2e), 2013.
2. A. S. Sedra, K. C. Smith, Microelectronic circuits, Oxford University Press, (6e), 2011.
3. R. L. Boylestad, L. Nashelsky, Electronic Devices and Circuit Theory, PHI, (11e), 2014.

#### **ICE 2152: DIGITAL ELECTRONIC CIRCUITS [2 1 0 3]**

Performance metrics of logic families, Binary codes, Boolean Algebra, Karnaugh map, Quine-McCluskey method, Arithmetic circuits, Code convertors, Multiplexers, De-multiplexers, Encoders, Decoders, Comparators, Parity generators and checker. Latches, flip-flops, Synchronous and Asynchronous circuits - Counters, Shift registers, Cycles, Races and Hazards, Finite State Machines, ASM Chart, Timing issues.

##### **References:**

1. Donald D. Givone, Digital Principles and Design, TMH, (1e), 2002.
2. M. Morris Mano, Digital Design, PHI, (5e), 2002.
3. C. H. Roth, Fundamentals of Logic Design, Thomson, (6e), 2000.
4. A. Anand Kumar, Switching Theory and Logic Design, PHI, (2e), 2014.

#### **ICE 2153: ELECTRONIC MEASUREMENTS [3 0 0 3]**

Sources and detectors, Anderson Bridge, De-Sauty Bridge, Schering Bridge, Shielding, Wien's bridge, Electro dynamometer type wattmeter,

energy-meters, Digital Storage Oscilloscopes. Measurement using CRO's, Sampling oscilloscope, display devices – LED, LCD, Dot matrix, Digital Voltmeters, Digital Multimeter, Digital Frequency meter, Q-meter, LCR meter, Analog and digital recorders, Wave Analyzers, Spectrum Analyzers, Power Analyzers.

##### **References:**

1. David A Bell, Electronic Instrumentation and Measurements, Oxford Press, (2e), 2004.
2. H S Kalsi, Electronic Instrumentation, MGH education, (2e), 2004.
3. Helfrick A.D, Cooper W.D, Modern Electronic Instrumentation & Measurement Techniques, PHI, (5e), 2002.

#### **ICE 2154: NETWORK ANALYSIS AND SIGNALS [3 1 0 4]**

Analysis of circuits with dependent sources, Network theorems, Initial conditions and transient analysis of RL, RC and RLC circuits, Continuous time signals and systems, LTI systems - convolution integral, Response of Continuous time LTI systems to complex exponentials, Fourier series, Fourier transform, Properties of Fourier series and Fourier transform, Analysis of networks by Laplace transform method, Transform functions, Transform circuits, Network functions, Two port network parameters.

##### **References:**

1. Van Valkenberg, Network Analysis, (3e), PHI, 2010.
2. Allan Oppenheim, Allan Willsky with Ian T Young, Signals and Systems, PHI, 1999.
3. Hayt W. H., J. E. Kemmerly & S. M. Durbin, Engineering Circuit Analysis, (7e), TMH, 2010.
4. Schaum's outline series, Electric Circuits, MGH, (5e), 1992.

#### **ICE 2155 SENSORS & TRANSDUCERS [3 0 0 3]**

Functional elements of an Instrument, Types of transducers, Null and Deflection methods, Input/output configurations, characteristics, types of errors, Resistive, Capacitive, Inductive transducers, Hall Effect sensors, magneto elastic transducers, solid state sensors, eddy current transducers, Piezo Electric transducers, pH Measurement, Semiconductor sensors, photo electric transducers, CCD, shaft encoder and decoders, optical encoders, gas sensors, density, viscosity, moisture and humidity measurements.

##### **References:**

1. E.O. Doebelin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.
2. DVS Murthy, Transducers & Instrumentation, PHI, (2e), 1999.
3. B.G. Liptak, Process Measurement & Analysis, Chilton Book Company, (4e), 2003.

#### **ICE 2161: DIGITAL CIRCUITS LAB [0 0 3 1]**

Boolean functions using logic gates, Code Conversion Circuits, Adders, Subtractors, Magnitude comparator, Parity checker / generator, Multiplexers, Demultiplexers, Encoders, Decoders, Flip flops, Counters, Shift Registers, Sequential circuits.

##### **References:**

1. M. Morris Mano, Digital Design, PHI, (5e), 2002.
2. Ronald J. Tocci, Digital Systems, Pearson Education, (11e), 2003.

**ICE2162: MEASUREMENTS AND TRANSDUCERS  
LABORATORY [0 0 3 1]**

AC bridges, network theorems, measurement of energy, measurement of self and mutual inductance, series and parallel resonance, characteristics of sensors and transducers, measurements of temperature, pressure, flow, torque, force, displacement and intensity of light.

**References:**

1. A.K Sawhney, A course in Electrical and Electronic Instrumentation Measurements, (7e), Dhanpat Rai & Co, 2002.
2. E.O. Doebelin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.

**ICE 2163: VIRTUAL INSTRUMENTATION LAB [0 1 3 2]**

Introduction to Lab VIEW, Arithmetic and logical operations, Arrays, Clusters, and Loops. Structures, Graphs, timing pallets, Strings and file I/O, Measurement and automation explorer, Simulation of DAQ, DIAdem, ULTIboard.

**References:**

1. Gary Johnson, LabVIEW Graphical Programming, McGraw Hill, (2e), 1997.
2. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI learning, 2010.

**FOURTH SEMESTER**

**MAT 2258: ENGINEERING MATHEMATICS IV [2 1 0 3]**

Statistics: Mean, Median, Mode measures of dispersion. Finite sample spaces, Conditional probability and independence, Bayes' theorem, One dimensional random variable, Mean, Variance, Chebyshev's inequality, Two and higher dimensional random variables, Covariance, Correlation coefficient, curve fitting. Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential distributions, Moment generating function, Functions of one and two dimensional random variables, Sampling theory, Central limit theorem. Difference equations with constant coefficients, solutions. Z-transforms and Inverse Z-transforms, Solutions of difference equations using Z-transforms. Solution of boundary value problems, Numerical solutions of Laplace and Poisson equations, Heat and wave equations by explicit methods.

**References:**

1. P.L.Meyer., Introduction to probability and Statistical Applications , (2e), American Publishing Co., 1979
2. Erwin Kreyszig, Advanced Engineering Mathematics, (5e), Wiley Eastern, 1985.
3. A.V.Openheim & R.W.Schafer , Digital Signal Processing 1975, Prentice Hall
4. Hogg & Craig, Introduction to Mathematical Statistics, (4e), MacMillan, 1975
5. Narayanan, Ramaniah and Manicavachagom Pillay, Advanced Engineering Mathematics, Vol.3

**ICE 2251: DIGITAL SYSTEM DESIGN [2 1 0 3]**

Digital System implementation using PLDs, PLAs and PALs, Programmable ASICs (PLDs & FPGAs), levels and domains of abstraction, Design flow, Introduction to CAD Tools, Introduction to Verilog, Verilog for Combinational Circuits – Conditional operator, Verilog Operators, Verilog for Sequential Circuits – Verilog Constructs of Storage Elements, Blocking and Non-Blocking Assignments, Module, Language

Elements, Data Types, Register Types, Expressions, types of modeling, Verification, Architecture of CPLDs and FPGAs, Antifuse, SRAM, EEPROM based technologies, logic cells, I/O cells, programmable interconnect, Design flow, placement and routing, Testing combinational and sequential circuits, Functional and Timing simulation, boundary scan, faults, fault simulation, BIST, DFT, Verification.

**References:**

1. Samir Palnitkar, Verilog HDL: A guide to digital design and synthesis, Prentice Hall Professional, (2e), 2003.
2. J. Bhasker, A Verilog HDL Primer, BSP, (1e), 2001.
3. Stephen Brown, Fundamentals of Digital Logic with Verilog Design, TMH, (3e), 2013.

**ICE 2252: INDUSTRIAL INSTRUMENTATION [3 0 0 3]**

Temperature measurement using RTD, Thermistors and thermocouple. Solid-state temperature sensors, radiation methods, Pressure Measurement - Manometers, Elastic types, Bell gauges, Electrical types, Differential Pressure transmitters, Dead weight Pressure gauges. Low Pressure Measurement, Flow Measurement, head type flow meters, variable area flowmeters, anemometers, velocity based flowmeters, Measurement of mass flowrate - Radiation, angular momentum, impeller, turbine, constant torque hysteresis clutch, twin turbine, Coriolis, gyroscopic. Target flowmeters, V-cone flowmeters, Multiphase flow measurement, Measurement of Speed, velocity and Acceleration, Level Measurement.

**References:**

1. Patranabis D, Principles of Industrial Instrumentation, TMH, (3e), 2005.
2. Liptak B. G, Handbook of Process Measurement and Analysis, Chilton Book Company, (3e), 1995.
3. Gioia Falcone, Geoffrey Hewitt, C Alimonti, Multiphase Flow Metering- Principles and Applications, Elsevier Publication, 2009.

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

Mathematical modeling, transfer functions, Block diagram representation and reduction, signal flow graph, Masons gain formula, time domain specifications. Stability, Steady state errors, generalized error coefficients, Routh-Hurwitz criterion, Root-Locus plots, compensator design using root-locus, frequency domain specifications. Correlation between frequency domain and time domain specifications, Bode diagrams, Polar plots, Nyquist stability criterion, compensator design by frequency response approach.

**References:**

1. Norman S. Nise, Control Systems Engineering, Wiley India, (5e), 2009.
2. K. Ogata, Modern control engineering, PHI, (5e), 2011.
3. R.C Dorf and R.H Bishop, Modern Control Systems, Pearson, (11e), 2013.

**ICE 2254: LINEAR INTEGRATED CIRCUITS [3 1 0 4]**

Op Amp fundamentals, Current to Voltage, Voltage to current Converters, Current amplifiers, Difference Amplifiers, Instrumentation Amplifiers, Active Filters, Static and Dynamic Op Amp Limitations, Voltage comparators, Comparator applications, Schmitt trigger, Precision rectifiers, Peak detector, Sample and hold circuit. Sine wave generators, Multivibrators, Monolithic Timers, Triangular wave generators, Voltage to frequency and Frequency to voltage converters, Voltage regulators, Digital to Analog and Analog to Digital Converters, Phase locked loops, VCO.

**References:**

1. Franco Sergio, Design with Op amps & Analog Integrated Circuits, McGraw Hill, (3e), 2017.
2. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, PHI, (4e), 2015.
3. Robert F. Coughlin and Frederick S. Driscoll, Operational Amplifiers and Linear Integrated Circuits. Pearson education Pvt ltd., 2002.
4. Sedra and Smith, Micro Electronic Circuits, Oxford university press, (6e), 2000.

**ICE 2261: ANALOG CIRCUITS LABORATORY [0 1 3 2]**

Rectifier circuits, Voltage regulators, Frequency Response of RC coupled Amplifier, OPAMP applications - Inverting amplifier, Non-inverting amplifier, Summing Amplifier, Difference amplifier, Integrator, Differentiator, Comparator, Schmitt trigger, Astable and Monostable multivibrator, Wein Bridge Oscillator using OPAMP, Active filter, 555 Timer circuits.

**References:**

1. Albert Malvino, Electronic Principles, McGraw Hill, (7e), 1999.
2. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, PHI, (4e), 2015.
3. Sedra and Smith- Micro Electronic Circuits, Oxford university press, (6e), 2000.

**ICE 2262: CIRCUIT SIMULATION AND HDL LAB [0 0 3 1]**

Analysis of electrical circuits, Transient analysis of RL and RC and RLC circuits, Series and parallel resonance, Analysis of diode and transistor circuits. Design of combinational and sequential systems using Verilog, Design of finite state machines using Verilog.

**References:**

1. Van Valkenberg, Network Analysis, (3e), PHI, 2010.
2. Samir Palnitkar, Verilog HDL: A guide to digital design and synthesis, Prentice Hall Professional, (2e), 2003.

**ICE 2263: INSTRUMENTATION LAB [0 0 3 1]**

Design of measurement circuits for liquid level, viscosity, force, displacement, flow, humidity, temperature, pressure and calibration. Object detection using image, posture estimation.

**References:**

1. C S Rangan, G R Sharma and V S V Mani, Instrumentation Devices & Systems, TMH, (2e), 2004.
2. E.O.Doeblin, Measurement Systems – Application and Design, McGraw Hill, (4e), 1992.

**FIFTH 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

**ICE 3151: CONTROL SYSTEM COMPONENTS [3 0 0 3]**

A.C & D.C Servomotor, Tachogenerator, Synchros, Stepper motor, I/P converter, Pressure booster, Issues in control valves, Valve positioner, Valve selection, Cavitation and flashing, Valve sizing, Types of Control valves, Actuators, Pneumatic relays, Gear and Gear Trains, Cams and followers, Fluid and Pneumatic control, Pneumatic control devices, Hydraulic control system, Gear pump, Vane pump, Ball pump, Spool type pilot valve, Centrifugal pump and displacement pump, Linear induction motors, Reluctance motors, Gyroscopes.

**References:**

1. M.D.Desai, Control system components, PHI, 2010.
2. J.E Gibson & F.B Teuter, Control System Components, MGH, 2013.

**ICE 3152: MICROCONTROLLERS [4 0 0 4]**

Processor architecture, Architecture of 8051, 8051 Addressing Modes, 8051 Instruction Set, Programming 8051 using Assembly Language and C, 8051 Timer, Serial Port and Interrupt Programming using Assembly Language and C. Introduction to ARM, ARM Architecture, Introduction to LPC2148, Architecture of LPC2148 and Programming, Interfacing of I/O ports, ADC, DAC, LCD, Keyboard, Stepper motor, DC motor using 8051 and LPC2148.

**References:**

- 1) Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education, (2e), 2007.
- 2) Kenneth J. Ayala, The 8051 Microcontroller, Cengage Learning, (3e), 2004.
- 3) Steve Furber, ARM System-on-Chip Architecture, Addison Wesley, (2e), 2000.
- 4) LPC21XX User Manual, 2007.

**ICE3153: MODERN CONTROL THEORY [3 1 0 4]**

State Space Analysis, Phase variable and canonical form representation, Derivation of state models, Stability analysis, Eigen values, Eigen vectors, Solution of state equations, Cayley Hamilton theorem, Controllability and observability, Pole placement, Observer design, Non Linear Systems, Phase plane analysis, Construction of the phase trajectory, Describing function, Lyapunov's stability analysis, Sylvester's criterion, Lyapunov theorems of stability, Lyapunov function for continuous time state equations.

**References:**

1. K. Ogata, Modern Control Engineering, Prentice Hall India, (5e), 2011.
2. Nagrath and Gopal, Control System Engineering, New age international Limited, (2e), 1984.
3. M Gopal, Control Systems Engineering: Principles and Design, McGrawHill, (4e), 2012.

**ICE 3154: PROCESS INSTRUMENTATION AND CONTROL [3 0 0 3]**

Mathematical modelling of level, pressure and thermal processes, Self-regulation, Servo and regulatory operation, On-off, proportional, single-speed, floating, integral and derivative control modes, PI, PD and PID control modes, Pneumatic and Electronic controller realization, Anti-Reset windup, Controller evaluation criteria's, Controller tuning- Process reaction curve method, Ziegler Nichols method, Damped oscillation method, Two-point method, Multiloop Control-Feed forward, Ratio, Cascade, Inferential, Split range control, Internal Model Controller, Dead time Compensator.

**References:**

1. Stephanopoulos, G, Chemical Process Control, PHI, 2008.
2. Donald R Coughanower, Process Systems Analysis and Control, MGH, (3e), 2017.
3. Curtis D. Johnson, Process Control Instrumentation Technology, PHI, (8e), 2009.

**ICE 3161: MICROCONTROLLERS LAB [0 1 3 2]**

8051 Programming - Timer, Serial Port and Interrupt Programming, ARM programming, Peripherals Interfacing to 8051 and LPC2148.

**References:**

- 1) Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education, (2e), 2007.
- 2) Kenneth J. Ayala, The 8051 Microcontroller, Cengage Learning (3e), 2004.
- 3) Steve Furber, ARM System-on-Chip Architecture, Addison Wesley, (2e), 2000.
- 4) LPC21XX User Manual, 2007.

**ICE 3162: PROCESS CONTROL LAB [0 0 3 1]**

Open loop, On/Off, P, PI, PD and PID control actions for Temperature, Level, Flow and Pressure Control, Cascade, Feed Forward and Ratio Control, Control valve characteristics, Control of Non-linear system, PID tuning, DAQ system, Interacting tank control, Model extraction, MIMO control.

**References:**

1. Curtis D. Johnson, Process Control Instrumentation Technology, PHI, (8e), 2009.
2. Donald R Coughanower, Process Systems Analysis and Control, MGH, (3e), 2017.
3. Wayne Bequette, Process control, Modelling, simulation & Control, PHI, (1e), 2004.

**SIXTH 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-GrawHill 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.

**ICE 3251: DIGITAL SIGNAL PROCESSING [3 1 0 4]**

LTI discrete time systems, Linear convolution, Cross correlation and autocorrelation, Analysis of discrete time systems, DFT, Inverse DFT, FFT Algorithms, Radix 2 DITFFT and DIFFFT, IIR Filters - Butterworth, Chebyshev and elliptic filters, Impulse invariance, Bilinear transformation, FIR Filters, Structures for FIR systems, Structures for IIR systems, Applications.

**References:**

1. Proakis John G, Manolakis Dimitris G., Digital Signal Processing, PHI, (4e), 2003.
2. Rabiner L.R and Gold Bernard, Theory and Applications of Digital Signal Processing, PHI, 2002.
3. Sanjit Mitra K, Digital Signal Processing: A Computer Based Approach, TMH, (3e), 2008.

**ICE 3252: INDUSTRIAL AUTOMATION [4 0 0 4]**

Data loggers, Data Acquisition Systems, Direct Digital Control, SCADA, Programmable Logic Controller, Ladder logic Programming, PID functions, analog PLC operation, Alternate Programming Languages, PLC Maintenance, Interface and Backplane Bus Standards, Field bus, HART protocol, Smart transmitters, Valves and Smart actuators, MODBUS, Profibus, IEC 1158-2 Transmission Technology, Distributed Control Systems, Local Control Unit, Communications for DCS, Displays - Engineering interfaces.

**References:**

1. John. W. Webb Ronald A Reis, Programmable Logic Controllers - Principles and Applications, PHI, (4e). 1998.
2. Lukcas M.P, Distributed Control Systems, Van Nostrand Reinhold Co., 1986.
3. Frank D. Petruzella, Programmable Logic Controllers, MGH, (2e), 1997.

**ICE 3261: AUTOMATION LAB [0 0 3 1]**

Ladder and Function block diagram programming, Distributed control system programming, Interface of process loops with DCS/ PLC, HMI.

**References:**

1. John. W. Webb Ronald A Reis, Programmable Logic Controllers - Principles and Applications, PHI, (4e), 1998.
2. Lukcas M.P, Distributed Control Systems, Van Nostrand Reinhold Co., New York, 1986.

**ICE 3262: CONTROL SYSTEMS LAB [0 0 3 1]**

Block diagram reduction, Time domain analysis, Steady state errors, State space analysis, Stability analysis, Lag, Lead, Lag-Lead compensator design using Bode plot and root locus, Study of P, PI, PID controller, Modeling practice with SIMULINK.

**References:**

1. K. Ogata, Modern Control Engineering, PHI, (5e), 2011.
2. R.C. Dorf and R. H. Bishop, Modern Control systems, Wesley Longman, 1998.
3. Norman S. Nise, Control Systems, Wiley, (7e), 2000.

**ICE 3263: DSP LAB [0 1 3 2]**

Generation of basic signals and discrete sequences, Analysis of discrete time systems, DTFT, DFT computation, Analog filter design, IIR and FIR filter design.

**References:**

1. Proakis John G, Manolakis Dimitris G, Digital Signal Processing, PHI, (4e), 2003.
2. Rabiner L.R and Gold Bernard, Theory and applications of Digital Signal Processing, PHI, 2002.
3. Sanjit Mitra K, Digital Signal Processing: A computer based approach, TMH, (4e), 2008.

**SEVENTH SEMESTER**

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

**EIGHTH SEMESTER****ICE 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.

**ICE 4299: PROJECT WORK/PRACTICE SCHOOL**

The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions. The duration of the project

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

**PROGRAM ELECTIVES****ELE 4061: ARTIFICIAL INTELLIGENCE [2 1 0 3]**

Foundation and History of AI, State of the art, Fields of application, Performance measures, Rationality, Specification and properties of task environment, Structure of Agents, Problem solving by searching, Searching for solutions, uninformed search strategies, Informed search strategies, Heuristic functions, Local search algorithms, Online search agents, Knowledge based agents, The Wumpus World, Propositional logic – reasoning patterns, effective inference, First order logic - Syntax and semantics, Knowledge engineering, Inference rule, forward and backward chaining, Ontological engineering, categories and objects, Processes and intervals, reasoning systems, Truth maintenance systems, Uncertainty, Basic probability notation, Axioms, Baye's rule, Bayesian networks, Inference in Bayesian networks.

**References:**

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (3e), Pearson, 2012
2. Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence (3e), Tata McGraw Hill, 2012
3. David Poole and Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents (2e), Cambridge University Press, 2017  
<http://nptel.ac.in/courses/106105077/>
4. IIT, Kharagpur

**ECE 4051: COMPUTER VISION [2 1 0 3]**

Image formation model using pinhole camera, Linear filters and convolution, Image derivatives, Features: corners, SIFT, HOG, textures. Segmentation using clustering (K-means, Mean-Shift, Watershed) and fitting model, Segmentation and fitting using probabilistic methods (EM algorithm), Geometry of two view and Camera calibration including radial distortion, Bayes Classifier: using class histograms, using class conditional density, Support Vector machine

**References:**

1. David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003
2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, (2e), Cambridge University Press, 2004
4. Linda Shapiro and George Stockman, Computer Vision, Pearson Education, 2001

**ECE 4052: MACHINE LEARNING [2 1 0 3]**

Machine learning basics, Naïve Bayesian Model. Non-Parametric Techniques: Density Estimation, Parzen Windows, k- Nearest-Neighbor Estimation, K- nearest neighbor classification, Radial Basis Function Network, Learning Vector Quantization, Clustering, K-Means clustering, Competitive learning, Self-Organizing Maps, Recurrent Neural Network, Hopfield Neural Network, Adaptive Resonance Theory, Support vector

machines, Statistical Hypothesis testing- t-test, ANOVA, feature selection methods – Filter based techniques and wrapper methods, Principal Component Analysis, Applications of PCA, PCA, Independent component analysis, Voting, Error correcting output codes, Bagging, Boosting

**References:**

1. Ethem Alpaydin, Introduction to Machine Learning, (2e), MIT Press, 2010.
2. Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, (2e), Wiley, 2001
3. Peter Harrington, Machine Learning in Action, Manning Publications, 2012.
4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
5. Richard Jensen, Qiang, Shen Computational Intelligence and Feature Selection: Rough and Fuzzy Approaches, Vol. 8, IEEE Press Series on Computational Intelligence, John Wiley & Sons, 2008
6. Marshall, E. (2016). The Statistics Tutor's Quick Guide to Commonly Used Statistical 210 Tests. <http://www.statstutor.ac.uk/resources/uploaded/tutorsquickguidetostatistics.pdf>

**ELE 4062: SOFT COMPUTING TECHNIQUES [2 1 0 3]**

Introduction to Soft computing, soft computing techniques, Artificial Neural Networks, Multilayer Perceptron, Gradient descent, Logistic discrimination, Single layer Perceptron, Training a perceptron, Multilayer perceptron, Back-Propagation Algorithm, Fuzzy Systems, Fuzzy Logic, Membership Functions, Fuzzy Controllers, Evolutionary Algorithms, Genetic Algorithms, Other Optimization Techniques, Metaheuristic Search, Traveling Salesman Problem, Introduction to hybrid systems, Adaptive Neuro-Fuzzy Inference Systems, Evolutionary Neural Networks, Evolving Fuzzy Logic, Fuzzy Artificial Neural Networks

**References:**

1. Jacek M Zurada, "Introduction to Artificial Neural Systems", Jaico publication, 2016
2. Timothy J Ross, "Fuzzy Logic with Engineering Applications", Intl. edition, McGraw Hill publication, 2012.
3. Anupam Shukla, Ritu Tiwari, Rahul Kala, Real Life Applications of Soft Computing, CRC Press, Taylor and Francis Group, London 2010
4. Shivanandam & Deepa, "Principles of Soft Computing", Wiley India edition, 2009
5. Rajasekaran and G.A.Vijayalakshmi Pai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning, 2003

**ICE 4051: DIGITAL CONTROL SYSTEMS [3 0 0 3]**

Sampling, Data acquisition, Quantization, sample and hold, zero order hold, frequency domain consideration in sampling and reconstruction, Difference equations, pulse transfer function, Block diagram analysis of sample data systems, time response of discrete time control systems, Steady State error analysis, Stability, Jury's stability test, bilinear transformation, Root locus technique, W transformation, Bode Plot. Nyquist Stability analysis, Design of Lag, Lead, Lag-lead compensator using root locus and Bode plot, Design of PID controller, Lyapunov Stability Analysis, State Space Analysis, Diagonalization, Solution of state equations, Controllability, Observability, Representation of the system in different canonical forms, Pole Placement- Ackermann's Formula, Dead beat Algorithm.

**References:**

1. K. Ogata, Discrete time control systems, PHI, (7e), 2011.
2. M. Gopal, Digital control and state variable methods, TMH, 2001.
3. C.H Houpis and G.B Lamont, Digital Control Systems - Theory and Hardware, MGH, 1992.
4. G.F. Franklin, J. David Powell, M. L. Workman, Digital Control of Dynamic Systems, A-Wesley Publishing Company, (2e), 1990.
5. V. I. George and C.P. Kurian, Digital Control Systems, Cengage publishers, 2012.

**ICE 4052: NONLINEAR CONTROL SYSTEMS [3 0 0 3]**

Lyapunov stability using Krasovskii's method, Variable Gradient method, L2 stability of state models, L2 gain, small gain theorem, Passivity, Memory less functions, L2 gain and Lyapunov stability, passivity theorems, passivity based control, Review of describing function method, Absolute Stability Circle criterions, Popov Criterion, stabilization via linearization and Integral control, Gain scheduling, Graphical Linearization Methods, Analytical Linearization Method, Evaluation of Linearization Coefficients by Least-Squares Method, Local linearization, Feedback linearization, Input-state linearization, Input-output linearization, Internal dynamics, Zero dynamics, Model Reference Adaptive Control (MRAC). Sliding mode Control, sliding surfaces, continuous approximations of switching control laws, modeling performance trade off, Tracking regulation via Integral control, Lyapunov redesign, non-linear damping, back stepping, high gain observers.

**References:**

1. H.K. Khalil, Nonlinear Systems, (3e), PHI, 2002
2. R. Marino and P. Tomei Nonlinear Control Design - Geometric, Adaptive and Robust, Prentice Hall, 1995.
3. J.J.E. Slotine and W.Li, Applied Nonlinear control, Prentice Hall, 1998.
4. Alberto Isidori, Non-linear Control Systems, Springer Verlag, 1999.

**ICE 4053: ROBUST CONTROL [3 0 0 3]**

Issues in Control System Design, Norms for signals and systems, Input-Output Relationships, Computing the Norm by State-Space Methods, Condition for Internal stability, sensitivity and complementary sensitivity function, Asymptotic tracking, Performance, Sources of Model Uncertainties, Plant Uncertainty Model, Small Gain Theorem, Robust Stability, Robust Performance, Existence of Stabilizing Controllers, Parameterization of All Stabilizing Controllers, Coprime Factorization. Loop shaping with C, Shaping S, T, or Q,P-1 Stable, P-1 Unstable, The Modified Problem, Spectral Factorization, Case Studies-Robust Control for Mass Damper Spring Systems, Spacecraft and Inverted Pendulum.

**References:**

1. Doyle, J.C., B.A. Francis and A. Tannenbaum, Feedback Control Theory, Macmillan publishing co., 1990.
2. Kemin Zhou, Doyle J.C and Glover K., Robust and Optimal Control, Prentice Hall Inc, 1995.
3. William A. Wolovich, Automatic Control Systems, Saunders college publishing, 1994.
4. Kemin Zhou and Doyle J.C, Essential of Robust Control", Prentice Hall Inc, 1998.

**ICE 4054: SYSTEM IDENTIFICATION [3 0 0 3]**

Introduction to system modeling, Types of system models, Importance of system models, Model development techniques – first principle based and data driven based, Introduction to System Identification, Procedure for identification, Concept of Identifiability, Signal to Noise Ratio,



Overfitting, LTI System Modeling using time and frequency, Direct impulse response identification, Direct step response identification, Impulse response Identification using step response, Empirical Transfer function Identification, Correlation Methods, Linear Regression, Least Square Estimation, Equation Error Models – ARX Models, ARMAX Models, ARIMAX Models, OE Models, Box Jenkins Model, Model Validation Techniques.

**Reference books:**

1. Arun. K. Tangirala, Principles of System Identification Theory and Practice, CRC Press, 2016.
2. Karel. J. Keesman, System Identification – An Introduction, Springer, 2011.

**ECE 4053: EMBEDDED SYSTEM DESIGN [2 1 0 3]**

Typical embedded system: Core of the embedded system, memory, sensors & actuators, communication interface, Serial/Parallel Communication protocols, Hardware and software co-design: Data-path and controller design, Architecture design; Development Environment: OS and non-OS based firmware embedding techniques; Firmware Design and Development; operating system basics; Embedded development life cycle.

**References:**

1. Frank Vahid & Tony Givargis, Embedded System Design, Wiley Publication, 2002.
2. Shibu K. V, Introduction to Embedded Systems, McGraw Hill Publication, 2013.
3. Paul S R Chisholm, David Hanley, Michael Jones, Michael Lindner, and Lloyd work, C Programming: Just the FAQs, SAMs publishing, 1995.
4. Wayne Wolf, Modern VLSI Design-IP based Design, Prentice Hall, 4th Edition, 2008.

**ELE 4063: FPGA BASED SYSTEM DESIGN [2 1 0 3]**

Overview of Digital Systems – Implementation options , FPGA – Architecture, Programming technologies, Altera & Actel logic cells, I/O Blocks, Programmable interconnects, Logic implementation , Design verification- Test bench codes, Hardware testing, FPGA Architectural options; granularity of function and wiring resources, reconfigurable architectures- Fine grained, Coarse grained, Medium grained, Embedded multipliers, adders, MACs, processor cores, Configuring an FPGA ; Vendor specific issues, Logic block architecture, timing models-static and dynamic timing analysis, Input and Output cell characteristics , Power dissipation, Partitioning and placement, Routing resources , Embedded system design using FPGAs, DSP using FPGAs, Multi FPGA systems, Reconfigurable systems, Application case studies

**References:**

1. M.J.S. Smith, Application Specific Integrated Circuits, Pearson, 2000
2. Peter Ashenden, Digital Design using Verilog, Elsevier, 2007
3. W. Wolf, FPGA Based System Design, Pearson, 2004
4. Clive Maxfield, The Design Warriors Guide to FPGAs, Elsevier, 2004
5. Paul S. Graham and Maya Gokhale Reconfigurable Computing Accelerating Computation with Field-Programmable Gate Arrays, Springer, 2005.

**ECE 4054: INTERNET OF THINGS [2 1 0 3]**

Introduction to Internet of Things, Sensing, actuation, Basics of Networking, Sensor networks, Machine to Machine communication

(M2M), IOT technologies and Architectures: Infrastructure and service discovery protocols for the IoT ecosystems; Realization of IoT ecosystem using wireless technologies; Interoperability in IoT , Data handling and analytics, cloud computing, Real world design constraints; IoT use Cases

**References:**

1. Pethuru Raj & Anupama C Raman, The Internet of Things: Enabling Technologies, Platforms & Use Cases, CRC Press, 2017
2. Arshdeep Bagha & Vijay Mediseti, Internet of Things: A Hands on Approach, University Press
3. Jan Holler, Vlasios T Siatsis, Catherine Mulligan, Stamaticos Karnouskos, Stefan Avesand, David Boyle, From Machine to Machine to the Internet of Things: Introduction to a New Age of Intelligence, Academic Press, 2014
4. Frank Vahid, Givargis Embedded Systems Design: A Unified Hardware/Software Introduction, Wiley Publications, 2000
5. Jan Axelson, Parallel Port Complete, Penram publications

**ELE 4064: REAL TIME SYSTEMS [2 1 0 3]**

Introduction to real time embedded system, terminology, Real time design issues, characteristics. Types of real time systems, timing constraints, precedence constraints, dependencies, functional and resource parameters. Real time operating systems, kernels, queues, semaphores, Multi processing and multitasking, priority inversion, dead-lock. Real time services, Real time standards, System resources, Processing, scheduling policies, Performance measures for real time systems. Scheduling algorithms, periodic and aperiodic, priority driven, frame size constraints, real time communication.

**References:**

1. Jane W.S.Liu , Real Time Systems, Pearson Education, 2006
2. Sam Siewert, Real Time Embedded Systems and Components, Cengage Learning, 2007
3. Qing Li, Real Time Concepts for Embedded Systems, CMP Books, Elsevier, 2003
4. Santanu Chattopadhyay, Embedded System Design, PHI, 2011
5. C.M.Krishna, Kang.G.Shin, Real Time Systems, McGraw Hill, 1997

**ELE 4065: INTEGRATED LIGHTING DESIGN [2 1 0 3]**

Interior lighting design: Artificial illumination design techniques: quality and quantity aspects, Energy efficiency in illumination systems, lamp and luminaire selection, Energy conservation, visual comfort and thermal comfort. Design calculations. Exterior lighting design: Road Lighting, Sports lighting and flood lighting, Daylight -artificial light integration, Simulation assisted design of interior and exterior, lighting design standards – Subjective analysis in lighting design, daylight-artificial light integration and energy performance.

**References:**

1. National Lighting Code 2010 (SP 72: 2010), Bureau of Indian Standards.
2. I.E.S.N.A., New York, Lighting Hand Book, (10e), 2011.

**ELE 4066: LIGHTING CONTROLS: TECHNOLOGY & APPLICATIONS [2 1 0 3]**

Strategies and technologies: occupancy sensing, switching controls, daylight adaptation and photo sensors, Commissioning and energy codes, Controller and control algorithms: Integral reset, open-loop and closed loop control, adaptive control, predictive control, inverse control

with online adaptive learning, Camera based measurement, virtual scenario based intelligent lighting control, Protocols and Networking: architecture, standard lighting protocols, wired and wireless , centralized and distributed, WSA lighting control application, connected lighting system, SoC solutions for lighting control system, Power-over-Ethernet, Commissioning of smart lighting system.

**References:**

1. Simpson, Robert S. Lighting control: technology and applications. Taylor & Francis, 2003.
2. DiLouie, Craig. Lighting controls handbook. The Fairmont Press, Inc., 2008.
3. Cai, H. "Luminance gradient for evaluating lighting." Lighting Research & Technology 48.2, 2016: 155-175.
4. Serpanos, Dimitrios, and Marilyn Wolf. Internet-of-things (iot) Systems: Architectures, Algorithms, Methodologies. Springer, 2017.
5. Yang, Kun. "Wireless sensor networks." Principles, Design and Applications, 2014.

**ELE 4067: LIGHTING SCIENCE: DEVICES AND SYSTEMS [2 1 0 3]**

Light & Vision: Human visual system, photoreceptors, colour perception -spectral, spatial, and temporal characteristics, chromatic adaptation and contrast sensitivity. Lighting technologies: Light sources and Luminaires, Generation, distribution and control, emerging sources and luminaires, optical, electrical and thermal characteristics. Photometry & Colorimetry: measurements and calculations, characterization of colors of lights and objects - experimental and simulation analysis, measuring instruments, testing, reliability and lifetime of luminaires, evaluation of lighting products .

**References:**

1. Lighting Handbook, (10e), IESNA, 2011.
2. Patrick Mottier, LED for Lighting Applications, (1e), Wiley, 2009.
3. Spiros Kitsinelis, Light Sources: Technologies & Applications, CRC press, 2010.
4. M.a. Cayless & A.M. Marsdon, Lamps & Lighting, 4th ed., Oxford & IBH publishing company, 1996
5. Jack L. Lindsey, Applied Illumination Engineering, (2e), Fairmont Press, INC 1997
3. Code of practice for interior illumination - IS 3646 (Part 1) 1992, IS 3646 (Part 2).
4. 1966, IS 3646 (Part 3) 1968.
5. Code of practice for road lighting - IS 1944 (Part 1 to 6)
6. Karlen, Mark, Christina Spangler, and James R. Benya, Lighting design basics. John Wiley & Sons, 2017.

**ELE 4068: SOLID STATE LIGHTING [2 1 0 3]**

General Characteristics of LEDs, Electrical and optical characteristics of high brightness LEDs, CIE Chromaticity coordinates, viewing angle, Binning, Mac dam ellipse, spectral tuning and optimization algorithms, Case study: Circadian rhythm, Daylight matching spectrum and its applications in healthcare - skin and Brain related therapies, Vitamin D synthesis, LED-on-the-Tip Endoscope, LEDs in Horticulture and Automotive lighting, LED drivers: power supply, dimming and controller, Thermal management and Heat sink design , lifetime and reliability.

**References:**

1. E Fred Schubert, Light emitting Diodes, Cambridge ,(2e), University press, 2006
2. Vinod Kumar Khanna, "Fundamentals of Solid state Lighting" CRC press, 2014

3. Arturas Zukauskus, Michael S. Shur and Remis Gaska, "Introduction to solid state lighting", wiley interscience 2002.
4. Gilbert Held, "Introduction to Light Emitting Diode Technology and Applications", CRC press, 2009
5. Mohan Underland and Robbins, "Power Electronic converters, Applications and Design", John Wiley and sons, 1989

**ICE 4055: ADVANCED SENSOR TECHNOLOGY [3 0 0 3]**

Sensor classifications, Advanced sensing materials, Properties of materials, Design and modeling issues, Fiber optic light propagation, Graded index fibers, Fiber optic communication driver circuits, Laser classifications, Driver circuits for solid state laser diodes, Radiation sensors and Optical combinations, Accelerometers, Thermal, Humidity and moisture sensor, Proximity detectors using polarized light, Semiconductor gas sensor, Fluidic and Micro-fluidic sensors, Gyroscope laser, Chemical sensor characteristics, Classification of Chemical sensing mechanism, Sensors based on direct and indirect sensing techniques.

**References:**

1. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, Springer, 2010.
2. P Ripka, A Tipek, Modern Sensors Handbook, Wiley Publication, 2007.
3. Sabaree Soloman, Sensors Hand Book, MGH, 1998.

**ICE 4056: MICRO ELECTROMECHANICAL SYSTEMS [3 0 0 3]**

Overview of MEMS and NEMS, scaling laws, Rigid-body dynamics, Electrostatic and electro-magnetic forces, Materials, Photolithography, Ion implantation, Diffusion, Oxidation, Chemical Vapor Deposition, Physical vapor Deposition-Sputtering, Deposition by epitaxy, Etching, Bulk Micro manufacturing, Surface Micromachining, LIGA process, Microsystem Design- Process design, Mechanical design, Introduction to computer aided design using COMSOL Multiphysics, Electrostatic sensors and actuation, Thermal sensing and actuation, Piezoelectric sensing and actuation, Microsystem Packaging-Types, Interfaces, Technologies, Selection, Design and packaging case study.

**References:**

1. Tai-Ran-Hsu, MEMS & Microsystems Design and Manufacture, TMH, 2002.
2. Chang Liu, Foundations of MEMS, Pearson International Edition, 2006.
3. Sergey Edward Lyshevski, MEMS and NEMS systems, Devices and Structures, CRC Press, 2002.
4. Stephen D. Senturia, Microsystem Design, Kluwer Academic Publishers, Springer, 2000.

**ICE 4057: MULTISENSOR DATA FUSION [3 0 0 3]**

Concept and role of fusion, Fusion types, Sensor configuration, Architecture of fusion nodes, Fusion topologies, Benefits of fusion, data refinement, Classification of data refinement, Spatial alignment, Temporal alignment, Semantic and radiometric alignment, Concept and need for data association and decision making, data registration, data association techniques, Decision making techniques, Information requirement for decision making. JDL framework, Revised JDL, Dasarathy's model, Thompolus framework, Luo-Key framework, Pau's framework, Waterfall and omnibus framework, distributed black box, Esteban framework, Kalman filter, Baysien filter, extended information filter, Estimation, Approximate agreement, Optimization filter, Distributed dynamic fusion, Dynamic data flow analysis.

**References:**

1. David L. Hall, *Mathematical Techniques in Multisensor Data Fusion*, Artech House, 2004.
2. H B Mitchell, *Data Fusion: Concepts and Ideas*, Springer Publishers, 2012.

**ICE 4058: SMART SENSOR [3 0 0 3]**

Introduction, Signal conditioning, Separate versus integrated signal conditioning, Digital conversion, MCU control, MCUs for sensor interface, Techniques and Systems Considerations for MCUs, DSP control, Sensor integration, IEEE standards, Plug and play, Automated/ Remote sensing, Process control over the Internet, Other communication standards with case studies, Wireless zone sensing, Surface acoustical wave devices, Intelligent transportation system, RF-ID, RF MEMS basics, Varactors, Micro optics, Micro grippers, Microprobes, Micro mirrors, FEDs, Data processing, Pattern recognition and classification, Centralized and decentralized system of the measurement chains.

**References:**

1. Gerard Merjer, *Smart Sensor Systems*, Wiley Publisher, 2008.
2. Randy Frank, *Understanding Smart Sensors*, Artech House Publications, 92e), 2000.
3. Paul W. Chapman, *Smart Sensors*, ISA Press, 1996.
4. Krzysztof Iniewski, *Smart Sensors for Industrial Applications*, CRC Press, 2013.

**ECE 4055: ADVANCED DIGITAL SIGNAL PROCESSING [2 1 0 3]**

Multi-rate systems, decimation and interpolation, interpolated FIR approach, poly phase filter structure, filter banks, perfect reconstruction, Principles and applications of adaptive filters, Weiner filters, steepest descent algorithm, LMS and RLS algorithms. Homomorphic system, cepstrum, homomorphic systems for convolution and de-convolution, applications of homomorphic signal processing. Stochastic models, Maximum likelihood, expected maximization, Bayesian estimation, random signal detection. Sparse representation, regularization, Total Variation, Compressed Sensing.

**References:**

1. P. P Vaidyanathan, *Multirate Systems and Filter Banks*, Prentice Hall, India, 1993.
2. Vikram M Gadre, Aditya S Abhyankar, *Multiresolution and Multirate Signal Processing: Introduction, Principles and Applications*, McGraw Hill, 2017.
3. S. J Orfanidis, *Optimum Signal Processing*, Mc Graw Hill, NJ, 2007.
4. A.V Oppenheim and R.W. Schafer, *Digital Signal Processing*, PHI Learning, 2008.
5. Russell B. Millar, *Maximum Likelihood Estimation and Inference*, John Wiley & Sons, Inc. 2011.

**ELE 4073: DIGITAL IMAGE PROCESSING [2 1 0 3]**

Image representation, relationship between pixels, Convolution and correlation. Unitary 2D transforms, DFT, DCT, subband coding, multiresolution analysis, DWT, contourlet transform, SVD. Intensity transformations, histogram processing, spatial and frequency domain filters, noise types, Wiener filter, local and nonlocal filtering, Boundary detection, canny edge detector, segmentation, Otsu's thresholding, image compression standards, Morphological operations and algorithms, Hit or Miss transform, colour image representation. Applications.

**References:**

1. S. Jayaraman, S. Esakkirajan, T. Veerakumar, *Digital Image Processing*, TMH, 2012.
2. Rafael C Gonzalez, Richard E Woods, *Digital Image Processing*, Pearson Education, 2nd Edition, 2003.
3. William K Pratt, *Digital Image Processing*, John Wiley, 2001.
4. Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis, and Machine Vision*, (4e) Cengage Learning.
5. A.K. Jain, *Fundamentals of Digital Image Processing*, PHI, New Delhi, 1995.

**ECE 4056: DIGITAL SPEECH PROCESSING [2 1 0 3]**

Anatomy, physiology and modeling of speech production system. Time and frequency domain analysis of speech. Cepstral analysis of speech and its applications. Linear predictive modeling of speech and its applications. Speech coding and synthesis, automatic speech recognition. Speech enhancement in the presence of noise.

**References:**

1. Rabiner L.R and Schaffer R.W, *Digital Processing of Speech Signals*, Prentice Hall, NJ, 2007.
2. Thomas F. Quatieri, *Discrete. Time Speech Signal Processing - Principles and Practice*, Pearson Education, Inc., 2004.
3. Douglas O' Shaughnessy, *Speech Communications: Human and Machine Reading*, Addison Wesley, 1987.
4. Shaila D. Apte, *Speech and Audio Processing*, Wiley India, 2012.
5. Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana, *Fundamentals of Speech Recognition*, Pearson, 2011.

**ELE 4074: LINEAR ALGEBRA FOR SIGNAL PROCESSING [2 1 0 3]**

Vectors, matrices, norms of vector and matrices, Lp norms, Holder, Cauchy - Schwarz, and triangular inequalities, inner product spaces and their applications. System of linear equations and its solution sets, Gaussian elimination and back-substitution, echelon forms, matrix operations, LU - factorization, inverse matrices, Gauss-Jordan technique, transpose, elimination, and permutation matrices. Row space, column space, and null space of a matrix, bases and dimension, rank and nullity of a matrix, matrices as linear transformations, pseudo-inverse and applications, change of basis, affine transformations. Orthogonal subspaces, projections, Gram-Schmidt process, generalized Fourier series, QR factorization, least squares and their applications. Characteristic equation, diagonalization, Jordan canonical form, special matrices, positive definite matrices and applications. Symmetric, Orthogonal, Hermitian, Unitary, Jacobian, and Hessian matrices, singular value decomposition and related applications.

**References:**

1. Gilbert Strang, *Linear Algebra and its Applications*, (3e), Thomson Learning Asia, 2003.
2. David C. Lay, *Linear Algebra and its Applications*, (3e), Pearson Education (Asia) Pvt. Ltd, 2005.
3. Kenneth Hoffman and Ray Kunze, *Linear Algebra*, (2e), PHI, 2004.
4. Sohail A Dianat and Eli Saber, *Advanced Linear Algebra for Engineers with MATLAB*, (1e), CRC Press.

**ECE 4061: ANALOG AND MIXED SIGNAL DESIGN [3 0 0 3]**

Analog circuit design issues, second order effects, current mirror circuits: Wilson, cascode and wide swing, voltage references, cascode and differential amplifier, Gilbert cell, operational transconductance amplifier, current conveyor, current feedback op-amp; Mixed signal circuit design: fully differential circuits, current mode signal processing,

OTA-C continuous-time filters, ladder filters, DAC architectures: current-mode R-2R, current steering and charge scaling. ADC, flash, successive approximation and noise shaping, Layouts, analog and mixed signal circuits.

**References:**

1. Johns D. A, Martin K, Analog Integrated Circuit Design, John Wiley and Sons, 2002.
2. Baker R. J., Li H W, Boyce D. E., CMOS Circuit Design, Layout, and Simulation, IEEE Press, PHI, 1998.
3. Razavi B., Design of Analog CMOS Integrated Circuits, Tata McGraw Hill, 2002.
4. Baker R. J., CMOS Mixed Signal Circuit Design, Volume II, Wiley Inter-science, 2002.
5. Mohan P. V. A., Current mode VLSI Analog Filters Design and Applications, Birkhauser, 2003.

**ECE 4062: DIGITAL DESIGN VERIFICATION [3 0 0 3]**

System Verilog: Introduction to System Verilog, Data types, scheduling semantics and assignment statements, Connecting test bench and DUT. Verification: Introduction, Verification Methodologies, Types of Verifications and approaches, Coverage-Driven functional verification, Assertion based verification (ABV), Verification Planning and Test Bench Architecture, System-Level Verification, Processor Integration Verification, Assertions for Formal tools.

**References:**

1. Padmanabhan T.R. and Sundari B.B.T., Design Through Verilog HDL, John Wiley & Sons, 2004.
2. Palnitkar S., Verilog@HDL. A Guide to Digital Design and Synthesis IEEE1361-2001 Compliant (2e), Prentice Hall, 2003.
3. Bhaskar J., A Verilog HDL Primer, BS Publications, 2005.
4. Brown S. and Vranesic Z., Fundamentals of Digital Logic with Verilog Design (5e), Tata McGraw Hill, 2005.
5. Ciletti M.D., Advanced Digital Design with the Verilog HDL, PHI, 2005.

**ECE 4063: LOW POWER VLSI DESIGN [3 0 0 3]**

Power dissipation in digital ICs, low power methodologies and their design, Impact of device technology and scaling on power, dynamic power reduction techniques, Sources of leakage current and techniques for leakage power reduction, power analysis and power estimation methods, switching activity reduction in CMOS circuits, Low power clock distribution techniques with zero or tolerable clock skew, Power and performance management, Circuit and system level architectures for low power, low power architectures for arithmetic and memory circuits.

**References:**

1. Yeap G. K., Practical Low Power Digital VLSI Design, KAP, 2002.
2. Piguet C., Low Power CMOS Circuits – Technology, Logic Design and CAD Tools, CRC Press, 2006.
3. Rabaey J. M, and Pedram M., Low Power Design Methodologies, Kluwer Academic, 1997.
4. Roy K. and Prasad S., Low Power CMOS VLSI Circuit Design, Wiley, 2000.
5. Yeo K. S., Rofail S. S. and Goh W. L., CMOS/BiCMOS ULSI: Low Voltage, Low Power, Pearson, 2002.

**ECE 4064: SEMICONDUCTOR DEVICE THEORY [3 0 0 3]**

Energy Bands in Solids, Electron and Hole Densities in Equilibrium, Excess carriers—Non-equilibrium Situation, Junctions and Interfaces,

Charge Transport in Semiconductors, P-N Junctions and its applications. Junction Field Effect Transistor and Metal-Semiconductor, MIS Junction/capacitor - ideal C-V characteristics and deviations due to interface states/charges and work function differences, threshold voltage. Field Effect Transistor, MOSFETs. - operation and characteristics.

**References:**

1. Achuthan M. K. and Bhat K. N., Fundamentals of Semiconductor Devices, Tata McGraw Hill, New Delhi, 2011.
2. Streetman B. G. and Banerjee S., Solid State Electronic Devices, PHI, New Delhi, 2011.
3. Gupta N.D and Gupta A.D, Semiconductor Devices. Modelling and Technology, PHI, New Delhi, 2004.

**ICE 4059: NEURAL NETWORK AND FUZZY LOGIC [3 0 0 3]**

McCulloch–Pitts model, Activation functions, Feedforward and feedback networks, Learning rules, Supervised Learning network, Multi-layer Feedforward Networks, Back propagation network, Unsupervised Learning network, Maxnet, Mexican Hat net, Kohonen self-organizing feature map, Vector quantization, Fuzzy sets, Membership functions, Fuzzification, Defuzzification methods, Fuzzy rule base and approximate reasoning, Fuzzy inference systems, Fuzzy logic control system, Applications.

**References:**

1. Laurence Fausett, Fundamentals of Neural networks, Architecture, Algorithm and Applications, Pearson Education India, 1st ed., 2004.
2. Timothy J. Ross, Fuzzy logic with engineering applications, John Wiley & Sons, 4th ed., 2016.
3. S. N. Sivanandan, S.N. Deepa, Principles of soft computing, Wiley India, 2010
4. B. Yegnanarayana, Artificial Neural Networks, PHI, 2004.

**ICE 4060: REAL TIME OPERATING SYSTEM [3 0 0 3]**

Real Time Concept, Real time tasks, Timing constraints, Threads and tasks, Scheduling, Rate monotonic algorithm, Memory management, Interrupt routines and handling of interrupt, Interrupt latency, OS security Issues, UNIX based RTOS, Windows as RTOS, POSIX, PSOS, VRTX, VxWorks, QNX, RT Linux, Windows CE, Real time communication: LAN, IEEE 802.5 protocol, Routing, Resource reservation, Traffic shaping and policing, Scheduling Mechanisms, QoS Models.

**References:**

1. Rajib Mall, Real-Time Systems: Theory and Practice, Pearson Education, 2006.
2. Jane W. S. Liu, Real Time Systems, Pearson Education, 2006.
3. Raj Kamal, Embedded Systems: Architecture, Programming and Design, TMH, (3e), 2014.

**ICE4061: DSP ALGORITHM AND ARCHITECTURE [3 0 0 3]**

Basic architectural features of DSP processors, Data addressing modes of TMS320C54XX, Memory space of TMS320C54XX, Program control, On-chip peripherals, Interrupts of TMS320C54XX Processors, Pipeline operation, Implementation of DSP Algorithms, Signal spectrum, Interfacing peripherals to DSP Devices, Memory interface, Parallel I/O interface, Programmed I/O, Direct memory access, Synchronous serial interface, Multichannel buffered serial port, Applications.

**References:**

1. Avatar Singh, S. Srinivasan, Digital Signal Processing Implementations: Using DSP Microprocessors with Examples from TMS320C54XX, Thomson/Brooks/Cole, 2004.
2. B. Venkataramani, M. Bhaskar, Digital Signal Processors: Architecture, Programming and Applications, TMH, 2002.
3. Sen-Maw Kuo, Woon-Seng Gan, Digital Signal Processors: Architectures, Implementations, and Applications, Pearson Prentice Hall, 2005.

**ICE 4062: ANALYTICAL AND OPTICAL INSTRUMENTATION [3 0 0 3]**

Spectroscopy, Radiation Sources, Monochromator, Optical Gratings, Optical Filters. Detectors, Sample Holders, UV/Visible/IR Spectrophotometers, Mass Spectrometers, X-Ray Spectrometers, Lasers, Interferometry, Interference effect, Radiometry, Interferometers-Michelson's, Fabry-perot, Sagnac, Refractometer, Rayleigh's interferometers, Holography, Fiber optics.

**References:**

1. R S Kandpur, Handbook of Analytical Instruments, TMH, (92e), 2003.
2. Willard, Merritt, Dean and Settle, Instrumental Methods of Analysis, CBS Publishers, (7e), 1988.
3. J. Wilson & J F B Hawkes, Opto Electronics: An Introduction, PHI, (2e), 1993.

**ICE 4063: AUTOMOTIVE ELECTRONICS [3 0 0 3]**

Spark and Compression Ignition Engine, Engine control functions, Fuel control, Automotive transmissions, Vehicle braking, Steering Control, Passenger Safety and Convenience occupant protection systems, Tire pressure monitoring system, Hybrid Vehicles, Sensors in airbag system, Chassis control systems, Electronic engine control system, Automotive communication protocols, Telematics, GPS and GPRS, Safety Systems, Electronic transmission checks and diagnosis.

**References:**

1. Ronald K Jurgen: "Automotive Electronics Handbook, MGH, (2e), 1999.
2. James D Halderman: "Automotive electricity and Electronics", PHI Publication (5e), 2016.
3. Terence Rybak, Mark Stefika: Automotive Electromagnetic Compatibility (EMC), Springer, 2004.

**ICE 4064: BIO-MEDICAL INSTRUMENTATION & EQUIPMENT'S [3 0 0 3]**

Biomedical transducers, Cardiovascular system, Electrocardiography, Central Nervous System and muscular system, Electroencephalography, Electromyography, Therapeutic equipment's and life saving devices, Blood flow meter, Oximeter, Plethysmography, Ultrasound therapy unit, Nerve stimulators, Pacemakers and defibrillators, Heart lung machine, Diathermy, Ventilator's, Spirometer, Oxygenators, Artificial kidney, Modern Imaging systems.

**References:**

1. R.S. Khandpur, "Handbook of Biomedical Instrumentation", MGH, (2e), 2008.
2. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, "Biomedical Instrumentations and Measurements", PHI, (2e), 2012.
3. J.G. Webster, "Medical instrumentation application & design", John Wiley and sons, 2003

**ICE 4065: DATA STRUCTURES USING C++ [3 0 0 3]**

Data Types, Operators, Manipulators, Decision statements, Programming control statements, Functions, Pointers, Classes, Constructors and Destructors, Operator overloading, Friend classes and functions. Inheritance, Templates, Linked List, Recursion, Trees, Queues, Sorting and searching algorithms.

**References:**

1. Nell Dale, "C++ Plus Data Structures", Jones and Bartlett Publishers, (4e), 2010.
2. Maria Litvin, Gary Litvin, Programming with C++ and Data Structures, Vikas Publishing House Pvt. Ltd., 2001.
3. E Balagurusamy, "Object-oriented Programming with C++", TMH, (2e), 2001.
4. Yashavant P Kanetkar, "Let us C++", BPB Publications, 2003.

**ICE 4066: CYBER PHYSICAL SYSTEMS [3 0 0 3]**

Synchronization in complex systems, Graph theory, Leader and leaderless cases, Motion invariants for first-order consensus, Lyapunov techniques for control, Potential fields and Motion control, Pinning control, Cooperative optimal control. Stability and optimality, Adaptive tuning laws, Impulsive systems, Safety of execution of CPS, Scheduling, Hybrid dynamical models, Hybrid automata, Deployment, Task mapping and partitioning, State estimation for attack detection, Automotive case study.

**References:**

1. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
2. E. A. Lee, Sanjit Seshia, Introduction to Embedded Systems – A Cyber-Physical Systems Approach, MIT Press, (2e), 2017.
3. Andre Platzer, Logical Foundations of Cyber-Physical Systems, (2e), Springer Publishing, 2018

**ICE 4067: POWER ELECTRONICS [3 0 0 3]**

Power Diodes, SCR, Gate Trigger Circuits of SCR, Traic, GTO, BJT, Power MOSFET, IGBT, DC Motor Drives, Battery chargers, HVDC transmission, Single phase fully controlled AC to DC converter, Snubber Single phase half controlled converter, Three phase half wave AC to DC converter, Three phase fully controlled ac to dc converter, Inverter mode of operation, Constraints of commutation in inverter mode, Effect of source inductance, Single phase unity power factor converter, DC- DC Power Converters, Switched Power supplies, DC-AC Power Converters, Three phase inverters, Line commuted inverters.

**References:**

1. Ned Mohan, Undeland, Robbins, Power Electronics, John Wiley, (3e), 2002.
2. M. H. Rashid, Power Electronics, PHI, (3e), 2004.
3. Bimbhra P.S, Power Electronics, Khanna Publication, (3e), 1999.
4. M. Ramamurthy, Thyristors and their Application, East-West Press, 1977.

**ICE 4068: ROBOTICS [3 0 0 3]**

Degrees of Freedom, Kinematics of Manipulators, Differential motions, Linear and angular velocity of a rigid body, Dynamics of Manipulators, Trajectory planning, Joint Space and Cartesian Space, Control schemes for robot manipulators: PID, State Feedback, Force control, Hybrid force control, Position controller.

**References:**

1. Mark. W. Spong, Robotics Dynamics and Control, Wiley, (1e), 1989.
2. John. J. Craig, Introduction to robotics – Mechanics and Control, Pearson Education, (4e), 2017.

**ICE 4069: RELIABILITY AND SAFETY ENGINEERING [3 0 0 3]**

Sampling distributions, Testing of hypotheses, Failure data, Failure modes, Hazard rates and failure density function, Hazard models and bath-tub curve, Reliability of systems, Redundancy, Reliability improvement methods, Reliability Tests, Component reliability and MIL standards, Safety policy, Safety Organization, Measurement and prediction of human reliability and operator training, Safety margins in critical devices, Incident Recall Technique, Disaster control, Job Safety Analysis, Safety Audit.

**References:**

1. Govil, A.K., Reliability Engineering, TMH, 1983.
2. Sinha and Kale, Introduction to Life-Testing, Wiley Eastern, New Delhi, 1992.
3. Wisley, Human Engineering - Guide for Equipment Designers, University of California Press, 1973.
4. Hoang Pham, Hand book of Reliability Engineering, Springer, 2003.
5. Krishnan N.V, Safety Management in Industry, Jaico Publishing House, Bombay, 1997.

**ICE 4070: WIRELESS SENSOR TECHNOLOGY [3 0 0 3]**

Single-Node Architecture, Energy Consumption, Operating Systems and Execution, Optimization Goals and figures of merit, Gateway Concepts, Networking sensors, WSN protocols, Wakeup Radio Concepts, Address and Name Management, Routing Protocols, Time Synchronization, Localization and Positioning, Sensor Tasking and Control, Sensor Node Hardware, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

**References:**

1. Holger Karl & Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley, 2012.
2. Feng Zhao & Leonidas J. Guibas, Wireless Sensor Networks- An Information Processing Approach, Elsevier, 2007.
3. Kazem Sohraby, Daniel Minoli, & Taieb Znati, Wireless Sensor Networks - Technology, Protocols, And Applications, John Wiley, 2007.

**ICE 4071 INDUSTRIAL INTERNET OF THINGS [3 0 0 3]**

IOT-Introduction, Architecture, Components, Categories, Challenges. Device to Internet Service Connection, Modem, Router, Gateways, Message Queuing Telemetry Transport, Constrained Application Protocol, Message Queuing Protocol, Basics of Cloud services, IEEE 802.15.4, IPv6, Bluetooth, Zigbee, Smart HOME, Smart Grid, Industrial Internet of Things (IIoT), Architecture, Function of IIoT, components, Connecting Microcontroller to Cloud Service.

**Reference Books:**

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2018
2. Qusay F. Hassan, "Internet of Things A to Z: Technologies and Applications", Wiley, 2018.
3. Arshdeep Bahga and Vijay Madiseti, "Internet of Things: A Hands-on Approach", Universities Press, 2014
4. Nasreddine Bouhai, "Internet of Things: Evolutions and Innovations", Wiley, 2017

5. Cuno Pfister, "Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud", O'Reilly Media, 2011

**OPEN ELECTIVES****ICE 4301: FEEDBACK CONTROL THEORY [3 0 0 3]**

Feedback control systems, Mathematical modeling, Derivation of transfer functions for electrical networks, Mechanical systems, Signal flow graph, Mason's gain formula, State variable representation of linear systems, Solution of state equations, Time domain specifications for second order systems, Steady state errors of unity feedback systems, Definitions of stability, Routh Hurwitz criterion, Frequency response - gain margin, phase margin.

**References:**

1. Nagrath and Gopal, Control Systems Engineering, New age international Limited, (2e), 1984.
2. Norman S. Nise, Control Systems Engineering, (5e), Wiley India, 2009.
3. R.C Dorf and R.H Bishop, Modern Control Systems, (11e), Addison-Wesley Longman Inc., 2013.

**ICE 4302: INDUSTRIAL AUTOMATION [3 0 0 3]**

Evolution of PLC, PLC Vs PC, Architecture of PLC - I/O Modules, CPU, Program Memory, Process Image Tables, Bus System and Power Supply, Sequential Flow Chart technique for programming style, Programming a PLC, Timers & Counters, Special Instructions, Levels of Industrial control, Networking, Buses Networks, Protocols., SCADA & DCS, Profibus, Modbus, SMART devices.

**References:**

1. John W. Webb and Ronald A. Reis, Programmable Logic Controllers – Principles and Applications, (5e), PHI, 2003.
2. W. Bolton, Programmable Logic Controllers, (94e), Newnes Publications, 2006.
3. Frank D. Petruzella, Programmable Logic Controllers, MGH, 1989.

**ICE 4303: INDUSTRIAL INSTRUMENTATION [3 0 0 3]**

Measurement System, Classification of transducers, Temperature and Pressure measurement, Level and Thickness measurement, Flow measurement-Variable head type, variable area type, Mass flowmeters, Measurement of Thermal conductivity, velocity, acceleration, pH and Force, Semiconductor sensors, Optical sensors.

**References:**

1. E.O. Doebelin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.
2. Patranabis D, Principles of Industrial Instrumentation, TMH, (3e), 2005.
3. A. K. Sawhney, A course in Mechanical Measurement and Instrumentation, (7e), Dhanpat Rai and Co, 2002.

**ICE 4304: SENSOR TECHNOLOGY [3 0 0 3]**

Basic sensor technology, characteristics, Capacitive and Inductive Sensors, Displacement Sensors, Temperature Sensors, Force/Torque Sensors, Humidity and Moisture Sensors, Acoustic Sensors, Flow Sensors, Occupancy-Motion Detectors, Acceleration and Vibration Sensors, Chemical and Biosensors, Optical and radiations Sensors, Introduction to Wireless Sensor Networks (WSN) and Applications.

**References:**

1. Jon S Wilson, Sensor Technology Handbook, Newnes Elsevier Publication, 2005.
2. Jacob Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, Springer, 2004.

### ICE 4305: SMART SENSOR [3 0 0 3]

MCUs and DSPs, integrated signal conditioning, IEEE1451 standards, Plug and play, Sensor Communication, Wireless zone sensing, Surface acoustical wave devices, Intelligent transportation system, RF-ID, RF MEMS basics, Micro optics, Micro grippers, Microprobes, Micro mirrors, FEDs, Centralized and decentralized measurement chains, Intelligent sensors, Nanosensors, Biosensors

#### References:

1. Randy Frank, Understanding Smart Sensors, (2e), Artech House Publications, 2000.
2. Paul W. Chapman, Smart Sensors, ISA Press, 1996.
3. Krzysztof Iniewski, Smart Sensors for Industrial Applications, CRC Press, 2013.

### ICE 4306: VIRTUAL INSTRUMENTATION [3 0 0 3]

Architecture of a virtual instrument, Virtual instruments V/s Traditional instruments, Advantages of VI, Graphical programming, Creating Virtual Instruments using LabVIEW-Loops, Arrays, Clusters, String and file I/O, Graphs, Data Acquisition, Common Instrument Interfaces, Current loop, System buses, Interface buses, VISA, Image acquisition and processing, Design of ON/OFF controller for a mathematically described processes using VI software

#### References:

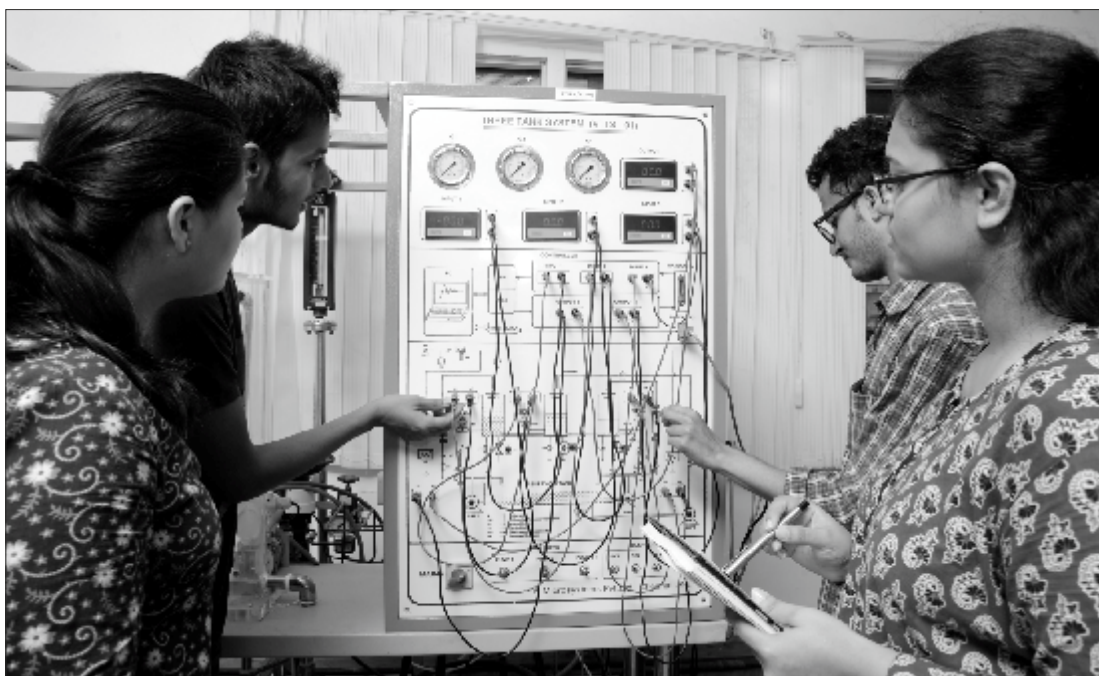
1. Gary Johnson, LabVIEW Graphical Programming, (2e), MGH, 1997.
2. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, National Instruments, 1997.
3. S. Sumathi, P Surekha, LabVIEW based Advanced Instrumentation systems, Springer, 2007.
4. Rick Bitter, Taqi Mohiuddin, Matt Nawrocki, LabVIEW Advanced Programming Techniques, CRC Press, 2007.
5. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2010.

### ICE 4307: FARM AUTOMATION [3 0 0 3]

Farm mechanization, sources of farm power, renewable energy sources, IC engines, tillage, sowing, plant protection, intercultural operations, harvesting, threshing, biomass management techniques, Watershed concept and theory, soil erosion, measures, hydrological cycle, irrigation methods, devices, Water conveyance systems, Water harvesting, aquifer and its types, interaction of water resources with the changing environment, Engineering properties of biological materials, heat and mass transfer, devices for cleaning, grading, milling and storage of farm produce. Drying and dehydration, function and features of green house, Resource conservation management, precision farming, automated irrigation scheduling, variable rate seed and chemical applicators, robotics, Rainfall-runoff prediction models, watershed modeling, climate change impact analysis on bio-resources, drying characteristics, storage or process kinetics, simulation and modeling in tillage implements.

#### References :

1. Elements of Agricultural Engineering, Jagdshwar Sahay, Standard Publishers Distributors.
2. Principles of Agricultural Engineering, Vol I & II. A. M. Michael & T. P. Ojha, Jain Brothers.
3. Unit operations of Agricultural Processing, K M Sahay, K. K. Singh, Vikas Publishing House Pvt Ltd
4. Robotics & Automation in the food Industries (Current & Future Technologies), Da-Wen Sun, Wood Head Publishing Ltd, Oxford.
5. Remote Sensing and Geographical Information System, A. M. Chandra, S. K. Ghosh, Alpha Science.



## **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 Be Door, *Introduction to Numerical analysis*, McGraw Hill.

**MAT 5304: MATHEMATICAL MODELLING [2 1 0 3]**

Introduction, Techniques, classification and characteristics of mathematical models, mathematical modeling through algebra, ordinary differential equations of first order. Mathematical modeling through systems of ordinary differential equations of first order, Prey- Predator model Mathematical modeling through systems of ordinary differential equations, modeling in medicine A model for diabetic mellitus. Modelling

on population dynamics Mathematical modelling through difference equations. Some simple models. Modelling of economics and finance through difference equations, population dynamics and generation of models through difference equations, modeling in probability theory, examples. Optimization models: Mathematical modeling through linear programming. Mathematical modelling through graphs: elements of graphs, digraphs. Mathematical models for blood flow. Mathematical model for Peristaltic transport of two layered.

**References:**

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

**MAT 5305: OPTIMIZATION TECHNIQUES [2 1 0 3]**

Formulation, Linear programming-simplex method, Penalty 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 – Unlenbeck 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.
- B. Bhushan ed., "Springer Handbook of Nanotechnology", Springer Publishers, Berlin, 2004.

### **OPEN ELECTIVES**

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

Spectroscopic methods of analysis: Properties of EMR, General features of spectroscopy, Types of molecular spectra, Interaction of EMR with matter, Instrumentation, Applications, Theory, Instrumentation and applications of Microwave, Raman, Infrared, UV-Visible, NMR spectroscopic techniques. Chromatographic Techniques: General

concepts, Classification, Principles, Experimental techniques of CC, HPLC, TLC, GC and their applications. Electroanalytical methods: Basic principles and applications of conductometric, potentiometric titrations.

#### **References:**

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

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

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

#### **References:**

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

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

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

#### **References:**

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