I SEMESTER

21EE01 APPLIED MATHEMATICS FOR EMBEDDED SYSTEMS

NUMBER THEORY: Divisibility, fundamental theorem of arithmetic, division algorithm, Euclid's algorithm, arithmetical function - Euler totient function and its properties – theory of congruences, linear congruences, Fermat’s little theorem, Euler’s Theorem, The Chinese remainder theorem, primality testing– Fermat's pseudoprimality test, Miller Rabin test. (7+4)

ALGEBRAIC STRUCTURES: Groups – subgroups, modulo groups - primitive roots - discrete logarithms. Ring, field – finite fields, crypotosystem, elliptic curve crypotosystem (7+3)


Total L: 30 +T:15 = 45

REFERENCES:

21EE02 EMBEDDED CONTROLLERS AND APPLICATIONS


ARM7 : Architecture overview - RISC processor design: ARMArchitecture – Programming Model, Pipelined data path design - Pipeline Hazards,Addressing Modes, -Processor modes – Data types – Registers – Program status registers – Floating Point dataprocessing, Interrupts & Exception Handling— Simple programs. (11)

ARM Programming: ARM Instruction Set – Thumb Instruction Set - DSP Extensions, MixedC and Assembly programming, AMBA bus system Peripherals, SoC design using ARM core, Debug support, Memory system design- Cache Memory, Memory Management unit – VirtualMemory. ARM advanced CPU cores, Applications development using Kell IDE. (11)

REAL WORLD INTERFACING: Master Synchronous Serial Port ((MSSP) structure - Detail study of UART, SPI, I2C, ADC and Comparators, 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)

Total L : 45

REFERENCES:

21EE03 REAL-TIME CONCEPTS FOR EMBEDDED SYSTEMS


REFERENCES:

21EE04 FPGA BASED SYSTEM DESIGN

3 1 0 4


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. (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+4)


Total L:45 T:15 = 60

REFERENCES:

21EE05 EMBEDDED SYSTEM NETWORKS

3 0 0 3


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 -

126
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)


REFERENCES:
4. Jan, Axelsson, "USB Complete", Lake View Research, 2005

21EE06 / 21EA06 / 21ED06 / 21EM06 RESEARCH METHODOLOGY AND IPR
vide Automotive Engineering 21AE06

21EE72 AUDIT COURSE I
vide Automotive Engineering 21AE72

21EE51 EMBEDDED SYSTEM DESIGN LABORATORY

LIST OF EXPERIMENTS
1. On-chip Peripherals Programming in 8051 Microcontroller: 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, USART
5. Design and Implementation of simple embedded applications using FPGA

In this course, Students have to complete the given list of experiments to get an exposure to work with all the peripherals of 8051 Microcontroller, ARM Microcontroller and FPGAs. In addition to that, each student is expected to do at-least one mini project by using the facilities available in the laboratory and submit a detailed report with relevant references, proposed methodology and results obtained.

Total P: 60

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

LIST OF EXPERIMENTS
I. Object Computing using C++
   1. Implementation of basic programming concepts like conditionals and loops
   2. Implementation of function and operator overloading
   3. Creation of classes and objects
   4. Implementation of constructors and destructors
   5. Implementation of array of objects and dynamic objects.
   7. Implementation of friend functions, inline functions and default arguments.
   8. Implementation of inheritance and its types

II. Data Structures using C++
   1. Programs using arrays.
   2. Implementation of various sorting algorithms.
   3. Implementation of Stacks using array.
   4. Application of Stack
   5. Implementation of queue using array.

Total P: 60
REFERENCES:

II SEMESTER
21EE07 REAL-TIME OPERATING SYSTEMS


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 + 5)


Total L: 45 T:15 = 60

REFERENCES:

21EE08 LINUX ARCHITECTURE AND DEVICE DRIVERS

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 editor - Commands – Overview of shell and GUI. (11+3)


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+4)


Total L: 45 + T: 15 = 60

REFERENCES:
21EE82 AUDIT COURSE II  
vide Automotive Engineering 21AE82

21EE61 REAL-TIME SYSTEMS LABORATORY

LIST OF EXPERIMENTS
1. Creating a Makefile for an Embedded Application
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

In this course, Students have to complete the given list of experiments to get an exposure to work with all Kernel Objects of an Open Source Real-Time Kernel. In addition to that, each student is expected to do at-least one mini project by using the facilities available in the laboratory and submit a detailed report with relevant references, proposed methodology and results obtained.

Total P: 60

21EE62 EMBEDDED NETWORKING AND DEVICE DRIVERS LABORATORY

LIST OF EXPERIMENTS
1. Implementation of I2C and SPI Protocols
2. Implementation of Controller Area Network Protocol
3. Development of USB based Driver for an External Storage Device
4. Development of SPI based Driver for Micro SD Card
5. Development of Drivers for Wi-Fi and Bluetooth Devices

In this course, Students have to complete the given list of experiments to get some exposure on Networking Protocol Implementation and Device Driver Development Process. In addition to that, each student is expected to do at-least one mini project that involves all the concepts learnt in this course and submit a detailed report with relevant references, proposed methodology and results obtained.

Total P: 60

21EE63 INDUSTRIAL VISIT AND TECHNICAL SEMINAR  
vide Automotive Engineering 21AE63

III SEMESTER

21EE71 PROJECT WORK I  
vide Automotive Engineering 21AE71

IV SEMESTER

21EE81 PROJECT WORK II  
Vide Automotive Engineering 21AE81

PROFESSIONAL ELECTIVES
21EE21 / 21ED23 / 21EM23 INTERNET OF THINGS

3 0 0 3


Total: L: 45

REFERENCES
2. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", John Wiley and Sons Ltd, UK 2012.

21EE22 / 21ED24 TOTALLY INTEGRATED AUTOMATION

3 0 0 3

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)


Total L:45

REFERENCES:

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

3 0 0 3

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.

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

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.

REFERENCES:
4. John Park, Steve Mackey and Edwin Wright, ”Data Communications for Instrumentation and Control”, Elsevier 2003


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.


REFERENCES:


REFERENCES:
21EE26 ARTIFICIAL INTELLIGENCE


KNOWLEDGE REPRESENTATION AND REASONING: Ontologies, foundations of knowledge representation and reasoning, Logical Agents, Propositional Logic, First Order Logic, Inference in first order logic, Rule based systems, Knowledge representation, Automated planning. (11)

UNCERTAIN KNOWLEDGE AND REASONING: Quantifying Uncertainty, Basic probability notation, Naive bayes models, Probabilistic reasoning, Exact and Approximate Inference in Bayesian Network, Causal Networks, Time and Uncertainty, Hidden Markov models, Kalman filter, Probabilistic programming. (11)


Total: L: 45

REFERENCES:

21EE27 MULTI-CORE EMBEDDED SYSTEMS

MULTI-CORE ARCHITECTURES: Introduction to parallel computers: Instruction Level Parallelism (ILP) vs. Thread Level Parallelism (TLP); performance issues: brief introduction to cache- hierarchy and communication latency. Shared memory multiprocessors: general architecture and the problem of cache-coherence; synchronization primitives; locks: tickets, array; barriers: central and true; performance implications in shared memory programs. (12)

PROGRAM OPTIMIZATION IN MULTI-CORE PROCESSORS: overview of parallelism, shared memory programming; introduction to OpenMP; data flow analysis, pointer analysis, alias analysis, data dependence analysis, solving data dependence equations (integer linear programming problem); loop optimizations; memory hierarchy issues in code optimization. (11)

OPERATING SYSTEM ISSUES FOR MULTIPROCESSING: scheduling techniques: usual OS scheduling techniques, threads, distributed-scheduler, multiprocessor scheduling, gang scheduling; communication between processes, message boxes, shared memory; sharing issues and synchronization, sharing memory and other structures. (11)


Total: L: 45

REFERENCES:
21EE28 ROBOTICS PROCESS AUTOMATION


REFERENCES:

21EE29 ADVANCED EMBEDDED CONTROLLERS

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)


ARCHITECTURE OF ARM CORTEX M: ARM Cortex-M 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. (10)

PERIPHERALS OF ARM CORTEX – Mx CONTROLLER: Cortex-M 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. (10)

REFERENCES:
21EE30 BLOCKCHAIN TECHNOLOGY

3 0 0 3

DISTRIBUTED SYSTEMS AND CRYPTOGRAPHY: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. Cryptography: Hash function, Digital Signature - ECDSA, Merkle Tree, Memory Hard Algorithm, Zero Knowledge Proof. (10)

BASIC BLOCKCHAIN: Concepts germane to Bitcoin and contemporary proof-of-work based consensus mechanisms, operations of Bitcoin blockchain, crypto-currency as application of blockchain technology (11)

BLOCKCHAIN 2.0: Blockchains with smart contracts and Turing complete blockchain scripting – issues of correctness and verifiability, Ethereum platform and its smart contract mechanism - BLOCKCHAIN 3.0 – Plug-and-play mechanisms for consensus and smart contract evaluation engines, Hyperledger fabric platform (13)

BEYOND CRYPTOCURRENCY – Applications of blockchain in cyber security, integrity of information, E-Governance and other contract enforcement mechanisms - Limitations of blockchain as a technology - myths vs. reality of blockchain technology (11)

REFERENCES:

21EE31 / 21EA41 / 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)


Total L: 45

REFERENCES:

21EE32 AUTOMOTIVE SOFTWARE ARCHITECTURE

3 0 0 3


REFERENCES:

21EE33 GRAPHICAL PROGRAMMING FOR REAL-TIME APPLICATIONS

3 0 0 3


REFERENCES:

21EE34 INDUSTRIAL NETWORKING AND STANDARDS

3 0 0 3


FIELD AREA NETWORKING PROTOCOLS: Actuator Sensor Interface - Structure of AS-i slave ICs, AS-i messages, AS-i modulation technique, Troubleshooting


REFERENCES:

21EE35 / 21EA27 INTERNETWORKING AND ITS APPLICATIONS


REFERENCES:

21EE36 / 21EA33 WIRELESS SENSOR NETWORKS

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.


REFERENCES:

21EE37 WIRELESS AND MOBILE COMMUNICATION
3 0 0 3


REFERENCES:

21EE38 CRYPTOGRAPHY AND NETWORK SECURITY
3 0 0 3


REFERENCES:

Total L: 45

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21EE39 ADVANCED DIGITAL SIGNAL PROCESSING


REFERENCES:

Total L: 45

21EE40 COMPUTER VISION


REFERENCES:

Total L: 45

21EE41 GRAPH THEORY AND APPLICATIONS


Total L: 45

138


APPLICATIONS: Network Flows – Transport Networks – Max-Flow Min-Cut Theorem – Activity Networks – Graphs in Game Theory

REFERENCES:

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


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.

REFERENCES:

21EE43 / 21ED26 / 21EM26 DIGITAL CONTROLLERS FOR POWER ELECTRONICS

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.

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

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 Encoded Pulse (QEP) Circuitry, General Event Manager Information, Programming of ADC and Event Managers.

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.
REFERENCES:
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. MS320x28xx, 28xxx Enhanced Pulse Width Modulator (ePWM) & High-Resolution Pulse Width Modulator (HRPWM)
   Module Reference Guide - SPRU791 & SPRU924

21EE44 / 21ED36 / 21EM36 SMART GRID TECHNOLOGIES

3 0 0 3

SMART GRID ARCHITECTURE AND COMPONENTS: Need for Smart Grid – Functions – Opportunities – Benefits and challenges, Difference between conventional & Smart Grid, Concept of Robust & Self-Healing Grid, Smart Grid Architecture - Models – Standards, and Road map for Smart Grid in India. WIDE AREA MONITORING SYSTEM: Fundamentals of Synchronized Phasor Technology, Structure and functions of Phasor Measuring Unit (PMU) and Phasor Data Concentrator (PDC), Operational experience and Blackout analysis using PMU - Case study on Blackout on Indian Grid.


REFERENCES:
5. IEE Transactions on Smart Grid.

21EE45 / 21EA38 SOFT COMPUTING

3 0 0 3


REFERENCES:


21EE46 / 21EM29 MACHINE LEARNING AND ITS APPLICATIONS


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

NEURAL NETWORKS: Introduction, Reinforcement 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

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

REFERENCES:


21EE47 E-MOBILITY


REFERENCES:

OPEN ELECTIVES

21EE91 BUSINESS ANALYTICS
21EA91 vide Applied Electronics

21EE92 ELECTRONIC WASTE MANAGEMENT
21EA92 vide Applied Electronics

21EE93 INDUSTRIAL SAFETY AND STANDARDS
21EA93 vide Applied Electronics

21EE94 INNOVATION AND PRODUCT DEVELOPMENT
21EA94 vide Applied Electronics