

**B TECH in ELECTRICAL & ELECTRONICS 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								
	ELE 2151	Analog System Design	3	1	0	4	ELE 2251	Electrical Machinery – II	2	1	0	3								
	ELE 2152	Digital System Design	3	1	0	4	ELE 2252	Generation Transmission & Distribution	3	1	0	4								
	ELE 2153	Electrical Circuit Analysis	3	1	0	4	ELE 2253	Linear Control Theory	3	1	0	4								
	ELE 2154	Electrical Machinery – I	2	1	0	3	ELE 2254	Microcontrollers	3	1	0	4								
	ELE 2155	Electromagnetic Theory	3	1	0	4	*** ****	Open elective - I				3								
	ELE 2161	Analog System Design Lab	0	0	3	1	ELE 2261	Electrical Machinery Lab	0	0	6	2								
ELE 2162	Digital System Design Lab	0	0	3	1	ELE 2262	Microcontroller Lab	0	0	3	1									
			<b>16</b>	<b>6</b>	<b>6</b>	<b>24</b>			<b>13</b>	<b>5</b>	<b>9</b>	<b>24</b>								
	<b>Total Contact Hours (L + T + P)</b>						<b>28</b>	<b>Total Contact Hours (L + T + P) + OE</b>						<b>27 + 3 = 30</b>						
	<b>FIFTH SEMESTER</b>										<b>SIXTH SEMESTER</b>									
III	HUM 3152	Essentials of Management	2	1	0	3	HUM 3151	Engg Economics and Financial Management	2	1	0	3								
	ELE 3151	Communication Systems	4	0	0	4	ELE 3251	Power Electronics	3	1	0	4								
	ELE 3152	Digital Signal Processing	3	1	0	4	ELE 3252	Switch Gear & Protection	4	0	0	4								
	ELE 3153	Measurements & Instrumentation	2	1	0	3	ELE ****	Program Elective -I	2	1	0	3								
	ELE 3154	Power System Analysis	3	1	0	4	ELE ****	Program Elective -II	2	1	0	3								
	*** ****	Open elective -II				3	*** ****	Open Elective - III				3								
	ELE 3161	DSP Lab	0	0	3	1	ELE 3261	Power Electronics Lab	0	0	6	2								
ELE 3162	Measurements & Instrumentation Lab	0	0	3	1	ELE 3262	Power Systems Lab	0	0	6	2									
			<b>14</b>	<b>4</b>	<b>6</b>	<b>23</b>			<b>13</b>	<b>4</b>	<b>12</b>	<b>24</b>								
	<b>Total Contact Hours (L + T + P) + OE</b>						<b>24 + 3 = 27</b>	<b>Total Contact Hours (L + T + P) + OE</b>						<b>29 + 3 = 32</b>						
	<b>SEVENTH SEMESTER</b>										<b>EIGHTH SEMESTER</b>									
IV	ELE ****	Program Elective – III	3	0	0	3	ELE 4298	Industrial Training				1								
	ELE ****	Program Elective – IV	3	0	0	3	ELE 4299	Project Work/Practice School				12								
	ELE ****	Program Elective – V	3	0	0	3	ELE 4296	Project Work (Only for B.Tech honour Students)				20								
	ELE ****	Program Elective – VI	3	0	0	3														
	ELE ****	Program Elective – VII	3	0	0	3														
*** ****	Open Elective – IV				3															
			<b>15</b>	<b>0</b>	<b>0</b>	<b>18</b>						<b>13</b>								
	<b>Total Contact Hours (L + T + P) + OE</b>						<b>15 + 3 = 18</b>	<b>Total Contact Hours (L + T + P) + OE</b>												

## **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. Power & Energy Systems**

ELE 4069: Distributed Generation Systems  
ELE 4070: Energy Storage Devices  
ELE 4071: Power System Operation & Control  
ELE 4072: Smart Grid Technologies

### **VI. Sensor Technology**

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

### **VII. 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

### **VIII. VLSI Design**

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

### **IX. 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

## **X. Business Management**

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

## **XI. 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**

ELE 4075: Computer Networks  
ELE 4076: Control System Design  
ELE 4077: Data Analytics  
ELE 4078: Data structures & Algorithms  
ELE 4079: Database Management Systems  
ELE 4080: Design & Modelling of Special Electrical Machines  
ELE 4081: Digital System Design using Verilog  
ELE 4082: Energy Auditing  
ELE 4083: HVDC & FACTS  
ELE 4084: Introduction to Electric Vehicles  
ELE 4085: Modern Power Converters  
ELE 4086: Renewable Energy  
ELE 4087: Solar Photovoltaics  
ELE 4088: Solid State Drives

## **Open Electives**

ELE 4301: Energy Auditing  
ELE 4302: Introduction to Lighting Design  
ELE 4303: MATLAB for Engineers  
ELE 4304: Solar Photovoltaics

### THIRD SEMESTER

#### **MAT 2152: ENGINEERING MATHEMATICS – III [2 1 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(43e), Khanna Publishers, 2015.
2. Erwin Kreyszig: Advanced Engg. Mathematics(10e), Wiley Eastern, 2015.
3. Gerald and Wheatley , Applied Numerical Analysis(7e) , Pearson education India, 2007.
4. Murray R. Spiegel: Vector Analysis., Schaum Publishing Co, 1959.
5. Narayanan, Ramaniah and Manicavachagom Pillay, Advanced Engineering Mathematics, Vol 2 and 3, Vishwanth Publishers Pvt Ltd. 1998.

#### **ELE 2151: ANALOG SYSTEM DESIGN [3 1 0 4]**

MOSFET Characteristics, structure, biasing, current mirrors, Basic Amplifier Configurations. CS, CD, CG configurations, small signal model, frequency response, high frequency model. Large signal amplifiers, different types, Basic Differential amplifier, common mode and difference mode signals, OPAMP configuration, OPAMP in linear Mode, follower property and inversion property, OPAMP with positive and negative feedback, Linear applications of OPAMP, Nonlinear applications of OPAMP, 555 timer

#### **References:**

1. Behzad Razavi., Fundamentals of microelectronics, (2e), Wiley Publishers, 2013.
2. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, (4e). McGraw-Hill series, 2014.
3. Adel S. Sedra, Kenneth C. Smith, Arun N. Chandorkar, Microelectronic Circuits: Theory and Application(6e), Oxford, 2017.
4. Robert. F. Coughlin & Fredrick F. Driscoll, Operational Amplifiers and Linear Integrated Circuits (2e), PHI/Pearson, 2009.
5. James M. Fiore, Op - Amps and Linear Integrated Circuits, Thomson Learning, 2010.

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

Overview of Algebraic simplification of Boolean expressions, realization using logic gates, minimization using Karnaugh map. Minimization using variable entered maps, Quine -McCluskey algorithm. Combinational circuit design using MSI chips, Arithmetic circuits. Logic families and their characteristics. Sequential logic circuits: Overview of flipflops. Counters, shift registers, shift register counters, ring counter, twisted ring counter. Analysis and design of synchronous sequential finite state machines, ASM charts. Digital System Implementation Options.

#### **References:**

1. Wakerly, Digital Design Principles & Practices, Pearson 2003.
2. Givone, Digital Principles & Design, TMH 2011.
3. Leach D. P. & A. P. Malvino, Digital Principles and Applications, MGH, 2008.
4. Roth C. H., Fundamentals of logic design, Jaico, 2007.
5. Morris Mano, Digital Design, Pearson, 2008.

#### **ELE 2153: ELECTRICAL CIRCUIT ANALYSIS [3 1 0 4]**

Controlled sources, Superposition, Thevenin's, Nortons and Maximum power transfer theorems, Signals, Odd and even components, Continuous time step, ramp and impulse signals, impulse response, convolution, Causality, LTI systems, Time domain analysis, Initial and final conditions, Transients analysis of RL, RC and RLC circuits, Laplace domain analysis, Laplace Transforms of signals, Transformed circuits, Analysis of networks using Laplace Transforms, Frequency domain analysis, Fourier series representation, Fourier transforms of signals, Parseval's theorem, Two port networks, Z, Y, T and h parameters, Relation between parameters, Series, parallel and cascade connections.

#### **References:**

1. Hayt W. H., J. E. Kemmerly & S. M. Durbin, Engineering Circuit Analysis(7e), TMH, 2010.
2. Van Valkenberg, Network Analysis(3e), PHI, 2009.
3. Nilsson J. W. & S. A. Reidel, Electric Circuits(9e), PH, 2011.
4. Haykin S., Signals and Systems, Wiley, 1999.
5. Oppenheim, Willisky, and Nawab, Signals and Systems (2e), PHI, 1997.

#### **ELE 2154: ELECTRICAL MACHINERY – I [2 1 0 3]**

Transformers: Types of transformers; Single phase transformers - working principle, construction, phasor diagram, equivalent circuit, voltage regulation, losses and efficiency, energy efficiency, testing, parallel operation, inrush current, harmonics, tap changing, auto transformer. Three phase transformers: Connections: star – star, star-delta, delta – star, delta-delta, zigzag, open delta; three winding transformer. Induction Machines: Three phase Induction motor, types, construction, rotating magnetic field, working principle, armature winding, equivalent circuit, losses and efficiency, torque-slip characteristics, tests – no load & blocked rotor, starting, braking, speed control, Deep bar and double cage induction motors, Induction generator, Single phase induction motor – types, double field revolving theory, torque-slip characteristics. DC Machines: DC generators – working principle, construction, types, armature winding, Magnetization characteristics, armature reaction, commutation, load characteristics.

#### **References:**

1. Langsdorf E.H., Theory of Alternating Current Machinery (2e), TMH, 2004.
2. Say M. G., Alternating Current Machines (5e), ELBS, 1994.
3. Clayton A. E. & Hancock N. N., Performance and Design of Direct Current Machines, CBS, 2004.
4. Kothari D. P. & Nagrath I. J., Electric Machines (4e), TMH, 2013.

#### **ELE 2155: ELECTROMAGNETIC THEORY [3 1 0 4]**

Vector analysis: Vector algebra, Rectangular, Cylindrical and Spherical Coordinates, Electrostatics: Field intensity, Flux density, Boundary conditions, Capacitance, Laplace's and Poisson's equations, Magnetostatics: Field intensity, Flux density, Boundary conditions, Magnetic forces, Inductance, Time varying fields: Maxwell's equations, Uniform Plane wave: Wave equation and its solution, Wave propagation in different media, Poynting's theorem

**References:**

1. William Hayt, Engineering Electromagnetics, TMH, 1993.
2. Mathew Sadiku, Elements of Electromagnetics, Oxford University Press, 2000.
3. Narayana Rao, Elements of Engineering Electromagnetics, Pearson Education, 2006.
4. Kraus.J.D, Electromagnetics, MGH, 1992.
5. Harishankar Ramachandran, Electromagnetic Fields, NPTEL, December 2009.
6. <http://nptel.ac.in/courses/108106073/>

**ELE 2161: ANALOG SYSTEM DESIGN LAB [0 0 3 1]**

Module I: Design, Simulate and Test basic analog electronic circuits using diodes, Rectifiers without and with capacitor filter, Fixed and variable voltage power supplies, Zener diodes, voltage regulators, MOSFET biasing and current mirror circuits, Frequency response of Amplifier Circuits, Power amplifiers, Differential amplifier circuit.

Module II: Design, Simulation and Testing of operational amplifier based circuits in linear and nonlinear mode, Timer based Mono-stable and Astable-Multivibrators circuits.

**References:**

1. Behzad Razavi, Fundamentals of Microelectronics (2e), Wiley Publishers, 2013.
2. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits (4e), McGraw-Hill series, 2014.
3. Adel S. Sedra, Kenneth C. Smith, Arun N. Chandorkar, Microelectronic Circuits: Theory and Application (6e), Oxford, 2017.

**ELE 2162: DIGITAL SYSTEM DESIGN LAB [0 0 3 1]**

Design and Testing of combinational circuits using gates, multiplexers, decoders, arithmetic circuits etc., Design and Testing of sequential digital electronic circuits such as counters, shift registers & sequence generators, sequence detectors etc..

**References:**

1. Givone, Digital Principles & Design, TMH 2011.
2. Wakerly, Digital Design Principles & Practices, Pearson 2003.
3. Roth C. H., Fundamentals of logic design, Jaico, 2007.
4. Stephen Brown/Zvonko Vranesic, Fundamentals of Digital logic with Verilog design, TMH, 2008.

**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 (10e), Wiley Eastern, 2015.
3. A.V.Openheim & R.W.Schafer, Digital Signal Processing, Prentice Hall, 1975.
4. Hogg & Craig, Introduction to Mathematical Statistics, (4e), MacMillan, 1975.
5. Narayanan, Ramaniah and Manicavachagom Pillay, Advanced Engineering Mathematics, Vol 2 and 3, Vishwanth Publishers Pvt Ltd. 1998.

**ELE 2251: ELECTRICAL MACHINERY – II [2 1 0 3]**

DC Machines: DC Motors – working principle, types, torque-speed characteristics, starting, braking, speed control, losses, efficiency, and testing. BLDC motors – working principle and control. Synchronous Machines: Alternators – working principle, types, construction, armature windings, emf equation, Field MMF, Modelling of non-salient pole alternator, Phasor diagrams, voltage regulation, Synchronization, Synchronizing power and torque, power angle characteristics, Load sharing, Alternator connected to infinite bus, Modelling of salient pole alternator - Two reaction theory, Phasor diagrams, slip test. Synchronizing power and torque, power angle characteristics. Synchronous motors: working principle, Starting methods, Synchronizing power and torque, Performance characteristics, Hunting, Synchronous condenser. PMSM, SRM – operation & control. Load characteristics, Selection of motors for specific applications.

**References:**

1. Langsdorf E.H., Theory of Alternating Current Machinery (2e), TMH, 2004.
2. Say M. G., Alternating Current Machines (5e), ELBS, 1994.
3. Clayton A. E. & Hancock N. N., Performance and Design of Direct Current Machines, CBS, 2004.
4. Kothari D. P. & Nagrath I. J., Electric Machines (4e), TMH, 2013.
5. Krishnan R., Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press, 2009.
6. Dubey G. K., Fundamentals of Electric Drives (2e), CRC Press, 2002.

**ELE 2252: GENERATION TRANSMISSION & DISTRIBUTION [3 1 0 4]**

Introduction, General layout of a power system, renewable and non renewable power generation, computation of line parameters for single phase and three phase, line performance, need for reactive power compensation, mechanical design of lines, sag and tension calculation, overhead insulators, underground cables, corona, distribution schemes, reliability indices, introduction to LVDC.

**References:**

1. J. Duncan Glover, Mulukutla S Sarma and Thomas J Overbye, Power System Analysis and Design, (5e), Cengage Learning, 2012.
2. S.N. Singh, Electric Power Generation, Transmission & Distribution (6e), PHI, 2011.
3. Kothari & Nagrath, Power System Engineering (2e), TMH, 2010.
4. Nag P K, Power plant engineering, Tata McGraw Hill, 2005.
5. Wadhwa, Electrical Power System (3e), New Age Intl, 2013.

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

Classification of control systems, Mathematical modelling of electrical circuits/mechanical systems (translational & rotary)/electro-mechanical systems/geared systems, reduction of sub-systems, signal flow graphs, Time domain response of 1st and 2nd order systems, RH criteria, Root Locus technique, Bode plots, Nyquist Plots, Frequency domain based compensator design and their realization through OPAMPS, Design/realization of active P, PI, PID controllers for LTI systems, State equation, state space modelling, Physical variable form of electrical/mechanical/ electromechanical systems, Phase variable form of electrical/ mechanical/ electromechanical systems, State space models from transfer function, Solution of state equation for continuous time system, State transition matrix, Controllability criteria, Observability criteria.

#### **References:**

1. Norman S. Nise, Control Systems Engineering, John Wiley & Sons, Inc, 2010.
2. Ogata K, Modern Control Engineering, Englewood Cliffs, NJ: Prentice Hall, 2010.
3. Gopal M., Control Systems: Principles and Design, McGraw Hill, 2008.
4. S.D. Agashe, Control Engineering, NPTEL, December 2009. <http://nptel.ac.in/courses/108101037/>
5. Dynamic Systems and Control, 241J, MIT Open CourseWare, Spring 2011.
6. <http://ocw.mit.edu/courses/electricalengineering-and-computer-science/6-241j-dynamic-systems-and-control-spring-2011>

### **ELE 2254: MICROCONTROLLERS [3 1 0 4]**

Introduction to microprocessors and microcontrollers, general purpose and embedded systems. CISC and RISC architectures, AT89C51 (8051) microcontroller: Architecture, pin diagram, addressing modes, instruction set, programming, stack, subroutines, GPIO, timers, serial port, interrupts. Interfacing keyboard, LCD, ADC and DAC to 8051. Embedded software development in 'C'. Programming 8051 in 'C'. ARM processors: ARM7TDMI; Processor modes, visible registers, ARM instruction set, programming, stack, subroutine, exceptions and pipelined architecture. ARM7 based NXPLPC21XX microcontroller: architecture, programming, interfacing. Introduction to ARM CORTEX processors and Microcontrollers.

#### **References:**

1. Muhammad Ali Mazidi and GillispieMazidi, The 8051 Microcontroller and embedded systems, using assembly and 'C', Pearson education, 2013.
2. Kenneth. J. Ayala, The 8051 Microcontroller and embedded systems, using assembly and 'C', Cengage Learning, 2009.
3. Steve Furber, ARM System - on - Chip Architecture (2e), Pearson, 2015.
4. William Hohl, Hinds Christopher, ARM Assembly Language, CRC Press, 2016.
5. Jonathan M Valvano, Introduction to ARM CORTEX – M Microcontrollers, Volume 1, 2017.

### **ELE 2261: ELECTRICAL MACHINERY LAB [0 0 6 2]**

Transformers: OC and SC tests on single phase transformer; Sumpner's test; Polarity tests and connection of single phase transformers as three phase bank; Parallel operation of single phase transformers. Induction machines: No load and blocked rotor tests, Load test on three phase

squirrel cage & Slip ring Induction motor, Load test on induction generator. Load test on Single Phase induction Motor. DC Machines: Magnetisation characteristics of DC generator, Load test on dc machines, Speed control of D.C. shunt motor. Testing of DC Machines, Synchronous Machines: V- and inverted V-curves of synchronous machines, Measurement of Xd and Xq of a salient pole synchronous machine, Predetermination of regulation of alternator. Armature winding: Design & Development of AC & DC armature winding.

#### **References:**

1. Langsdorf E.H., Theory of Alternating Current Machinery (2e), TMH, 2004.
2. Say M. G., Alternating Current Machines (5e), ELBS, 1994.
3. Clayton A. E. & Hancock N. N., Performance and Design of Direct Current Machines, CBS, 2004.
4. Kothari D. P. & Nagrath I. J., Electric Machines (4e), TMH, 2013.
5. Shawney A. K., Design of Electrical Machines, DhanpatRai, 1997.

### **ELE 2262: MICROCONTROLLER LAB [0 0 3 1]**

Module I: Experiments using 8051 Microcontroller simulator.

Module II: Interfacing exercises using 8051 microcontroller

Module III: Experiments using ARM7 processor based microcontroller.

#### **References**

1. Muhammad Ali Mazidi and GillispieMazidi, The 8051 Microcontroller and embedded systems, using assembly and 'C', Pearson education, 2013.
2. Kenneth. J. Ayala, The 8051 Microcontroller and embedded systems, using assembly and 'C', Cengage Learning, 2009.
3. Steve Furber, ARM System - on - Chip Architecture (2e), Pearson 2016.
4. LPC21XX User Manual.

## **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 departmentation, Line & Staff concepts, Functional authority, Art of delegation, Decentralisation of authority. HR planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership- leadership behaviour & styles, Managerial grid. Basic control process, Critical control points & standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA, Application of Theory Z. The nature & purpose of international business & multinational corporations, Unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections

#### **References:**

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

### **ELE 3151: COMMUNICATION SYSTEMS [4 0 0 4]**

Elements of communication systems; Analog Communication techniques : Amplitude modulation Schemes, Angle (Non-Linear) Modulation; Pulse Modulation schemes ; Data transmission using analog carriers- Shift Keying techniques; Channel Encoding & decoding technologies; Conceptual idea of encryption & decryption; Communication Protocols & Networking; Internet of Things; Wireless sensor actuator networks, Applications: Spread Spectrum & Mobile Communications - Optical fiber communication- Digital telephony , Basic principles of Digital TV Broadcasting

#### **References:**

1. Haykin, Simon, and Michael Moher, Introduction to analog & digital communications, John Wiley & Sons. 2007.
2. Haykin, Simon, Communication systems, John Wiley & Sons, 2008.
3. Stallings, William, Cryptography and network security: principles and practices, Pearson Education India, 2006.
4. Torrieri, Don, Principles of spread-spectrum communication systems, Springer, 2015.
5. Rappaport, Theodore S., Wireless communications: principles and practice, Vol. 2. New Jersey: prentice hall PTR, 1996.

### **ELE 3152: DIGITAL SIGNAL PROCESSING [3 1 0 4]**

Time domain analysis of discrete-time signals & systems: linear-time invariant systems, impulse response, convolution, causality and stability, representation of LTI systems, Frequency domain analysis of discrete-time signals and systems: Discrete-time Fourier series, Discrete-time Fourier transform, properties and applications, Z transform representation of discrete time signals and systems, properties and applications. Sampling in time and frequency domain. Discrete Fourier Transform-Linear convolution using DFT. Computation of DFT-Fast Fourier Transform, Decimation in time and Decimation in frequency FFT algorithms. Digital Filters-Digital filter structures, FIR and IIR filters. FIR filter design- FIR design by Fourier approximation, Window method, Frequency sampling method, Optimal FIR design. IIR filter design: Classical filter design using Butterworth and Chebyshev approximations, Impulse invariant and bilinear transformation methods, Frequency transformation technique for HP, BP and BS filter design. Direct design of IIR filters. Applications of DSP.

#### **References:**

1. Haykin S., Signals and Systems, Wiley, 1999.
2. Oppenheim, Willisky, and Nawab, Signals and Systems (2e), PHI, 1997.
3. Proakis J.G. and D.G. Manolakis, Introduction to Digital Signal Processing, PHI, 2009.
4. Oppenheim A.V. and R.W. Schafer, Discrete time signal processing, Pearson, 2009.
5. Mitra S. K., DSP: A computer based approach (2e), TMH, 2006.

### **ELE 3153: MEASUREMENTS & INSTRUMENTATION [2 1 0 3]**

Electrical instrumentation, characteristics, electromagnetic interference, instrumentation transformers, Moving Coil and Moving Iron Instruments, Bridge circuits for R, L and C measurements, Modern Transducers for R, L and C measurements, Signal Isolation (Magnetic and Optical), Charge amplifiers, Instrumentation amplifiers, Active filters, Sallen Key Topology, State Variable Filters, Sample & Hold circuits, Successive Approximation, Flash A/D Converter, PWMD/A converter, R 2R and Binary weighted D/A converter, Net metering concepts, PMU, Applications.

#### **References:**

1. K Sawhney, A course in electrical & electronic measurement and instrumentation, DhanpatRai & Sons, 2014.
2. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, McGraw Hill, 2014.
3. Robert B. Northrop, Introduction to Instrumentation & Measurements, CRC Press, 2005.
4. Hank Zumbahlen, Linear Circuit Design Handbook: Analog Devices, Elsevier, 2008.
5. Clarence W. deSilva, Sensors & Actuators: Engineering System Instrumentation(2e), CRC Press.

### **ELE 3154: POWER SYSTEM ANALYSIS [3 1 0 4]**

Single line diagram, per unit concept, selection and change of base quantities, three winding transformer in power system, symmetrical short circuit current calculation, current limiting reactors, selection of circuit breakers, symmetrical components, sequence networks, unsymmetrical fault analysis in loaded and unloaded system involving transformers, admittance model of power system, load flow solution by numerical method, stability studies, equal area criterion.

#### **References:**

1. Stevenson William D, Elements of Power System Analysis (4e), TMH, 2014.
2. Nagrath I.J. & D.P.Kothari, Modern Power System Analysis (2e), TMH, 2013.
3. HadiSaadat, Power System Analysis, TMH, 2004.
4. ElgerdOlle I., Electric Energy System Theory, TMH, 2011.
5. Stagg & Elabid, Computer methods in power system analysis, MGH, 1986.

### **ELE 3161: DSP LAB [0 0 3 1]**

Generation of waveforms, Sample and reconstruct analog signals, time and frequency response of LTI systems, Convolution, analysis of DTFT, DFT, Z transforms, pole zero diagrams, Spectrogram analysis of non-stationary signals, digital filter structures, Analysis of various classical discrete-time filters such as LP, HP, BP, BS, comb, notch, multi-notch, sinusoidal oscillators, all pass filters, FIR filter design, IIR filter design, simple applications of DSP in communication systems, speech processing, image processing, and electrical power.

#### **References:**

1. Proakis J.G. and D.G. Manolakis, Introduction to Digital Signal Processing, PHI, 2009.
2. Oppenheim A.V. and R.W. Schafer, Discrete time signal processing, Pearson, 2009.
3. Mitra S. K., DSP: A computer based approach (2e), TMH, 2006.

### **ELE 3162: MEASUREMENTS & INSTRUMENTATION LAB [0 0 3 1]**

Module 1: Familiarization of LabVIEW: Introduction to LabVIEW, Sub VI's and Loops, Case Structure, Express VI, Module 2: Realization of a Digital Instrumentation System using  $\mu C$ : Signal conditioning: Realization of Instrumentation Amplifier, Realization of Analog Filter using TI ASLKv2010 Starter Kit, Realization of a DC Voltmeter, Realization of Room Temperature Monitor, Module 3: Realization of a Digital Instrumentation System using PC: Realization of Digital spectrum analyser & digital voltmeter using LabVIEW.

References:

1. Jovitha Jerome, Virtual Instrumentation Using LabVIEW, PHI.
2. K.R.K. Rao, C.P. Ravikummar, Analog system lab pro kit manual, MikroElektronika Ltd. 2012.
3. Jeffrey Travis, Jim Kring, LabVIEW for Everyone: Graphical Programming Made Easy and Fun (3e), Prentice Hall Professional.

## 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, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios.

References:

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

### ELE 3251: POWER ELECTRONICS [3 1 0 4]

SCR Family: Structure, Operation, Static Characteristics, Dynamic Characteristics and Ratings. MOSFET: Structure, Operation, Static Characteristics, Dynamic Characteristics and Ratings. IGBT: Structure, Operation, Static Characteristics, Dynamic Characteristics and Ratings. Protection of Power Electronic Devices. Comparison of Power Electronic Devices. Analysis of Non Isolated Second Order DC to DC Converters, Analysis of Flyback Converter; Inductor Design, High Frequency Transformer Design, Classification of Choppers, Introduction to Soft Switching (ZVS and ZCS). Analysis of Single Phase Fully Controlled Full Wave Rectifiers with R, RL, RLE Load and RL Load with Freewheeling Diode, Analysis of Single Phase Half Controlled Full Wave Rectifiers, Analysis of Three Phase Fully Controlled Full Wave Rectifiers with R, RL, RLE Load and RL Load with Freewheeling Diode, Semi converter and

Dual Converter. Analysis of AC Voltage Controller, Matrix Converter. Analysis of Single Phase Half Bridge and Full Bridge Inverter with R and RL Load (Square Wave, Bipolar and Unipolar SPWM Technique), Analysis of Three Phase Inverters (1200, 1800 and SPWM Technique), Space Vector Pulse Width Modulation, Multi Level Inverters, Current Source Inverter. Application of Power Electronics in Power System, Renewable Energy Systems, Motor Control, SMPS and UPS, and LED Drivers.

References:

1. Hart D. W., Introduction to Power Electronics, PH, 2010.
2. Ned Mohan et. al., Power Electronics, Converters, Applications & Design (2e), Wiley, 2001.
3. Bose B.K., Modern Power Electronics and AC Drives, Pearson, 2002.
4. Rashid M.H., Power Electronics, Circuits, Devices and Applications, PHI, 2010.
5. Rashid M. H. SPICE for Power Electronics and Electrical Power, PH, 1993.

### ELE 3252: SWITCH GEAR & PROTECTION [4 0 0 4]

Circuit breakers: Arc phenomenon, arc interruption theories, Special duties. CB types: Oil circuit breakers, Air circuit breakers, SF6 CB, Vacuum CB, CO2 CB, MCB, MCCB and HVDC circuit breakers. CB rating, testing, operating mechanism, Autoreclosure, metal clad switchgear, GIS. Isolators and earthing switches. Fuses. Neutral grounding. Protective Relaying: Functions, characteristics, standard definition of relay terminologies, classifications & operating principles. Protection schemes for bus zone, transformer, alternator, transmission Line and Induction Motor. Static Relays, Numerical relaying: Building blocks, signal conditioning, DFT, phasor estimation, numerical relaying algorithms. Introduction to SCADA, IEDs and IEC 61850 protocol.

References:

1. Rao S.S., Switchgear Protection and Power systems, Khanna Publishers, 2015.
2. Badriram and Vishwakarma, Power System Protection & Switchgear, MGH, 2014.
3. Ravindranath & Chander, Power System Protection and Switchgear, New Age International, 2018.
4. Mason, The Art and Science of Protective Relaying, Wiley, 1972.
5. Ravindra P. Singh, Digital Power System Protection, PHI, 2007.

### ELE 3261: POWER ELECTRONICS LAB [0 0 6 2]

Effect of non-linear load on single phase and three phase supply, Power electronic devices – characteristics, driver requirements, Study of LED driver, control scheme, UPS and PV system, Design and simulation of isolated/non isolated dc-dc converter, AC-DC converters, AC-AC converters, Single phase and three phase inverters, Speed control of DC motor, induction motor and PMSM/BLDC motor. Power electronic circuit simulation using SPICE, Realization of DC-DC converter.

References:

1. Hart D. W., Power Electronics, Tata McGraw-Hill, 2011.
2. Ned Mohan et. al., Power Electronics, Converters, Applications & Design (2e), Wiley, 2010.
3. Bose B.K., Modern Power Electronics and AC Drives, Pearson, 2010.
4. Rashid M. H., SPICE for Power Electronics and Electrical Power, PH, 1993.

### **ELE 3262: POWER SYSTEMS LAB [0 0 6 2]**

Software Module: Transmission line Performance, Relay Co-ordination, Load Flow Analysis, Transient Stability Analysis, Short Circuit Analysis using simulation tools.

Hardware Module: Numerical Overcurrent Relay, Solar Simulator, Digital Energy Meter, Transmission Network Simulator.

#### **References:**

1. M Stagg & El-Abiad, Computer Techniques in Power System Analysis, MGH, 1984.
2. HadiSaadat, Power System Analysis, MGH, 2004.
3. Nagrath I.J. & D.P.Kothari, Modern Power System Analysis (3e), TMH, 2003.
4. Badriram and Vishwakarma, Power System Protection & Switchgear, TMH, 2013.
5. MiPower and PSCAD user manuals.

## **SEVENTH SEMESTER**

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

## **EIGHTH SEMESTER**

### **ELE 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.

### **ELE 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 [3 0 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.
4. Sudeshna Sarkar and AnupamBasu, Artificial Intelligence, NPTEL, Dec 2009.<http://nptel.ac.in/courses/106105077/>

### **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) Edition, 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. EthemAlpaydin, 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.,The Statistics Tutor's Quick Guide to Commonly Used Statistical 210 Tests, 2016. <http://www.statstutor.ac.uk/resources/uploaded/tutorsquickguidetostatistics.pdf>



### **ELE 4062: SOFT COMPUTING TECHNIQUES [3 0 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. e), 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]**

Introduction, 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(7e), PHI 2011.
2. M. Gopal, Digital control and state variable methods. Tata McGraw Hill New Delhi, 2001.
3. C.H Houppis and G.B Lamont, Digital Control Systems, Prentice Hall, 1995.
4. G.F.Franklin, J.David Powell, M. L.Workman, Digital Control of Dynamic Systems(2e), A-Wesley Publishing Company, 1990.
5. V. I. George and C.P. Kurian, Digital Control Systems, Cengage publishers. New Delhi, 2012.

### **ICE 4052: NON-LINEAR CONTROL SYSTEMS [3 0 0 3]**

Introduction, 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 criteria, 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), Prentice Hall, 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]**

Introduction, 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 New Jersey. 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, New Jersey. 1998.
5. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Addison Wesley Longman. 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

#### **References:**

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(4e), Prentice Hall, 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. Hauck, S. and DeHon, A., Reconfigurable computing: the theory and practice of FPGA-based computation, Elsevier, 2010.

### **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, Stamatis 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 (India e), Cengage Learning, 2007.
3. Qing Li, Real time concepts for Embedded Systems, CMP Books, Elsevier, 2003.
4. Santanu Chattopadhyay, Embedded System Design, PHI Learning Pvt.Ltd, 2011.
5. C.M. Krishna, Kang. G. Shin, Real time systems(Intl e), 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, Bureau of Indian Standards, SP 72: 2010.
2. I.E.S.N.A., New York, Lighting Hand Book (10e), 2011.
3. Code of practice for interior illumination - IS 3646 (Part 1) 1992, IS 3646 (Part 2) 1966, IS 3646 (Part 3) 1968.
4. Code of practice for road lighting - IS 1944 (Part 1 to 6).
5. Karlen, Mark, Christina Spangler, and James R. Benya, Lighting design basics. John Wiley & Sons, 2017.

### **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, WSAN 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.
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, Springer-Verlag London, 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. SpirosKitsinelis, Light Sources: Technologies & Applications, CRC press, 2010.
4. M.a.Cayless& A.M. Marsdon, Lamps & Lighting (4e), Oxford & IBH publishing company, 1996.
5. Jack L. Lindsey., Applied Illumination Engineering, (2e), Fairmont Press, INC 1997.

### **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 (2e), Cambridge 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.

### **ELE 4069: DISTRIBUTED GENERATION SYSTEMS [2 1 0 3]**

Introduction to Distributed Generation Systems- Principle and Structure of DGS- Features of DGS, Distributed Generation Technologies- Overview, Integrating Distributed Energy Resources with the Grid, Planned/non-planned DG, Micro Grid and it's features. DG-

Technologies:Wind Energy Conversion System, Photovoltaic Systems-PV grid tied systems and different configurations. Micro turbine Generation, Small Hydro Generation Systems, Fuel Cells.Energy Storage Technologies-Different Energy storage technologies-Overview, Design Issues and control of Distributed Generation Systems-General model of DGS, Technical Regulation of DG integration, DG Optimization and Energy Management.

#### References:

1. G.B. Gharehpetian and S. Mohammad MousaviAgah, Distributed Generation Systems. Design, Operation and Grid Integration, Butterworth-Heinemann, 2017.
2. Magdi S. Mahmoud, Fouad M. AL-Sunni, Control and Optimization of Distributed Generation Systems, Springer International Publishing, 2015.
3. Bo Zhao, Caisheng Wang, Xuesong Zhang, Grid integrated and standalone photovoltaic distributed generation systems analysis, design and control, Wiley, 2017.

### **ELE 4070: ENERGY STORAGE DEVICES [2 1 0 3]**

Introduction to different forms of energy storage. Energy storage as a structural unit of a power system, applications of energy storage-utilities, transport, industry, house hold. Energy storage techniques: Electrochemical energy storage- Secondary batteries, battery charge controller design, Fuel cells. Case Study on Electrical Vehicle- System design Consideration. Thermal energy storage, Flywheel storage, Superconducting magnetic energy storage, Pumped hydro storage, Compressed air energy storage, Capacitor bank storage, Power system considerations for energy storage:Integration of energy storage systems-Effect of energy storage on transient regimes in the power system.

#### References:

1. A.G. Ter-Gazarian, Energy Storage for Power Systems(2e), (IET Power and Energy Series 63), The Institution of Engineering and Technology, United Kingdom, 2011.
2. Gregory L Plett, Battery Management Systems, Volume- 1, Battery Modeling, Artech House Publishers, 2015.
3. Gregory L Plett, Battery Management Systems, Volume- 1, Equivalent circuit methods, Artech House Publishers, 2015.
4. R. Bove and S. Ubertini, Modeling Solid Oxide Fuel Cells, Springer, 2008.

### **ELE 4071: POWER SYSTEMS OPERATION & CONTROL [2 1 0 3]**

Modern Power Systems: Evolution, power system network, synchronous grid; Equipment and Stability Constraints in System Operation : generator constraints, transmission line constraints, stability problem, voltage instability; Frequency control in power system : definition of system frequency, frequency control, speed governors, Automatic generation control; transformer tap control, Voltage and reactive power control: Generator Excitation Systems and reactive power characteristics, HVDC Converters; Real and Reactive power Scheduling & Optimization; Preventive, emergency & restorative control : State estimation, blackout.

**References:**

1. Wood & Woolenber, Power System Operation & Control John Wiley, 2003.
2. R. Bergen, Vijay Vittal, Power System Analysis (2e), PHI.
3. Hingorani & Gyugui, Understanding FACTS, Wiley-IEEE 1999.
4. P Kundur, Power System Analysis & Control, TMH, 2006.
5. S. N. Singh, Power Systems Operation & Control, NPTEL, December 2009. <http://nptel.ac.in/courses/108101039/>

**ELE 4072: SMART GRID TECHNOLOGIES [3 0 0 3]**

Smart Grid Overview- Smart Grid evolution, Definition of the Smart Grid, Key Characteristics of Smart Grid, Key Functions of a Smart Grid, Smart Grid Elements. Traditional Electric Grid Model, Generation, Transmission, Distribution, Energy Storage, Micro-grids, Integration of new technologies into the grid, Smart Grid vision and its realization in Urban/Rural, Smart Grid infrastructure, Functionality, Reliability, Cost/Tariff, Standards, Smart Grid cyber security, Smart Grid Operations- Electric Grid (power delivery), SCADA (supervisory control and data acquisition), Smart Grid Control Layer-fault detection and location, Data collection and management, Control Layer Infrastructure, Software-Define Networks (SDN), Control Algorithms, Volt-VAR control, Distribution automation, Grid storage systems, Intermittent renewable, Cooperative grids.

**References:**

1. James Momoh, Smart Grid: Fundamentals of Design and Analysis, (I E E Power Engineering Series)– Wiley-Blackwell, 2012.
2. Takuro Sato, Daniel M. Kammen, Bin Duan, Martin Macuha, Zhenyu Zhou, and Jun Wu, Smart Grid Standards: Specifications, Requirements, and Technologies, Wiley-Blackwell, 2015.
3. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, and Nick Jenkins, Smart Grid: Technology and Applications, Wiley, New Delhi, 2015.
4. Lars T. Berger and Krzysztof Iniewski, Smart Grid Applications, Communications, and Security, Wiley, New Delhi, 2015.
5. Salman K. Salman, Introduction to the Smart Grid, (IET Energy Engineering Series 94)- The Institution of Engineering and Technology, United Kingdom, 2017.

**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. J.G. Webster, Medical Instrumentation Application and Design, Houghton Mifflin Co. 2004.

**ICE 4056: MICRO ELECTRO MECHANICAL 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, Tata McGraw-Hill Edition, 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. Boston, Micro machined Transducers Sourcebook, WCB McGraw Hill, 1998
5. Stephen D. Senturia, Microsystem Design, Kluwer Academic Publishers, Springer, 2000.

**ICE 4057: MULTI SENSOR DATA FUSION [3 0 0 3]**

Concept and role of fusion, Fusion types, Sensor configuration, Architecture of fusion nodes, Fusion topologies, Benefits of fusion, Need for 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, Bayesian 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 SENSORS [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, Practical examples of the intelligent sensors.

**References:**

1. Gerard Merjer, Smart Sensor Systems, Wiley Publisher, 2008.
2. Randy Frank, Understanding Smart Sensors, (2e). Artech House Publications, 2000.

3. Paul W. Chapman, Smart Sensors, ISA Press, 1996.
4. Krzysztof Iniewski, Smart Sensors for Industrial Applications, CRC Press, 2013.
5. Jacob Fraden, Handbook of Modern Sensors-Physics, Designs, and Applications(4e), Springer, 2010.

#### **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, McGraw Hill, NJ, 2007.
4. A.V Oppenheim and R.W. Schaffer, 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(2e), 2003.
3. William K Pratt, Digital Image Processing, John Willey, 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 Interscience, 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.

### **ELE 4075: COMPUTER NETWORKS [2 1 0 3]**

Introduction to computer networks and Internet, network edge and core, delay and throughput in packet switched networks, Protocol layers and their service models. Session, Presentation, and Application Layers. Examples: DNS, SMTP, FTP, HTTP. Transport layer: UDP, TCP. Connection establishment and termination, flow and congestion control, timers. Network layer: Internet Protocol, IPv4, IPv6, ICMP, Network Address Translation. Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Link Layer: Error detection (Parity checks and CRC), Multiple Access Protocols - ALOHA, CSMA. Switched LANs-addressing, ARP, Ethernet-Gigabit Ethernet, VLANs. Datacenter networking. Wireless LANs-Wi-Fi (802.11). Multimedia Networking - UDP and HTTP streaming, Voice-over-IP, Case studies- Skype, YouTube, Case study on Webpage request, Overview of Software defined Networks (SDN)

#### **References:**

1. AS Tanenbaum, DJ Wetherall, Computer Networks(5e), Prentice-Hall, 2010.
2. LL Peterson, BS Davie, Computer Networks: A Systems Approach (5e), Morgan-Kaufman, 2011.
3. JF Kurose, KW Ross, Computer Networking: A Top-Down Approach(5e), Addison-Wesley, 2009.
4. W Stallings, Cryptography and Network Security, Principles and Practice(5e), Prentice-Hall, 2010.

### **ELE 4076: CONTROL SYSTEM DESIGN [2 1 0 3]**

Control system performance objectives, Design of cascade & feedback compensation, Scalar and multivariable control systems, Industrial PID controllers, state space systems and PID control, PID tuning, Pole placement techniques for design of controllers and observers, Kalman filter, Robust control, H<sub>∞</sub> techniques; Non-linear control system design: Linearization, compensation and design of non-linear systems, design of non-linear control system using phase plane analysis, Lyapunov stability; optimal control theory and applications; Adaptive Control ; Self tuning control; Model reference adaptive control; practical aspects: Control system design examples; MATLAB & SIMULINK for Control system Design.

#### **References:**

1. Katsuhiko Ogata, Modern Control Engineering (5e), PHI, 2010.
2. Stanley M. Shinnars, Advanced modern control system theory and design, John Wiley & Sons, 1998.
3. Michael A. Johnson, Mohammad M. Moradi, PID Control: New Identification and Design Methods, Springer 2005.

4. V. I. George, C.P. Kurian, Digital Control Systems (1e), Cengage Learning, 2012.
5. Norman S. Nise, Control Systems Engineering (5e), John Wiley & Sons Inc, 2010.

#### **ELE 4077: DATA ANALYTICS [2 1 0 3]**

Introduction to Data science, Data analytics. Similarity, sequencing, sampling and quantization. Data Preprocessing, Error types, Error handling, Filtering, Data transformation and Data integrations. Modelling with data and Data visualizations. Correlation and causality tests. Regression analysis, Forecasting, Classification and Clustering techniques. Introduction to R-programming for data analytics

#### **References:**

1. Thomas A. Runkler, Data Analytics Models and Algorithms for Intelligent Data Analysis (2e) Springer Publications, 2016.
2. Scott A. Pardo, Empirical Modeling and Data Analysis for Engineers and Applied Scientists, Springer Publications, 2016. DOI 10.1007/978-3-319-32768-6.
3. Wei Lee Woon, ZeyarAung, Oliver Kramer, Stuart Madnick (Eds.), Data Analytics for Renewable Energy Integration, Springer 2017. DOI 10.1007/978-3-319-50947-1.
4. Robert I. Kabacoff, R in action: Data analysis and graphics with R, Manning Publications C, 2011.

#### **ELE 4078: DATA STRUCTURES & ALGORITHMS [2 1 0 3]**

Pseudocode, algorithm analysis, asymptotic notations, iterative and recursive algorithms. Data Structures, data structure operations, review of arrays, structures, Stacks and Queues, stack and queue operations, array representation of stacks and queues, queues and stacks using linked lists, applications of queues and stacks. Properties of Binary search trees, array and linked list representation of binary search trees, binary search tree traversals. Graphs and their representations, application of graphs. Searching and sorting methods. Algorithm design techniques – Greedy, Divide and Conquer, Dynamic programming and Backtracking. Addressing limitations of algorithmic power - P, NP, and NP-Complete Problems

#### **References:**

1. Cormen, Leiserson and Rivest, Introduction to algorithms(3e), MGH 2009.
2. Aho, Hopcroft and Ulmann, Design and Analysis of Algorithms(1e), Pearson 2002.
3. Aho, Hopcroft and Ulmann, Data Structures & Algorithms(1e), Pearson 2002.
4. Horowitz and Sahni, Fundamentals of computer algorithms(1e), Universities Press. 2008.

#### **ELE 4079: DATABASE MANAGEMENT SYSTEMS [2 1 0 3]**

Data-base system applications, Data models, schemas and instances. Three-schema architecture and data independence. Entity-Relationship Model: Entity, Attribute, Constraints. Relational model Concepts, Relational algebra: SELECT, PROJECT and DIVISION. Relational database design using ER-to-Relational Mapping. Structured Query Language (SQL), Queries in SQL. Query processing and optimisation, Database design: Functional dependencies, normalisation. Transaction management: ACID properties, concurrency control, transactions and scheduling, locking. Data warehousing, datamining and data analytics. Applications and case studies.

#### **References:**

1. AviSilberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts(6e), McGraw-Hill, 2016.
2. RamezElmasri, Shamkant B. Navathe, Fundamentals of Database Systems(7e), Pearson, 2016.

#### **ELE 4080: DESIGN & MODELLING OF SPECIAL ELECTRICAL MACHINES [2 1 0 3]**

Permanent Magnets and Machines, Introduction to Inverters and Their Control .Dynamic Modeling of Permanent Magnet Synchronous Machine, Control Strategies for a Permanent Magnet Synchronous Machine, Flux-Weakening Operation, Design of Current and Speed Controllers, Parameter Sensitivity and Compensation, Rotor Position Estimation and Position Sensor less Control, PM Brushless DC Machine, Commutation Torque Ripple and Phase Advancing, Half-Wave PMBDCM Drives, Design of Current and Speed Controllers, Sensorless Control of PMBDCM Drive

#### **References:**

1. Ramu Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press.
2. Md. enamul Haque, Permanent Magnet Synchronous Motor Drives: Analysis, Modeling and Control, VDM Verlag.
3. Chang-liang Xia, Permanent magnet brushless DC motor drives and controls, Wiley.

#### **ELE 4081: DIGITAL SYSTEM DESIGN USING VERILOG [2 1 0 3]**

Digital implementation options, Digital system modeling: Domains , levels of abstraction. Introduction to Verilog: Behavioral, data-flow and Gate level modeling. Design case studies - combinational, sequential, FSM, Test Benches. Verilog HDL Synthesis, Interfacing Applications, Programmable ASICs, Programming Technologies.

#### **References:**

1. Smith M.J.S., Application Specific ICs, Pearson, 2010.
2. Samir Palnitkar, Verilog HDL: A Guide to Digital design and Synthesis, PHI, 2003.
3. Brown S. & Vranesic Z., Fundamentals of Digital Logic with Verilog Design, TMH 2013.
4. Nazeih M. Botros, HDL Programming: VHDL and Verilog, Dreamtech Press, 2009.

#### **ELE 4082: ENERGY AUDITING [2 1 0 3]**

Energy Types, Needs, Scenario, Energy Security, Environmental Impact, Energy Reforms, Material & Energy Balance, Consumption Pattern, Sankey Diagram, Energy Policy, Information Systems, Energy Conservation Act 2001, Electricity Act 2003, Energy Reforms, National Action Plan for Climate Change (NAPCC), Standards & Labels ,Energy Audit Purpose & Scope, Types of Energy Audit & Methodologies, Audit Instruments, Energy Management principles, Benchmarking and Strategies, Performance assessment of Electrical utilities, Performance Assessment of Thermal Utilities, Energy Economic Analysis, Role of ESCOs

#### **References:**

1. Paul W. O'Callaghan, Energy Management A comprehensive guide to reducing costs by efficient energy use, McGraw Hill, England, 1992.
2. Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2000.

3. IEEE Std. 739-1995, IEEE recommended practice for energy management in industrial and commercial facilities.
4. Steve Doty and Wayne C. Turner, Energy Management Handbook(7e), Fairmont Press, USA, 2009.
5. BEE Study Material, Energy Management & Energy Audit, www.beeindia.gov.in

#### **ELE 4083: HVDC & FACTS [2 1 0 3]**

HVDC transmission system, merits and demerits application and schemes of HVDC, equivalent circuit diagram of a two terminal HVDC link, HVDC control, grid firing units for converters. Introduction to FACTS controllers- configuration and working principle of SVC, STATCOM, TCSC, SSSC, SPS and UPF- Steady state characteristics, effect of FACTS devices on transient stability, power flow, power oscillation damping and voltage stability.

##### **References:**

1. K R Padiyar, FACTS Controllers in power transmission and distribution systems, New Age International publishers, New Delhi, 2007.
2. Narendra G Hingorani & L. Gyugyi, Understanding FACTS: Concepts and Technology of flexible AC transmission systems, IEEE Press, 2000.
3. K R Padiyaar, HVDC power transmission systems, Technology and System Interactions, New Age International publishers, New Delhi, 1999.
4. Vijay K. Sood, HVDC and FACTS Controller, Kluwer Academic Publisher, 2004.

#### **ELE 4084: INTRODUCTION TO ELECTRIC VEHICLES**

Introduction to Electric Vehicles: History, social and environmental importance, Impact of modern drive-trains; Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization; Electric Drive-trains: Basic concepts, power flow control, topologies; Electric Propulsion unit: Introduction, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives; Energy Storage: Introduction, Battery based energy storage, Fuel Cell based energy storage, Super Capacitor based energy storage and Flywheel based energy storage and analysis; Sizing the drive system: Sizing the propulsion motor, power electronics, energy storage technology, Communications, supporting subsystems; Energy Management Strategies: Introduction, classification, comparison, implementation issues; Case Studies: Design of a Battery Electric Vehicle (BEV).

##### **References:**

1. Mehrdad Ehsani, Yimin Gao, Sebastien E .Gay, and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press 2004.
2. Evaluation of the 2004 Toyota Prius Hybrid Electric Drive System, Oak Ridge National Lab 2006 report.
3. Evaluation of the 2010 Toyota Prius Hybrid Electric Drive System, Oak Ridge National Lab 2011 report.
4. Davide Andrea, Battery Management Systems for Large Lithium-Ion Battery Packs, Artech House, 2010.
5. C.Mi, M.A.Masrur, D.W.Gao, Hybrid Electric Vehicles, Wiley 2011.

#### **ELE 4085: MODERN POWER CONVERTERS [2 1 0 3]**

Switched Mode Power converters: generalized comparison between switched mode and linear regulators, operation and steady state

performance of buck, boost, buck-boost, cuk : continuous conduction mode, discontinuous conduction mode; Performance analysis of converters using DC Transformer model; DC-DC converters with isolation- Fly back converter, Forward converter, push-pull converter, half bridge and full bridge DC-DC converters; Resonant Converters-series and parallel loaded converters in continuous and discontinuous mode of operation, zero current switch resonant converter (ZCS), zero voltage switch resonant converter (ZVS); Control techniques- Voltage feed forward PWM control, current mode control, digital pulse width modulation control; Converter modelling- equivalent circuit modelling of converters using state space averaging technique; Closed loop converter design – PID design issues; Electromagnetic interference – input filter design and its effect on converter performance

##### **References:**

1. Robert W. Erickson, Dragan Maksimovic, Fundamentals of Power Electronics, (2e), Springer, 2005.
2. Hart D. W., Introduction to Power Electronics, PH, 2010.
3. Ned Mohan et. al., Power Electronics, Converters, Applications & Design (2e), Wiley, 2001.
4. P. Krein, Elements of Power electronics, OUP, 1998.
5. U. Umanand & Ramanarayanan V, Switched mode power conversion, NPTEL, March 2013. <http://nptel.ac.in/courses/108108036/#>.

#### **ELE 4086: RENEWABLE ENERGY [2 1 0 3]**

Energy sources and their availability - Solar Energy - solar radiation and measurements, solar energy storage, - Solar Photo-Voltaic systems design - Wind Energy - estimation, Maximum power and power coefficient, wind energy conversion systems - design considerations and applications - Energy from Bio-Mass - Sources of bio-mass, Biomass conversion technologies - Thermo-chemical conversion and Bio-chemical conversions, Anaerobic digestion and Fermentation, Bio-gas generation Pyrolysis and Liquefaction, Classification of Gasifiers, Energy plantation -Energy from the Oceans - Ocean Thermal Energy Conversion, Open and Closed Cycle plants, Site selection considerations, Origin of tides, Tidal energy conversion systems, Wave energy conversion systems - Hybrid Energy Systems.

##### **References:**

1. Khan B. H., Non-conventional Energy Resources, TMH, 2006.
2. Twidell J. W. & Weir A. D., Renewable Energy Resources, ELBS, 1986.
3. Mukherjee D. & Chakrabarti S., Fundamentals of Renewable Energy Systems, New Age Intl., 2004.

#### **ELE 4087: SOLAR PHOTOVOLTAICS [2 1 0 3]**

Solar Radiation: Spectrum, Terminologies, Measurement, Estimation; Sun-Earth Movement & PN Junction Diode & Characteristics, Solar Cell, Photovoltage, Light Generated Current, I-V equation & Characteristics: Short Circuit Current, Open Circuit Voltage, Maximum Power Point, Fill Factor, Efficiency, Losses, Equivalent Circuit, Effect of Series & Shunt Resistance, Solar Radiation, Temperature on Efficiency Solar PV Modules: Series & Parallel connection, Hotspots, Bypass & Blocking Diodes, Power Output, Ratings, I-V & Power Curve, Effect of Balance of System (BOS): Batteries: Classification, Capacity, Voltage, Depth of Discharge, Life Cycle, Factors affecting Battery Performance; Charge Controllers, DC to DC Converters, DC to AC converters, Maximum Power Point Tracking (MPPT).  
PV Systems: Standalone, Grid, Hybrid, Design Methodology.



**References:**

1. Chetan Solanki, Solar Photovoltaics: Fundamentals, Technologies and Application, PHI New Delhi, 2009.
2. G.N. Tiwari, Solar Energy: Fundamentals, Design, Modeling and Applications, Narosa Publications New Delhi, 2013.
3. Suneel Deambi, Photovoltaic System Design, CRC Press USA, 2016.
4. Frank Kreith and D. Yogi Goswami, Energy Management and Conservation Handbook(2e), CRC Press USA, Fairmont Press, USA, 2017.
5. John Balfour, Michael Shaw and Nicole B. Nash, Advanced Photovoltaic Installations, Jones & Barlett Learning USA, 2013.

**ELE 4088: SOLID STATE DRIVES [2 1 0 3]**

Fundamentals of Electric Drives: components, dynamics, multi-quadrant operation, equivalent moment of inertia and torque, nature and classification of load torque, steady state stability; classes of motor duty. DC Drives: single phase and three phase controlled rectifier fed dc drives- controlled freewheeling, speed torque characteristics, waveforms, expressions for voltage, current, speed, torque and power. Chopper fed DC drives- quadrants of operation; AC drives: Induction Motor Drives- stator voltage control, rotor resistance control, slip power recovery scheme, frequency control-control strategies, DQ model, principle vector control, direct and indirect vector control scheme.; Synchronous Motor Drives- overview of scalar and vector control schemes of PMSM and BLDC motors, brushless DC excitation.

**References:**

1. Dubey G.K., Power Semiconductor Controlled Drives, PH, 1989.
2. Dubey G.K., Fundamentals of Electric Drives, Narosa, 2010.
3. Murphy J.M.D. & F.G. Turnbull, Power Electronic Control of AC motors, Pergamon 1989.
4. Bose B.K., Modern Power Electronics and AC Drives, Pearson, 2010.
5. Krishnan R., Electric Motor Drives: Modeling, Analysis, and Control, Pearson, 2011.

**OPEN ELECTIVES****ELE 4301: ENERGY AUDITING [2 1 0 3]**

Energy Types, Needs, Scenario, Energy Security, Environmental Impact, Energy Reforms, Material & Energy Balance, Consumption Pattern, Sankey Diagram, Energy Policy, Information Systems, Energy Conservation Act 2001, Electricity Act 2003, Energy Reforms, National Action Plan for Climate Change (NAPCC), Standards & Labels, Energy Audit Purpose & Scope, Types of Energy Audit & Methodologies, Audit Instruments, Energy Management principles, Benchmarking and Strategies, Performance assessment of Electrical utilities, Performance Assessment of Thermal Utilities, Energy Economic Analysis, Role of ESCOs.

**References:**

1. Paul W. O'Callaghan, Energy Management A comprehensive guide to reducing costs by efficient energy use, McGraw Hill, England, 1992.
2. Amit K. Tyagi, Handbook on Energy Audits and Management, TERI, 2000.
3. IEEE Std. 739-1995, IEEE recommended practice for energy management in industrial and commercial facilities.
4. Steve Doty and Wayne C. Turner, Energy Management Handbook (7e), Fairmont Press, USA, 2009.
5. BEE Study Material, Energy Management & Energy Audit. www.beeindia.gov.in

**ELE 4302: INTRODUCTION TO LIGHTING DESIGN [2 1 0 3]**

Visible spectrum- psychophysics of vision-photometric quantities- laws of illumination-point by point method of illuminance calculations -Light sources- luminaires- principles of light control elements-light Intensity distribution diagram-evaluation of total flux-illuminance and visual performance- Lumen method calculations-principles and general requirements of interior & exterior lighting for different applications- Lighting Design Examples- Energy and cost effectiveness of lighting schemes.

**References:**

1. IESNA New York, Lighting Handbook (10e), 2011.
2. Jack L. Lindsey, Applied Illumination Engineering (2e), Fairmont Press, INC 1997.
3. D.W. Durrant, Interior Lighting Design(5e), Lighting Industry Federation Limited, London 1977.
4. J.B. de Boer and D. Fischer, Interior Lighting(2e), Philips Technical Library, 1981.

**ELE 4303: MATLAB FOR ENGINEERS [2 1 0 3]**

MATLAB desktop, workspace variables and types, creating and calling functions, 2D & 3D plots, control flow statements, introduction to Cody Coursework platform, introduction to live script environment, symbolic computation using MuPAD app, linear regression analysis using Statistics and Machine Learning Toolbox, interpolating & extrapolating set of data, generating, importing data from various data tools, introduction to Simulink, solving ordinary differential equations in Simulink, introduction to Simscape, development of graphical user interface with GUIDE tool and app designer tool, creating MS Windows executable applications, installing support packages of external hardware, external hardware interface using MATLAB editor, Simulink and app designer.

**References:**

1. Stephen J. Chapman, Essentials of MATLAB Programming, BAE Systems (3e), Cengage Learning.
1. Catherine Wilkins, Exploring Mathematics with MuPAD, University of Oxford.
2. Sulaymon L. Eshkavilov, MATLAB & Simulink Essentials: MATLAB & Simulink for Engineering Problem Solving and Numerical Analysis, Lulu Publishing.

**ELE 4304: SOLAR PHOTOVOLTAICS [2 1 0 3]**

Solar Radiation: Spectrum, Terminologies, Measurement, Estimation; Sun-Earth Movement & Angles, Sun Tracking, PN Junction Diode & Characteristics, Solar Cell, Photovoltage, Light Generated Current, I-V equation & Characteristics: Short Circuit Current, Open Circuit Voltage, Maximum Power Point, Fill Factor, Efficiency, Losses, Equivalent Circuit, Effect of Series & Shunt Resistance, Solar Radiation, Temperature on Efficiency, Solar PV Modules: Series & Parallel connection, Hotspots, Bypass & Blocking Diodes, Power Output, Ratings, I-V & Power Curve, Effect of Solar Irradiation & Temperature, Balance of System (BOS): Batteries: Classification, Capacity, Voltage, Depth of Discharge, Life Cycle, Factors affecting Battery Performance; Charge Controllers, DC to DC Converters, DC to AC converters, Maximum Power Point Tracking (MPPT).

**References:**

1. Chetan Solanki, Solar Photovoltaics: Fundamentals, Technologies and Application, PHI New Delhi, 2009.
2. G.N. Tiwari, Solar Energy: Fundamentals, Design, Modeling and Applications, Narosa Publications New Delhi, 2013.
3. SuneelDeambi, Photovoltaic System Design, CRC Press USA, 2016.
4. Frank Kreith and D. Yogi Goswami, Energy Management and Conservation Handbook(2e), CRC Press USA, Fairmont Press, USA, 2017.
5. John Balfour, Michael Shaw and Nicole B. Nash, Advanced Photovoltaic Installations, Jones & Barlett Learning USA, 2013.



## **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
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