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Master of Technology (Embedded System)

SEMESTER II

COURSE CODE	CATEGORY	COURSE NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL					
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*	Th	T	P	CREDITS
MTES201	EC	Advance Controllers	60	20	20	30	20	3	1	2	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. To teach programming for MSP432 using high level language such as C.
2. To teach students how a microcontroller can be used as a computer within a single integrated circuit.
3. To present the microcontrollers input/output interface capabilities for developing embedded systems with microcontrollers.
4. To illustrate how a microcontroller is a component within embedded systems controlling the interaction of the environment with system hardware and software.

Course Outcomes:

After successful completion of the course, student will be able:

1. To understand the generalized architecture of advanced microcontroller MSP432 and its programming.
2. To interface MSP432 with analog peripherals & communication systems.
3. To design an embedded system using MSP432 for a particular task.

Syllabus:

UNIT I

Introduction to Microcontrollers & Embedded System

Background of Microcontrollers: Definition, Classification, Features & Applications, Architecture of Cortex M4 and its features, MSP–EXP432P401R and its Booster Packs, Energia: Development Environment, Libraries, Fundamental Programming Concepts.

Embedded System: Definition, Characteristics, Block diagram, Design Process, Case study: Weather monitoring system.

UNIT II

MSP432 Operating Parameters and Interfacing

Operating Parameters, Input Devices, Output Devices, High Power DC Interfaces, Interfacing to DC Devices, AC Devices, Educational Booster Pack Mk-II, Grove Starter Kit for LaunchPad Application.

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UNIT III

MSP432 Memory System and Power System

Memory System: Basic Memory Concepts, Memory Operations in C Using Pointers, Memory Map, Flash Memory, Direct Memory Access (DMA), External Memory: Bulk Storage with an MMC/SD Card.

Power Systems: Operating Modes and Speed of Operation, Power Supply System, Power Control Module, Operating Modes, Transition PSS and PCM Registers, Battery Operation.

UNIT IV

Time-Related Systems, Resets and Interrupts

Time-related Signal Parameters: Frequency, Period, Duty Cycle, MSP432 Clock System, Energia-related Time Functions, Watchdog Timer, Timer32, Timer A, Real-Time Clock, MSP432 Resets, Interrupts, MSP432 Interrupt System, Energia Interrupt.

UNIT V

Analog Peripherals & Communication Systems

Programming the MSP432 ADC System, Voltage Reference, Comparator, Serial Communication Concepts, MSP432 UART, Serial Peripheral Interface-SPI, Inter-Integrated Communication - I2C Module

Text Books:

1. Dung Dang, Daniel J. Pack, Steven F. Barrett, "Embedded Systems Design with the Texas Instruments MSP432 32-bit Processor", Morgan & Claypool Publisher, 2017.
2. Ying Bai, "Microcontroller Engineering with MSP432: Fundamentals and Applications", Taylor & Francis,CRC Press, 2017

Reference Books:

1. Chris Nagy, "Embedded Systems Design using the TI MSP430 Series" Newnes, 2003.
2. John H. Davies, "MSP430 Microcontroller Basics", Newnes, 2008.
3. Manuel Jiménez, Rogelio Palomera, Isidoro Couvertier, "Introduction to Embedded Systems: Using Microcontrollers and the MSP430", Springer, 2014.
4. Raj Kamal, "Embedded Systems: Architecture, Programming and Design", TMH, 2008.

List of Experiments:

1. Introduction to MSP–EXP432P401R Launch Pad, Code Composer Studio and Energia.
2. Interfacing LED using MSP432.
3. Interfacing 7-segment display to MSP432.
4. Interfacing dot-matrix display to MSP432.
5. Setting up communication interface using IR sensors.
6. Interfacing MSP432 with various sensors
7. Driving stepper motor using MSP432.
8. Interfacing memory to MSP432.
9. Setting up wireless communication Network.
10. Setting up IoT link for various sensors using MSP432.

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			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTES202	EC	Embedded Operating System	60	20	20	30	20	3	1	2	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. Introduction of the real time systems.
2. Computing required for the real time embedded systems.
3. Communication required for the real time embedded systems.
4. Present an overview of the real time embedded systems in practice.

Course Outcomes:

Students shall be able:

1. To present the mathematical model of the system.
2. To develop real time algorithm for task scheduling.
3. To understand the working of real time operating systems and real time database.
4. To work on design and development of protocols related to real time communication.

Syllabus:

UNIT I

Review of Operating Systems: Basic Principles, Operating System structures, System Calls, Files, Processes, Design and Implementation of processes, Communication between processes, Introduction to Distributed operating system, distributed scheduling.

UNIT II

Overview of RTOS: RTOS Task and Task state, Process Synchronisation, Message queues, Mail boxes, pipes, Critical section, Semaphores, Classical synchronisation problem, Deadlocks.

UNIT III

Real Time Models and Languages: Event Based, Process Based and Graph based Models, Real Time Languages, and RTOS Tasks, RT scheduling, Interrupt processing, Synchronization, Control Blocks, Memory Requirements.

UNIT IV

Real Time Kernel: Principles, Design issues, Polled Loop Systems, RTOS Porting to a Target, Comparison and study of various RTOS like QNX, VX works, PSOS, C Executive, Case studies.

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UNIT V

RTOS Application Domains: RTOS for Image Processing, Embedded RTOS for voice over IP, RTOS for fault Tolerant Applications, RTOS for Control Systems.

Text Books:

1. Raymond J.A.Bhur, Donald L.Bailey, "An Introduction to Real Time Systems", PHI 1999.
2. Mukesh Sighal and N G Shi "Advanced Concepts in Operating System", McGraw Hill 2000.

Reference Books:

1. John P. Peatman, "Design with Micro-Controllers",TMH.
2. Jonathan W. Valvano, "Embedded Micro-Computers System. Real time Interfacing", Thomson learning.
3. Charles Crowley, "Operating Systems-A Design Oriented approach" McGraw Hill 1997.
4. C.M. Krishna, Kang, G.Shin, "Real Time Systems", McGraw Hill, 1997.
5. Jane W.S. Liu, "Real Time Systems", Pearson Education.
6. Majidi & Majidi, "The 8051 Microcontroller and Embedded Systems", Pearson Education.
7. K. C. Wang, "Embedded and Real-Time Operating Systems", Springer, 2017.

List of Experiments:

1. Creation of tasks for toggle the bit 0, 1 and 2 of port 1 of 89C52 microcontroller using TINY OS.
2. Create tasks for toggle the port 0, port 1 and port 2 of 89C52 microcontroller using TINY OS.
3. Creation of tasks and sending signal to another task using TINY OS.
4. Creation of tasks then made another task as pended task and delete the main task TINY OS.
5. Program to suspend task for TINY OS.
6. Program to create pended suspended task for TINY OS.
7. To understand DEADLOCK in TINY OS.
8. Traffic light control using TINY OS.

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COURSE CODE	CATEGORY	COURSE NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTES203	EC	FPGA Architecture & Applications	60	20	20	30	20	3	1	2	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. Students will implement real-world designs in field programmable gate arrays (FPGAs) as well as test and optimize the FPGA-implemented systems.
2. Students will get exposure to medium-scale digital system design projects.
3. Design and optimize complex combinational and sequential digital circuits.

Course Outcomes:

1. Students will be able to understand the FPGA Architecture.
2. Students will be able to design and model digital circuits with Verilog HDL at behavioral, structural, and RTL Levels.
3. To Develop test benches to simulate combinational and sequential circuits.

Syllabus:

UNIT I

Programmable logic devices (PLDs). Programmable gate arrays. Xilinx series FPGAs and CPLDs. Altera series CPLDs and FPGAs. FPGA- based system design. FPGA fabrics. Combinational network delay. Power and energy optimization sequential machine design styles. Rules for clocking. Performance analysis.

UNIT II

Algorithms for fast convolution. Algorithmic strength reduction in filters and transforms. DCT and inverse DCT. Parallel FIR filters. Pipelining of FIR filters. Parallel processing. Pipelining and parallel processing for low power.

UNIT III

Bit level arithmetic structures- parallel multipliers, interleaved floor plan and bit plan based digital filters. Bit serial multipliers. Bit serial filter design and implementation. Canonic signed digit arithmetic, Distributed arithmetic.

UNIT IV

Synthesis and simulation using HDLs-Logic synthesis using verilog and VHDL. Short time Fourier Transform Computation of DWT using filter banks. Implementation and verification on FPGAs.

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UNIT V

Computation of special functions using CORDIC. Vector and rotation mode of CORDIC. CORDIC architectures. Implementation and verification on FPGAs.

Text Books:

1. W. Wolf, "FPGA-Based System Design, Pearson, 2004".
2. U. Meyer- Basese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, 2004.

Reference Books:

1. Stephen Brown I Zvanko Vranesic, "Fundamentals of Digital Logic with Verilog Design", The Mc Graw Hill, Third Edition 2014.
2. Peter Wilson, "Design Recipes for FPGA using Verilog and VHDL", Newnes Publication, Second Edition 2016.
3. M. Morris Mano, Michael D. Cilletti, "Digital Design with an Introduction to the Verilog HDL", Pearson, Fifth Edition 2012.
4. K. K. Parhi, "VLSI Digital Signal Processing Systems, John Wiley, 1999.

List of Experiments:

Students should implement and verify digital systems through Verilog/VHDL. After synthesis and simulation the design should be implemented on FPGA board.

1. Design of Boolean functions using gate instantiation.
2. Design of various adders circuits.
3. Design of various multiplexers.
4. Design and analysis of Encoder and Decoders.
5. Design of various latches and flip flops with Preset and Clear capability.
6. Design of various Shift registers.
7. Design Johnson and Ring counters.
8. Design synchronous and asynchronous up/down counters.
9. Design of a frequency divider circuit.
10. Design of Digital System based on Mealy and Moore machine

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COURSE CODE	CATEGORY	COURSE NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTDC124	EC	CMOS VLSI Design	60	20	20	0	0	3	1	-	4

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. Be able to use mathematical methods and circuit analysis models in analysis of CMOS digital electronics circuits, including logic components and their interconnects.
2. Be able to create models of moderately sized CMOS circuits that realize specified digital functions.
3. Be able to apply CMOS technology-specific layout rules in the placement and routing of transistors and interconnect, and to verify the functionality, timing, power, and parasitic effects.
4. Have an understanding of the characteristics of CMOS circuit construction

Course Outcomes:

1. Be able to complete a significant VLSI design project having a set of objective criteria and design constraints.
2. To design static CMOS combinational and sequential logic at the transistor level, including mask layout.
3. Use different analysis and verification tools, implementation and synthesis methodologies and testability techniques that will enable them to design high performance and efficient digital systems.
4. Design digital systems for a variety of applications, including microcomputers and special purpose computing systems

Syllabus:

UNIT I
Fundamental of MOS Transistor its Characteristic under Static and Dynamic Conditions, MOS Transistor Secondary Effects, Process Variations, Technology Scaling, CMOS Inverter -Static Characteristic, Dynamic Characteristic, Power, Energy, and Energy Delay parameters.

UNIT II
Stick diagram, Layout diagrams, combinational logic design examples, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation, Low Power Design principles.

UNIT III
Static Latches and Registers, Dynamic Latches and Registers, Timing Issues, Pipelines, Pulse and sense amplifier based Registers.

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UNIT IV
Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Speed and Area Tradeoffs, Memory Architectures, and Memory control circuits

UNIT V
CMOS Processing Technology Introduction, Wafer Formation, Photolithography, N-well process, Twin tub process, Stick Diagrams, layout design rules, CMOS process enhancements.

Text Books:

1. Neil H.E. Weste, David Money Harris, "CMOS VLSI Design, A circuits and systems perspective", IV Edition, Pearson, 2010.
2. Neil H.E. Weste, David Money Harris Ayan Banerjee, "CMOS VLSI Design, A circuits and systems perspective", III Edition, Pearson Education, 2004.
3. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw-Hill Education, 2002.
4. Peter Van Zant, "Microchip Fabrication, A Practical Guide to Semiconductor Processing", Sixth Edition, McGraw Hill Professional, 2013.

References Books:

1. Randall L. Geiger, Philip E. Allen, Noel R. Strader, "VLSI Design Techniques for analog and digital circuits", Tata McGraw Hill, 1989.
2. Sung Mo Kang, Yusuf Lebliabici, "CMOS Digital Integrated Circuits: Analysis and Design", IV Edition, Tata McGraw Hill, 2015.
3. Douglas A. Pucknell, Kamran Eshraghian, "Basic VLSI Design", III Edition, Prentice Hall, 1994.
4. S M Sze, VLSI Technology, II Edition, Tata McGraw-Hill Education, 2003.
5. Sorab Gandhi, "VLSI Fabrication Principles", Wiley India.

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COURSE CODE	CATEGORY	COURSE NAME	TEACHING & EVALUATION SCHEME								
			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTDC214	EC	Cryptography & E-Security	60	20	20	0	0	3	1	0	4

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:
Students are expected to demonstrate the ability to:

1. Identify computer and network security threats, classify the threats and develop a security model to prevent, detect and recover from the attacks.
2. Encrypt and decrypt messages using block ciphers, sign and verify messages using well known signature generation and verification algorithms.
3. Analyze existing authentication and key agreement protocols; identify the weaknesses of these protocols.

Course Outcomes:

1. Students will be able to download and install an e-mail and file security software, PGP, and efficiently use the code to encrypt and sign messages. …
2. Develop SSL or Firewall based solutions against security threats, employ access control techniques to the existing computer platforms such as Unix and Windows NT.
3. Write an extensive analysis report on any existing security product or code, investigate the strong and weak points of the product or code.

Syllabus:

UNIT I
The distributed information systems security problem, Basic definitions, risk analysis, physical security of systems, personnel security of documents and keys, Possible security violations, security attack, mechanism and services, X.800 security services and their categories, Network security models.

UNIT II
Cryptographic Tools, Symmetric key systems, Caesar, Mono-alphabetic, Playfair, Hill cipher etc., Block cipher method, Simplified DES, DES, Feistel algorithm, avalanche effect, block cipher modes of operation (ECB, CBC, CFB, OFB, CTR),

UNIT III
Elements of finite fields, Galois Field GF (p), Euclid's algorithm Cryptography & E-Security of GCD, polynomial arithmetic, AES triple DES, Blowfish.

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UNIT IV
Message digest functions, key management, privacy issues (clipper / skipjack.), Confidentiality, Asymmetric key systems, RSA, ECC, hash function and algorithms. Authentication: Authentication requirements, message authentication codes, authentication protocols, kerberos, X.509 certificates. Message Security: Digital signature (RSA, DSS, MD5).

UNIT V
Electronics Mail implementations (PGP, PEM, S/MIME), World Wide Web Transactions, System Security, E-security issues, types of network attacks (e.g. denial of service), firewalls, DeMilitarized Zones (DMZ), Intrusion Detection System (IDS). System Management - IP security, SNMP Version, Database Security.

Text Books:

1. W. Stallings, "Cryptography and network security", Pearson Education.
2. Schiller, "Applied Cryptography", Wiley.
3. Kahate, "Cryptography and Network Security", TMH.

Reference Books:

1. C. Kaufman, R. Perlman, S. Speciner, "Network Security", PH.
2. D. Champman, E. Zwickey, "Building Internet Firewalls", O'Reilly and Associates.
3. Albrecht Beutelspacher, "Cryptology", Cambridge Univ.

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			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTES215	EC	**Embedded Control System Design**	60	20	20	30	20	3	1	2	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

1. To introduce the basic concepts of control systems and its embedded implementation.
2. To learn the basics of control systems.
3. To learn control theory as used in embedded systems.
4. To learn application of control systems.
5. To learn I/O devices used in control systems.

Course Outcomes:

After completion of this course the students will be able

1. Understand the different aspects of embedded system.
2. Apply the concepts of control system to in embedded system.
3. Design and analyze various applications in embedded system.

Syllabus:

UNIT I

Introduction: The Idea of System Control, Computer in the Loop, Centralized and Distributed Control Systems, SCADA Systems, Hardware Requirements for Computer Control, General Purpose Computers, Microcontrollers, Software Requirements for Computer Control, Polling, Using External Interrupts for Timing, Using Timer Interrupts, Sensors Used in Computer Control, Temperature Sensors, Position Sensors, Velocity and Acceleration Sensors, Force Sensors, Pressure Sensors, Liquid Sensors, Air Flow Sensors.

UNIT II

Sampied Data Systems and the z-Transform: The Sampling Process, The z-Transform, Unit Step Function, Unit Ramp Function, Exponential Function, General Exponential Function, Sine Function, Cosine Function, Discrete Impulse Function, Delayed Discrete Impulse Function, The z-Transform of a Function Expressed as a Laplace Transform, Properties of z-Transforms, Inverse z-Transforms, Pulse Transfer Function and Manipulation of Block Diagrams, Open-Loop Systems, Open-Loop Time Response, Closed-Loop Systems, Closed-Loop Time Response, System Time Response Characteristics, Time Response Comparison, Time Domain Specifications, Mapping the s-Plane into the z-Plane, Damping Ratio and Undamped Natural Frequency in the z-Plane, Damping Ratio, Undamped Natural Frequency.

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UNIT III

System Stability: Factorizing the Characteristic Equation, Jury's Stability Test, Routh-Hurwitz Criterion, Root Locus, Nyquist Criterion, Bode Diagrams.

UNIT IV

Discrete Controller Design: Digital Controllers, Dead-beat Controller, Dahlin Controller, Pole-placement Control - Analytical, Pole-placement Control - Graphical, PIC Control, Saturation and Integral Wind-up, Derivative Kick, PID Tuning.

UNIT V

Controller Realization: Direct Structure, Direct Canonical Structure, Direct Noncanonical Structure, Cascade Realization, Parallel Realization, PID Controller Implementations, Microcontroller Implementations, Implementing Second-Order Modules, Implementing First-Order Modules, Implementing Higher-Order Modules, Choice of Sampling Interval.

Text Books:

1. Dogan Ibrahim, "Microcontroller Based Applied Digital Control", 2006 John Wiley & Sons, Ltd. ISBN: 0-470-86335-8

References Books:

1. Jim Ledin, "Embedded control systems in C/C++", CMP Books, 2004.
2. TimWescott, "Applied control for embedded systems", Elsevier Publications, 2006.
3. Jean J. Labrosse, "Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C", The publisher, Paul Temme, 2011.
4. Ball S.R., "Embedded microprocessor Systems - Real World Design", Prentice Hall, 2002.
5. Lewin A.R.W. Edwards, "Open source robotics and process control cookbook", Elsevier Publications, 2005.
6. Ben-Zion Sandler, "Robotics", Elsevier Publications, 1999.

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			THEORY			PRACTICAL		Th	T	P	CREDITS
			END SEM University Exam	Two Term Exam	Teachers Assessment*	END SEM University Exam	Teachers Assessment*				
MTES225	EC	Communication Protocols & Interface	60	20	20	30	20	3	1	2	5

Legends: **L** - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** – Practical; **C** - Credit;
***Teacher Assessment** shall be based following components: Quiz/Assignment/ Project/Participation in Class, given that no component shall exceed more than 10 marks.

Course Objectives:

To impart knowledge on:

1. Serial and parallel communication protocols.
2. Application Development using USB and CAN bus for PIC microcontrollers.
3. Application development using Embedded Ethernet for Rabbit processors.
4. Wireless sensor network communication protocols.

Course Outcomes:

After successful completion of the course, student wili be able to

1. Apply the fundamentals of embedded networking with the real world problems.
2. Develop the different applications using different interface of microprocessor and microcontroller

Syllabus:

UNIT I

Embedded Communication Protocols: Embedded Networking: Introduction, Serial/Parallel Communication, Serial communication protocols, RS232 standard, RS485, Synchronous Serial Protocols, Serial Peripheral Interface (SPI), Inter Integrated Circuits (I2C), PC Parallel port programming, ISA/PCI Bus protocols, Firewire.

UNIT II

USB and CAN BUS: USB bus, Introduction, Speed Identification on the bus, USB States, USB bus communication: Packets, Data flow types, Enumeration, Descriptors, PIC 18 Microcontroller USB Interface, C Programs, CAN Bus, Introduction, Frames, Bit stuffing, Types of errors, Nominal Bit Timing, PIC microcontroller CAN Interface, A simple application with CAN.

UNIT III

Ethernet Basics: Elements of a network, Inside Ethernet, Building a Network: Hardware options, Cables, Connections and network speed, Design choices: Selecting components, Ethernet Controllers, Using the internet in local and internet communications, Inside the Internet protocol.

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UNIT IV

Embedded Ethernet: Exchanging messages using UDP and TCP, Serving web pages with Dynamic Data, Serving web pages that respond to user Input, Email for Embedded Systems, Using FTP, Keeping Devices and Network secure.

UNIT V

Wireless Embedded Networking: Wireless sensor networks, Introduction, Applications, Network Topology, Localization, Time Synchronization, Energy efficient MAC protocols, MAC, Energy efficient and robust routing, Data Centric routing.

Text Books:

1. Frank Vahid, Givargis, "Embedded Systems Design: A Unified Hardware/Software Introduction", Wiley Publications.

Reference Books:

1. Jan Axelson, "Parallel Port Complete" , Penram publications.
2. Dogan Ibrahim, "Advanced PIC microcontroller projects in C", Elsevier 2008
3. Jan Axelson "Embedded Ethernet and Internet Complete", Penram publications
4. Bhaskar Krishnamachari, "Networking wireless sensors", Cambridge press 2005

List of Experiments:

Experiments based on following interfaces:

1. RS-232
2. I^2C
3. RS-485
4. CAN
5. BlueTooth
6. InfraRed
7. ZigBee
8. SPI
9. USB
10. Ethernet

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