SEMESTER I

18EA01/18EE01/18ED01/18EM01 MATHEMATICS OF SYSTEMS ENGINEERING

2 2 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. (8+7)

LINEAR TRANSFORMATIONS: General linear transformations, kernel and range, inverse linear transformations, matrices of general linear transformations, eigenvalues and eigenvectors, diagonalization. (8+7)

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+7)

STOCHASTIC PROCESSES: Classification. Markov chain: Transition probability matrices – Chapman Kolmogorov equations - classification of states, limiting probabilities, Poisson process - continuous time Markov chains: Birth-death processes. (8+7)

Total L:32 +T:28 = 60

REFERENCES:

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

18EE02 /18EA02/18EM02 EMBEDDED CONTROLLERS AND APPLICATIONS

3 0 0 3

8051: 8051 microcontroller – Architecture – Instruction sets – Addressing modes – I/O ports – Timer/Counter – Serial Communication – Interrupts – Assembly language programming. (11)

PIC18F: PIC18f Micro-controller – Device overview – Pin diagrams. PIC18f micro-controller memory organization – Special Function Registers - I/O ports – Timers – Capture/ Compare/ PWM modules (CCP). Analog to Digital Converter module – Instruction set – Oscillator selection – Reset – Interrupts – Watch dog timer – PIC microcontroller programming. (11)

ARM7: ARM7TDMI – Architecture overview - Processor modes – Data types – Registers – Program status registers – ARM Instruction Set – Thumb Instruction Set – Simple programs. (11)

REAL WORLD INTERFACING: Master Synchronous Serial Port ((MSSP) structure - Detail study of UART, SPI, I2C, ADC and Comparators, Interfacing of PIC18F serial port - ADC using I2C. - RTC using I2C. – Design of data acquisition System - frequency counter with display on LCD - Digital Multimeter - DC motor control using PWM with signal. (12)

REFERENCES:

1. William Hohl and Christopher Hinds, “ARM Assembly Language Fundamentals and Techniques”, CRC Press, Second Edition, 2015.
2. Danny Causey, Muhammad Ali Mazidi and Rolin D. McKinlay, “PIC Microcontroller & Embedded System: Using Assembly and C for PIC18”, Pearson Education India, 2008.
3. MykePredko, “Programming and Customizing the PIC Microcontroller”, Tata McGraw Hill, 3rd Edition, 2008.
4. Mazidi M.A., Mazidi J.G. and McKinlay R.D., “The 8051 Microcontroller and Embedded Systems”, Prentice Hall India, 2nd Edition, New Delhi, 2007.
5. “ARM System Developer's Guide, Designing and Optimizing System Software”, Andrew Sloss Dominic Symes Chris Wright, 1st Edition, 2004.
6. John B. Peatman, “Design with PIC Microcontrollers”, Prentice Hall, 2003.

18EE03 REAL-TIME CONCEPTS FOR EMBEDDED SYSTEMS

3 0 0 3

PROGRAMMING LANGUAGE AND TOOLS FOR EMBEDDED SOFTWARE DEVELOPMENT: Fundamentals of Embedded Systems – Embedded Software Development Process: Programming Languages - Embedded C Building Blocks – Mixing of Assembly and C – Preprocessor - Compiler – Assembler - Linker and Loader - Cross Platform Development -Compiler Optimization Techniques – Executable File Formats-Concept of Make Utility - Super Loop based Design Approach (12)

REAL-TIME OPERATING 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 – Concept of Pseudo Multitasking and True Multitasking (11)

INTER-TASK SYNCHRONIZATION AND COMMUNICATION: Critical Sections – Atomic Operation – Concept of Reentrancy – Semaphores – Event Flag Registers - Inter-task Communication Methods: Shared Memory Technique, Mailbox, Message Queues, and Pipes – Common Design Problems: Premature Task Deletion, CPU Starvation, Deadlocks, and Unbounded Priority Inversion (11)

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 - Application Modularization for Concurrency: Outside-In Approach – UML Diagrams - Design Examples (11)

Total L: 45

REFERENCES:

1. Bernd Bruegge, Allen Dutoit, "Object-oriented Software Engineering – Using UML, Patterns and Java", Prentice Hall, USA, 2010.
2. Insup Lee, Joseph Leung, and Sang Son, "Handbook of Real-Time Systems", Chapman and Hall, 2008.
3. Qing Li, "Real-Time Concepts for Embedded Systems", CMP Books, 2003.
4. Albert Cheng, "Real-Time Systems: Scheduling, Analysis and Verification", Wiley Interscience, 2002.
5. David E. Simon, "An Embedded Software Primer", Addison-Wesley Professional, 1999

18EE04 / 18EA03 DIGITAL SYSTEM DESIGN AND TESTING

3 2 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+5)

VERILOG: Signals, Identifier, Net and variable types, Operators, Gate instantiations, Modules and ports, data flow, gate level, Behavioral level, Switch level and state machine modeling, Concurrent and procedural statements, UDP, sub circuit parameters, function and task, timing and delays - test benches - design of combinational and sequential circuits using Verilog. (11+10)

CPLD and FPGA: Complex PLDs (CPLDs) – Xilinx cool runner architecture. Types of Field Programmable Gate Arrays - 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+10)

HARDWARE TESTING AND DESIGN FOR TESTABILITY: Defects, errors, faults, Levels of Fault models, Types, Fault Detection in Combinational Logic circuits: Path sensitization method, Boolean difference method. Fault Detection in sequential logic circuit, Design for Testability: Scan path Testing, Boundary Scan Test, Built in Self Test. (11+5)

(11+10)

Total L: 45 + T: 30 = 75

REFERENCES:

1. Samir Palnitkar, "Verilog HDL : A Guide to Digital Design and Synthesis", Pearson Education Asia, 2014.
2. Charles H Roth and Lizy Kurian John, "Digital Systems Design Using VHDL", Cengage Learning, 2013.
3. Michael D Ciletti, "Advance Digital Design with the Verilog HDL", Prentice Hall of India Learning, 2012.
4. Wayne Wolf, "FPGA - Based System Design", Prentice Hall, New Jersey, 2012.
5. Bhaskar J., "A Verilog Primer", Prentice Hall of India Learning, 2012.
6. Michael L Bushnell, Vishwani D Agrawal, "Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits", Springer, 2002.

18EE05 / 18EA05 / 18ED05 OBJECT COMPUTING AND DATA STRUCTURES

3 2 0 4

.**PRINCIPLES OF OBJECT ORIENTED PROGRAMMING:** Procedure Oriented Programming, Object Oriented Programming paradigm - Basic concepts and benefits of OOP - Object Oriented Language - Applications of C++ - Operators in C++ - Classes and Objects - Manipulators. Functions in C++ - Call by Reference - Return by reference - Inline functions - Default, Const Arguments - Function Overloading - Friend Functions - Member functions - Nesting of Member functions -Private member functions - Static data members - Static Member Functions - Arrays of Objects -Objects as Function Arguments - Friend Functions.
(10+7)

CONSTRUCTORS: Parameterized Constructor - Copy constructor - Multiple Constructors in a Class – Destructors. **Inheritance** - Defining Derived Classes - Single Inheritance - Making a Private Member Inheritable - Multiple Inheritance - Hierarchical Inheritance – Hybrid Inheritance. **Polymorphism** - Compile and Run Time Polymorphism – Operator Overloading - Virtual function. (11+7)

DATA STRUCTURES: Abstract data Types - Primitive data structures - Analysis of algorithms - Best, worst and average case time complexities – Notation. **ARRAYS**: Operations - Implementation of one, two, three and multi dimensioned arrays - Sparse and dense matrices - Applications. **SORTING:** Insertion sort - Selection sort - Bubble sort - Radix sort - Algorithms and their time complexities. (12+7)

LINEAR DATA STRUCTURES: Stacks: Primitive operations - Sequential implementation - Applications: Subroutine handling, Recursion- **Queues:** Primitive operations - Sequential implementation - Applications: Job Scheduling. **Lists:** Primitive Operations - Singly linked lists, Doubly linked lists, Circular lists – Applications: Addition of Polynomials
NON-LINEAR DATA STRUCTURES: Trees: Terminologies - Binary Tree traversal. (12+9)

Total L: 45 + T: 30 = 75

REFERENCES:

1. Herbert Schildt, "C++ - The Complete Reference", Tata McGraw Hill, New Delhi, 2012.
2. Nell Dale, "C++ Plus Data Structures", Jones & Bartlett, Massachusetts, 2011.
3. Harvey M Deitel and Paul J Deitel, "C++ How to Program", Prentice Hall, New Delhi, 2010.
4. Aaron M Tanenbaum, Moshe J Augenstein and Yedidyah Langsam, "Data structures using C and C++", Pearson Education, New Delhi, 2009.
5. Stanley B Lippman, JoseeLajoie and Barbara E Moo, "The C++ Primer", Pearson Education, New Delhi, 2009.
6. SahniSartaj, "Data Structures, Algorithms and Applications in C++", Universities Press, Hyderabad, 2005.

18EE51 EMBEDDED CONTROLLERS LABORATORY

0 0 4 2

List of Experiments

1. On-chip Peripherals Programming in 8051Microcontroller: GPIO, Timers, Serial Port
2. Interfacing of Sensors and Actuators with 8051 Microcontroller
   a) Sensor Interfacing using External ADC
   b) Actuator Interfacing: Relay, DC Motor, Stepper Motor and Servo Motor
3. Interrupts and Low Power Modes in 8051 Microcontroller
4. On-chip Peripherals Programming in ARM7 Microcontroller – GPIO, Timers, RTC, ADC, PWM
5. Serial Communication Protocols in ARM7 Microcontroller: USART, SPI, I^2C
6. Mini Project

Total P: 60

SEMESTER II

18EE06 REAL-TIME OPERATING SYSTEMS

3 0 0 3

REAL-TIME SYSTEMS: Basic Terminologies - Limits of Current Real - Time Systems - Desirable Features of Real-Time Systems – Factors affecting Predictability – Types of Task Constraints: Timing Constraints, Precedence Constraints and Resource Constraints - Classification of Scheduling Algorithms - Metrics for Performance Evaluation - Scheduling Anomalies (10)

UNIPROCESSOR SCHEDULING ALGORITHMS: Periodic Tasks Scheduling: Cyclic Schedulers, EDF, RMA, and DMA - Aperiodic Task Scheduling**:** Jackson's Algorithm, Horn's Algorithm, Bartley's Algorithm, Scheduling of Aperiodic Tasks with Precedence Constraints – Hybrid Task Set Scheduling: Foreground and Background Scheduling, Polling Server, Deferrable Server, Priority Exchange Server, Sporadic Server, and Slack Stealing (13)

RESOURCE ACCESS CONTROL PROTOCOLS: Problems involved in Resource Sharing: Priority Inversion and Deadlock – Deadlock Detection and Avoidance Algorithm - Non-Preemptive Protocol – Highest Locker Priority Protocol – Priority Inheritance Protocol – Priority Ceiling Protocol – Comparison of Resource Access Control Protocols – Handling Task Dependencies (10)

MULTIPROCESSOR SCHEDULING and REAL-TIME KERNEL DESIGN ISSUES: Multiprocessor Task Partitioning and Scheduling Algorithms - 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 – Development Tools – Performance Anlayzers (12)

Total L: 45

REFERENCES:

1. Giorgio C. Buttazzo, "Hard Real-Time Computing Systems", Springer, New York, 2011.
2. Jean J. Labrosse, "µC/OS-III, The Real-Time Kernel", Micrium Press, 2009.
3. Jane W. Liu, "Real-Time Systems", Pearson, New Delhi, 2006.

18EE07 EMBEDDED SYSTEM NETWORKS

3 0 0 3

THE CAN BUS: Introduction – Concepts of Bus Access and Arbitration – Error Processing and Management – Definition of the CAN Protocol ISO 11898-1 – Error Properties, Detection and Processing – Framing - The Rest of the Frame - CAN 2.0B (11)

THE CAN PHYSICAL LAYER: Introduction – Signal Propagation – Bit Synchronisation – Network Speed and Range – High Speed CAN – Low Speed CAN – CAN Components – Event-Triggered and Time-Triggered Protocols - CAN Applications**:** Application Layers and Development Tools for CAN. (11)

LIN, MOST and FLEXRAY: LIN: Introduction - Basic Concept of the LIN 2.0 Protocol - Conformity of LIN – MOST: The MOST (Media Oriented Systems Transport) Bus – General - MOST concept – Flexray: Genesis of FlexRay - FlexRay Consortium - Aim of FlexRay - Physical Time - Local Time - Channels, Cycles, Segments and Slots - Channels and Cycles – Segments - Communication Frames - Symbol Window Segment - Network Idle Time Segment**.** (11)

USB AND TCP/IP FOR EMBEDDED SYSTEMS: Introduction **–** Types of USB Transfers: Control Transfer – Bulk Transfer – Interrupt Transfer – Isochronous Transfer – Introduction to the Enumeration Process – Introduction to USB Development Tools. TCP/IP for Embedded Systems: Introduction – Embedded SMTP Client – Embedded SMTP Server (12)

Total L: 45

REFERENCES:

1. Dominique Paret, “Flexray and Its Applications”, A John Wiley & Sons Ltd., Publication Wiley, 2012.
2. Dominique Paret, “Multiplexed Networks for Embedded Systems”, Wiley, 2007.
3. Jan, Axelson, “USB Complete”, Lake View Research, 2005.
4. Edward Insam, “TCP/IP Embedded Internet Applications”, Elsevier, 2003.
5. Tim Jones, “TCP/IP Application Layer Protocols for Embedded Systems”, Charles River Media, 2002.
6. John Hyde, “USB Design by Example”, Intel University Press, 2001.

18EE08 LINUX ARCHITECTURE AND DEVICE DRIVERS

3 2 0 4

BASIC ARCHITECTURE: 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+10)

LINUX KERNEL ARCHITECTURE: Layer diagram of OS - Hardware Abstraction Layer (HAL) – Memory manager – scheduler – file system – I/O subsystem – Networking subsystem – IPC – user space. (11+6)

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+6)

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+8)

Total L: 45 + T: 30 = 75

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 Dreamtech India Pvt. Ltd., New Delhi, 2005.

18EE09 ADVANCED EMBEDDED CONTROLLERS

3 2 0 4

ARCHITECTURE OF MIXED SIGNAL PROCESSOR: Introduction to 16-bit Mixed Signal Controller- Important aspects of Mixed Signal Controller’s Hardware – CPU – Functional Block Diagram - Memory Mapping – Clock System - Addressing Modes - Register Mode – Indexed Mode – Introduction to functions – Interrupts - Low Power Modes - Development Environment - Programming and Debugging (10+6)

PERIPERALS OF MIXED SIGNAL PROCESSOR: Parallel ports - Digital Inputs/ Outputs – Timers - Watchdog Timer - Capture/Compare module – Generation of Periodic Signal – Generation of PWM Signal - Operation of the ADC Peripheral (ADC10) - Internal Temperature Sensor – Serial Communication Protocols (12+9)

ARCHITECTURE OF ARM CORTEX M_x: ARM Cortex-M_x 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. (11+6)

PERIPHERALS OF ARM CORTEX – Mx CONTROLLER: Cortex-Mx Peripherals - Parallel I/O Ports - Timer Interfacing - Pulse Width Modulation - Frequency Measurement - Binary Actuators - Integral Control of a DC Motor – DAC - ADC - Serial Communication Protocols. (12+9)

Total L: 45 + T: 30 = 75

REFERENCES:

1. Valvano J. W., "Embedded Systems: Real-Time Interfacing ARM Cortex – Microcontrollers", Fourth edition, Volume 2, ISBN: 978-1477508992, 2014.
2. Valvano J. W., "Embedded Systems: Introduction to ARM Cortex-M Microcontrollers", Fourth Edition, Volume 1, ISBN: 978-1477508992, 2013.
3. Ravikumar C.P., "MSP430 Microcontroller in Embedded System Project", First Edition, Elite Publishing House Private Ltd., Dec, ISBN: 978-81-88901-46-3, 2011.
4. John H. Davies, "MSP430 Microcontroller Basics", First Edition, Newnes Publication, ISBN: 978-93-80501-85-7, 2010.
5. Steven F.Barret, Daniel J Pack, "Microcontroller Programming and Interfacing: Texas Instruments MSP430", Morgan & Claypool Publishers, ISBN: 9781608457137
6. Cortex-M4 Devices, Generic User Guide By ARM.

18EE52 REAL-TIME SYSTEMS LAB

0 0 4 2

LIST OF EXPERIMENTS:

1. Creating a Make file for an Embedded Application
2. Task Management and Resource Management using Open Source Real-Time Kernel
3. Inter-task Communication in Open Source Real-Time Kernel
4. Interrupt Management and Memory Management using Open Source Real-Time Kernel
5. Performance Evaluation of Single-core and Multi-core Scheduling Algorithms
6. Mini Project

Total P: 60

18EE61 INDUSTRIAL VISIT & TECHNICAL SEMINAR

0 0 4 2

The student will make at least two technical presentations on current topics related to the specialization. The same will be assessed by a committee appointed by the department. The students are expected to submit a report at the end of the semester covering the various aspects of his/her presentation together with the observation in industry visits. A quiz covering the above will be held at the end of the semester.

Total P: 60

SEMESTER III

18EE53 EMBEDDED SYSTEM DESIGN LABORATORY

0 0 4 2

LIST OF EXPERIMENTS

1. Implementation of Controller Area Network Protocol
2. Development of USB based Driver for an External Storage Device
3. Development of SPI based Driver for Micro SD Card
4. Development of Drivers for Wi-Fi
5. Development of Drivers for Bluetooth Devices
6. Mini Project

18EE71 PROJECT WORK – I

0 0 6 3

- Identification of a problem.
- Literature survey of identified problem.
- Finalization of project specification and requirements
- Presentation / Demonstration of sub block(s) of the Project (Hardware / Software / both)

SEMESTER IV

18EE72 PROJECT WORK – II

0 0 28 14

- Project Implementation (Hardware / Software / both)
- Presentation / Demonstration about the work done
- Consolidated report preparation

PROFESSIONAL ELECTIVE (ELECTIVE 3 Associated with Centre of Excellence)

18EE21 / 18EA22 / 18ED22 / 18EM23 INTERNET OF THINGS

3 2 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+5)

IoT PROTOCOLS: Physical and Data Linnk Layer Protocols: RFID: NFC, FFC, ZigBEE, Bluetooth Low Energy, Z-Wave, Wi-Fi, Wireless HART - Network Layer Protocols: IPv4, IPv6, TCP & UDP, 6LoWPAN - Application Layer Protocols: COAP, MQTT. (13+10)

CLOUD COMPUTING: NIST Visual Model – Essential Characteristics –Components of Cloud Computing - Service Models – Deployment Models – Service Management and Security – Examples – Basics of Fog Computing (12+7)

SECURITY IN IoT: 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 (11+8)

Total L: 45 + T: 30 = 75

REFERENCES:

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

18EE22 / 18EM22 / 18ED23 / 18EA23 TOTALLY INTEGRATED AUTOMATION

3 2 0 4

INTRODUCTION TO FACTORY & PROCESS AUTOMATION: Evolution of Industrial Versions - Control elements of Industrial Automation – IEC / ISA Standards for Control Elements – Selection criteria for control elements – Utilisation Category with IEC standards - Construction of Relay Ladder logic with different control elements - Need for PLC - PLC evolution. (6+3)

PROGRAMMABLE LOGIC CONTROLLERS: Architecture of PLC - Types of PLC – PLC modules, PLC Configuration - Scan cycle - Capabilities of PLC - Selection criteria for PLC – PLC Communication - PLC Wiring - Installation of PLC and its Modules. Types of Programming – Bit Instructions - Timers and counters – PLC arithmetic functions PTO / PWM generation - High Speed Counter – Analog Scaling – Encoder Interfacing - Servo drive control – Stepper Motor Control. (12+13)

HMI SYSTEMS: Need for HMI in Industrial Automation, Types of HMI – Configuration of HMI, Screen development and navigation, Configuration of HMI elements / objects and Interfacing with PLC. (6+7)

NETWORKING: PLC Networking - Networking standards & IEEE Standard - Protocols - Field bus - Process bus and Ethernet – EttherCAT (7+0)

SUPERVISORY CONTROL AND DATA ACQUISITION: Architecture – Tools – Tag Configuration - Internal & External graphics, Alarm logging – Tag logging – structured tags – Trends – history – Report generation (14+7)

Total L: 45 + T: 30 = 75

REFERENCES:

1. Bolton W., "Programmable Logic Controllers", Elsevier Ltd., 2015.
2. Frank D Petruzella, "Programmable Logic Controllers ‖", McGraw Hill, 2011.
3. John R Hackworth and Fredrick D Hackworth Jr., "Programmable Logic Controllers: Programming Methods and Applications ‖", Pearson Education, 2006.

18EE23 INDUSTRIAL DRIVES FOR AUTOMATION

3 2 0 4

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+7)

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+7)

SPECIAL DRIVES: PMSM - principle - PMSM flux density distribution - Controller – SynRM - principle - magnetic flux density and operating point - converter VA requirements. (10+8)

CONFIGURATIONS AND 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+8)

Total L: 45 + T: 30 = 75

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. Miller T. J. E., “Brushless Permanent - Magnet and Reluctance Motor Drives”, Clarendon Press Oxford, 1989.
5. 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.

PROFESSIONAL ELECTIVES

18EE24 / 18EA08 COMPUTER ARCHITECTURE AND PARALLEL PROCESSING

3 0 0 3

REGISTER TRANSFER LANGUAGE AND MICRO-OPERATIONS: Register transfer language – Inter-register transfer - Arithmetic micro-operations – Logic micro-operations – Shift micro-operations – Control functions - Data path Organisation - Binary arithmetic unit – BCD arithmetic unit – Floating point arithmetic unit – Processor bus configuration – Data transfer and manipulation – Hardwired and micro-programmed control. (12)

MEMORY UNIT AND INPUT-OUTPUT UNIT: Memory hierarchy – Main memory – Back-up storage units – Multiple module memories – Interleaved memory – Associative memory - Virtual memory systems – Structure – Paging – TLB – Segmentation – Replacement strategies – Cache memory: Basic cache structure – Direct, fully associative and set associative mapping – Replacement policies – Multiple caches – Memory management hardware - Characteristics of I/O subsystem – Interrupt mechanisms and special hardware – Direct Memory Access – I/O processors and I/O channels – Asynchronous data transfer. (10)

PARALLEL PROCESSING AND PIPELINING: Basic uniprocessor architecture – Parallel processing mechanisms – Levels of parallelism – Balancing of subsystem bandwidth – Parallel computer structures – Architectural classifications – Parallel processing applications - Linear pipelining – Pipeline processors – Instruction and Arithmetic pipelines – Organization of pipelined units – Instruction pre-fetch and branch handling – Pipeline hazards – Reducing branch penalties – Branch prediction strategies – Vector processing: requirements and characteristics – High performance Architectures: Superscalar Architecture – VLIW Architecture. (11)

ARRAY PROCESSING AND MULTIPROCESSOR ARCHITECTURE: SIMD array processors – Masking and data routing mechanisms – SIMD Interconnection networks -Multiprocessor Architecture - 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 – Thread level parallelism – Multithreading – Clusters. (12)

Total L : 45

REFERENCES:

1. John Hennessy and David Patterson, "Computer Architecture: A Quantitative Approach", Elsevier India Publishers, 5th Edition, 2017.
2. Kai Hwang and Faye A Briggs, "Computer Architecture and Parallel Processing", McGraw Hill Book Company, 2016.
3. Stallings W., “Computer Organisation and Architecture – Designing for Performance”, Pearson Publishers, 9th Edition, 2014.
4. Mano M.M., "Computer System Architecture", Pearson Publishers, 3rd Edition, 2013.

18EE25 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. (11)

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) (11)

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 (11)

Total L: 45

REFERENCES:

1. Robert Bosch, “Automotive Electrics Automotive Electronics”, Wiley, 5th Edition, 2010.
2. Nicolas Navet and Francoise Simonot-Lion, “Automotive Embedded Systems Handbook”, CRC Press, USA, 2008.
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. Bechhold, “Understanding Automotive Electronics”, SAE, 1998.

18EE26 GRAPHICAL PROGRAMMING FOR REAL-TIME APPLICATIONS

3 0 0 3

BASICS OF GRAPHICAL PROGRAMMING: Fundamental Concepts of Virtual Instrumentation and Graphical Programming - Data Flow Programming - Data Types – Modular Programming - Debugging Techniques – Customization of VI Properties - VI Documentation
PROGRAMMING STRUCTURES: Formula Nodes - Expression Nodes – Loops – Shift Registers – Feedback Nodes - Local and Global Variables – Case and Sequence Structures – Key Navigation-Dialog Boxes - Arrays and Clusters - Graphs and Charts -Mechanical Action of Boolean Switches - String and File I/O (14)

DATA ACQUISITION AND INTERFACING STANDARDS: Temperature Monitoring System using PC based Data Acquisition System - Motion Control - Image Acquisition and Processing - Communication: RS232 - RS485 - GPIB – System Interface Buses: USB-PXI (9)

ADVANCED PROGRAMMING OPTIONS: Event Driven Programming - Diagram Disable Structures- Sound VI’s- Reentrant VIs- VI server -Web publishing tool- Multithreading in LabVIEW - State Machines – Nest Case Selector- Property Nodes-Invoke Nodes-LabVIEW Interface for Arduino – Introduction to Object Oriented Programming in LabVIEW (10)

REAL-TIME APPLICATIONS: Real-Time Concepts including Determinism and Jitter – Configuration of Real-Time I/O Hardware in MAX - Host & Target VI – Prioritization of Tasks – Timed Programming Structures in LabVIEW Real-Time – Sharing Data between Deterministic & Non-Deterministic Processes – Real-Time Application Deployment using myRIO – Run-time Interaction with Deployed Applications – Running Web Services in myRIO (12)

Total L: 45

REFERENCES:
1. Rick Bitter, Taqi Mohiuddin and Matt Nawrocki, “LabVIEW Advanced Programming Techniques”, CRC Press, 2009.
2. Sanjay Gupta and Joseph John, “Virtual Instrumentation Using LabVIEW”, Tata McGraw Hill, 2008.
3. Garry W Johnson, "LabVIEW Graphical Programming", Tata McGraw Hill, 2001.
4. Barry Paron, "Sensors, Transducers and LabVIEW", Prentice Hall, 2000.

18EE27 INDUSTRIAL NETWORKING AND STANDARDS

3 0 0 3

SERIAL INTERFACE STANDARDS: Modern Instrumentation and Control Systems – Open Systems Interconnection Model – EIA-232 Interface Standard – Major Elements of EIA-232 – Half-Duplex and Full-Duplex operation of EIA-232 Interface – Overview of EIA-422 and EIA-423 Interface Standards - EIA-485 Interface Standard – Comparison of Serial Interface Standards – Noise problems in serial communication and troubleshooting. (11)

HART AND MODBUS PROTOCOL: HART PROTOCOL over 4-20 mA Signal Base – Wireless HART Protocol - **MODBUS:** Modbus Protocol Structure: Data types, Transmission modes, Messaging Structure–Modbus Function Codes- Fault Handling Mechanisms of Modbus Protocol – Applications of Modbus Protocol (11)

FIELD AREA NETWORKING PROTOCOLS: Actuator Sensor Interface: Structure of AS-i slave ICs, AS-i messages, AS-i modulation technique, Troubleshooting - **Device Net:** Physical Layer Topology – Device Taps – Datalink Layer: Frame Format – Medium Access – Fragmentation- Process Field Bus (PROFIBUS) - **Foundation Fieldbus:** Physical Layer and Wiring Rules – Datalink Layer – Application Layer – Error Detection and Diagnostics. (11)

INDUSTRIAL ETHERNET: Overview – Ethernet Hardware Basics – Ethernet Protocol and Addressing – Introduction to10 Mbps, 100 Mbps and Gigabit Ethernet – Real-time Ethernet for Automation Applications – Time-triggered Ethernet – Security in Industrial Communications (12)

Total L: 45

REFERENCES:
1. Perry Marshall and John Rinaldi, “Industrial Ethernet”, The Instrumentation, Systems and Automation Society, 2005.
2. Richard Zurawski, “Industrial Communications Technology Handbook”, CRC Press, 2005.
3. John Park, Steve Mackey, and Edwin Wright, “Data Communications for Instrumentation and Control”, Elsevier, 2003.

18EE28 / 18EA40 INTERNETWORKING AND APPLICATIONS

3 0 0 3

INTERNETWORKING: Overview of Internetworking, Underlying networking technologies, Concept and Architectural model, Protocol layering – LAN Fundamentals – Wired LANS : ETHERNET Protocol – Wireless LANS : 1EEE 802.11, Bluetooth, WiMax - Connecting Devices : Repeaters, Hub, Switches, Routers, Unicast Routing - Multicast Routing (12)

NETWORK PROTOCOLS AND APPLICATIONS: Protocols: Network layer introduction - **Network layer protocols:** IPv4 Datagram Format, IPv4 Addresses, Forwarding IP packets, ICMPv4 – DHCP, Transport layer protocols - Transmission Control Protocol (TCP) – User Datagram Protocols (UDP) - **Applications:** Simple Mail Transfer Protocol (SMTP) – Multipurpose Internet Mail Extension (MIME) – World Wide Web and HTTP – **Remote login:** Telnet, Electronic Mail - Next Generation IP. (11)

NETWORK MANAGEMENET AND SECURITY: Areas of Network Management – SNMP – SMI – MIB - ASN.1, Introduction to network security – Confidentiality – Message Integrity - Message Authentication - Digital Signature – Digital Certification – HTTPS-Entry Authentication - Key management – Internet Security – Firewalls. (11)

MOBILE NETWORKS & MULTIMEDIA COMMUNICATIONS: Mobile phone technologies: different generations, Mobile Internet Protocol, Synchronization and replication protocols, WAP Architecture: Introduction, Components, Infrastructure, Security issues, WAP gateways.
Multimedia Networking Applications, Streaming stored video, Voice over IP, Protocols for real-time conversational applications, network support for multimedia. (11)

Total L: 45

REFERENCES:

1. Behrouz A Forouzan and Firouz Mosharraf, “Computer Network – a Top Down Approach”, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.
2. Jochen Burkhardt, Horst Henn, Stefan Hepper, Klaus Rindtoroff, Thomas Schaeck, “Pervasive Computing – Technology and Architecture of Mobile Internet Applications”, Pearson, 2012.
3. James F. Kurose, Keith W.Ross, “Computer Networking – a Top Down Approach”, Pearson, 2012.
4. Behraouz A Forouzan, “TCP/IP Protocol Suite”, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2011.
5. Doughlas Comer, “Internetworking with TCP/IP : Principles, Protocols and Architecture”, Prentice Hall, New Delhi, 2006.

18EE29 / 18EA33 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)

LOCALIZATION AND MANIPULATION: Localization and positioning, Coverage and connectivity, Single-hop and multihop localization, Self configuring localization systems, Sensor management. Data Storage and Manipulation, Data centric and content based routing, Storage and retrieval in network, Compression technologies for WSN, Data Aggregation Techniques. (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. KazemSohraby, Daniel Minoli and TaiebZnati, “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. Anna Ha´c, “Wireless Sensor Network Designs”, John Wiley & Sons Ltd., 2007
4. 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.
5. Raghavendra, Cauligi S, Sivalingam, Krishna M., ZantiTaieb, “Wireless Sensor Network”, Springer, 2004.

18EE30 WIRELESS AND MOBILE COMMUNICATION

3 0 0 3

PRINCIPLES OF WIRELESS COMMUNICATION: Digital modulation techniques – Linear modulation techniques – Spread spectrum modulation – Performance of modulation – Multiple access techniques – TDMA – FDMA – CDMA – SDMA – Overview of cellular networks – Cellular concept – Hand-off strategies – Path loss – Fading and Doppler effect. (10)

WIRELESS PROTOCOLS: Issues and challenges of wireless networks – Location management – Resource management – Routing – Power management – Security – Wireless media access techniques – ALOHA – CSMA – Wireless LAN – MAN – IEEE 802.11 - Wireless routing protocols – Mobile IP – IPv4 – IPv6 – Wireless TCP -Protocols for 3G & 4G cellular networks – IMT – 2000 – UMTS – CDMA2000 – Mobility management and handover technologies – All-IP based cellular network . (11)

TYPES OF WIRELESS NETWORKS: Mobile networks – Ad-hoc networks – Ad-hoc routing – Sensor networks – Peer-Peer networks – Mobile routing protocols – DSR – AODV – Reactive routing – Location aided routing – Mobility models – Entity based – Group mobility – Random way – Point mobility model.
Issues and challenges of mobile networks – Security issues – Authentication in mobile applications – Privacy issues – Power management – Energy awareness computing. Mobile IP and Ad-hoc networks – VoIP applications. (12)

CELLULAR TECHNOLOGIES: GSM, GPS, GPRS, CDMA and 3G: Bluetooth – Radio Frequency Identification – Wireless Broadband – Mobile IP – Internet Protocol Version 6 (IPv6) – Java Card – GSM Architecture – GSM Entities – Call Routing in GSM – PLMN Interfaces – GSM addresses and Identifiers – Network aspects in GSM – Authentication and Security – Mobile computing over SMS – GPRS and Packet Data Network – GPRS Network Architecture – GPRS Network Operations – Data Services in GPRS – Applications for GPRS – Limitations of GPRS – Spread Spectrum technology – Is-95 – CDMA Versus GSM – Wireless Data – Third Generation Networks – Applications on 3G. (12)

Total L: 45

REFERENCES:

1. Charles E. Perkins, "Ad -Hoc Networking", Addison – Wesley, December 2008.
2. Lee W. C. Y., "Mobile Communications Engineering: Theory and Applications", 2nd Edition, TMH, 2006.
3. Stallings W, "Wireless Communications & Networks", Prentice Hall, 2 Edition, November 2004.
4. Schiller J., "Mobile Communications", Addison-Wesley, 2003.
5. Pahlavan K. and Krishnamurthy P., "Principles of Wireless Networks", Prentice Hall, 2002.
6. Theodore S. Rappaport, "Wireless Communications, Principles and Practice", Prentice Hall, 2nd Edition, December 2001.

18EE31 CRYPTOGRAPHY AND NETWORK SECURITY

3 0 0 3

SECURITY BASICS: The OSI Security Architectures - Conventional Encryption – Classical Techniques and Modern Techniques -Modes of operation - DES, AES, Key Distribution. (11)

PUBLICKEY CRYPTOGRAPHY AND HASH FUNCTIONS: Number Theory Concepts – Prime numbers- Modular Arithmetic – Fermat & Euler Theorem – Euclid Algorithm – RSA Algorithm – Diffie Hellman Key Exchange Elliptic Curve Cryptography –Hashing techniques - SHA-HMAC – Digital Signatures - DSS, Digital Signature Algorithm. (12)

NETWORK SECURITYAND STANDARDS: Intruders and Intrusion – Viruses and Worms – OS Security – Firewalls – Design Principles – Packet Filtering – Application gateways – Trusted systems - Security Standards**:** IEEE, RSA and ISO standards -Blueprint for Security – Design of Security Architecture. (11)

NETWORK ISSUES: Authentication Applications – Kerberos – Electronic Mail Security – PGP – IP Security – Architecture - Web Security - SSL – TLS – SET. (11)

Total L: 45

REFERENCES:

1. William Stallings, "Network Security Essentials, Applications and Standards", Dorling Kindersley I P. Ltd., Delhi, 2008.
2. Behrouz A Forouzan, "Cryptography and Network Security", Tata McGraw Hill Ltd., New Delhi, 2008.
3. AtulKahate, "Cryptography and Network Security" Tata McGraw Hill Ltd, New Delhi, 2008.
4. William Stallings, "Cryptography and Network Security - Principles and Practice", Pearson Education, Delhi, 2007.
5. Richard E. Smith, "Internet Cryptography", Addison – Wesley, 2004.
6. Wenbo Mao, "Modern Cryptography: Theory and Practice", Prentice Hall, New Delhi, 2003.

18EE32 ADVANCED DIGITAL SIGNAL PROCESSING

3 0 0 3

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)

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)

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)

WAVELET TRANSFORM: Short-Time Fourier 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)

Total L: 45

REFERENCES:

1. John G Proakis and Dimitris G Manolakis, "Digital Signal Processing-Principles, Algorithms and Applications", Prentice Hall of India, 2013.
2. Vaidyanathan PP., "Multirate Systems and Filter Banks", Pearson Education, 2011.

3. Soman K.P. and Ramachandran K.I., "Insight into Wavelets - From Theory to Practice", Prentice Hall of India, 2010.
4. Rao, R.M and Bopardikar A.S., "Wavelet Transforms: Introduction to Theory and Applications", Addison Wesley, Reprint 2003.
5. Fliege N.J., "Multirate Digital Signal Processing" John Wiley & Sons Ltd., Reprinted with Correction, 2000.

18EE33 / 18EA35 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. Jayaraman S., Esakkirajan S., Veerakumar T., "Digital Image Processing", Tata McGraw Hill, 2011.
3. Jain A.K., "Fundamentals of Digital Image Processing", Prentice Hall of India, 2010.

18EE34 GRAPH THEORY AND APPLICATIONS

3 0 0 3

BASICS: Simple Graph – Finite and infinite Graphs – Incidence and Degree – Isolated and Pendent Vertices – Sub-Graphs – Isomorphism – Paths and Connections – Connected Graphs, Disconnected Graphs and Components – The Shortest Path Problem – Trees – Spanning Tree Algorithms – Cut Edges and Bonds – Cut Vertices – Cayley's Formula – The Connector Problem. (11)

CUT-SETS, PLANAR AND DUAL GRAPHS AND CONNECTIVITY: Cut-sets – Properties – Connectivity – Blocks – Construction of Reliable Communication Networks – Euler Trees and Hamiltonian Cycles – Planar and Dual graphs – Kuratowski's Graphs – Directed Graphs – Euler Digraphs – The Chinese Postman Problem – The Traveling Salesman Problem. (11)

MATCHING, COLOURING AND COVERING: Matching – Covering in Bipartite Graphs – Perfect Matching – The Personal Assignment Problem – The Optimal Assignment Problem – Edge Colouring – Edge Chromatic Number – Vizing's Theorem – The Time Tabling Problem – Independent Sets and Cliques – Applications – Vertex Colouring – Chromatic Polynomials – Five Colour Theorem – Applications (12)

MATRIX REPRESENTATION OF GRAPHS AND GRAPH ENUMERATION: Operations on Graphs – Incidence Matrix – Circuit Matrix – Fundamental Circuit Matrix – Cut-set Matrix – Path Matrix – Adjacency Matrix – Types of Enumeration – Counting Labeled and Unlabeled Trees – Polya's Counting Theorem – Graphs Enumeration with Polya's Theorem.
APPLICATIONS: Network Flows – Transport Networks – Max-Flow Min-Cut Theorem – Activity Networks – Graphs in Game Theory (11)

Total L: 45

REFERENCES:

1. NarsinghDeo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall, 2007.
2. Reinhard Diestel, "Graph Theory", Springer Publication, 2006.
3. Jonathan Gross and Jay Yellen, "Graph Theory and Its Applications", Chapman and Hall, 2005.

18EE35 / 18EA39 / 18ED33 / 18EM32 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. Sharma J K., "Operations Research: Theory and Applications", Macmillan Company, New Delhi, 2013.
2. Hamdy A Taha, "Operations Research: An Introduction", Pearson Education, New Delhi, 2012.
3. Gupta C B., "Optimization Techniques in Operations Research", I K International, New Delhi, 2012.

18EE36 / 18ED25 / 18EM36 DIGITAL CONTROLLERS FOR POWER ELECTRONIC APPLICATIONS

3 0 0 3

TMS C2XX DSP: Introduction to the C2xx DSP core and code generation. The components of the C2xx DSP core, Peripherals and Peripheral Interface, System configuration registers, Memory, Types of Physical Memory, memory Addressing Modes, Code Composer Studio for C2xx DSP. (12)

I/O AND INTERRUPTS: Pin Multiplexing (MUX) and General Purpose I/O Overview, Multiplexing and General Purpose I/O Control Registers, Programming I/O. Introduction to Interrupts, Interrupt Hierarchy, Interrupt Control Registers, Initializing and Servicing Interrupts in Software, Programming Interrupts (11)

ADC AND EVENT MANAGERS: ADC Overview, Operation of the ADC in the DSP, Overview of the Event manager (EV), Event Manager Interrupts, General Purpose (GP) Timers, Compare Units, Capture Units and Quadrature Enclosed Pulse (QEP) Circuitry, General Event Manager Information, Programming of ADC and Event Managers (11)

DESIGN OF CONTROLLER IN POWER ELECTRONICS: Typical applications: DSP-based implementation of DC-DC buck-boost converter - DSP-based control of permanent magnet brushless DC machines - DSP-based Implementation of clarkes's and park's transformations - DSP-Based implementation of SPWM, SVPWM inverter pulse generation. (11)

Total L: 45

REFERENCES:

1. Hamid.A.Toliyat and Steven G.Campbell "DSP Based Electro Mechanical Motion Control" CRC Press New York, 2004.
2. TMS320C28x CPU and Instruction Set Reference Guide - SPRU430
3. TMS320x28xx, 28xxx Peripheral Reference Guide - SPRU566
4. TMS320x2833x System Control and Interrupts Reference Guide - SPRUFB0
5. TMS320x2833x Analog-to-Digital Converter (ADC) Reference Guide - SPRU812
6. TMS320x28xx, 28xxx Enhanced Pulse Width Modulator (ePWM) & High-Resolution Pulse Width Modulator (HRPWM) Module Reference Guide - SPRU791 & - SPRU924

18EE37 / 18ED38 / 18EM38 SMART GRID TECHNOLOGIES

3 0 0 3

SMART GRID ARCHITECTURE AND COMPONENTS: Introduction to Smart Grid, Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self-Healing Grid, Present development & International policies in Smart Grid, Smart Grid Architecture Models, Components of Smart Grid: Smart Generation systems, Smart Transmission Grid : Geographic Information System (GIS). Intelligent Electronic Devices (IED) & their application for Monitoring & Protection. Wide Area Monitoring Protection and Control (WAMPAC), Phasor Measurement Unit (PMU) and its applications in Smart Grid. (11)

MICROGRIDS AND DISTRIBUTED ENERGY RESOURCES: Micro grid: Concept of Micro grid, Need & Applications of Micro grid. Micro grid Architecture, Issues of interconnection, Protection & Control of Micro-grid. Distributed Energy Resources: Plastic & Organic Solar cells, Thin Film Solar cells. Variable Speed Wind Generators, Fuel cells, Micro turbines, Captive Power plants, Integration of Renewable energy sources. Power Quality issues of Grid connected Renewable Energy Sources. Power Quality Conditioners for Smart Grid. Web based Power Quality monitoring and Power Quality Audit. (12)

SMART METERING AND DISTRIBUTION MANAGEMENT SYSTEM: Smart Distribution Systems: Smart Meters, Automatic Meter Reading (AMR), Advanced Metering Infrastructure (AMI), Real Time Pricing, Smart Appliances. Smart Substations : Substation Automation, Feeder Automation, Outage Management System (OMS). Smart Sensors: Home & Building Automation, Plug in Hybrid Electric Vehicles (PHEV), Algorithms for Vehicle to Grid and Grid to Vehicle Management, Smart Charging Stations. Energy Storage for Smart Grids: Battery Energy Storage Systems (BESS), Superconducting Magnetic Energy Storage (SMES), Compressed Air Energy Storage (CAES). (11)

COMMUNICATION NETWORKS AND CYBER SECURITY FOR SMART GRID: Communication Architecture for Smart Grids, Home Area Network (HAN) :IEEE 802.11, IEEE 802.15.4, 6LoWPAN, Neighborhood Area Network (NAN) / Field Area Network (FAN): Radio over Power-Lines (BPL/PLC), IEEE P1901, Wide Area Network (WAN) : Optical Fiber Communication, Cellular Networks, Wi-Max and Wireless Sensor Networks. Big Data Analytics in Smart Grid, Cyber Security Challenges in Smart Grid - Load Altering Attacks - False Data Injection Attacks - Defense Mechanisms. (11)

Total L: 45

REFERENCES:

1. Ali Keyhani, "Design of Smart Power Grid Renewable Energy Systems", Wiley, 2016.
2. Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions", CRC Press, 2012.

3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu and Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley, 2012.

18EE38 / 18EA41 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 – Learning factors – Linear separability. Hopfield network – Discrete Hopfield networks – Associative memories – Recurrent auto association memory – Bi-directional associative memory – Boltzman machine. (12)

UNSUPERVISED LEARNING NETWORKS: Hamming networks – Self-organising feature maps – Adaptive resonance theory network – Instar model – Outstar model – Counter propagation network – Radial basis function networks (10)

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 ALGORITHMSANDSOFT 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 – Communication - Control systems, Applications of Fuzzy Logic: Fuzzy Pattern Recognition - Fuzzy Image compression - Fuzzy Logic controllers. (12)

Total L: 45

REFERENCES:

1. Sivanandam S N, Sumathi S., and Deepa S. N., “Introduction to Neural Networks using Matlab 6.0”, Tata McGraw Hill Publications,
New Delhi, 20th Reprint, 2014.
2. Sivanandam S N, and Deepa S. N., “Principles of Soft Computing”, Wiley India (P) Ltd., New Delhi, 2nd Edition, June 2011.
3. Timothy Ross, “Fuzzy Logic with Engineering Applications”, McGraw Hill, Singapore, 3rd Edition, 2010.
4. Laurene Fausett, “Fundamentals of Neural Networks”, Pearson Education India, New Delhi, 2004.
5. David E Goldberg, “Genetic Algorithms in Search, Optimisation and Machine Learning, Pearson Education, New Delhi, 2004.
6. Zimmermann H.J., “Fuzzy Set Theory and its Applications”, Springer India (P) Ltd., New Delhi, Nov. 2001.

18EE39 / 18EA42 / 18ED 36 / 18EM33 MACHINE LEARNING AND APPLICATIONS

3 0 0 3

PROBABILITY DISTRIBUTIONS: Basic Definitions, Types of learning, Probability Theory, Probability Reasoning, Model Selection, Curse of Dimensionality, Decision Theory, Information Theory, Binary Variables, Multinomial Variables, Gaussian Distribution, Exponential Family, Nonparametric Methods, Belief Networks. (12)

LINEAR MODELS FOR REGRESSION AND CLASSIFICATION: Linear Basis Function Models, Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison, Evidence Approximation, Limitations of Fixed Basis Functions, Discriminant Functions, Probabilistic Generative and Discriminative Models, Laplace Approximation, Bayesian Logistic Regression. (11)

NEURAL NETWORKS: Introduction, Reforcement Learning, Feed-forward Network functions, Error Backpropogation, Hessian Matrix, Mixture Density Networks, Bayesian Neural Networks, Convolution Neural Network, Dual Representations, Constructing Kernels, Gaussian Processes, Maximum Margin Classifiers, Relevance Vector Machines. (11)

APPLICATIONS OF MACHINE LEARNING ALGORITHMS: Content Based Image Retrieval, Machine Learning Approach for face Recognition, Computer Aided Diagnosis, Computer Vision, Speech Recognition, Text Mining, Thinking Machines, Smart Machines, Business Applications of Deep Learning, Software Reliability Prediction, Medical Imaging. (11)

Total L: 45

REFERENCES:

1. Pradeep Kumar and Arvind Tiwari, “Ubiquitous Machine Learning and Its Applications”, IGI Global, 2017.
2. Ethem Alpaydin, “Introduction to Machine Learning”, Prentice Hall of India, New Delhi, 2014.
3. David Barber, “Bayesian Reasoning and Machine Learning”, Cambridge University Press, New Delhi, 2014.

18EE40 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- Web application development: opening an URL-creating a simple web page- Overview of webapp2 and Flask- Micropython (12)

Total L: 45

REFERENCES:

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

ONE CREDIT COURSE

18EK06 FIELD PROGRAMMABLE ANALOG ARRAY FOR ANALOG SYSTEM DESIGN

1 0 0 1

INTRODUCTION: Overview of Analog Design - Introduction to Field Programmable Analog Array (FPAA) and its advantages - Role of EDA tool in Analog Design process. (2)

CONFIGURABLE ANALOG MODULES: Introduction to Anadigm`s inbuilt Analog Functions (CAM) - Generation of Clock Signals - Signal Delay - Performance of CAM. (3)

SIMULATION and PHYSICAL REALIZATION: Features of ANADIGMDESIGNER2 EDA tool for simulating the analog design-Configuring the FPAA with analog design - Real time verification. (2)

FPAA IO INTERFACING: Interfacing of input and output signals to the FPAA - Rauch Filter - Output Buffer. (2)

STATIC CONFIGURATION: Full Wave Rectifier - Tone Generation and Notch filter - Voltage Controlled Oscillator - Pulse Width Modulation - Phase Detector. (3)

DYNAMIC RECONFIGURATION: Reconfigurable Analog design using FPAA, Various methods of Reconfiguration - Real time verification. (3)

Total L : 15

REFERENCES:

1. Thomas L. Floyd "Electronic devices Conventional Current Version" Pearson Education Ltd, Ninth Edition, 2012.
2. Thomas L. Floyd "Instructor's Resource Manual to Accompany Electronic Devices" Pearson Education Ltd, Eighth Edition, 2008.
3. Thomas L. Floyd "Electronic Devices" Pearson Education Ltd, Eighth Edition, 2008.

18EK07 AUTOMOTIVE SOFTWARE TESTING

1 0 0 1

BASICS OF AUTOMOTIVE SOFTWARE TESTING: Introduction – Conventional Software Testing Vs Automotive Software Testing - Need for Automotive Software Testing - Major recalls and impact of recalls – Case study. (3)

FUNDAMENTALS OF SOFTWARE TESTING: Basics of Software Development Life Cycle – Model Based - Modular - Reusable Design - Static Analysis, Dynamic Analysis - Code Coverage including MC/DC (Modified Condition/Decision Coverage) and LCSAJ (Linear Code Sequence and Jump) - Data Flow and Control Flow analysis- Unit/System/Integration Testing - Code Quality - Software Quality metrics - test management - Importance of using qualified software for software testing. (6)

CODING STANDARDS: Coding Standards - important - Coding Standard for Automotive Industry – MISRA C: 2012 with Security Amendments - Top 10 secure coding best practices - Advantages of adhering to coding standards. (3)

PROCESS STANDARD: Introduction to ISO 26262 – Functional Safety Standard - Details about ASIL (Automotive Safety Integrity Level) - Details about Part 4 and Part 6 of ISO 26262 – Failure Mode Effective analysis (FMEA). (3)

Total L : 15

Lab Session (along with Theory Class)

- Practical Implementation of Fundamentals of software testing using LDRA Software.
- Adhering to MISRA C coding guidelines using LDRA Software.
- Achieving compliance to ISO 26262 using LDRA Software.
- In case of non-availability of MISRA C document, students may refer to CERT C standard.
- Example of Code Coverage and Executing Test Cases on Raspberry Pi or Arduino.

REFERENCES:

1. Pradeep Oak and Renu Rajani , "Software Testing – Effective Methods, Tools and Techniques", Tata McGraw Hill Publications, 2004.
2. Stephen L. Montgomery,"MISRA C: Guidelines for the use of the C Language in Critical Systems", Motor Industry Research Association,2013.
3. Robert C. Seacord, "The CERT C Secure Coding Standard", Addison-Wesley Professional, 1st edition, 2008.
4. Justyna Zander, Ina Schieferdecker,Pieter J. Mosterman, "Model-based Testing for Embedded Systems", CRC Press, Taylor and Francis Group, 2012.

18EK13 SYSTEM ENGINEERING FOR AUTOMOTIVE APPLICATIONS

1 0 0 1

INTRODUCTION: Systems, Systems Engineering and System on Systems Design Models flow: Waterfall, Spiral and INCOSEVEE model Product development flow Values of Systems Engineering (4)

ROLES OF SYSTEM ENGINEER: Understanding the Systems Engineering goal, Significance of documentation, Knowing about DSM (Design structure matrix), Interdisciplinary role of Systems Engineering, Behavioral aspects of Systems Engineering (3)

PROCESS : Requirements process, Baseline creation

INNOVATION IN SYSTEM ENGINEERING: Creativity characteristics, About TRIZ, Ideality, Contradictions and approach to resolve Innovation in Technical systems: Architectural Innovation (3)

DESIGN PROCESS : Definitions, Axioms, Design Matrices, Types and examples, Constraints (3)

SYSTEM RELIABILITY: Approach to achieve system reliability, significance of Reuse (1)

EXAMPLE SYSTEM DESIGN: Designing an Automotive ECU (1)

Total L : 15

REFERENCES:

1. Benjamin S. Blanchard, John E. Blyler, "System Engineering Management", 5th Edition, Wiley, 2016
2. INCOSE Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities, Wiley, 2015
3. Alexander Kossiakoff, William N. Sweet, Samuel J. Seymour, Steven M. Biemer, "Systems Engineering Principles and Practice", 2nd Edition, Wiley, 2011

18EK14 ELECTRIC VEHICLES

1 0 0 1

INTRODUCTION TO ELECTRIC VEHICLES: Social and environmental importance of electric vehicles. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance. (3)

History of Hybrid Electric Vehicles - Energy consumption Concept of Hybrid Electric Drive – Architecture: Series Hybrid Electric Drive, Parallel hybrid electric drive. Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Super Capacitors. (3)

ELECTRIC PROPULSION UNIT: Electric components, Configuration and control of drives: DC Motor - Induction Motor - Permanent Magnet Motor - Switch Reluctance Motor. Drive system efficiency - Energy storage for EV and HEV - Energy storage requirements, Battery parameters, Modelling of Battery. (5)

Power Electronic Converter for Battery Charging - Charging methods for battery- Design of Z-converter for battery charging. Case Study: Design of a Battery Electric Vehicle (BEV). (4)

Total L : 15

REFERENCES:

1. Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer, 2013.
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles Principles And Applications With Practical Perspectives, Wiley Publication, 2011.
3. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2010
4. M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2009
5. James Larminie, John Lowry, Electric Vehicle Technology Explained Wiley, 2003.
6. C.C. Chan and K.T. Chau, Modern Electric Vehicle Technology, OXFORD University Press, 2001.

18EK15 PHASOR MEASUREMENT UNITS AND APPLICATIONS

1 0 0 1

INTRODUCTION: Phasor Measurement Units (PMUs), Global Positioning System (GPS), Functional requirements of PMUs and Phasor Data Concentrators (PDCs), Phasor estimation of nominal frequency inputs. (2)

TRANSIENT RESPONSE: Transient response of Instrument Transformers, Transient response of Filters, Transient response during Electromagnetic and Power Swings, Impact of Transient Response of Phasor Measurements. (2)

APPLICATIONS OF PHASOR MEASUREMENT UNITs: Phasor Measurements Unit based Adaptive Protection of Transmission Lines, Out-of-Step protection, Adaptive System Restoration, Phasor Measurement units in Large Scale Integration of Wind and Solar Energy systems, Introduction to Wide Area Monitoring, Protection and Control (WAMPAC). Deployment of large scale PMUs in Utilities, Globally and in Indian Power sector. (8)

STANDARDS: Synchrophasor Standards - IEEE C37.118.1-2011, IEEE C37.118a-2014, IEC 61850 & IEEE C37.118, Evaluation / Validation of PMU-Total Vector Error (TVE) both Steady State and Dynamic/Transient conditions. IEEE C37.118.2-2011. (3)

Total L: 15

REFERENCES:

1. A.G.Phadke, J.S. Thorp, 'Synchronized Phasor Measurements and Their Applications', Springer Publications, Second Edition, 2017
2. IEEE Synchrophasor Test Suite Specification Version2, 2015
3. IEEE C37.242, 2013 - Guide for Synchronization, Calibration, Testing, and Installation of Phasor Measurement Units (PMU) for Power System Protection and Control
4. IEEE C37.244, 2013 - Guide for Phasor Data Concentrator (PDC) Requirements for Power System Protection, Control, and Monitoring.
5. A.G.Phadke, J.S. Thorp, 'Computer Relaying for Power Systems', John Wiley and Sons Ltd., Research Studies Press Limited, 2nd Edition, 2009
6. IEC 61850-90-5, Communication networks and systems for power utility automation – Part 90-5: Use of IEC 61850 to transmit Synchrophasor information according to IEEE C37.118

18EK17 CAD TOOLS FOR VLSI DESIGN AUTOMATION

1 0 0 1

INTRODUCTION TO VLSI DESIGN PROCESS: Design flow – Role of CAD tools in the design process. (3)

DESIGN CAPTURE: Features of Mentor Graphics Design Architect IC a tool for schematic capture, netlisting, simulation setup and results viewing - Creating an Inverter using DA_IC- ELDO simulator. (3)

SIMULATION: Features of Advance MS simulator a tool for verification platform for AMS design and verification - Exercises. (3)

PHYSICAL LAYOUT: Features of the IC Station Tool Suite for full custom IC design flow editing, Schematic-driven layout and top-level floor planning/routing – Exercises. (3)

PHYSICAL VERIFICATION: Features of Calibre LVS for physical verification tool, for layout versus schematic – Exercises. (3)

Total L: 15

REFERENCES:

1. Michael John Sebastian Smith, "Application-Specific Integrated Circuits" Addison-Wesley Publishing Company.
2. WayneWolf," Modern VLSI Design: Systems on Chip Design", Pearson Education Inc., Indian Reprint, 2007.
3. http://www.mentor.com/products/ic_nanometer_design

18EK18 DIGITAL DESIGN WITH VERILOG HDL

1 0 0 1

INTRODUCTION: Digital Design, Verification, and Hardware description languages. (1)

VERILOG FOR DESIGN: Introduction to Logic Synthesis, Synthesizable Constructs - Inferring Combinational Circuit elements -Inferring Sequential Circuit elements - State Machines - Counters -Encoders/Decoders - Synthesis of Loops - Data Path - Design Partitioning / Methodology - Synthesizable Code-care about, Sensitivity list and Simulation Synthesis mismatch conditions. (3)

VERILOG FOR VERIFICATION: Delay Modeling in Verilog on Briefly behavioral constructions, Fork-join, Events - Clock Generation - Data Generation, Deterministic, Random - Some Systems Tasks - Test Bench Architecture. (2)

DESIGN EXAMPLES: RISC Stored Program Machine - UART Design (2)

Mini Projects Specification and Scope Discussions (3)

Review of Projects: Presentation by student groups (3)
(15 min per student group)

Feedback on the Design Project (1)

Total L : 15

REFERENCES:

1. Michael D. Ciletti, “Advanced Digital Design with the Verilog HDL”, Pearson Education, 2003
2. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”, Prentice Hall NJ, USA, 2003.
3. Bhaskar J,”A Verilog Primer”, Prentice Hall of India Learning, 2012.

18EK19 AUTOMOTIVE ELECTRICAL SYSTEM

1 0 0 1

INTRODUCTION: Major components of an Automobile Systems and its functions - Overview of four stroke I.C. engine - Four Cylinder Engine – Spark firing sequence. (2)

AUTOMOBILE ELECTRICAL AND ELECTRONIC SYSTEMS AND COMPONENTS: Block diagram of Automobile electrical system - Typical wiring diagram - Starter system: General layout - Basic starting circuit - Ignition system: Battery and magneto types - Battery ignition system for four cylinder engine - Ignition system circuit - Distributed ignition coil and ignition advance. Charging system: Typical alternator in common use - cut-out and regulator - Lighting & accessories system - Wiper motor – circuit diagram of wind screen wiper motor and washer. (5)

SENSORS AND ACTUATORS: Physical Variables to be measured in automobiles: Position sensor: Magnetic reluctance and Hall effect sensor - Temperature sensor: Coolant temperature - Speed sensor – Fuel level sensor - Acceleration sensor - Actuator: Principle of solenoid and Fuel injector. (4)

DIAGNOSTICS AND COMMUNICATION BUS: Block diagram of Engine control unit **-**Diagnostics procedure: Introduction – Diagnostics theory – On board and Off-board diagnostics – Diagnostics Link Connector – Vehicle condition monitoring - CAN bus - topology – Data transmission – CAN Protocol – Overview of CAN controller - LIN bus: overview – Data Transmission System – LIN protocol. (4)

Total L: 15

REFERENCES:

1. KK Jain , RB Sharma “Automobile engineering”, Tata McGraw Hill Publications, 2011
2. Ronald K.J, “Automotive Electronics Handbook”, McGraw Hill Publications, USA, 2009.
3. William B.Ribbens, Norman P.Mansour, “Understanding of Automotive Electronics”,Butterworth-Heinemann,United Kingdom 2003
4. “Automotive Electrics / Automotive Electronics - Ed5”, Robert Bosch GmbH, 2004.
5. EdMay, “Automotive Mechanics Vol -2”, McGraw Hill Publications, Australia 2004.
6. Tom Denton, “Automobile Electrical and Electronics systems”, Routledge Taylor & Francis Group London & New York, 2002.

AUDIT COURSES

18EE81 ENGLISH FOR RESEARCH PAPER WRITING

vide Automotive Engineering 18AE81

18EE82 RESEARCH METHODOLOGY AND IPR

vide Automotive Engineering 18AE82