21EA01 / 21ED01 / 21EM01 / 21UC01 MATHEMATICS OF SYSTEMS ENGINEERING

2 1 0 3

VECTOR SPACES: Real vector spaces, subspaces, linear independence – basis and dimension of a vector space - inner product space, orthonormal bases, Gram-Schmidt process. (7+3)

LINEAR TRANSFORMATIONS: General linear transformations, kernel and range, inverse linear transformations, matrices of general linear transformations, eigenvalues and eigenvectors. (7+4)

CALCULUS OF VARIATIONS: Variational problems of fixed boundaries: Variations and its properties - simplest variational problems – Euler equation – Brachistochrone problem – variational problems involving several unknown functions – Functional involving first and second order derivatives. (8+4)

STOCHASTIC PROCESSES: Introduction, classifications, Poisson process, discrete time Markov chain, transition probability matrix, classification of states, Chapman Kolmogorov equations , limiting probabilities. (8+4)

Total L: 30 +T:15 = 45

REFERENCES:

1. David C Lay, “Linear Algebra and its Applications”, Pearson Education, New Delhi, 2017.
2. Elsgolts L., “Differential Equation and Calculus of Variation”, MIR Publication, Moscow, 1977.
3. Howard Anton and Chris Rorres, “Elementary Linear Algebra: Applications Version”, Wiley India, New Delhi, 2018.
4. Medhi J., “Stochastic Processes”, New Age International Publishers, New Delhi, 2017.
5. Saeed Ghahramani, “Fundamentals of Probability with Stochastic Processes”, Pearson, New Delhi, 2016.

21EA02 ADVANCED DIGITAL SYSTEM DESIGN

3 1 0 4

REVIEW OF DIGITAL LOGIC CIRCUITS: Designing combinational circuit using multiplexer, decoder – Finite State Machines – Mealy Machine- Moore Machine – State Diagram – State table - Design of state machines using Algorithmic State Machines (ASM) chart as a design tool. System Design using PLDs: Basic concepts – Programming technologies - Programmable Logic Element (PLE) - Programmable Array Logic (PLA) - Programmable Array Logic (PAL) – Programmable Logic Architectures – 16L8 – 16R4 – 22V10–Design of combinational and sequential circuits using PLDs. (12+4)

CPLD and FIELD PROGRAMMABLE GATE ARRAYS: Complex PLDs (CPLDs) –Xilinx cool runner architecture. Types of FPGA - Xilinx XC4000 series - Logic Cell Array (LCA) – Configurable Logic Blocks (CLB) - Input/output Blocks (IOB) - Programmable Interconnection Point(PIP) Implementing Functions in FPGAs Dedicated Memory in FPGAs – Dedicated Multipliers in FPGAs - Mapping, Placement and Routing - Verilog based design flow for FPGA. (11+3)

SYSTEM VERILOG BASICS: Language Elements: Literal values – Data types - user defined types -enumerated types -Arrays – Dynamic Arrays – Associative arrays – Queues -Strings -Composite types: Structures -Unions -Classes-Expressions: Parameters, Constants, Variables – Nets – Operators -Behavioral modeling: Procedural Constructs – Loop statement -Case statement –Continuous Assignments - Parallel block - Procedural blocks – Structural modeling: Module -Interface -Tasks and Functions. (11+4)

SYSTEM VERILOG ADVANCED VERIFICATION: Clocking Block – Program Block - Verification guidelines - Inter-process communication and Synchronization -Random Constraints Generation- Assertions: Immediate assertions – Concurrent assertions – Functional coverage - System verilog Test bench. (11+4)

Total L:45 + T:15 = 60

REFERENCES:

1. Nelson, V.P., Nagale, H.T., Carroll, B.D., and Irwin, J.D., "Digital Logic Circuit Analysis and Design", Prentice Hall International, Inc., New Jersey, 1995.
2. Charles H Roth and Lizy Kurian John “Digital Systems Design Using VHDL,” Cengage Learning,2013.
3. Wayne Wolf,” FPGA - Based System Design” Prentice Hall, New Jersey,2012.
4. J. Bhasker, “A System Verilog Primer”, BS publications, reprint 2016.
5. Chris Spear, Greg Tumbush, “System Verilog for Verification – A guide to Learning the Test bench Language Features”, Third Edition, Springer 2012.

21EA03 EMBEDDED SYSTEM DESIGN

3 0 0 3

Introduction to Embedded Systems: Introduction – Embedded systems versus general computing systems – Classification – Major application areas – Hardware and Software components: CPU of an embedded system – Memory – Input/Output devices, Sensors and actuators, Firmware, other system components–. Characteristics and quality attributes (Design Metric) of embedded system. Real time system’s requirements, real time issues, interrupt latency. Embedded Product development life cycle. (11)

Embedded Hardware and Design : **ARM7TDMI:** Architecture overview - Processor modes – Data types – Registers – Program status registers – ARM Instruction Set – Thumb Instruction Set. **ARM Cortex-Mx**: Processor Core overview -

Programmers Model - Memory Model - Exception and Fault Handling - Power Management - Instruction Set Summary - CMSIS Functions - Hardware-Software Synchronization - Interrupt Synchronization - Multithreading - Register Map - System Timer - Nested Vectored Interrupt Controller - Floating Point Unit (FPU)-Optional Memory Protection Unit. (12)

Embedded Software Development Environments: Challenges and issues in embedded software development, Co-design. Real time operating systems, kernel architecture: Hardware, task/process control subsystem, device drivers, file subsystem, system calls, Embedded operating systems, task scheduling in embedded systems: task scheduler, first-in first-out, shortest job first, round robin, priority based scheduling, context switch: task synchronization: mutex, semaphore, timers, types of embedded operating systems. (11)

Validation and Debugging: Validation Types and Methods - Cross-compilers -ROM Emulator - Logical Analyzer - JTAG - In-Circuit Emulator -– Hardware-software co-design and program modeling - Issues in co-design – Introduction to UML – Hardware-software trade-offs – Code optimization, Fixed point and floating point implementation of algorithms – Analysis and Optimization of CPU Power Consumption. (11)

Total L: 45

REFERENCES:

1. William Hohl and Christopher Hinds, “ARM Assembly Language Fundamentals and Techniques”, CRC Press, Second Edition, 2015.
2. Marilyn Wolf, “Computers as components: Principles of Embedded Computing Design, 4th Edition, Morgan Kaufmann, 2016.
3. Shibu K. V., “Introduction to Embedded Systems”, Tata McGraw Hill, 2009.
4. J. W. Valvano, “Embedded Systems: Introduction to ARM Cortex -M Microcontrollers”, Fourth edition, Volume 1, ISBN: 978-1477508992, 2013
5. Cortex-M4 Devices, Generic User Guide by ARM

21EA04 ADVANCED DIGITAL SIGNAL PROCESSING

3 1 0 4

MULTIRATE DSP: Sampling–Spectral representation: DFT and FFT–Review of Digital filters-Decimation and Interpolation by an integer and rational factors– Multistaging– Decimation and Interpolation with poly phase filters – Realizations – Applications of multirate signal processing. (11+3)

FILTER BANKS: Analysis and Synthesis of Filter Banks– Quadrature Mirror Filter (QMF) banks– Filter bank with perfect reconstruction– 2-Channel and M-channel– Paraunitary filter banks– Biorthogonal and Linear phase filter banks– Tree and parallel structured filter banks–Transmultiplexer filter banks– Multi resolution analysis – Subband coding and its applications (12+4)

WAVELET TRANSFORM: Short-TimeFourier Transform – limitations - time-frequency scaling- Heisenberg’s uncertainty – Continuous Wavelet Transform – Discrete Wavelet Transform – Haar, Daubechy’s wavelets – Multi Resolution Analysis of audio signal. (11+4)

ADAPTIVE FILTERS: FIR adaptive filters – adaptive filters based on steepest descent method – LMS algorithm – Variants of LMS algorithm – adaptive channel equalization – adaptive echo cancellation – RLS adaptive algorithm. (11+4)

Total L: 45 + T:15=60

REFERENCES:

1. VikramGadre and Aditya S Abhyankar, ” Multi resolution and Multirate Signal Processing : Introduction, Principles and Applications” , McGraw Hill Education, July 2017.
2. Vaidyanathan P P, “Multirate Systems and Filter Banks”, Pearson Education, 2011.
3. StephaneMallat , “A Wavelet Tour of Signal Processing”, Elsevier, Academic Press, Third Edition, December 2008.
4. Rao, R.M and A.S.Bopardikar,”Wavelet Transforms: Introduction to Theory and Applications, Addison Wesley, Reprint 2003.
5. Simon Haykin,” Adaptive Filter Theory” , Pearson Education, Fourth Edition, 2008.

21EA05 SYSTEM THEORY

3 1 0 4

MODELLING: Introduction to state space modeling , modeling of physical systems, State-space realization of SISO systems using controllable, observable canonical forms (phase-variable approach), Diagonal and Jordan's canonical forms. Development of linear state-space models for nonlinear systems. (10+4)

ANALYSIS: Solution of LTI state-equation, state-transition matrix - properties and computational techniques -Eigen values, Eigen vectors, Diagonalization - Forced response of LTI Systems– State transition matrix and solutions of LTV system -. Controllability and Observability - Tests. (12+4)

SYNTHESIS: Relationship between pole location and system's dynamic performance, control specifications, choice of desired closed loop poles based on dominant pole pair approach from controller specifications, regulation and reference tracking problems. State feedback control design and Observer Design using Ackermann's formula, Kalman filter algorithm. LQR and LQG controller design. Introduction to Eigen structure assignment. (13+4)

STABILITY: Stability concepts - BIBO - Asymptotic stability - stability definitions in state space domain .stability theorems on local and global stability. Lyapunov stability analysis -Krasovskii Method. (10+3)

Total: L:45 + T:15 = 60

REFERENCES:

1. K. Ogata, “Modern control engineering”, Prentice Hall of India Pvt. Ltd., New Delhi, 2011
2. J. Nagrath and M. Gopal, "Control systems Engineering", New Age International Pvt Limited, New Delhi, 2012
3. FaridGolnaraghi and Benjamin C Kuo, “Automatic Control Systems”, Tenth Edition, McGraw-Hill Education, 2017.
4. M. Gopal, “Digital Control and state variable methods”, Tata McGraw Hill, New Delhi, 2012
5. C.T. Chen, ‘Linear Systems Theory and Design’’ Oxford University Press, 2014.

21EA06 / 21EE06 / 21ED06 / 21EM06 RESEARCH METHODOLOGY AND IPR

vide Automotive Engineering 21AE06

21EA72 AUDIT COURSE I

vide Automotive Engineering 21AE72

21EA51 / 21EE52 / 21ED52 OBJECT COMPUTING AND DATA STRUCTURES LABORATORY

0 0 4 2

Object Computing (Using C++):

Implementation of the following problems:

Implementation of basic programming concepts like conditionals and loops
Implementation of function and operator overloading
Creation of classes and objects.
Implementation of constructors and destructors
Implementation of array of objects and dynamic objects.
Implementation of call by value, call by reference and return by reference.
Implementation of friend functions, inline functions and default arguments.
Implementation of inheritance and its types
Implementation of polymorphism and its types.

Data Structures (Using C++):

Programs using arrays.
Implementation of various sorting algorithms.
Implementation of Stacks using array.
Application of Stack
Implementation of queue using array.
Implementation of Linked Lists: Singly linked, doubly linked and Circular lists and applications.

Total P: 60

REFERENCES:

1. Herbert Schildt, “C++ - The Complete Reference", Tata McGraw Hill, New Delhi, 2012.
2. Aaron M Tanenbaum, Moshe J Augenstein and YedidyahLangsam, "Data structures using C and C++", Pearson Education, New Delhi, 2009.
3. Harvey M Deitel,andPaul J Deitel, “C++ How to Program”, Prentice Hall, New Delhi, 2010.
4. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++”, Pearson Education, Fourth Edition, 2014.
5. SahniSartaj, "Data Structures, Algorithms and Applications in C++", Universities Press, Hyderabad, 2005.

21EA52 EMBEDDED SYSTEM DESIGN LABORATORY

0 0 4 2

LIST OF EXPERIMENTS
1. Data acquisition using analog and digital sensors
2. Implementation of PWM and PLL techniques for control applications
3. Implementation of communication protocols in embedded applications
4. Study on different power saving modes of embedded processors
5. Implementation of multitasking control systems using RTOS.
6. Mini project

Total P= 60

21EA07 VLSI DESIGN AND TESTING

3 0 0 3

BASIC ELECTRICAL PROPERTIES OF MOS AND CMOS CIRCUITS: VLSI design process -Introduction to MOS devices-characteristics - Second order effects - MOS models - NMOS inverter - Depletion mode and enhancement mode pull ups – CMOS inverter - DC characteristics - Inverter delay - Pass transistor - Transmission gate – Power consumption in CMOS gates. (8)

LAYOUT DESIGN RULES AND LOGIC DESIGN: CMOS based design rules - Simple layout examples - Sheet resistance - Area capacitance - Wiring capacitance - Driving large capacitive loads. Switch logic - Pass transistor and transmission gate based design - Gate logic - Other forms of CMOS logic . Structured design - Combinational logic design examples - Parity generator - Multiplexers ; Clocked sequential circuits - Two phase clocking - Charge storage - Dynamic register element - NMOS and CMOS - Dynamic shift register - Semistatic register - JK flip flop circuit. Design of a ALU subsystem - Implementing ALU functions with an adder - Multipliers (14)

FAULT MODELS AND FAULT SIMULATION: Need for testing - Fault models - Fault detection and redundancy - Combinational circuits – Sequential circuits - Fault equivalence - Fault dominance – Logic simulation - Compiler driven Simulation - Event driven Simulation - Fault simulation techniques - Serial, parallel, deductive.
TESTING FOR SINGLE STUCK-AT FAULTS: Test generation algorithms for combinational circuits - Fault oriented ATG – D-algorithm – Examples – PODEM – Fault independent ATG - Random test generation – ATG for SSFs in sequential circuits - TG using iterative array models - Random test generation. (14)

DELAY TEST AND DESIGN FOR TESTABILITY: Delay test problem – Path delay test – Transition faults – Delay test methodologies. Adhoc design for testability techniques - Controllability and Observability by means of scan registers – Storage cells for scan designs – Level Sensitive Scan Design (LSSD) - Partial Scan – Boundary scan – BIST concepts and architectures (9)

Total L: 45

REFERENCES:

1. Kamran Eshraghian, Douglas A Pucknell, and Sholeh Eshraghian, “Essentials of VLSI Circuits and Systems”, Prentice Hall of India, New Delhi, 2018.
2. Neil H E Weste, David Money Harris, " CMOS VLSI Design: A Circuits and Systems Perspective ",Pearson, Chennai, 2017..
3. Abramovici M., Brever A. and Friedman D., "Digital Systems Testing and Testable Design", Jaico Publishing House, 2014.
4. Xiaoqing Wen, Cheng Wen Wu and Laung Terng Wang, “VLSI Test Principles and Architectures: Design for Testability”, Elsevier, 2013.
5. Michael L Bushnell and Vishwani D Agarwal, “Essentials of Electronic Testing for Digital, Memory and Mixed Signal Circuits”, Springer, 2002.

21EA08 INTERNET OF THINGS

3 1 0 4

FUNDAMENTALS OF IoT: Introduction to Internet of Things (IoT) – Machine to Machine (M2M) – Functional Characteristics – Recent Trends in the Adoption of IoT – Societal Benefits of IoT – Consumer IoT vs Industrial Functional Components of a typical IoT System: Sensors, Actuators, Embedded Computation Units, Communication Interfaces , Software Development . (9+3)

IoT PROTOCOLS: Physical and Data Linnk Layer Protocols: RFID: NFC, FFC, ZigBEE, Bluetooth Low Energy, Z-Wave, Wi-Fi, LoRA - Network Layer Protocols: IPv4, IPv6, TCP & UDP, 6LoWPAN - Application Layer Protocols: COAP, MQTT.(13+4)

CLOUD COMPUTING: NIST Visual Model – Essential Characteristics –Components of Cloud Computing - Service Models – Deployment Models – Service Management and Security – Examples – Basics of Fog Computing (11+4)

IoT SECURITY AND APPLICATIONS: IEEE 802.11 Wireless Networks Attacks: Basic Types, RFID Security – Security Issues in ZigBEE: Bluetooth Security: Threats to Bluetooth Devices and Networks - IoT Applications**:** Health Care, Connected Vehicles, Smart Grid, Smart Home, and Smart City (12+4)

Total: L:45 + T:15= 60

REFERENCES:

1. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and Sons Ltd, UK, 2014.
2. Olivier Hersent, David Boswarthick and Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, John Wiley and Sons Ltd., UK 2012.
3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, “Architecting the Internet of Things”, Springer, New York, 2011.
4. Johnny Cache, Joshua Wright and Vincent Liu, “Hacking Exposed Wireless: Wireless Security Secrets and Solutions”, Tata McGraw Hill, New Delhi, 2010.
5. Vijay Madisetti, Arshdeep Bahga, “Internet of Things (A Hands-on Approach), Universities Press, 2015.

21EA82 AUDIT COURSE II
vide Automotive Engineering 21AE82

21EA61 MODELING AND SIMULATION LABORATORY

0 0 4 2

LIST OF EXPERIMENTS

1. Simulation of CMOS Digital Circuits using SPICE
2. Simulation of CMOS Analog circuits using SPICE
3. Design and implementation of state feedback controller for regulatory and tracking applications.
4. Implementation of state estimator on the simulated model.
5. Generation, visualization, spectral analysis, and filtering of DT signals
6. Mini project

Total P= 60

21EA62 ELECTRONIC SYSTEM DESIGN LABORATORY

0 0 4 2

LIST OF EXPERIMENTS

1. Design and Simulation of Digital Circuits using System Verilog.
2. Layout of Simple NMOS/CMOS Circuits.
3. Implementation of Digital Circuit Testing Algorithms.
4. Applications using DSP Processors.
5. Verification of Digital circuits using System Verilog
6. Mini Project.

Total P= 60

21EA63 INDUSTRIAL VISIT AND TECHNICAL SEMINAR

vide Automotive Engineering 21AE63

21EA71 PROJECT WORK – I

vide Automotive Engineering 21AE71

21EA81 PROJECT WORK – II

Vide Automotive Engineering 21AE81

PROFESSIONAL ELECTIVE THEORY COURSES (Four to be opted)

21EA21 ALGORITHMS FOR VLSI DESIGN AUTOMATION

3 0 0 3

INTRODUCTION TO DESIGN METHODOLOGIES: VLSI Design problem-The Design Domains-Design methods and Technologies. (3)

ALGORITHMIC GRAPH THEORY AND COMPUTATIONAL COMPLEXITY: Data structures for the representation of graphs - Computational Complexity - Graph Algorithms - Depth first search - Breadth first search - Dijkstra's shortest path algorithm - Prim's algorithm. (8)

PLACEMENT, PARTITIONING AND FLOOR PLANNING: Circuit representation - Types of Placement Problem- Placement Algorithms- Constructive Placement, Iterative Improvement - Partitioning - Kernighan - Lin Partitioning algorithm - Floor Planning - Representation - Shape functions and floor plan sizing. (11)

ROUTING: Local routing problems - Area routing - Channel routing- Channel Routing Models, The Vertical Constraint Graph, Horizontal Constraints and the Left-edge Algorithm, Channel Routing Algorithms - Global routing - Standard-cell, Building-block Layout and Channel Order, Algorithms for Global Routing. (11)

SIMULATION: Gate level modeling and simulation - Compiler driven simulation - Event driven simulation - Switch-level modeling and simulation. (6)

HIGH LEVEL SYNTHESIS: Hardware models - Allocation - Assignment - Scheduling - Assignment Problem - High level transformation. (6)

Total L: 45

REFERENCES :

1. SabihH.Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 2011.
2. WayneWolf," Modern VLSI Design: Systems on Chip Design", Pearson Education Inc., Indian Reprint, 2007.
3. NaveedSherwani, " Algorithms For VLSI Physical Design Automation ", Springer-Verlag, 2013.

4. Sadiq M Sait and Habib Youssef, "VLSI Physical Design Automation", IEEE Press, New York., 2010.
5. Abramovici M, Brever A and Friendman D, "Digital Systems Testing and Testable Design", Jaico Publishing House, 2014.

21EA22 ANALOG VLSI DESIGN

3 0 0 3

ANALOG CIRCUIT BUILDING BLOCKS: Switches, Active Resistors, Current Sources and Sinks, Current Mirrors – Simple. Wilson, Cascode, Folded – Cascode. Voltage and Current References – General biasing circuits for analog design – Supply Independent biasing, Temperature independent biasing, Bandgap voltage references , Comparators, Multipliers. (11)

CMOS SINGLE STAGE AMPLIFIERS: MOS inverting amplifier, Improving the performance of inverting amplifier. Single stage MOS amplifiers. T- CS stage, CG stage , Source Follower, Frequency response of amplifiers (11)

CMOS MULTI STAGE AMPLIFIERS: Cascode and Folded cascode stage, Current amplifiers, output amplifiers, Differential amplifiers, CMOS operational amplifiers, uncompensated and compensated Op Amps, Noise performance of Op-Amps, Op-Amp design techniques with examples. High performance CMOS Op-Amps. (9)

SWITCHED CAPACITOR FILTERS: Introduction to Switched capacitor filters, Switched capacitor resistors. (3)

DATA CONVERTERS: Data Converter fundamentals, DAC Architectures: Current Switched, Resistive, charge redistribution, Hybrid, Segmented D/A Converters. ADC architectures: Flash, Pipeline, Integrating, Successive Approximation and folding A/D Converters. (8)

FIELD PROGRAMMABLE ANALOG ARRAY (**FPAA):** Overview of analog design – Introduction to Field Programmable analog array (FPAA) and its advantages – Role of EDA tool in Analog Design process. (3)

Total L : 45

REFERENCES:

1. Phillip Allen and Douglas Holberg, “CMOS Analog Circuit Design”, Oxford University Press, 3rd Edition, Reprint September, 2014.
2. Behzad Razavi, “Design of CMOS Integrated Circuits”, Tata McGraw Hill, New Delhi, 2011.
3. Roubik Gregorian, Gabor C. Temes, “Analog MOS Integrated Circuits for Signal processing”, John Wiley & Sons, 2013.
4. David A Johns and Ken Martin, “Analog Integrated Circuit Design”, John Wiley and Sons, 2002, 2nd Edition, 2011.
5. Jacob Baker R, Lee H W and Boyce D E, “CMOS Circuit Design, Layout and Simulation”, Prentice Hall of India, 2nd Edition, 2010.

21EA23 HARDWARE DESIGN VERIFICATION TECHNIQUES

3 0 0 3

VERIFICATION TECHNIQUES: Introduction – Testing Versus Verification – Design and Verification reuse. Techniques based on simulation – Analytical and Formal approaches – Function verification – Timing verification – Formal verification – Basic of equivalence checking and model checking. (10)

VERIFICATION TOOLS: Linting Tools – Simulators – Waveform viewers – Code Coverage – Functional Coverage – Metrics.
VERITIFCATION PLAN: Levels of verification – Verification Strategies – Test cases – Test benches. (13)

STIMULUS AND RESPONSE: Reference signals – Simple stimulus – Simple output – Complex Stimulus and response – Transaction Level Interface. (11)

ARCHITECTING TEST BENCHES: Test Harness – VHDL Test Harness – Design Configuration – Self Checking Test benches – Directed stimulus – Random stimulus – VHDL configuration management. (11)

Total L: 45

REFERENCES:

1. Andreas Meyer, “Principles of Functional Verification”, Newnes, 2009.
2. Samir Palnitkar, “Design Verification with e”, Pearson Education, 2008.
3. Janick Bergeron, “Writing Test Benches: Functional Verification of HDL Models” Springer 2007.
4. M Kemal Inan and Robert P Kurshan, “Verification of Digital and Hybrid Systems”, Springer Verlag, 2000.
5. Thomas Kropf “Introduction to Formal Hardware Verification”, Springer Verlag, 1999.

21EA24 ASIC DESIGN

3 0 0 3

INTRODUCTION TO ASICS, CMOS LOGIC AND ASIC LIBRARY DESIGN: Types of ASICs - Design flow - CMOS transistors CMOS Design rules - Combinational Logic Cell – Sequential Logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort - Library cell design - Library architecture . (11)

PROGRAMMABLE ASICS :Anti fuse - static RAM - EPROM and EEPROM technology - PREP benchmarks - Actel ACT - Xilinx LCA - Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks. (11)

PROGRAMMABLE ASIC INTERCONNECT, PROGRAMMABLE ASIC DESIGN SOFTWARE AND LOW LEVEL DESIGN ENTRY: Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Design systems - Logic Synthesis - Half gate ASIC -Schematic entry - Low level design language – Introduction to PLA tools. (7)

LOGIC SYNTHESIS, SIMULATION AND TESTING : VHDL and logic synthesis - types of simulation -boundary scan test - fault simulation automatic test pattern generation. (6)

ASIC CONSTRUCTION, FLOOR PLANNING, PLACEMENT AND ROUTING : System partition - FPGA partitioning - partitioning methods - floor planning - placement - physical design flow - global routing - detailed routing - special routing - circuit extraction-EMI/EMC considerations- ASIC failures and work arounds. (10)

Total L: 45

REFERENCES:

1. Smith M.J.S, - " Application - Specific Integrated Circuits " - Addison -Wesley Longman Inc., 2013.
2. Chu P., “FPGA Prototyping by VHDL Examples”, Wiley, 2008.
3. Andrew Brown, - " VLSI Circuits and Systems in Silicon", McGraw Hill, 1991.
4. Francis R.J., Rose J., Vranesic Z.G., Brown S.D., “Field Programmable Gate Arrays " - Springer Verleg, 2007.
5. Mohammed Ismail and Terri Fiez, " Analog VLSI Signal and Information Processing ", Mc Graw Hill, 1994.

21EA25 SYSTEM ON CHIP

3 0 0 3

INTRODUCTION: System trade-offs and evolution of ASIC Technology – System on chip concepts and methodology – SoC design issues – SoC challenges and components. (4)

DESIGN METHODOLOGIC FOR LOGIC CORES: SoC Design Flow – On-chip buses – Design process for hard cores – Soft and firm cores – Designing with hard cores, soft cores – Core and SoC design examples. (8)

DESIGN METHODOLOGY FOR MEMORY AND ANALOG CORES: Embedded memories – Simulation modes – Specification of analog circuits – A to D converter – D to A converter – Phase-locked loops – High speed I/O (11)

DESIGN VALIDATION: Core level validation – Test benches- SoC design validation – Co-simulation – Hardware/software co-verification. (11)

SOC TESTING: SoC Test issues – Testing of digital logic cores – Cores with boundary scan – Test methodology for design reuse – Testing of microprocessor cores – Built in self test method – Testing of embedded memories. Case Studies. (11)

Total L: 45

REFERENCES:

1. Rajanish K Kamat, Santosh A Shinde, Vinod G Shelake, “Unleesh the System-on-Chip using FPGAs and Handle C, Spinger 2009.
2. Laung-Terng Wang, Charles E Stroud and Nur A Toubq, “System on Chip Test Architectures: Nanometer Design for Testability”, Morgan Kaufmann, 2008.
3. Wgel Badawy, Graham A Jullien, “System-on-Chip for Real-Time Applications”, Kluwer Academic Press, 2003.
4. Rochit Rajsuman, “System-on-a-chip: Design and Test”, Artech House, London, 2000.

21EA26 / 21EE24 COMPUTER ARCHITECTURE AND PARALLEL PROCESSING

3 0 0 3

FUNDAMENTALS OF COMPUTER DESIGN: Register transfer language –Micro-operations- Control unit implementation - Arithmetic for computers: Binary arithmetic unit – BCD arithmetic unit – Floating point arithmetic unit-Memory Hierarchy - Main memory –Interleaved memory – Associative memory - Virtual memory systems – Structure – Paging – TLB – Segmentation – Replacement strategies – Cache memory: Basic cache structure – Replacement policies – Multiple caches – Memory management hardware. (12)

INSTRUCTION-LEVEL PARALLELISM: Trends towards parallel processing- Parallelism in uniprocessor systems- Parallel processing mechanisms- Parallel computer structure- Architectural classification schemes –Instruction level parallelism: Pipelining and Handling Hazards - Instruction Scheduling - Static and Dynamic Branch Prediction - Hardware Based Speculation – Multi-threading- Limitations of ILP. (11)

VECTOR, SIMD AND GPU ARCHITECTURES: Basics of vector processing Architecture -Issues in vector processing- SIMD architecture- SIMD Instruction Set -GPU Architecture - Detecting and Enhancing Loop Level Parallelism. (11)

MULTIPROCESSOR AND MUTLICORE ARCHITECTURES: Functional structures: Loosely and Tightly coupled Multiprocessors – Processor characteristics for multiprocessing – Symmetric Multiprocessors (SMP) – Non-Uniform Memory Access (NUMA) – Interconnection structures for multiprocessors – Cache coherence– Symmetric and distributed shared memory architecture – Homogeneous and Heterogeneous Multi-core architectures-INTEL Multi-core architecture. (11)

Total L: 45

REFERENCES:

1. Mano, M.M., "Computer System Architecture", Pearson Publishers, 3rd Edition, 2013.
2. Stallings W., "Computer Organisation and Architecture – Designing for performance", Pearson Publishers, 9th Edition, 2014.
3. Kai Hwang and Faye A Briggs., "Computer Architecture and Parallel Processing", McGraw Hill Book Company, 2016.
4. John Hennessy and David Patterson, "Computer Architecture: A Quantitative approach", Elsevier India Publishers, 5th Edition, 2017.
5. David A. Patterson, John L. Hennessy, "Computer Organization and Design MIPS Edition: The Hardware/Software Interface", Morgan Kaufmann,2014.

21EA27 / 21EE35 INTERNET WORKING AND ITS APPLICATIONS

3 0 0 3

INTERNETWORKING: Overview of Internetworking, Underlying networking technologies, Concept and Architectural model, Protocol layering – LAN Fundamentals – Wired LANS– Wireless LANS : IEEE 802.11, Bluetooth - Connecting Devices : Hub, Switches, Routers, Access point, Wireless Router (10)

NETWORK AND TRANSPORT LAYER PROTOCOLS : Network layer protocols : IPv4 Datagram Format, IPv4 Addresses, Forwarding IP packets, Subletting -ICMPv4 – DHCP -Next Generation IP, Transport layer protocols - Transmission Control Protocol (TCP)- Connection Establishment and closing- Data transfer- Sliding window protocol – User Datagram Protocols (UDP) (10)

APPLICATION LAYER PROTOCOLS AND NETWORK SECURITY : Simple Mail Transfer Protocol (SMTP) – Multipurpose Internet Mail Extension (MIME) – World Wide Web and HTTP – FTP - Remote login : Telnet, Electronic Mail -Areas of Network Management – SNMP – SMI – MIB - ASN.1, Introduction to network security – Confidentiality – Message Integrity - Message Authentication - Digital Signature– HTTPS- Entry Authentication - Key management – Internet Security – Firewall (12)

MULTIMEDIA APPLICATIONS & MOBILE NETWORKS: Multimedia Networking Applications, Streaming stored video, Voice over IP, Protocols for real-time conversational applications, network support for multimedia.
Cellular Networks - Evolution of Mobile Networks-1G, 2G,3G,4G,5G and 6G.Working principles of GSM, GPRS, UMTS and LTE (13)

Total L : 45

REFERENCES:

1. James F. Kurose, Keith W.Ross, "Computer Networking – a Top Down Approach" Pearson 2012.
2. Doughlas Comer, "Internetworking with TCP/IP : Principles, Protocols and Architecture", Prentice Hall, New Delhi, 2006
3. Jack L. Burbank, Julia Andrusenko, Jared S. Everett, William T. M. Kasch, "Wireless Networking: Understanding Internetworking Challenges", Wiley-IEEE Press, 2013
4. Behrouz A Forouzan and Firouz Mosharraf, "Computer Network – a Top Down Approach", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.
5. Jochen Burkhardt, Horst Henn, Stefan Hepper, Klaus Rindtoroff, Thomas Schaeck, "Pervasive Computing – Technology and Architecture of Mobile Internet Applications" Pearson 2012.

21EA28 REAL-TIME OPERATING SYSTEMS

3 0 0 3

REAL-TIME SYSTEMS: Basic Terminologies of Real-Time Embedded Systems – Concepts of OS-based Software Development – Real-Time Operating Systems: Definition, Characteristics and Structure – Task Management: Definition, Classification, Structure, States, and Scheduling – RMA – EDF – Aperiodic Task Scheduling (12)

INTER-TASK SYNCHRONIZATION AND COMMUNICATION: Critical Sections – Atomic Operation – Concept of Reentrancy – Semaphores – Event Flag Registers – Mailbox - Message Queues - Pipes – Common Design Problems: Premature Task Deletion, CPU Starvation, Deadlocks, and Unbounded Priority Inversion – Resource Access Control Protocols. (12)

INTERRUPT MANAGEMENT, I/O SUBSYSTEMS AND MEMORY MANAGEMENT: Exceptions and Interrupts – Processing of Exceptions and Interrupts – I/O Sub-systems – Memory Management – Dynamic Memory Allocation and Fixed-size Memory Allocation in Embedded Systems (10)

REAL-TIME KERNEL DESIGN ISSUES: Structure of a typical Real-Time Kernel - Data Structures –List Management – Kernel Primitives - Standards for Real-Time Operating Systems – Survey of Commercial Real-Time Operating Systems – Free RTOS, Micrium OS, VxWorks. (11)

Total L: 45

REFERENCES:

1. Giorgio C. Buttazzo, “Hard Real-Time Computing Systems”, Springer, New York, 2011.
2. Jane W. Liu, “Real-Time Systems”, Pearson, New Delhi, 2006.
3. Qing Li, “Real-Time Concepts for Embedded Systems”, CMP Books, 2003.
4. Jean J. Labrosse, “ µC/OS-III, The Real-Time Kernel”, Micrium Press, 2009.
5. Insup Lee, Joseph Leung, and Sang Son, “Handbook of Real-Time Systems”, Chapman and Hall, 2008.

21EA29 LINUX ARCHITECTURE AND DEVICE DRIVERS

3 0 0 3

INTRODUCTION: Evolution of Linux OS – Main characteristics of Linux – Typical Linux distributions – Linux directory structure – User and super/root users – access rights – Home directory – Vi editior - Commands – Overview of shell and GUI. (11)

LINUX KERNAL ARCHITECTURE: Layer diagram of OS - Hardware Abstraction Layer (HAL) – Memory manager – scheduler – file system – I/O subsystem – Networking subsystem – IPC – user space (11)

LINUX FILE SYSTEM: Layers of Linux file system – structure of inode – process file system – The Ext2 File system –System programming concepts – API & ABIs – C library and compiler. (11)

DEVICE DRIVER: System start up (Booting) Methods **-** PC I/O architecture – classification of Linux devices: character and block devices – port I/O – PCI and ISA bus – polling, interrupt, and waiting queue – Device Files - Device driver Registration – Device driver initialization – I/O operation - typical Linux driver – dynamic and static drivers - kernel modules – Linking and unlinking of modules – On Demand modules linking. (12)

Total L: 45

REFERENCES:

1. Michael beck, Harald bohme, Mirko dziadzka, Ulrich Kunitz "Linux Kernel Programming", Pearson Education, 2002.
2. Raghavan P., Amol Lad, Sriram Neelakandan “Embedded Linux System Design and Development”, Tailor & Francis Group, 2006
3. Daniel P.Bovet, Marco Cesati “Understanding the Linux kernel”, Shroff publishers & distributors Pvt Ltd, 2005,
4. Robert Love “ LINUX System Programming” Shroff publishers & distributors Pvt Ltd,2007.
5. Tim jones M. “ GNU/Linux Application Programming”, Wiley Dreamtechindia Pvt. Ltd, New Delhi, 2005.

21EA30 / 21EM30 VIRTUAL INSTRUMENTATION SYSTEMS

3 0 0 3

INTRODUCTION: Concept of virtual instrumentation, virtual instrumentation model, design flow with graphical system design, graphical data flow programming - Modular programming, repetition and loops, arrays, clusters, plotting data, structures, strings, state machines –file I/O- creating LabVIEW executables and projects. (12)

DATA ACQUISITION: DAQ hardware configuration, DAQ hardware– Sampling and grounding techniques- analog I/O, digital I/O, counter/timer, DAQ software architecture, network data acquisition. Application design using Real Time Targets: PXI, cRIO. (11)

INSTRUMENT INTERFACES: Virtual Instrumentation Software Architecture (VISA), instrument drivers, serial and parallel interfaces: RS232, USB, firewire, controller area network (CAN), GPIB, Industrial Ethernet. OLE for Process Control (OPC) (11)

ADVANCED FEATURES IN LabVIEW: System identification and control design, signal processing, image acquisition and processing, data logging and supervisory control, LabVIEW Interface for processor, case studies on machine vision, control, GSD applications. (11)

Total: L: 45

REFERENCES:

1. Gary Johnson and Richard Jennings, “LabVIEW Graphical Programming”, McGraw Hill Inc., 2006.
2. Rick Bitter, Taqi Mohiuddin and Matt Nawrocki, “LabVIEW Advanced Programming Techniques”, CRC Press, 2009.
3. Jovitha Jerome, “Virtual Instrumentation using LabVIEW”, PHI Learning Pvt. Ltd, New Delhi, 2010.
4. Sanjay Gupta and Joseph John, “Virtual Instrumentation Using LabVIEW”, Tata McGraw-Hill, 2008.
5. Mathivanan, N. “PC-Based Instrumentation”, PHI Learning Pvt. Ltd, New Delhi, 2009.

21EA31/21EM31 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

3 0 0 3

ARTIFICIAL INTELLIGENCE: Introduction, AI Fundamentals, Intelligent Agents: Structure of Agents – Environments, Problem Solving Agents: Formulating Problems - Searching for Solutions - Search Strategies, Informed Search Methods, Game Playing. (11)

KNOWLEDGE, REASONING, AND PLANNING: Logical Agents: Knowledge-Based Agents –Logic- Propositional Logic, First-Order Logic: Representation - Syntax and Semantics of First-Order Logic, Knowledge Engineering, Inference in First-Order Logic ,Logical Reasoning Systems, Planning: Representations for Planning – Example and Algorithm. (12)

MACHINE LEARNING: Definition of learning systems, problems, data, Visualizationtools, Goals and applications, types of learning, hypothesis space and inductive bias, Decision tree learning, Linear regression, Model representation for single variable, Single variable Cost Function, Gradient Decent for Linear Regression. (11)

ARTIFICIAL NEURAL NETWORKS: Representation – Convolutional neural networks , Dual Representations, Constructing Kernels, Gaussian Processes, Maximum Margin Classifiers, Relevance Vector MachinesRecurrent Networks –Evaluating hypothesis, Bayesian learning, Computational learning theory. (11)

Total L: 45

REFERENCES:

1. Stuart Russsel and Peter Norvig, " Artificial Intelligence – A Modern Approach", Pearson Education, New Delhi, 2020
2. Elaine Rich, Kevin Knight, & Shivashankar B Nair, Artificial Intelligence, McGraw Hill, 3rd ed.,2019
3. Tom Mitchell, "Machine Learning", McGraw Hill, 2017.
4. Ethem Alpaydın, "Introduction to Machine Learning", Prentice Hall of India, New Delhi, 2014.
5. Ameet V Joshi, "Machine Learning and Artificial Intelligence", Springer, 2020

21EA32 / 21EE42 / 21ED34 / 21EM32 OPTIMIZATION TECHNIQUES

3 0 0 3

LINEAR PROGRAMMING: Statement of Optimization problems, Graphical method, Simplex method, Revised simplex method, Two phase simplex method, Duality in linear programming, Sensitivity analysis. (12)

NON-LINEAR PROGRAMMING (UNCONSTRAINED OPTIMIZATION): Direct search methods - Univariate method, Pattern search method, Simplex method, Descent methods - Steepest Descent method, Conjugate gradient method, Quasi Newton method. (11)

NON-LINEAR PROGRAMMING (CONSTRAINED OPTIMIZATION): Direct methods - The Complex method, Zoutendijk's Method of Feasible Directions, Rosen's Gradient Projection Method , Indirect method - Transformation Techniques, Basic Approach of the Penalty Function Method, Interior Penalty Function Method, Exterior Penalty Function Method. (11)

DYNAMIC PROGRAMMING: Multistage decision process, Suboptimization and Principle of Optimality, Computational procedure, Final value problem to initial value problem, Linear Programming as a Case of Dynamic Programming, Continuous dynamic programming. (11)

Total L:45

REFERENCES:

1. Hamdy A Taha, "Operations Research: An Introduction", Pearson Education, New Delhi, 2012.
2. Singaresu S Rao, "Engineering Optimization: Theory and Practice", New Age International, New Delhi, 2011.
3. David.G.Luenberger, Yinyu Ye, "Linear and Nonlinear Programming", Springer, Newyork,2015.
4. Gupta C B, "Optimization Techniques in Operations Research", I K International, New Delhi, 2012.
5. Sharma J K, "Operations Research: Theory and Applications", Macmillan Company, New Delhi, 2013.

21EA33 / 21EE36 WIRELESS SENSOR NETWORKS

3 0 0 3

CHARACTERISTICS OF WSN: Characteristic requirements for WSN, Challenges for WSNs, WSN vs Adhoc Networks, Sensor node architecture, Commercially available sensor nodes, Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations. (11)

MEDIUM ACCESS AND ROUTING: Fundamentals of MAC protocols, Low duty cycle protocols and wakeup concepts, Contention based protocols, Schedule-based protocols: SMAC - BMAC - Traffic-adaptive medium access protocol (TRAMA), The IEEE 802.15.4 MAC protocol. Routing and Data Gathering Protocols, Routing Challenges and Design Issues in Wireless Sensor Networks, Flooding and gossiping, Data centric Routing, Energy aware routing, Hierarchical Routing, Real Time routing Protocols. (12)

NETWORK MANAGEMENT AND LOCALIZATION: Network Management Requirements – Network Management Design Issues –Naming and addressing: Fundamentals-Address and Name Management in WSN- Assignment of MAC addresses-Localization and positioning: Properties - Possible approaches- Proximity-Trilateration and Triangulation. - Coverage and connectivity, Single-hop and multihop localization, Self-configuring localization systems, Sensor management. (11)

OPERATING SYSTEMS AND APPLICATIONS: Operating Systems for Wireless Sensor Networks, Design Issues, Examples of Operating Systems: TinyOS – Mate – MagnetOS – MANTIS. WSN Applications, Home Control, Building Automation, Medical Applications, - Reconfigurable Sensor Networks, Civil and Environmental Engineering Applications Nanoscopic Sensor Applications, Case Study: IEEE 802.15.4 LR-WPANs Standard - Target detection and tracking - Contour/edge detection - Field sampling. (11)

Total L: 45

REFERENCES:

1. Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2015.
2. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2015.
3. K. Akkaya and M. Younis, "A survey of routing protocols in wireless sensor networks", Elsevier Ad Hoc Network Journal, Vol. 3, No. 3, pp. 325—349,2005.
4. Anna Ha´c, "Wireless Sensor Network Designs", John Wiley & Sons Ltd, 2007
5. Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, "Wireless Sensor Network", Springer, 2004

21EA34 BIOSIGNAL PROCESSING

3 0 0 3

BIO SIGNALS: Nature of Biomedical signals, Types: Action Potential, Electroneurogram (ENG), Electromyogram (EMG), Electrocardiogram (ECG), Electroencephalogram (EEG), Electrogastrogram (EGG), Phonocardiogram (PCG), Photoplethysmography (PPG). (11)

FILTERING FOR REMOVAL OF ARTIFACTS: Stationary versus non-stationary processes, Noise in event-related potentials, High-frequency noise in the ECG, Motion artifact in the ECG, Power-line interference in ECG signals, Maternal interference in fetal ECG, Time domain filters, Frequency domain filters, Optimal filtering: The wiener Filter, Adaptive filters for removal of Interference, Application: Removal of Artifacts in the ECG. (12)

MODELING STOCHASTIC SIGNALS: Random Processes, Mean and Autocorrelation function of a Random Processes, Stationarity and Ergodicity, General Linear Processes, Yule-Walker Equations, Autoregressive (AR) Processes, Moving Average (MA) Processes, Autoregressive- Moving Average(ARMA) Processes, Harmonic Processes. (12)

SIGNAL COMPRESSION: Direct Digital compression Techniques, Transformation Compression Techniques, Other Compression Techniques and Comparison. (10)

Total L : 45

REFERENCES:

1. Rangaraj M. Rangayyan, "Biomedical Signal Analysis, A case study Approach," IEEE Press, 2014.
2. Joseph D Bronzino, "The Biomedical Engineering Handbook, CRC Press, IEEE Press, 2000, 3rd Edition, May 2006.
3. D.C. Reddy, "Biomedical Signal Processing, Principles and Techniques", Tata McGraw Hill, New Delhi, 2012.
4. Kenneth E Banner and Gonzalo R Arce, "Nonlinear Signal & Image Processing – Theory methods & Applications", CRC Press, New York, 2004.
5. Eugene N. Bruce "Biomedical signal processing and signal modeling" Wiley series, 2007.

21EA35 WAVELETS AND APPLICATIONS

3 0 0 3

WAVELETS: Vector spaces–Relationship between functions, Sequences, Vectors–Properties–Fourier transform and non-stationary signals –Limitations–Review of sampling theorem.
Haar wavelet: Analysis of Haar wavelet in function of scale and time– Haar multiresolution Analysis: Analysis part and Synthesis part–Frequency domain analysis of Haar filter bank.
Daubechies Family: Calculation of scaling function–Daub-4 and Daub–6 design details. (12)

CONTINUOUS WAVELET TRANSFORM: The uncertainty principle–Time-bandwidth product–Time-Frequency tiling–STFT and wavelets–CWT-Comparison of STFT and CWT–Interpretation of spectrogram plot– Reconstruction and Admissibility–Discreitization of scale. (11)

DISCRETE WAVELET TRANSFORM: Dyadic MRA–Theorem–Inverse DWT computation–Bi-orthogonal and orthogonal filter banks–Construction of Orthogonal filterbank–Variants of MRA: Splines and Wavelet packets.
Other wavelet families: Mortlet, Mexican Hat, and Gabor–Multi-dimensional wavelets: 2-D Haar wavelet transform. (12)

APPLICATIONS: Review and demonstration of different wavelet applications: Compression–Denoising–Analysis of biomedical signals and power signals. (10)

Total L: 45

REFERENCES:

1. Vikram M Gadre, and Aditya S Abhyankar, "Multiresolution and Multirate Signal Processing", McGraw Hill Education, 2017.
2. Mallat S., "A Wavelet Tour of Signal Processing: The Sparse Way", 3rd Edition, Academic Press, 2009.
3. Rao, R.M and A.S.Bopardikar,"Wavelet Transforms: Introduction to Theory and Applications, Addison Wesley, Reprint 2003.
4. Gilbert Strang, and Truong Nguyen, "Wavelets and Filter Banks", Wellesley-Cambridge Press, 1997.

5. K.P.Soman and K.I.Ramachandran “Insight into Wavelets-From Theory to Practice”, Prentice Hall of India, 2010.

21EA36 ELECTRONIC PRODUCT DESIGN

3 0 0 3

STAGES OF PRODUCT DESIGN: Identifying Customer needs - Product Design Specification (PDS) - Concept design: Generation of ideas - Evaluation of concept - Design development: Technical drawings – Prototypes - Detail design: Exploring materials - Exploring manufacturing techniques - Testing and Refinement – Production - Design Education – Design Thinking – Design Rights. (11)

ELECTRONIC SYSTEM DESIGN: Design Considerations for Different Types ofPCBs - Layout Rules and Parameters. Design Rule Checks - System architecture development - Trade-off analysis- Cost modelling - Circuit design - Physical and mechanical design- Electronic packaging**:** Packaging Hierarchy, Driving Forces on Packaging Technology, Materials for Microelectronic Packaging, IC packaging,Types of Packaging-Discrete Components-Board to board connectors – substrates-Escape routing-PCA/module design metrics (11)

ELECTROMAGNETIC COMPATIBILITY & MECHANICAL DESIGN: Design for testability (DFT) and Design for manufacturability (DFM) - Design for circuit reliability - Electromagnetic fields and human health – EMC Control - Laws and Regulators – EMC Design: Grounding and shielding – Emission Suppression – Susceptibility hardening–EMI and EMC Testing - EMI shielding -Thermal management: High level thermal analysis, thermal issues in devices -mechanical integration. (11)

DESIGN QUALITY AND STANDARDS: Tolerance Design - Tolerance analysis - Design margins- Quality control - Quality assurance- Quality functional deployment- Quality in the design process- Concurrent design – Safety and Risk analysis- Quality in production–Green Design -Standards used for PCB Design and fabrication -RFI and Safety Standards - CE marking, ROHS compliance. (12)

Total L: 45

REFERENCES:

1. Tony Ward and James Angus, “Electronic Product Design”, Chapman and Hall publications,1996.
2. Bert Haskell, “Portable Electronics Product Design and Development: For Cellular Phones, PDAs, Digital Cameras, Personal Electronics and More”, McGraw-Hill, 2010.
3. Tim Williams “EMC for Product Designers”5th Edition, Copyright@2017 Elsevier Ltd.
4. Paul Rodgers and Alex Milton, “Product Design”, Laurence King Publishing Ltd, UK, 2011.
5. V. S. Bagad, ‘ Electronic Product Design’, Fourth Edition, Technical Publications, Pune, 2009.

21EA37 DIGITAL IMAGE PROCESSING

3 0 0 3

IMAGE FORMATION AND ENHANCEMENT: Human visual system–Sampling and Quantization–Color fundamentals–Spatial domain processing–Simple image operations–Point wise intensity transformations- Histogram processing - Linear and non-linear noise smoothening- Sharpening-Derivatives–Laplacian–Combing spatial enhancement methods. (11)

FREQUENCY TRANSFORMS AND APPLICATIONS: Frequency domain processing– 2-D transforms: DFT, DCT, and DWT–Properties–Frequency domain filtering techniques–Sub band coding of image compression– Coding techniques: Huffman, Run length, and Block transform–JPEG–Performance metrics. (11)

IMAGE RESTORATION AND RECONSTRUCTION: Image degradation–Noise models–Image observation models- Spatial filtering: mean filters, order statistics filters, adaptive filters- Inverse filtering- Wiener filtering – Constrained least squares filtering. Image Reconstruction from projections–Radon transform and it’s Application. (11)

SEGMENTATION AND FEATURE EXTRACTION: Edge detection: Gradient operators-edge linking and boundary detection: Global processing via Hough transforms, Graph theoretic techniques – Thresholding techniques–K-means Clustering–Feature extraction: Boundary feature descriptors–Region feature descriptors–Principal components– SIFT.Object Recognition applications. (12)

Total L: 45

REFERENCES:

1. Gonzalez R.C. Woods R.E, “Digital Image Processing”, Fourth edition, Pearson, 2017.
2. Jain A.K., ”Fundamentals of Digital Image Processing”, Prentice Hall of India, 2010.
3. S. Jayaraman, S. Esakkirajan, T. Veerakumar, “Digital Image Processing”, Tata McGraw Hill, 2011.
4. S.Sridhar, “Digital Image Processing”, Oxford University Press, 2nd Edition, 2016.
5. William K Pratt, “Digital Image Processing”, Wiley , 4th Edition, 2007

21EA38 / 21EE45 SOFT COMPUTING

3 0 0 3

FEED FORWARD NETWORKS AND SUPERVISED LEARNING: Fundamentals – Biological neural network – Artificial neuron – Activation function – Learning rules - Perceptron Networks – Adaline – Madaline – Back propagation networks - Hopfield network – Discrete Hopfield networks – Associative memories – Recurrent auto association memory – Bi-directional associative memory. (12)

UNSUPERVISED LEARNING NETWORKS: Hamming networks – Self-organising feature maps – Adaptive resonance theory network – Instar model – Outstar model – Counter propagation network – Boltzman machine. (11)

FUZZY SETS AND RELATIONS: Properties and Operations on Classical and Fuzzy Sets - Crisp and Fuzzy Relations - Cardinality, Properties and Operations, Composition, Tolerance and Equivalence Relations - Fuzzy Ordering - Simple Problems. ,Features of membership function - Standard forms and Boundaries - fuzzification - membership value assignments - Fuzzy to Crisp Conversions - Lambda Cuts for fuzzy sets and relations – Defuzzification methods. (11)

GENETIC ALGORITHMS AND SOFT COMPUTING APPLICATIONS: Introduction –Genetic operators – Selection, cross-over and mutation – Fitness function – A simple genetic algorithm – Applications, .Application of Neural Networks: Pattern Recognition - Image compression – Control systems, Applications of Fuzzy Logic: Fuzzy Clustering - Fuzzy Image Analysis - Fuzzy Logic controller. (11)

Total L: 45

REFERENCES:

1. Sivanandam S N, and Deepa S. N., “Principles of Soft Computing”, Wiley India (P) Ltd.,New Delhi,2nd Edition, June 2011.
2. Sivanandam S N, Sumathi S., and Deepa S. N., “Introduction to Neural Networks using Matlab 6.0”, Tata McGrawHill Publications, New Delhi, 20th reprint 2014.
3. LaureneFausett, “Fundamentals of Neural Networks”, Pearson Education India, New Delhi, 2004.
4. Timothy Ross, “Fuzzy Logic with Engineering Applications”, McGraw Hill, Singapore, 3rd Edition, 2010.
5. David E Goldberg, “Genetic Algorithms in Search, Optimisation and Machine Learning”, Pearson Education, New Delhi, 2004.

21EA39 / 21EE23 / 21EM39 INDUSTRIAL DRIVES FOR AUTOMATION

3 0 0 3

DYNAMICS OF ELECTRIC DRIVES: Fundamental torque equation- multi-quadrant operation- nature and classification of load torques- modes of operation. **Induction Motor Drives**: Construction-Principle – performance characteristics – stator voltage control, frequency control, v/f control, rotor resistance control, static rotor resistance control, slip power recovery: Static Krammer drive, Static Scherbius drive. (12)

VECTOR CONTROL OF INDUCTION MOTOR DRIVES: Introduction to Park’s and Clarke’s transformation- Principle of vector control-Direct vector control-indirect vector control- stator flux oriented vector control- rotor flux oriented vector control– sensorless control- Direct torque control. (12)

SPECIAL DRIVES: BLDC-principle, controllers; PMSM-principle-PMSM flux density distribution-Controller– SynRM-principle-magnetic flux density and operating point- converter VA requirements. (10)

CONFIGURATIONS OF I/O CONTROL: AC drive Hardware Blocks – Control Blocks – Automatic Motor Adaptation – Parameterization of Drives (Local and Remote).Digital input and output- Analog input and Output control- word access- motion control- sequential logic control(SLC)- parameterization of different communication protocol: RS 485 – MODBUS – PROFIBUS. (11)

Total L : 45

REFERENCES:

1. Gopal K Dubey, "Fundamentals of Electric Drives", Narosa Publishing House, New Delhi, 2005
2. Bimal K Bose, "Power Electronics and Variable Frequency Drives - Technology and Application", IEEE Press, New York 1997
3. Peter Vas, "Vector Control of AC Machines", Oxford University Press, 1990
4. John Park, Steve Mackey and Edwin Wright, "Data Communications for Instrumentation and Control", Elsevier 2003
6. Ned Mohan, “Advanced Electric Drives: Analysis, Control and Modeling using Simulink”, John Wiley and Sons Ltd, 2001.

21EA40 / 21EM40 PYTHON PROGRAMMING

3 0 0 3

BASICS OF PYTHON PROGRAMMING : Variables - Keywords - Strings and Numeric Data Types - Lists – Tuples - Sets - Dictionaries - Control Statements**:** if Statement, Relational Operators, Logical Operators, Bit Wise Operators, while Loop, break and continue, for Loop – Functions: - Scope - Passing Functions to a Function - Mapping Functions in a Dictionary – Lambda – Modules - Standard Functions. (12)

OBJECT ORIENTED FEATURES AND I/O HANDLING: Classes - Principles of Object Orientation - Creating Classes – Instance Methods – Special Methods - Class Variables – Inheritance – Polymorphism - Type Identification – Data Streams - Access Modes - Writing Data to a File - Reading Data from a File - Additional File Methods - Using Pipes as Data Streams. (10)

ERROR HANDLING AND REGULAR EXPRESSIONS: Run Time Errors - Exception Model - Exception Hierarchy - Handling Multiple Exceptions - Handling IO Exceptions **-** Regular Expressions**:** Simple Character Matches - Special Characters - Character Classes – Quantifiers - Dot Character - Greedy Matches – Grouping - Matching at Beginning or End - Match Objects – Substituting - Splitting a String - Compiling Regular Expressions. (11)

APPLICATIONS USING PYTHON: Network programming-Database Access- Creating simple Graphical User Interfaces - Sending e-mail using SMTP Library-Multithreading-CGI Programming - Extensions- Micropython - Web application development: opening an URL-creating a simple web page- Overview of webapp2 and Flask (12)

Total L: 45

REFERENCES:

1. Wesley J Chun, “Core Python Applications Programming”, Prentice Hall, 2012.
2. Mark Summerfield. “Programming in Python 3: A Complete introduction to the Python Language”, Addison-Wesley Professional, 2009.
3. Andreas C. Müller , Sarah Guido, “Introduction to Machine Learning with Python: A Guide for Data Scientists” , O’Reilly, 2016.
4. Sumit Gupta “Building Web Applications with Python and Neo4j”,Packt publishers,2015
5. Ron DuPlain, “ Instant Flask Web Development “,Packt publishers ,Second edition ,2013

21EA41 / 21EE31 / 21EM41 AUTOMOTIVE EMBEDDED SYSTEMS

3 0 0 3

INTRODUCTION: Current trends in modern automobiles – – Drive by wire Systems -Vehicle functional domains and their requirements - Components of an Automobile Electronic system and their functions: Sensors, Actuators, Control Units and Software structure of Control units (9)

POWER TRAIN, BODY AND CHASSIS DOMAIN: Power Train Domain: Gasoline engine management -Body Electronics: Vehicle power supply controllers – Lighting technology– Adaptive lighting system – Automatic wiper system – Door control modules - Vehicle to vehicle communication - Chassis Domain: Antilock Braking System (ABS) – Electronic Stability Program (ESP) (12)

AUTOMOTIVE INFOTRONICS AND SAFETY & SECURITY SYSTEMS: Automotive Vision System - Advanced Driver Assistant Systems (ADAS) – Multimedia systems- Intelligent Automotive Systems: Navigation Systems – Adaptive Cruise Control (ACC) - Active and Passive safety- Airbag System – Seat belt tightening system - Electronic Brake Force Distribution (EBD) - Lane Departure Warning System - Anti-theft technologies – Electronic Immobilizers – Remote Keyless entry. (12)

AUTOMOTIVE NETWORKING AND DIAGNOSTICS: Cross-system functions - Bus systems: Requirements, classification and applications – Review of CAN – LIN – Flexray - MOST On-Board Diagnostics – Off-board diagnostics – Diagnostics Link Connector – Vehicle Condition Monitoring - Diagnostic Interfaces – Connected Vehicles (12)

Total L:45

REFERENCES:

1. Nicolas Navet and Francoise Simonot-Lion, “Automotive Embedded Systems Handbook”, CRC Press, USA, 2008.
2. Robert Bosch,” Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive (Bosch Professional Automotive Information)”, 5th Edition, Springer Vieweg, 2013.
3. LjuboVlacic, Michel Parent & FurnioHarshima, “Intelligent Vehicle Technologies: Theory and Applications”, Butterworth-Heinemann publications, 2001.
4. Robert Bosch, “Automotive Hand Book”, SAE (5TH Edition),2000.
5. William Ribbens “Understanding Automotive Electronics- An Engineering Perspective”, 8th Edition, Butterworth-Heinamann, 2017.

21EA42 / 21EM42 MACHINE VISION

3 0 0 3

LOW-LEVEL VISION -Images and Imaging Operations -Basic Image Filtering Operations - -Thresholding Techniques - Edge Detection - Corner and Interest Point - Mathematical Morphology Texture. (9)

INTERMEDIATE-LEVEL VISION - Binary Shape Analysis-Boundary Pattern Analysis - Line Detection - Circle and Ellipse Detection -The Hough Transform -Image Transformations and Camera Calibration–Motion. (12)

REAL-TIME PATTERN RECOGNITION SYSTEMS - Automated Optical Inspection - Inspection of Cereal Grains -In-Vehicle Vision Systems Statistical Pattern Recognition -Image Acquisition -Real-Time Hardware and Systems Design Considerations Epilogue. (12)

MACHINE VISION WITH LabVIEW - Dimension Measurement Using Coordinate System - Geometric Matching - Binary Shape Matching - Binary Particle Classification - Contour Analysis -Image Calibration and Correction . (12)

Total L:45

REFERENCES:

1. E.R. Davis, “Computer and Machine Vision: Theory, Algorithms, Practicalities” , ,4th revised edition, Academic Press, 2012
2. Carsten Steger, Markus Ulrich, Christian Wiedemann, “Machine Vision Algorithms and Applications”, Wiley publisher, 2018
3. Kye-Si Kwon, Steven Ready, “Practical Guide to Machine Vision Software;An Introduction with LabVIEW”, Wiley publisher, 2015
4. Alexander Hornberg, “Handbook of Machine and Computer Vision; The Guide for Developers and Users”,Wiley,2017
5. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, Cengage Learning, 2015

21EA43 / 21EM43 DIGITAL CONTROL ENGINEERING

3 0 0 3

BASIC DIGITAL SIGNAL PROCESSING IN CONTROL SYSTEMS : Sampling theorem, quantization, aliasing and quantization error, hold operation, mathematical model of sample and hold, zero and first order hold, factors limiting the choice of sampling rate, reconstruction. (10)

MODELING OF SAMPLED DATA CONTROL SYSTEM : Difference equation description, Z-transform method of description, pulse transfer function, time and frequency response of discrete time control systems, stability of digital control systems, Jury's stability test, state space description, first companion, second companion, Jordan canonical models, discrete state variable models (elementary principles only). (12)

DESIGN OF DIGITAL CONTROL ALGORITHMS : Review of principle of compensator design, Z-plane specifications, digital compensator design using frequency response plots, discrete integrator, discrete differentiator, development of digital PID controller, transfer function, design in the Z-plane. (12)

PRACTICAL ASPECTS OF DIGITAL CONTROL ALGORITHMS: Algorithm development of PID control algorithms, standard programmes for microcontroller implementation, finite word length effects, choice of data acquisition systems, microcontroller based temperature control systems, microcontroller based motor speed control systems, DSP implementation of motor control system. (11)

Total L : 45

REFERENCES:

1. John J. D'Azzo, Constantive Houpios, “Linear Control System Analysis and Design", Mc Graw Hill,NewYork,2005.
2. M.Gopal, "Digital Control and Static Variable Methods", Tata McGraw Hill, New Delhi, 2009.
3. Benjamin.C.Kuo, “Digital Control System”, Holt, Rinehart and Winston, 2007
4. Katsuhiko Ogata, “Discrete-time Control Systems”, Prentice Hall International, 2007
5. Franklin G.F., Powell J.D., and Workman M.L., “Digital Control of Dynamic Systems”, Ellis-Kagle Press, 2006.

21EA44 / 21EM44 ROBOTICS AND ITS APPLICATIONS

3 0 0 3

INTRODUCTION: Industrial and Service Robots -Industrial robot-classifications- specifications, Forward and Inverse Kinematics-Link co-ordinates, D-H Representation, Arm equation -Two axis and three axis, robots**,** Inverse kinematics of two axis and three axis robots, Maneuverability – Workspace – Control. (10)

ROBOT CONTROL AND SENSORS: Control of robot manipulator -state equations -constant solutions -linear feedback systems, single-axis PID control -PD gravity control -computed torque control, variable structure control –introduction to programming-ROS-QTCreator. Sensors**:** Encoders, proximity and range sensors, ultrasonic, touch and slip sensors. Vision systems. (13)

ACTUATORS AND ROBOT END EFFECTORS : Robotic drives and actuators -electric, hydraulic, pneumatic -selection. End effectors -classification -mechanical, magnetic, vacuum and adhesive grippers. Gripper force analysis and gripper design. Work space analysis and motion analysis -pick and place operation. (12)

APPLICATIONS: Robots and their applications in industry, mobile and service applications. Robotic material handling, material transfer, machine loading and unloading. Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications, Robot centered cell and factors influencing the choice of a robot (10)

Total L : 45

REFERENCES:

1. Robert J Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, New Delhi,2013.
2. Mikell. P. Groover, Michell Weis, Roger. N. Nagel, Nicolous G. Odrey, "Industrial Robotics Technology, Programming and Applications ", McGraw Hill Int., 2012.
3. Richard D Klafter Thomas A.Chmielewski and Michael Negin, "Robotic Engineering: An Integrated approach", Prentice Hall of India, New Delhi,2010.

4. Corke, Peter, “Robotics, Vision and Control Fundamental Algorithms in MATLAB”, Springer,2017.
5. Mark R Miller, Rex Miller, “Robots and Robotics: Principles, Systems, and Industrial Applications”, McGraw-Hill Education,2017.

21EA45 / 21EM45 SENSORS, ACTUATORS AND INTERFACE ELECTRONICS

3 0 0 3

RESISTIVE AND REACTIVE SENSORS: General concepts and terminology, measurement systems, Resistive sensors: potentiometers, strain gages, resistive temperature detectors, magneto resistors, light-dependent resistors, Signal conditioning for resistive sensors: Wheatstone bridge, sensor bridge calibration and compensation, Instrumentation amplifiers, sources of interference and interference reduction, Reactance variation and electromagnetic sensors, capacitive sensors, differential, inductive sensors, linear variable differential transformers (LVDT), magneto elastic sensors, hall effect sensors, Signal conditioning for reactance-based sensors & application to the LVDT. (12)

SELF-GENERATING SENSORS: Self-generating sensors: thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors, Signal conditioning for self-generating sensors: chopper and low-drift amplifiers, offset and drifts amplifiers, electrometer amplifiers, charge amplifiers, noise in amplifiers. (11)

ACTUATORS DRIVE CHARACTERISTICS AND APPLICATIONS : Relays, Solenoid drive, Stepper Motors, Voice-Coil actuators, Servo Motors, DC motors and motor control, 4-to-20 mA and 0 -10 V Drive, Hydraulic actuators, variable transformers: synchros, resolvers, Inductosyn, resolver-to-digital and digital-to-resolver converters. (11)

DIGITAL SENSORS AND SEMICONDUCTOR DEVICE SENSORS : Digital sensors: position encoders, variable frequency sensors – quartz digital thermometer, vibrating wire strain gages, vibrating cylinder sensors, saw sensors, digital flow meters, Sensors based on semiconductor junctions: thermometers based on semiconductor junctions, magneto diodes and magneto transistors, photodiodes and phototransistors, sensors based on MOSFET transistors, CCD/CMOS imaging sensors, ultrasonic sensors, fiber-optic sensors, biometric sensors. (11)

Total L : 45

REFERENCES:

1. Andrzej M. Pawlak, “Sensors and Actuators in Mechatronics: Design and Applications”, CRC Press, 2006.
2. E.O. Doeblin, “Measurement System : Applications and Design”, McGraw Hill publications, 2017.
3. Ian Sinclair, “Sensors and Transducers”, Elsevier, 3rd Edition, 2011.
4. Ramon PallásAreny, John G. Webster, “Sensors and Signal Conditioning”, 2nd edition, John Wiley and Sons, 2000.
5. Clarence W. de Silva, “Sensors and Actuators: Control System Instrumentation”, CRC Press , 2007

21EA46 / 21EM46 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

3 0 0 3

EMI/EMC FUNDAMENTALS: Concepts of EMI and EMC-Definitions and Units of parameters- Electromagnetic environment-Elements of Interference, Sources and Victims of EMI, Mechanisms of EMI generation - Conducted and Radiated EMI emission and susceptibility. (11)

EMI COUPLING PRINCIPLES: Conducted, radiated and transient coupling-Common ground impedance coupling –Common mode and ground loop coupling -Differential mode coupling –Near field cable to cable coupling-Field to cable coupling –Power mains and Power supply coupling-Cross talk in transmission lines-Transients in transmission lines. (11)

EMI MITIGATION TECHNIQUES: Shielding-Filtering-Grounding-Electrical Bonding-EMI Suppression Cables-EMC connectors-Isolation transformer-Transient suppressors and Surge Suppression Devices – EMI Mitigation techniques for PCB. (12)

EMI MEASUREMENTS AND STANDARDS: Open area test site Measurements-Measurement Precautions-Anechoic Chamber-TEM cell-Reverberating Chamber, GTEM cell-Comparison of test facilities-Civilian standards: IEC, CISPR, FCC, EN, Military standards: MIL 461/46. (11)

Total L : 45

REFERENCES:

1. V.P.Kodali,”Engineering EMC principles, Measurements and Technology”, IEEE Press, Network, Wiley-Blackwell, SecondEdition,2016.
2. Clayton R. Paul, “Introduction to Electromagnetic compatibility”, John Wiley &Sons,2014.
3. DavidA. Weston, “Electromagnetic compatibility: Methods, Analysis, Circuits and Measurements’’ Third Edition, CRC Press, 2016.
4. Henry W. Ott, “Electromagnetic Compatibility Engineering”, John Wiley & Sons Inc, Newyork, 2009
5. Kenneth L Kaiser, “The Electromagnetic Compatibility Handbook”, CRC Press, 2005.

OPEN ELECTIVES

21EA91 / 21ED91 / 21EE91 BUSINESS ANALYTICS

3 0 0 3

Introduction: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution, Data Modeling, Sampling and estimation methods overview – Business Analytics Personnel, Data and models for Business analytics (11)

Business Analytics Techniques: Descriptive Analytics – Problem solving- Visualizing and Exploring Data-Important Resources – Business Analytics Technology- Predictive analytics, Predicative Modeling, Trendiness and Regression Analysis: Modelling Relationships and Trends in data – simple Linear Regression. (10)

Data Mining and Decision Analysis: Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.
Data Mining: Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modeling, nonlinear Optimization.
Decision Analysis: Formulating Decision Problems, Decision Strategies with without Outcome Probabilities-Decision Trees, The Value of Information, Utility and Decision Making (12)

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models., Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, News vendor Model, Overbooking Model, Cash Budget Model. Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Story telling and Data journalism (12)

Total: 45 Periods

References

1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey,"Business Analytics Principles, Concepts, and Applications: What, Why, and How", PearsonFTPress, 2014.
2. James R. Evans, "Business Analytics", Pearson Education, 2019.
3. Daniel T. Larose, Chantal D. Larose "Data Mining and Predictive Analytics", Wiley,2015
4. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulachi, "Introduction to Time Series Analysis and Forecasting" , Wiley,2015
5. Max Kuhn,Kjell Johnson, "Applied Predictive Modeling", Springer, 2014

21EA92 / 21ED92 / 21EE92 ELECTRONIC WASTE MANAGEMENT

3 0 0 3

Introduction: Electronic Waste - E-waste Life Cycle - E-waste Material Flow Model - Overview of E-waste Management – Current Practices of E waste management : Basel Convention, G-8 3Rs Initiative, StEP - Solving the E-waste, UNEP/ DTIE (IETC), GeSI: Global e-Sustainability Initiative- E-Waste Management Rules of India (2011 and 2016 Rules). (11)

E-Waste Collection systems: Collection Channels: Retailer Take Back and Storage, Producer Take Back and Storage, Municipal Collection and Storage, Other Collection Points - Collection Infrastructure - Guiding principles for design and formulation of technical specifications of Ewaste collection points (11)

Technologies for E-waste Management: E-waste Treatment Systems- First Level E-waste Treatment - Second Level E-waste Treatment :CRT treatment technology -Third Level E-waste Treatment - Environmental Impacts of the first, second and third level E-waste treatment system (12)

Recovery from E-Waste: Resource recovery from E-waste for environmental sustainability - Bio-recovery of precious metal nanoparticles from electronic waste - Recovery of waste printed circuit boards through pyrometallurgy - Life Cycle Assessment - LCA applications for Electronics – Case studies. (11)

Total: 45 Periods

References:

1 Johri R., "E-waste: implications, regulations, and management in India and current global best practices", TERI Press, New Delhi, 2008.
2 Majeti Narasimha Vara Prasad, Meththika Vithanage, "Electronic Waste Management and Treatment Technology", Butterworth-Heinemann, Elsevier, 2019
3 Anish Khan, Muenuddin Inamuddin, Abdullah M. Asiri, "E-waste Recycling and Management", Springer, 2020
4 Electronic Waste Management Rules 2016, Govt. of India, available online at CPCB website.
5 E Waste management Manual, UNEP, 2007

21EA93 / 21ED93 / 21EE93 INDUSTRIAL SAFETY AND STANDARDS

3 0 0 3

Introduction to Industrial Safety: Introduction-Industrial processes and hazards potential, mechanical electrical, thermal and process hazards. Safety and hazards regulations, Industrial hygiene. Factories Act, 1948 and Environment (Protection) Act, 1986 and rules thereof. The Electricity Act,2003, CEA(MSES)Regulations,2010 for Electrical Safety, National electrical Code-2017, National Building code 2016 - NFPA-70, E-OSHA Stadards, IEEE standards, "5 S" concepts, concepts of Total Protective Maintenance (TPM) - Preventive and protective management from fires and explosion, relief systems – relief valves, flares, scrubbers. Leaks and Leakages - Spill and leakage of liquids, vapors, gases and their mixture from storage tanks and equipment; Estimation of leakage/spill rate through hole, pipes and vessel burst; Release of toxics and dispersion. Mitigation measures for leaks and releases. (11)

Toxicology: Hazards identification-toxicity, fire, static electricity, noise and dust concentration; Material safety data sheet, hazards indices- Dow and Mond indices, hazard operability (HAZOP) and hazard analysis (HAZAN). Electrical Hazards - Hazardous area classification and classification of electrical equipments for hazardous areas - Electrical Hazards – Energy leakage – Clearance and insulation – Excess energy – Current surges – Electrical causes of fire and explosion – National electrical Safety code. (11)

Electrical Safety and Safety Components: Fundamentals of Electrical safety-Electric Shock- physiological effects of electric current - Safety requirements -Review of Electrical concept, Electrostatic – Electro magnetism – Stored energy – Typical supply situation. Introduction to conductors and insulators- voltage classification -safety against over voltages- safety against static electricity-Electrical safety equipments - Fire extinguishers for electrical safety. General first aid- Safety in handling hand held electrical appliances tools. (11)

Safety Practices and Safety Regulations: Electrical safety in train stations-swimming pools, external lighting installations, medical locations. Grounding - General requirements for grounding and bonding- System grounding-Equipment grounding - Earthing practices. Selection of Environment, Protection and Interlock. Safety in the use of portable tools Standards for Electrical Safety - Electricity Acts- Rules & regulations- Electrical standards-NFPA 70 E-OSHA standards-IEEE standards-National Electrical Code 2005 – National Electric Safety code NESC-Statutory requirements from electrical inspectorate – Factories Act, Safety regulations - Product safety – case studies (12)

Total L : 45 hours

REFERENCES:

1. John V.Grimaldi, Safety Management, AITB S Publishers, 2003.
2. Safety Manual, EDEL Engineering Consultancy, 2000.
3. David L.Goetsch, Occupational Safety and Health for Technologists, 5th Edition, Engineers and Managers, Pearson Education Ltd., 2005.
4. Kenneth G.Mastrullo, Ray A. Jones, “The Electrical Safety Program Book”, Jones and Bartlett Publishers, London, 2nd Edition, 2011
5. Palmer Hickman, “Electrical Safety-Related Work Practices”, Jones & Bartlett Publishers, London, 2009.
6. Massimo A.G.Mitolo, “Electrical Safety of Low-Voltage Systems”, McGraw Hill, USA, 2009.
7. John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, “Electrical Safety Hand book, McGraw-Hill, New York, USA, 4th edition, 2012.

21EA94 / 21ED94 / 21EE94 INNOVATION AND PRODUCT DEVELOPMENT

3 0 0 3

Innovation Management: Introduction – Innovation and Invention – Types of Innovation – Models of Innovation – Innovation as a management process – Entrepreneurship and innovation – Frugal Innovation – Innovation Diffusion theories. (11)

Design Thinking: Creativity and Thinking Design – Thinking For strategic innovations – DT Process – Empathy for Design – Human Centered Design – Customer Journey mapping – Multi-why – Design Inspired Innovation and User Innovation – Activities on Customer Journey Mapping and Empathy Map. (11)

Product Planning: Business Models – Range of business models – Parts of business models –Consideration in designing business models – Licensing business models – Product planning – Product strategy – Differentiation and Positioning – Benchmarking – Creative Techniques and Tools for Concept Generation and Concept Evaluation in Product Design – Activities on Business modeling and Benchmarking. (11)

New Product Development: Innovation and NPD Consideration on NPD – Growth strategy – NPD theories – Models of NPD – Human Factors and Ergonomics in Product Design – New Service Innovation – Types of Services – Classification of Service Innovations – Service Innovation and Consumer – Prototype development - Testing of new products – Activities on Product Design and Prototype development (12)

Total : 45 periods

References:

1. Paul Traut, “Innovation Management and New Product Development”, Pearson, 2017
2. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.