Vel Tech
Rangarajan Dr. Sagunthala
R&D Institute of Science and Technology
(Deemed to be University Estd. u/s 3 of UGC Act, 1956)

M.Tech Programme

Embedded Systems and Technologies

CHOICE BASED CREDIT SYSTEM

[CBCS]

M.TECH R16

CURRICULUM & SYLLABUS

M.Tech Embedded Systems and Technologies

PROGRAM OUTCOMES:

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PROGRAM SPECIFIC OUTCOMES:

PSO1: Provide suitable solutions to real time engineering problems in industry sectors using embedded technologies.

PSO2: To explore research problems in the field of embedded system and provide optimized solutions.

PROGRAM EDUCATIONAL OBJECTIVES:

PEO1: Ability to define, analyze, investigate and address problems in embedded system design.

PEO2: To impart the expertise in embedded system required for employability and entrepreneurship at global level.

PEO3: To develop effective communication skill, pursue research, lifelong learning and solve societal problems.

M.Tech Embedded Systems and Technologies

Minimum Credits required in Course Categories

Course Category	Minimum Credits Required
Foundation Course	4
Program Core	30
Programme Elective	12
Independent Learning	8
Project work	26
Total	**80**

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M.Tech Embedded Systems and Technologies

School of Electrical and Communication

Department of Electronics & Communication Engineering

M.Tech Embedded Systems and Technologies

Curriculum

Foundation Course

Course Code	Course Name	L	T	P	C
2160MA101	Applied Mathematics and Statistics	4	0	0	4

Program Core

Course Code	Course Name	L	T	P	C
2161EC102	DSP Processor and Architecture	4	0	0	4
2161EC108	Embedded Control Systems	4	0	0	4
2161EC109	Software Technology for Embedded Systems	4	0	0	4
2161EC120	Embedded Processor Architectures	4	0	0	4
2161EC121	Real Time Operating System	4	0	0	4
2161EC122	System on Chip Architecture	4	0	0	4
2161EC207	Embedded Linux and Device Drivers	3	0	2	4
2161EC308	Embedded System Lab	0	0	2	1
2161EC309	RTOS Lab	0	0	2	1

Program Elective

Course Code	Course Name	L	T	P	C
2162EC105	Hardware-Software Co Design	3	0	0	3
2162EC111	Internet of Things	3	0	0	3
2162EC115	Intelligent Systems and Machine Learning	3	0	0	3
2162EC127	Mobile Application Development	3	0	0	3
2162EC133	Automotive Communication Protocol	3	0	0	3
2162EC135	RTOS for FPGAs	3	0	0	3
2162EC136	Embedded System Security	3	0	0	3
2162EC137	Real Time Systems with FPGA	3	0	0	3
2162EC138	Fault Tolerant Systems	3	0	0	3
2162EC139	Autonomous Vehicles	3	0	0	3
2162EC140	Wireless Embedded Systems	3	0	0	3
2162EC141	Multimedia Architectures	3	0	0	3
2162EC142	Building Automation	3	0	0	3
2162EC143	Industrial Automation	3	0	0	3
2162EC144	Sensors based Systems	3	0	0	3
2162EC145	Wearable Embedded Technology	3	0	0	3
2162EC146	Analog-Digital Interface	3	0	0	3
2162EC147	Advanced Digital System Design	3	0	0	3
2162EC148	Automotive Real time Embedded System	3	0	0	3

Independent Learning

Course Code	Course Name	L	T	P	C
2163EC407	Massive Open Online Course	0	0	0	2
2163MG401	Research Methodology	0	0	0	2
2163GE401	Business Communication	0	0	0	2

2163EC801	Field Study	0	0	0	2
RESEARCH SEMINAR					
2163EC501	Smart Systems for Smart Buildings	0	0	0	2
2163EC502	Smart Vehicular Systems	0	0	0	2
2163EC503	Low Power Embedded SOC Design	0	0	0	2
2163EC504	IoT for Real world Applications	0	0	0	2

Project work

Course Code	Course Name	L	T	P	C
2164EC601	Project Work Phase-I	0	0	20	10
2164EC701	Project Work Phase-II	0	0	32	16

M.Tech Embedded Systems and Technologies

PROGRAM CORE

Course Code	Course Name	L	T	P	C
2161EC102	DSP Processor and Architecture	4	0	0	4
2161EC108	Embedded Control Systems	4	0	0	4
2161EC109	Software Technology for Embedded Systems	4	0	0	4
2161EC120	Embedded Processor Architectures	4	0	0	4
2161EC121	Real Time Operating System	4	0	0	4
2161EC122	System on Chip Architecture	4	0	0	4
2161EC207	Embedded Linux and Device Drivers	3	0	2	4
2161EC308	Embedded System Lab	0	0	2	1
2161EC309	RTOS Lab	0	0	2	1

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2161EC102	DSP PROCESSOR & ARCHITECTURE	4	0	0	4

a. Course Category

Program Core

b. Preamble

This course, DSP processor and Architecture provides an introduction on the industry based.DSP processor's architecture and their algorithms. Students will learn about the addressing modes, instruction set and memory allocation of the TMS320C67XX processor and their programming aspects using Embedded C.

c. Pre-requisite Courses

Microprocessor & Microcontroller, Digital Signal Processing

d. Related Courses

Signal Processing for Speech Recognition.

e. Course Outcomes

On successful completion of the course, the students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Understand the basic building blocks of a digital signal processor.	K2
CO2	Exposed to the programming aspects of a digital signal processor.	K2
CO3	Incorporate the basic algorithms of DSP on a digital signal processor.	K3
CO4	Understand the method of interfacing external memory, Serial and Parallel I/O devices in a digital signal processor.	K2
CO5	Learn about the development tools involved in DSP processor and its applications	K2

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	M	L	M	-	-
CO2	L	M	H	-	-
CO3	-	L	-	-	-
CO4	L	M	H	L	L
CO5	-	-	M	L	L

g. Course Content

UNIT–I ARCHITECTURES FOR PROGRAMMABLE DIGITAL SIGNAL PROCESSORS 12

Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Features for External Interfacing.

UNIT–II PROGRAMMABLE DIGITAL SIGNAL PROCESSORS 12

Introduction, Commercial digital Signal processing Devices, TMS320C67XX Processor, Data Addressing Modes - Memory Space - Program Control - Detail Study of Instructions and Programming - On-Chip peripherals - Interrupts - Pipeline Operation.

UNIT-III IMPLEMENTATION OF BASIC DSP ALGORITHMS 12

Introduction, The Q - notation, FIR Filters, IIR Filters, Interpolation and Decimation Filters (one example in each case) -Implementation Of FFT Algorithms: Introduction, An FFT Algorithm for DFT Computation, Overflow and Scaling, Bit-Reversed Index Generation & Implementation on the TMS32OC67XX.

UNIT-IV INTERFACING MEMORY, SERIAL AND PARALLEL I/O PERIPHERALS TO DSP DEVICES 12

Introduction, Memory Space Organization, External Bus Interfacing Signals, Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and I / O Direct Memory Access (DMA), Synchronous Serial Interface.

UNIT-V DEVELOPMENT TOOLS AND APPLICATIONS OF DSP PROCESSOR 12

DSP Development Tools, The DSP System Design Kit (DSK), The Assembler and the Assembly Source File, The Linker and Memory Allocation, The Code Composer Studio, Building blocks involved in a DSP Based Bio-telemetry Receiver and Image Processing System

Total: 60 Hours

h. Learning Resources

i. Text Books

1. B. Venkataramani and M. Bhaskar, “Digital Signal Processors, Architecture, Programming and Applications”, 2nd Edition, TMH, 2004.
2. Ifeachor& Jervis, “Digital Signal Processing- A practical approach”, 4th edition, Pearson Education, 2004.
3. J.G.Proakis, “Algorithms for Statistical Signal Processing”, 4th edition, Pearson, 2002.

ii. Reference

1. Peter Pirsch, “Architectures for Digital Signal Processing”, 2nd edition, John Weily, 2007
2. Avtar Singh and S. Srinivasan, “Digital Signal Processing”, 4th edition, Thomson Publications, 2004.
3. TMS320C50, TMS320C54XX, TMS320C6713 data books.

iii. Online Resources

1. http://www.ti.com/product/TMS320C6713/technicaldocuments
2. http://www.ti.com/tool/tmdsdsk6713.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2161EC108	EMBEDDED CONTROL SYSTEM	4	0	0	4

a. Course Category

Programme Core

b. Preamble

To introduce the basic concepts of control systems and its embedded implementation.

c. Prerequisite Courses

Embedded system design, Control System, Real Time System

d. Related Courses

Advanced Computer Architecture, Automotive electronics, Automobile Engineering, Operating Systems

e. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Apply the various communication protocol and hardware devices to design an embedded system.	K2
CO2	Identify and understand the software development tool benefits to create operating system.	K2
CO3	Design a system with real time communication with high speed data transfer.	K2
CO4	Design an embedded control system and write a control program	K2
CO5	Understand the designing and working principle of a embedded system specifically designed for a single application	K2

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	H	L	H	L	H
CO2	M	L	H	H	H
CO3	M	L	H	H	H
CO4	M	M	M	M	H
CO5	L	M	M	M	H

g. COURSE CONTENT

UNIT I EMBEDDED SYSTEM ORGANIZATION **12**

Embedded computing – characteristics of embedded computing applications – embedded system design challenges; Build process of Real time Embedded system – Selection of processor; Memory; I/O devices-Rs-485, MODEM, Bus Communication system using I2C, CAN, USB buses, 8 bit –ISA, EISA bus.

UNIT II REAL-TIME OPERATING SYSTEM 12

Introduction to RTOS; RTOS- Inter Process communication, Interrupt driven Input and Output – Non maskable interrupt, Software interrupt; Thread – Single, Multithread concept; Multitasking Semaphores**.**

UNIT III INTERFACE WITH COMMUNICATION PROTOCOL 12

Design methodologies and tools – design flows – designing hardware and software Interface – system integration; SPI, High speed data acquisition and interface-SPI read/write protocol, RTC interfacing and programming**.**

UNIT IV DESIGN OF SOFTWARE FOR EMBEDDED CONTROL 12

Software abstraction using Mealy-Moore FSM controller, Basic concepts of developing device driver – SCI – Software - interfacing & porting using standard C & C++; Functional and performance debugging with benchmarking Real-time system software – Survey on basics of contemporary RTOS – VXWorks, UC/OS-II

UNIT V CASE STUDIES WITH EMBEDDED CONTROLLER 12

Programmable interface with A/D & D/A interface; Digital voltmeter, control- Robot system; - PWM motor speed controller, serial communication interface.

TOTAL: 60 Hours

h. Learning Resources

i.Text Books

1. Steven F. Barrett, Daniel J. Pack, “Embedded Systems – Design and Applications with the 68HC 12 and HCS12”, Pearson Education, 2008.
2. Raj Kamal, “Embedded Systems- Architecture, Programming and Design” Tata McGraw Hill, 2006.
3. Micheal Khevi The M68HC11 Microcontroller application in control, Instrumentation & Communication”, PH NewJersy, 1997.
4. Chattopadhyay, “Embedded System Design”, PHI Learning, 2011.
5. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey, “PIC Microcontroller and Embedded Systems- Using Assembly and C for PIC18”, Pearson Education,2008.
6. Steven F.Barrett,Daniel J.Pack,”Embedded Systems-Design & Application with the 68HC12 & HCS12”, Pearson Education,2008.
7. Daniel W. Lewis, “Fundamentals of Embedded Software”, Prentice Hall India, 2004.
8. Jack R Smith “Programming the PIC microcontroller with MBasic” Elsevier, 2007.
9. Keneth J.Ayala, “The 8086 Microprocessor: Programming & Interfacing the PC”, Thomson India edition.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2161EC109	SOFTWARE TECHNOLOGY FOR EMBEDDED SYSTEMS	4	0	0	4

a. Course Category

Programme Core

b. Preamble

Introduce the student with software concepts used in embedded systems.

c. Prerequisite Courses

Microprocessor and Microcontrollers, Embedded system design, Embedded C.

d. Related Courses

Advanced Microcontrollers, Embedded System Design.

e. Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level(Based on revised Bloom's Taxonomy)
CO1	Learn to expose the students to the fundamentals of embedded Programming.	K2
CO2	Learn to Introduce the GNU C Programming Tool Chain in Linux.	K2
CO3	Studied the basic concepts of embedded C and Embedded OS.	K2
CO4	Introduced time driven architecture, Serial Interface with a case study.	K2
CO5	Ability to develop program using python language and fundamental modelling.	K2

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	M	H	L	L
CO2	L	M	H	H	H
CO3	L	M	H	H	H
CO4	L	M	H	H	H
CO5	L	M	H	H	H

g. Course Content

UNIT I EMBEDDED PROGRAMMING **12**

C and Assembly - Programming Style - Declarations and Expressions - Arrays, Qualifiers and Reading Numbers - Decision and Control Statements - Programming Process - More Control - Statements - Variable Scope and Functions - C Preprocessor - Advanced Types - Simple Pointers - Debugging and Optimization – In-line Assembly.

UNIT II C PROGRAMMING TOOLCHAIN IN LINUX **12**

C preprocessor - Stages of Compilation - Introduction to GCC - Debugging with GDB - The Make utility - GNU Configure and Build System - GNU Binary utilities - Profiling - using *gprof* - Memory Leak Detection with *valgrind* - Introduction to GNU C Library.

UNIT III EMBEDDED C **12**

Adding Structure to 'C' Code: Object oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts.

UNIT IV EMBEDDED OS **12**

Creating embedded operating system: Basis of a simple embedded OS, Introduction to sEOS, Using Timer 0 and Timer 1, Portability issue, Alternative system architecture, Important design considerations when using sEOS- Memory requirements - embedding serial communication & scheduling data transmission - Case study: Intruder alarm system.

UNIT V PYTHON PROGRAMMING **12**

Basics of PYTHON Programming Syntax and Style – Python Objects– Dictionaries – comparison with C programming on Conditionals and Loops – Files – Input and Output – Errors and Exceptions – Functions – Modules – Classes and OOP – Execution Environment.

TOTAL:60 Hours

h.Learning Resources

i.Text Books

1. Steve Oualline, 'Practical C Programming 3rd Edition', O'Reilly Media, Inc, 2006.
2. Stephen Kochan, "Programming in C", 3rd Edition, Sams Publishing, 2009.
3. Michael J Pont, "Embedded C", Pearson Education, 2007.
4. Mark Lutz,"Learning Python,Powerful OOPs,O'reilly,2011

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2161EC120	EMBEDDED PROCESSOR ARCHITECTURES	4	0	0	4

a. Course Category

Program Core

b. Preamble

This course discuss the concepts and architecture of Embedded systems and to make the students capable of designing Embedded systems. To achieve this, the architecture and programming of Industry popular 32-bit Microcontroller, ARM Cortex is covered in detail

c. Prerequisite

Nil

d. Related Courses

Nil

e. Course Outcome

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Illustrate the Embedded Concepts and Architecture of Embedded Systems	K2
CO2	Explain the ARM Architecture and Cortex-M3	K2
CO3	Explain the instruction set and Cortex M3 implementation	K2
CO4	Summarize the nested vectored interrupt controller	K2
CO5	Select a proper Cortex Microcontroller for a particular application	K2

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	M	L	M	L	L
CO2	L	M	L	L	L
CO3	-	-	L	L	L
CO4	-	-	L	L	L
CO5	M	M	L	M	M

g. Course Content

UNIT I EMBEDDED CONCEPTS **12**

Introduction to embedded systems, Classification of embedded systems, Applications of Embedded Systems, Overview of embedded system architecture, Hardware architecture, Software architecture, Embedded System Constraints, recent trends in embedded systems, Development and debugging Tools.

UNIT II ARM ARCHITECTURE **12**

Background of ARM Architecture, Architecture Versions, Processor Naming, Instruction Set Development, Thumb-2 and Instruction Set Architecture. Cortex-M3 Basics: Registers, General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Stack Memory Operations, Reset Sequence.

UNIT III CORTEX-M3 IMPLEMENTATION **12**

Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions. Cortex-M3 Implementation Overview: Pipeline, Block Diagram, Bus Interfaces on Cortex-M3, I-Code Bus, D-Code Bus, System Bus, External PPB and DAP Bus. Exceptions: Exception Types, Priority, Vector Tables, Interrupt Inputs, Pending Behavior, and Fault Exceptions, Supervisor Call.

UNIT IV NESTED VECTORED INTERRUPT CONTROLLER **12**

NVIC: Nested Vectored Interrupt Controller Overview, Basic Interrupt Configuration, Software Interrupts and SYSTICK Timer. Interrupt Behavior: Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail-Chaining Interrupts, Late Arrivals and Interrupt Latency

UNIT V CORTEX-M3/M4 MICROCONTROLLER **12**

STM32L15xxx ARM Cortex M3/M4 Microcontroller: Memory and Bus Architecture, Power Control, Reset and Clock Control. STM32L15xxx Peripherals: GPIOs, System Configuration Controller, NVIC, ADC, Comparators, GP Timers, USART. Development & Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler, Debugger, Simulator, In-Circuit Emulator (ICE), Logic Analyzer etc.

Total: 60 Hours

h. Learning Resources

i.Text Books

1. The Definitive Guide to the ARM Cortex-M3, Joseph Yiu, Second Edition, Elsevier Inc. 2010.
2. Andrew N Sloss, Dominic Symes, Chris Wright, “ARM System Developer's Guide - Designing and Optimizing System Software”, 2006, Elsevier.

ii.Reference Books

1. Steve Furber, “ARM System-on-Chip Architecture”, 2nd Edition, Pearson Education.
2. Cortex-M series-ARM Reference Manual.
3. Cortex-M3 Technical Reference Manual (TRM).
4. Embedded/Real Time Systems Concepts, Design and Programming Black Book, Prasad, KVK.
5. David Seal “ARM Architecture Reference Manual”, 2001 Addison Wesley, England; Morgan Kaufmann Publishers.
6. STM32L152xx ARM Cortex M3 Microcontroller Reference Manual.

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COURSE CODE	COURSE TITLE	L	T	P	C
2161EC121	REAL TIME OPERATING SYSTEM	4	0	0	4

a. Course Category

Program Core

b. Preamble

This course introduces the concept and development procedures of real-time operating system for a selected embedded architecture.

c. Prerequisite

Nil

d. Related Courses

Nil

e. Course Outcome

Upon the successful completion of the course, student will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain fundamentals of real-time operating system.	K2
CO2	Implement task management functions for any ARM processor architecture.	K3
CO3	Implement task scheduler functions for any ARM processor architecture.	K3
CO4	Implement task synchronization functions for any ARM processor architecture.	K3
CO5	Implement inter task communication functions for any ARM processor architecture.	K3

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	M	H	L	L
CO2	L	M	H	H	H
CO3	L	M	H	H	H
CO4	L	M	H	H	H
CO5	L	M	H	H	H

g. Course Content

UNIT-I RTOS INTRODUCTION **12**

Introduction to Operating System: Functions, Structure – Need for RTOS – RTOS Characteristics – Kernel components – reentrant functions – foreground/background systems –interrupt mechanism – bootloader – RTOS based system development process – RTOS porting. Introduction to ARM Controllers – ARM7 Programming.

UNIT-II TASK MANAGEMENT FUNCTIONS **12**

Task structure – task types: kernel task, application task – task states – task priorities – context switching implementation on ARM7 Controllers: task structure, stack, context switch functions, task wait list, setting/changing task priority, system task, task creation/deletion, delaying a task.

UNIT-III TASK SCHEDULER FUNCTIONS **12**

Task scheduling algorithms: preemptive, nonpreemptive, fixed priority, dynamic priority – RTOS initialization – implementation on ARM7 Controllers: scheduler initialization, scheduler suspend/resume, round robin scheduler, preemptive, nonpreemptive, Earliest Deadline First scheduler, Rate Monotonic Scheduler.

UNIT- IV TASK SYNCHRONIZATION FUNCTIONS **12**

Mutual exclusion – deadlock: occurrence, avoidance – semaphores – semaphore management functions – implementation on ARM7 Controllers: semaphore structure, semaphore wait list, semaphore creation/deletion, waiting on semaphore, signaling a semaphore, obtaining status of semaphore.

UNIT-V INTER TASK COMMUNICATION FUNCTIONS **12**

Need for communication – Inter task communication objects: mailbox, message queue – mailbox management functions – message queue management functions – implementation on ARM7 Controllers: memory partitions, mailbox waiting list, mailbox creation/deletion, waiting for message, sending a message, reading a message, obtaining status of mailbox.

Total 60 Hours

i. Learning Resources

i.Text Books

1. J.J.Labrosse, “MicroC/OS-II: The Real Time Kernel”, Taylor & Francis, 2002.
2. A.N.Sloss, D.Symes and C.Wright, “ARM System Developer’s Guide – Designing and Optimizing System Software”, Elsevier, 2014.

ii.Reference Books

1. B.W.Kernighan and D.Ritchie, “C Programming Language”, Prentice Hall, 1998.
2. J.J.Labrosse, “Embedded Systems Building Blocks: Complete and Ready-to-use Modules in C”, Taylor & Francis, 2000.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2161EC122	SYSTEM ON CHIP ARCHITECTURE	4	0	0	4

a. Course Category:
Programme Core

b. Preamble:
In this course, the students will learn about basic models of system on chip architecture for use in embedded system design. Concretely, they will learn (1) need for system on chip architecture, (2) architecture reconfigurability, (3) development of FPGA based embedded SoC,(4) development of PSoC based embedded SoC.

c. Prerequisite Courses:
Nil

d. Related Courses:
Nil

e. Course Outcomes:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Compare SoC architecture and design procedure with that of conventional embedded architectures.	K2
CO2	Relate SoC components with the embedded application needs.	K2
CO3	Classify SoC architecture based on reconfigurability and compare their features.	K2
CO4	Develop an embedded SoC application using FPGA.	K3
CO5	Develop an embedded SoC application using SoC.	K3

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	L	L	-	-
CO2	L	M	L	L	-
CO3	M	M	L	L	-
CO4	L	L	L	-	-
CO5	M	M	L	-	-

g. Course Contents

UNIT I SoC Methodology **8**

Need for SoC, Evolution of SoC, SoC vs SBC, Applications, SoC Model, Hardware-Software duality,Design process – top down, platform-based, design tradeoff – fault tolerance.

UNIT II Architecture Customization **12**

Processor core selection, Processor architectures – sequential processor model, ILP processor model, memory considerations, SoC memory model, cache interface parameters, cache organization, interconnect architecture specifications, bus based – arbitration, physical structure, AMBA and Core Connect SoC bus, noc based – static and dynamic network.

UNIT III Reconfigurable SoC **12**

Introduction, classification – based on granularity, reconfiguration scheme and coupling, design flow – system level design, detailed design, implementation design, comparative study of reconfigurable hardware technologies – Xilinx and Intel FPGA, Atmel FPSLIC, Motorola RCF, Cypress PSoC – architecture, granularity, device technology, reconfiguration scheme, design flow, application areas.

UNIT IV FPGA based SoC **14**

Intel Cyclone II FPGA Architecture overview, programmable logic block, programmable interconnections, FPGA based processors – soft and hard, Nios II architecture, system development flow, Quartus Prime Tool, Nios II hardware development, Nios II software development, Nios II programmable peripherals overview, Nios II RTL simulation, Nios II design example using Quartus Prime.

UNIT V PSoC based SoC **14**

Cypress PSoC Architecture overview – PSoC 1, PSoC 3, PSoC 4, PSoC 5, PSoC 6, PSoC 3 CPU Subsystem, PSoC 3 Digital Subsystem, PSoC 3 Analog Subsystem, PSoC Design flow, PSoC Creator Design entry tools, Building PSoC 3 project configuration, Programming and debugging, PSoC 3 design example using PSoC creator.

TOTAL: 60 Hours

h. Learning Resources

i.Online References

1.Michael J.Flynn and W.Luk, “Computer System Design: System-on-Chip”, Wiley Publications, 2011.

2. N.S.Voros and K.Masselos, “System Level Design of Reconfigurable Systems-on-Chip”, Springer, 2009.

3. Pong P.Chu, “Embedded SoPC Design with NIOS II Processor and Verilog Examples”, John
Wiley & Sons, 2012.

4. R.Ashby, “My First Five PSoC3 Designs”, Cypress Semiconductors, 2012.

ii.Reference Books

1. R.Dubey, “Introduction to Embedded System Design using Field Programmable Gate Arrays”, Springer, 2012.

2. P.Ienne and R.Leupers, “Customizable Embedded Processors”, Morgan Kaufmann, 2007.

iii.Online Resources

1. https://www.ee.ryerson.ca/~courses/coe838/
2. http://www.eng.auburn.edu/~nelson/courses/elec5260_6260/

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2161EC207	EMBEDDED LINUX AND DEVICE DRIVERS	3	0	2	4

a. Course Category

Programme Core

b. Preamble

This course is designed to show experienced programmers how to develop device drivers for embedded Linux systems, and give them a basic understanding and familiarity with the Linux kernel.

c. Prerequisite Courses

Nil

d. Related Courses

Nil

e. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Understand the basic building blocks of embedded Linux system.	K2
CO2	Describes about the kernel modules and file system.	K2
CO3	Describe the features of device drivers and its components.	K2
CO4	Illustrates the functionalities of character device drivers and developing methods.	K2
CO5	Illustrates the functionalities of PCI device drivers and provides basic understanding of variety of device drivers.	K2

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	M	H	H	H
CO2	L	M	H	H	H
CO3	L	M	H	H	H
CO4	L	M	H	H	H
CO5	L	M	H	H	H

g. Course Content

UNIT I INTRODUCTION **9**

Linux in Embedded Systems, Types of Embedded Linux Systems and features, Creating a target Linux system, Types of Host/Target development and debug setup, Generic Architecture of an Embedded Linux System, System Startup, Types of Boot Configurations, System Memory Layout, Hardware Support: Processor Architectures, Buses and Interfaces, I/O, Storage, General-Purpose Networking, Industrial-Grade Networking, System Monitoring.

UNIT II KERNEL and FILE SYSTEM **9**

Kernel Considerations, Root Filesystem Structure, Libraries, Kernel Modules, Device Files. MTD-Supported Devices, Installing MTD utilities, Filesystem Types and layout for Embedded Devices, Writing a Filesystem Image to Flash, Placing a Disk Filesystem on a RAM Disk, Embedded Bootloaders, Server Setup for Network Boot, Using the U-Boot Bootloader, real time kernel requirements.

UNIT III DEVICE DRIVERS AND ITS COMPONENTS **9**

Role of the Device Driver, Kernel functionalities, Classes of Linux kernel Modules, Compiling and Loading Kernel, The Kernel Symbol Table, kernel data types, Kernel module Initialization and Termination, Kernel initialization error handling, Kernel Debugging, Kernel Concurrency Management, Linux Device models.

UNIT IV CHARACTER DEVICE DRIVER **9**

Device numbers – representation and allocation, File structure, device registration, device layout, read and write operation, Memory Allocations, Parallel Port driver.

UNIT V PCI DEVICE DRIVER **9**

PCI system layout, PCI addressing, PCI configuration registers, Initialization and registration, PCI device enabling, Configuring and accessing I/O and memory spaces. Overview of USB Drivers, Block Drivers, Network Drivers, TTY Drivers.

Total: 45 Hours

	Practical Exercises		**30 Hrs** **Skill Level**
1	Linux Host Installation	CO1	S3
2	Introductory Linux Commands	CO1	S3
3	Linux C Programming	CO1	S3
4	Linux Makefile creation	CO1	S3
5	Explore features of selected embedded Board	CO1	S3
6	Bare-Metal Programming on selected embedded Board	CO1	S3
7	Building Cross-Compiling Linux Toolchain	CO2	S3
8	Building a target Linux system	CO2	S3
9	Booting the selected target embedded board	CO2	S3
10	Alternate Booting method for the selected embedded board	CO2	S3
11	Creating read-only Linux File System	CO2	S3
12	Creating read-write Linux File System	CO2	S3
13	Creating Linux Loadable kernel Modules	CO3	S3
14	Implementing Linux GPIO driver	CO4	S3
15	Implementing Linux UART driver	CO5	S3

h. Learning Resources

i.Text Books

1. Jonathan Corbet, Alessandro Rubini, and Greg Kroah-Hartman “LINUX DEVICE DRIVERS” 3rd Edition, O’Reilly Media, Inc., 2005.

2. Karim Yaghmour, Jon Masters, Gilad Ben-Yossef, and Philippe Gerum, “Building Embedded Linux Systems” 2nd Edition, O’Reilly Media, Inc., 2008.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2161EC308	EMBEDDED SYSTEM LAB	0	0	2	1

a. Course Category

Program core

b. Preamble

The aim of this course is to understand the fundamental and design of embedded system. Additionally this course includes design and implementation of switching circuits and data acquisition interfacing

c. Prerequisite

Nil

d. Related Courses

Nil

e. Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Develop embedded systems with Aurdino Uno	S3
CO2	Develop embedded systems with PIC Microcontroller.	S3
CO3	Develop embedded systems with the ARM 7	S3
CO4	Design and develop system using Raspberry Pi and MSB430.	S3

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	L	L	L	L
CO2	-	L	M	-	M
CO3	L	M	L	L	M
CO4	L	M	L	M	M

g. List of Experiments

S.No	Name of the Experiments	Course Outcomes
1.	Switches and LED interfacing using Arduino Uno	CO1
2.	Data Acquisition System (Temperature Controller) Using Arduino Uno	CO1
3.	DC Motor and stepper Motor Control using Aurdino Uno	CO1
4.	Data Acquisition System (Temperature Controller) Using PIC Microcontroller	CO2
5.	Stepper Motor Control Using PIC Microcontroller	CO2
6.	DC Motor Control Using PIC Microcontroller	CO2
7.	Arithmetic And Logical Operations Using ARM Processor	CO3

8.	Implementation of FIR Filter Using ARM Processor	CO3
9.	Design and Development of Automatic System Using Raspberry Pi	CO4
10.	Design And Development of Wired And Wireless Embedded System	CO4

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2161EC309	RTOS LAB	0	0	2	1

a. Course Category

Program core

b. Preamble

This course introduces the concept and development procedures of real-time operating system for ARM7 architectures.

c. Prerequisite

Nil

d. Related Courses

Nil

e. Course Outcomes

Upon the successful completion of the course, students will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Understand ARM7 programming using Embedded C	S3
CO2	Implement RTOS Kernel functions for any ARM processor architecture	S3

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	M	H	H	H
CO2	L	M	H	H	H

g. List of Experiments

S.No	Name of the Experiments	Course Outcomes
1.	ARM7 Embedded C programming (Teacher led experiment)	CO1
2.	ARM7 Peripheral Programming using C (Student led experiment)	CO1
3.	Task Structure creation for ARM7 Architecture (Teacher led experiment)	CO2
4.	Context switching functions for ARM7 Architecture (Teacher led experiment)	CO2
5.	Task creation/deletion functions for ARM7 Architecture (Student led experiment)	CO2
6.	Round Robin scheduler for ARM7 Architecture (Student led experiment)	CO2
7.	Fixed priority preemptive scheduler for ARM7 Architecture (Student led experiment)	CO2
8.	Semaphore creation/deletion functions for ARM7 Architecture (Student led experiment)	CO2

9.	Semaphore signaling/waiting functions for ARM7 Architecture (Student led experiment)	CO2
10.	Mailbox creation/deletion functions for ARM7 Architecture (Student led experiment)	CO2
11.	Message sending/reading functions for ARM7 Architecture (Student led experiment)	CO2

h. List of Major Equipment/ Instrument/Software with Broad Specifications (20 students)

1. Personal Computer (Windows or Linux) = 20 Nos.
2. ARM7 (LPC2148) Development Kits = 10 Nos.
3. KEIL IDE development tools.
4. Sensors and Actuators.
5. Electronic Consumables like resistor and capacitor.

M.Tech Embedded Systems and Technologies

PROGRAM ELECTIVE

Course Code	Course Name	L	T	P	C
2162EC105	Hardware-Software Co Design	3	0	0	3
2162EC111	Internet of Things	3	0	0	3
2162EC115	Intelligent Systems and Machine Learning	3	0	0	3
2162EC127	Mobile Application Development	3	0	0	3
2162EC133	Automotive Communication Protocol	3	0	0	3
2162EC135	RTOS for FPGAs	3	0	0	3
2162EC136	Embedded System Security	3	0	0	3
2162EC137	Real Time Systems with FPGA	3	0	0	3
2162EC138	Fault Tolerant Systems	3	0	0	3
2162EC139	Autonomous Vehicles	3	0	0	3
2162EC140	Wireless Embedded Systems	3	0	0	3
2162EC141	Multimedia Architectures	3	0	0	3
2162EC142	Building Automation	3	0	0	3
2162EC143	Industrial Automation	3	0	0	3
2162EC144	Sensors based Systems	3	0	0	3
2162EC145	Wearable Embedded Technology	3	0	0	3
2162EC146	Analog-Digital Interface	3	0	0	3
2162EC147	Advanced Digital System Design	3	0	0	3
2162EC148	Automotive Real time Embedded System	3	0	0	3

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC105	HARDWARE SOFTWARE CO- DESIGN	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**

An introduction to the design of mixed hardware-software systems, focusing on common underlying modelling concepts, the design of hardware-software interfaces, and the trade-offs between hardware and software components.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	To acquire the knowledge about system specification and modelling.	K2
CO2	To learn the formulation of partitioning the hardware and software	K2
CO3	To analyse about the hardware and software integration	K2
CO4	To study the hardware design languages and its components.	K2
CO5	To formulate the design specification and module creation.	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	L	L	-	-
CO2	L	L	L	-	-
CO3	L	L	L	-	-
CO4	L	L	L	-	-
CO5	L	L	L	-	-

g. **Course Content:**

UNIT –I CO-DESIGN CONCEPTS **9**

Nature of hardware & software, quest for energy efficiency, driving factors for hardware-software co design, design space, system specification and modelling- Embedded Systems- Functional decomposition, Hardware Software tradeoffs- Comparison of Co-Design Approaches, Models of Computation, Requirements for Embedded System Specification.

UNIT–II METHODOLOGY FOR CO-DESIGN **9**

Partitioning source description into different implementation domains, Dataflow modeling and transformation, Dataflow implementation in Hardware and Software, Analysis of Control flow and Dataflow, hardware-software co-synthesis, Distributed System Co-Synthesis.

UNIT–III HARDWARE-SOFTWARE INTEGRATION **9**

Prototyping and Emulation Techniques, Target Architectures-Micro Programmed Architectures, General-Purpose Embedded Cores, System-on-Chip, Hardware-Software Interfaces, Principles of Hardware/Software Communication, Microprocessor Interfaces, Hardware Interfaces

UNIT–IV OBJECTED ORIENTED HARDWARE DESIGN **9**

Motivation for object oriented techniques, object oriented design strategies, modelling hardware components as classes, designing specialized components, data decomposition, and Processor example.

UNIT–V SYSTEM C PROGRAMMING **9**

Design Methodology, Modules and Hierarchy, Processes, Ports and signals, Data types, Simulation using System C. CASE STUDY: Processor/Coprocessor design using System C.

Total : 45 Hours

h. **REFERENCES**

i. Text Book

1. Patrick Schaumont “A Practical Introduction to Hardware/Software Co-design”, Patrick Schaumont, Springer, 2012.

2. Ralf Niemann, “Hardware/Software Co-Design for Data Flow Dominated Embedded Systems”, Kluwer, 1998.

3. Alxel Jantsch, “Modeling Embedded Systems and SOC’s. Concurrency and Time in Models of Computation”, MK, 2004.

4. Vahid and Frank, “Embedded System Design: A Unified Hardware/Software Introduction”, Wiley, 2002.

5. Wolf and Wayne, “Computers as Components: Principles of Embedded Computing System Design”, MK, 2001.

6. Grotker T, Liao S, Martin G and Swan S, “System design with SystemC”, Kluwer Academic Publishers, 2002.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC111	INTERNET OF THINGS	3	0	0	3

a. Course Category

Programme Elective

b. Preamble

An introduction to the design of mixed hardware-software systems, focusing on common underlying modelling concepts, the design of hardware-software interfaces, and the trade-offs between hardware and software components.

c. Prerequisite Courses

Nil

d. Related Courses

Nil

e. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Describe the various types of sensors and communication modules that are used in IoT module.	K2
CO2	Explain different IoT protocols and Zigbee architecture	K2
CO3	Describe the data management and business processes in IoT. Explain about the M2M and IoT analytics	K2
CO4	Illustrate the layering concepts, IoT communication pattern and IoT protocol architecture.	K2
CO5	Describe the applications based on IoT that can be used in home, industries and other essential areas	K2

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	M	M	L	L
CO2	L	M	M	M	L
CO3	M	M	M	M	L
CO4	L	M	M	M	L
CO5	M	M	M	H	H

g. Course Content:

UNIT–I INTRODUCTION **9**

Components in internet of things: Control Units – Sensors – Communication modules – Power Sources – Communication Technologies – RFID – Bluetooth – Zigbee – Wifi – RF links – Mobile Internet–Wired Communication.

UNIT–II IOT PROTOCOLS **9**

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus – KNX – Zigbee Architecture – Network layer – APS layer – Security

UNIT–III M2M and IoT TECHNOLOGY FUNDAMENTALS **9**

Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service(XaaS), M2M and IoT Analytics, Knowledge Management

UNIT–IV IoT ARCHITECTURE **9**

The Layering concepts, IoT Communication Pattern, IoT protocol Architecture, 6LoWPAN, Security aspects in IoT

UNIT–V ADVANCED IOT APPLICATIONS **9**

IoT applications in home, Infrastructures, Buildings, Security, Industries, Home appliances, other IoT electronic equipments. Use of Big Data and Visualization in IoT, Industry 4.0 concepts

Total : 45 Hours

h. **REFERENCES**

i. Text Book

1. Dieter Uckelmann, Architecting the Internet of Things, Springer, 2011.
2. Honbo Zhou, The Internet of Things in the Cloud: A Middleware Perspective– CRC Press –2012
3. Dr. Ovidiu Vermesan, Dr. Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers

ii. Reference

1. Olivier Hersent , David Boswarthick, Omar Elloumi , The Internet of Things –Key applications and Protocols, Wiley, 2012
2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence**,** 1st Edition, Academic Press, 2014

iii. Online resources

1. http://web.mit.edu/professional/digital-programs/courses/IoT/index.html
2. *http://www.ti.com/ww/en/internet_of_things/iot-applications.html*

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC115	INTELLIGENT SYSTEMS AND MACHINE LEARNING	3	0	0	3

a. Course Category

Programme Elective

b. Preamble

The objective of the course is to introduce students to the concepts of 'machine-learning' or 'machine intelligence' and 'approximate reasoning' (universal approximation) with a particular emphasis on Fuzzy Systems & Artificial Neural Networks and the related synergy of the Neural-Fuzzy architecture.

c. Prerequisite Courses

Nil

d. Related Courses

Nil

e. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	View intelligent systems as problem solving systems and identify suitable search algorithms.	K2
CO2	Compare the performances of various search algorithms	K2
CO3	Apply a suitable knowledge representation technique for intelligent systems	K2
CO4	Define and classify various machine learning methods.	K2
CO5	Implement an intelligent system using neural network algorithm.	K2

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	M	M	L	L
CO2	L	M	M	M	L
CO3	L	M	M	L	L
CO4	L	M	M	M	L
CO5	M	M	M	H	H

g. Course Content:

UNIT–I INTRODUCTION TO INTELLIGENT SYSTEMS **8**

Intelligent Systems – Definition – Human Vs Machine Intelligence – Evolution of Artificial Intelligence. Intelligent System viewed as Goal-based Problem Solving – Problem description – Search process – Tree-based Search – Graph Search – Examples. Search method classification – Uniformed Search Methods – Informed Search – Single Agent search – Multi Agent search.

UNIT–II SEARCH ALGORITHMS **12**

Uniformed Search Methods – Breadth First, Depth First, Limited and Iterative Depth First, Backtracking, Branch and Bound, Bidirectional – performance evaluation. Informed Search Methods – Heuristics – Best First, Recursive Best First, Greedy, A * search – performance comparison. Iterative Search – Hill climbing, Simulated annealing. Adversarial Search – Min-Max Algorithm, designing the utility function.

UNIT–III KNOWLEDGE REPRESENTATION **12**

Knowledge Representation – Language – Method of Reasoning – Logical System – Propositional logic, First order predicate logic. Rule-based Knowledge representation – Elements – Rules classification – Structure – Types of rule-based systems – benefits and capabilities. Fuzzy-based Knowledge representation – Fuzzy set representation – operations and properties – Fuzzy rules – Fuzzyfication and Defuzzyfication

UNIT–IV INTRODUCTION TO MACHINE LEARNING **7**

Machine Learning – Definition – Machine Learning for Machine Intelligence – Learning steps – Classification of learning systems – Examples of machine learning problems.

UNIT–V NEURAL NETWORK BASED MACHINE LEARNING **6**

Similarities between Biological and artificial neural network – architecture of artificial neuron – Neural network types – Perceptron model – Activation function, learning rule, example, limitations – Multilayer model – Back propagation learning algorithm with one and two hidden layers.

Total : 45 Hours

h. REFERENCES

i. Text Book

1. Crina Grosan and Ajith Abraham, “Intelligent Systems – A Modern Approach”, Springer Publications, 2014.

2. Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, MIT Press,2014.

3. George A.Anastassiou, “Intelligent Systems II – Complete Approximation by Neural Network Operators”, Springer Publications, 2016.

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COURSE CODE	COURSE TITLE	L	T	P	C
2162EC127	MOBILE APPLICATION DEVELOPMENT	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**

An introduction to the design of creating applications for the myriad versions and varieties of mobile phone platforms on the market can be daunting to even the most seasoned developer. This authoritative guide is written in such as way that it takes your existing skills and experience and uses that background as a solid foundation for developing applications that cross over between platforms, thereby freeing you from having to learn a new platform from scratch each time.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	To acquire the knowledge about Preliminary Considerations	K2
CO2	To learn the Diving into Mobile: App or Website?	K2
CO3	To analyse about the Creating Consumable Web Services for Mobile Devices	K2
CO4	To study the how to Getting Started with Android	K2
CO5	To study about Getting Started with iOS	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	L	L	-	-
CO2	L	L	L	-	-
CO3	L	M	L	-	-
CO4	L	L	M	-	-
CO5	L	L	M	-	-

g. **Course Content:**

UNIT –I INTRODUCTION TO MOBILE APP DEVELOPMENT 9

Mobile Web vs. Mobile App - Cost of Development - Hardware - Software - Licenses and Developer Accounts - Documentation and APIs - The Bottom Line - Importance of Mobile Strategies in the Business World - Mobile Development Today - Mobile Myths - Third-Party Frameworks

UNIT–II CREATING CONSUMABLE WEB SERVICES FOR MOBILE DEVICE 9

Web Service - Examples of Web Services - Advantages of Web Services - Web Services Languages (Formats) - eXtensible Markup Language (XML) - JavaScript Object Notation (JSON) - Transferring Nontextual Data - Creating an Example Web Service - Using the Microsoft Stack - Using the Linux Apache MySQL PHP (LAMP) Stack - Debugging Web Services

UNIT–III MOBILE USER INTERFACE DESIGN 9

Effective Use of Screen Real Estate - Embrace Minimalism - Use a Visual Hierarchy - Stay Focused - Understanding Mobile Application Users - Proximity - Closure - Continuity -Figure and Ground - Similarity - The Social Aspect of Mobile - Usability - Accessibility - Understanding Mobile Information Design

UNIT–IV GETTING STARTED WITH ANDROID 9

Android as Competition to Itself - Multiple Markets and Market Locks - Getting the Tools You Need - Downloading and Installing JDK - Downloading and Installing Eclipse - Downloading and Installing the Android SDK - Downloading and Configuring the Eclipse ADT Plug-in - Installing Additional SDK Components - Android Development Practices - Android Fundamentals -Fragments as UI Elements.

UNIT–V GETTING STARTED WITH iOS 9

Apple Devices - Getting the Tools You Need - Hardware - xCode and the iOS SDK - The iOS Human Interface Guideline - iOS Project - Anatomy of an iOS App - Getting to Know the xCode IDE - Debugging iOS Apps - The iOS Simulator - Debugging Code- Instruments - Objective-C Basics – Classes - Control Structures

Total : 45 Hours

h. **REFERENCES**

i. Text Book

1.Jeff McWherter, Scott Gowell “Professional Mobile Application Development”, WILEY PUBLICATION, 2012.

2.Mahesh Panhale ·, “Beginning Hybrid Mobile Application Development”, apress publishers, 2015.

3.Meikang Qiu, Wenyun Dai, Keke Gai , “Mobile Applications Development with Android - Technologies and Algorithms”, CRC Press, 2016.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC133	AUTOMOTIVE COMMUNICATION PROTOCOL	3	0	0	3

a. Course Category

Programme Elective

b. Preamble

This course introduce the basics of communication protocols, CAN protocol and its structures in Automotive Embedded System. It explain LIN protocol and its structures in Automotive Embedded System, vehicle network diagnostics in Automotive Embedded System, Telematics basics and it technologies for Automotive Embedded System.

c. Prerequisite Courses

Nil

d. Related Courses

Nil

e. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	To give sufficient background for undertaking different protocols for Automotive Embedded control system.	K2
CO2	Understand about CAN in OSI Reference Model	K2
CO3	Understand LIN, LIN consortium and LIN specification	K2
CO4	Understand about the process of automotive Fault diagnostics	K2
CO5	Understand about telematics applications and technologies	K2

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	L	L	L	L
CO2	L	L	L	L	L
CO3	L	L	L	L	L
CO4	L	L	L	L	L
CO5	L	L	L	L	L

g. Course Content:

UNIT–I INTRODUCTION **9**

Basics of data communication networks and automotive communication protocols: Networks- Need for networks- Types of networks- Need for standards- TCP/IP model- Topologies- Error detection and correction mechanisms- Encoding schemes- Serial/parallel transmission- Bits-

Baud and bandwidth- Synchronous and asynchronous- Need and benefits of IVN- Classes of IV N protocols- Multiplexed electrical systems- Vehicle multiplexing- Bitwise contention- Network elasticity- Error processing and management and Case Study

UNIT–II CONTROLLER AREA NETWORK (CAN) PROTOCOL 9

History and foundation of CAN- CAN Applications- SAE J1939 Protocol- Main characteristics of CAN- CAN in OSI Reference Model- CAN Data Link Layer- Principles of data exchange in CAN- Arbitration- Data Frame- Remote Frame- Error detection and management in CAN- CAN physical Layer- Bit encoding- Bit timing and synchronization- Relationship between data rate and bus length- Single wire and twin wire media- CAN repeaters- Medium to medium gateway- Protocol handlers- Microcontrollers and line drivers- Time Triggered CAN (TTCAN)- Comparison with other IVN protocols

UNIT–III LOCAL INTERCONNECT NETWORK (LIN) PROTOCOL 9

Introduction to LIN- LIN consortium- LIN specification- LIN features- Technical overview- Work flow concept- LIN operation- LIN frame format- Scheduling table- Network management of LIN cluster- LIN Transport Layer- LIN node configuration and identification- LIN diagnostics- LIN physical layer- Comparison with other IVN protocols and Case Study

UNIT–IV IN VEHICLE NETWORK DIAGNOSTICS 9

Process of Automotive Fault Diagnostics- Fault Codes- Vehicle Systems (open loop and closed loop) - On and Off Board Diagnostics- OBDI- OBDII- Engine Analyzers- Steps taken to diagnose a fault- Diagnostics ProtocolKWP2000- SAEJ1587- SAEJ1708 and Case Study

UNIT–V TELEMATICS APPLICATIONS AND TECHNOLOGIES 9

Global Positioning Systems (GPS)- Inertial Navigation Systems (INS)- Vehicle Location and Navigation- Bluetooth- UWB- RFID- Intelligent Transportation Systems (ITS) and Wireless Access in Vehicular Environments (WAVE)- Vehicular Ad Hoc Networks (VANETs)- Communications- Air interface- Long and Medium range (CALM)- Real time management and planning of CRDI vehicle operation- Satellite Radio (XMRadio and SIRIUS)- Fleet Management and Case Study.

Total : 45 Hours

h. REFERENCES

i. Text Book

1. Communication Protocol Engineering (Hardcover) by Miroslav Popovic

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COURSE CODE	COURSE TITLE	L	T	P	C
2162EC135	RTOS FOR FPGA's	3	0	0	3

a. Course Category

Programme Elective

b. Preamble

This course focuses on the understanding of Embedded Linux, Kernel classification, and RTOS on ARM based FPGA hardware.

c. Prerequisite Courses

Nil

d. Related Courses

Nil

e. Course Outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Understand real-time systems concepts in Micrium OS II/III RTOS and its internal structure.	K2
CO2	Describe how Micrium OS II/III RTOS involve in task and time management.	K2
CO3	Understand µC/OS-II's services to have tasks and ISRs communicate with one another and share resource.	K2
CO4	Explain µC/OS-II's dynamic memory allocation feature using fixed-sized memory blocks.	K2
CO5	Describe in general terms what needs to be done to adapt µC/OS-II to different processor architectures.	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	M	M	M	M	L
CO2	M	M	M	M	L
CO3	M	M	M	M	L
CO4	M	M	M	M	L
CO5	M	M	M	M	L

g. Course Content

UNIT I Micrium OS II/III RTOS AND KERNEL 9

Foreground/Background Systems - Critical Sections – Resources – Multitasking – Context Switching - Scheduling – Task Priorities - Mutual Exclusion – Semaphores - Intertask Communications – Interrupts – Memory Requirements – Real Time Kernels – Critical Sections – Tasks and Task States - Task Control Blocks – Task Level Context Switch – Locking and Unlocking the Scheduler – Interrupts Under µc/OS -II – Clock Tick - µc/OS - Initialization – Starting µc/OS -II.

UNIT II TASK AND TIME MANAGEMENT 9

Creating a Task – Task Stacks – Stack Checking - Deleting a Task - Changing a Task's Priority – Suspending and Resuming a Task – Getting Information about a Task – Delaying a Task – Resuming A Delayed Task – System Time – Event Control Blocks – Semaphore Managements – Mutual Exclusion Semaphores – Event Flag Management.

UNIT III MESSAGE MAIL BOX AND QUEUE MANAGEMENT 9

Creating and Deleting a Mail Box – Waiting for a Message at Mail Box – Sending a Message – Non-Blocking Message – Status of a Mail Box – Creating and Deleting a Message Queues – Waiting for a Message at Queue – Sending a Message to a Queue FIFO, LIFO, FIFO or LIFO – Flushing a Queue - Status of a Queue.

UNIT IV MEMORY MANAGEMENT AND PORTING µC/OS -II 9

Memory Control Blocks – Creating a Partition – Obtaining a Memory Block – Returning a Memory Block – Obtaining a status of a Memory Partition – Using a memory partition – waiting for memory blocks from a partition – Porting µc/OS -II - µc/OS -II configuration.

UNIT V µC/OS -II FOR FPGAS 9

Nios II processor and the MicroC/OS-II RTOS – Zynq and the MicroC/OS-II RTOS - Hello MicroC/OS-II – System on Chip Design with MicroC/OS-II – Development Tools: µc probe, Traceanalyzer, Systemview

TOTAL: 45 Hours

h. REFERENCES

i.Text Books

1. K.C. Wang, "Embedded and Real-Time Operating Systems", Springer, 2017.
2. Jean J. Labrosse, "MicroC OS II: The Real Time Kernel", CRC Press, 2nd Edition, 2002.
3. https://www.micrium.com/rtos/
4. https://www.altera.com/products/processors/design-tools/embed-partners/micrium.html.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC136	EMBEDDED SYSTEM SECURITY	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**

A broad understanding of security principles, concerns, and technologies. Proven techniques for the efficient development of safe and secure embedded software. A study of the system architectures, operating systems and hypervisors, networking, storage, and cryptographic issues that must be considered when designing secure embedded systems

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	To acquire the knowledge about Embedded Systems Security	K2
CO2	To learn Systems Software Considerations	K2
CO3	To analyse about the Secure Embedded Software Development	K2
CO4	To study the Embedded Cryptography	K2
CO5	To study about Emerging Applications	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	L	L	-	-
CO2	L	L	L	-	-
CO3	L	M	L	L	-
CO4	L	L	M	-	-
CO5	L	L	M	L	L

g. **Course Content:**

UNIT –I INTRODUCTION TO EMBEDDED SYSTEMS SECURITY 9

Embedded Systems Complexity - Embedded Linux - Network Connectivity - Reliance on Embedded Systems for Critical Infrastructure - Sophisticated Attackers - Processor Consolidation - Security Policies - Perfect Security - Confidentiality, Integrity, and Availability - Isolation - Information Flow Control - Physical Security Policies -Application-Specific Policies - Security Threats - Case Study: VxWorks Debug Port Vulnerability

UNIT–II SYSTEMS SOFTWARE CONSIDERATIONS **9**

The Role of the Operating System - Multiple Independent Levels of Security - Information Flow - Data Isolation - Damage Limitation - Periods Processing - Always Invoked - Tamper Proof - Evaluable - Microkernel versus Monolith - Core Embedded Operating System Security Requirements - Memory Protection - Virtual Memory - Guard Pages - Location Obfuscation-Fault Recovery - Guaranteed Resources

UNIT–III SECURE EMBEDDED SOFTWARE DEVELOPMENT **9**

Secure Development Process - Change Management - Peer Reviews - Security-Oriented Peer Review - Development Tool Security - - Secure Coding - Coding Standards - Case Study: MISRA C:2004 and MISRA Cþþ:2008 - Preparing for a One-Time Retrofit Cost - Allowing for Management-Approved Exceptions to Reduce Regressions - Language Standards Are Never Perfect - Case Study: Green Hills Standard Mode

UNIT–IV EMBEDDED CRYPTOGRAPHY **9**

Cryptographic Modes - Block Ciphers - Authenticated Encryption - Public Key Cryptography - Key Agreement - Public Key Authentication - Elliptic Curve Cryptography - Cryptographic Hashes - Message Authentication Codes - Random Number Generation.

UNIT–V EMERGING APPLICATIONS **9**

Embedded Network Transactions - Automotive Security - Secure Android - Next-Generation Software-Defined Radio.

Total : 45 Hours

h. **REFERENCES**

i. Text Book

1. Kleidermacher, D., Kleidermacher, M. (2012). Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development. Netherlands: Elsevier Science.
2. Gebotys, C. H. (2010). Security in Embedded Devices. Netherlands: Springer US.
3. Stapko, T. (2011). Practical Embedded Security: Building Secure Resource-Constrained Systems. Netherlands: Elsevier Science.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC137	REAL TIME SYSTEMS WITH FPGA	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**
This course introduces basic concepts of real time system design using FPGA that integrate both FPGA and necessary EDA tools by following a systematic hardware/software co-design principle.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Understand the embedded system design using various abstraction levels, programming languages and tools.	K2
CO2	Realize the FPGA for embedded system design.	K2
CO3	Understand the EDA tools and development boards for real time system.	K2
CO4	Recognize the required peripheral drivers to develop a prototype.	K2
CO5	Describe the processors design and embedded system design.	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	L	L	-	-
CO2	L	L	L	L	-
CO3	M	L	L	L	-
CO4	L	M	L	L	L
CO5	M	L	L	-	

g. **Course Content:**

UNIT–I ELEMENTS OF EMBEDDED SYSTEM DESIGN 9

Abstraction Levels – Embedded System Design Flow – Design Tools – Hardware Design Trends – Arithmetic Sub Systems – RTL Design with HDL – Computer System – Computer Software – Instruction Set Architecture – SMPL CPU Design – SAYEH Design and Test

UNIT–II FIELD PROGRAMMABLE DEVICES 9

Read Only Memories – Programmable Logic Array – Programmable Array Logic – Complex Programmable Logic Devices: Xilinx, Altera; Field Programmable Gate Arrays: Logic blocks, Routing architecture; Design flow for FPGA Design - Mapping for FPGAs – Xilinx FPGA

Architecture: Xilinx XC4000 – Altera Architecture: FLEX 8000; Case studies: Virtex II Pro and Quartus II.

UNIT–III TOOLS FOR DESIGN AND PROTOTYPING 9

Hardware Design Flow: Data Path and Controller – HDL Simulation and Synthesis: Pre-Synthesis Simulation, Module Synthesis, Post Synthesis Simulation – Mixed Level Design with Quartus II: Design Specification, Block Diagram Design File, Creating and Inserting Design Component, Wiring Design Components, Design Compilation and Simulation, Synthesis Results; Design Prototyping: UP3 Board Specification, DE2 Board Specification, Programming DE2 Cyclone II.

UNIT–IV DESIGN OF UTILITY HARDWARE CORES 9

Library Management – Basic IO Device Handling: Debouncer, Single Stepper, Utilizing UP3 Basic IO, Utilizing DE2 IO; Frequency Divider – Seven Segment Display – LCD Display Adaptor – Keyboard Interface Logic – VGA Interface Logic.

UNIT–V DESIGN WITH EMBEDDED PROCESSORS 9

Embedded Design Steps – Filter Design – Design of a Microcontroller –Embedded Processors: Microblaze, Zynq, Nios II Processor – Avalon Switch Fabric – SOPC Builder – Integrated Development Environment – Embedded System Design: Calculator

Total : 45 Hours

h. **REFERENCES**

i. Text Book

1. Zainalabedin Navabi, “Embedded Core Design with FPGAs”, McGraw-Hill Education, 2006.
2. Athanas, Peter, Pnevmatikatos, Dionisios, Sklavos, Nicolas, “Embedded Systems Design with FPGAs”, Springer, 2013.
3. Dubey, Rahul, “Introduction to Embedded System Design Using Field Programmable Gate Arrays”, Springer, 2009

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC138	FAULT TOLERANT SYSTEMS	3	0	0	3

a. Course category

Programme Elective

b. Preamble

This course provides a broad understanding of fault diagnosis and fault tolerant design approach.

c. Prerequisite courses

Nil

d. Related courses

Nil

e. Course outcomes

Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain fundamentals of fault tolerant design	K2
CO2	Comprehend the design requirements of self-checking circuits	K2
CO3	Review the design for testability rules and techniques	K2
CO4	Explain the Built-in Self-Test logic	K2
CO5	Compare various test access methods	K2

f. Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	M	M	L	L
CO2	L	M	M	L	L
CO3	L	M	M	L	L
CO4	L	M	M	L	L
CO5	L	M	M	L	L

g. COURSE CONTENT

UNIT I FAULT TOLERANT DESIGN 9

Basic concepts: Reliability concepts, Failures & faults, Reliability and Failure rate – Relation between reliability and mean time between failure – maintainability and availability – Fault Tolerant Design: Basic concepts, static, dynamic, hybrid, triple modular redundant system

(TMR) – TMR reconfiguration techniques – Data redundancy – Time redundancy and software Redundancy concepts.

UNIT II SELF-CHECKING CIRCUITS 9

Self-Checking Circuits: Basic concepts of self-checking circuits, Design of Totally self-checking checker, Checkers using m out of n codes, Berger code, Low cost residue code – Fail Safe Design: Strongly fault secure circuits, fail safe design of sequential circuits using partition theory and Berger code, totally self-checkingcircuit design.

UNIT III DESIGN FOR TESTABILITY 9

Design for testability for combinational circuits: Basic concepts of Testability, Controllability and observability – The Reed Muller's expansion technique – use of control and syndrome testable designs – Design for testability by means of scan: Making circuits Testable, Testability Insertion, Full scan DFT technique – Full scan insertion – flip-flop Structures – Full scan design and Test – Scan Architectures – Shadow register DFT – Partial scan methods – multiple scan designs.

UNIT IV BUILT-IN-SELF-TEST LOGIC 9

BIST Basics – Memory-based BIST – BIST effectiveness – BIST types – Designing a BIST – Test Pattern Generation: Engaging TPGs, exhaustive counters, ring counters, twisted ring counter, Linear feedback shift register – Output Response Analysis: Engaging ORA's, One's counter, transition counter, parity checking, Serial LFSRs – Parallel Signature analysis – BIST architectures – Board-level BIST architecture – Random Test socket(RTS).

UNIT V TEST ACCESS METHODS 9

Boundary Scan Basics – Boundary scan architecture: Test access port, Boundary scan registers, TAP controller, the decoder unit, select and other units – Boundary scan Test Instructions – Board level scan chain structure: One serial scan chain – multiple-scan chain with one control test port, multiple-scan chains with one TDI,TDO but multiple TMS, Multiple-scan chain, multiple access port – RT Level boundary scan – inserting boundary scan test hardware for CUT – Two module test case – virtual boundary scan tester – Boundary Scan Description language.

Total -45 Hours

h. REFERENCES

i.TEXT BOOKS

1.Parag.K.Lala-"Fault Tolerant & Fault Testable Hardware Design"-Prentice Hall India- 1994.
2.Z.Navabi-"Digital System Test and Testable Design using HDL models and Architectures"-Springer-2010.

ii.REFERENCES

1.M.Bushnell, V.Agrawal-"Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits"-Kluwer Academic-2010.
2.Parag.K.Lala-"An Introduction to Logic Circuit Testing"-Morgan and Claypool-2009.
3.L.T.Wang, C.W.Wu, X.Wen-"VLSI Test Principles and Architectures: Design for Testability"-Elsevier-2006.

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COURSE CODE	COURSE TITLE	L	T	P	C
2162EC139	AUTONOMOUS VEHICLES	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**
The course deals with discussion of the principles, concepts and applications of autonomous vehicles.

c. **Prerequisite Courses**
Embedded Systems Design, IoT

d. **Related Courses**
Automotive Electronics

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Basic concept of measurement, types of errors, standards, Device under calibration, calibration techniques, requirement of calibration laboratory, Analysis of measurement data, Uncertainty & Reporting the outcome of measurement process.	K3
CO2	Sensors, Actuators & systems. Static & Dynamic characteristics of sensors & systems including Frequency response, response time, damping, reliability.	K2
CO3	Concept of open loop, closed loop control systems for a typical Instrumentation system. Mathematical analysis of first order & higher order systems for a typical practical Instrumentation system. Analysis of control system for a typical automobile.	K2
CO4	Metrology: Standards, Slip gauges, Measurement of angles, tapers, threads. Mechanical inspection methods, Inspection of straightness, flatness, alignment & surface finish	K2
CO5	Specifying product features using mechanical, Pneumatic, Electronic & Optical methods. Use of Optical flats & Interferometer.	K3

Correlation of COs with POs

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	M	L	-	-
CO2	M	L	M	-	-
CO3	L	M	L	-	-
CO4	L	L	M	-	-
CO5	M	L	L	-	-

f. **Course Content:**

UNIT-I INTRODUCTION TO AUTONOMOUS DRIVING 9

Autonomous Driving Technologies Overview – Autonomous Driving Algorithms - Autonomous Driving Client System – Autonomous Driving Cloud Platform – Components of autonomy – Difference between Unmanned and Autonomous Vehicles – Introduction to Unmanned Aerial Vehicles (UAVs).

UNIT–II FUEL CELL FOR AUTOMOTIVE POWER 9

Fuel cell-Introduction-Proton exchange membrane FC (PEM), Solid oxide fuel cell (SOFC)-properties of fuel cells for vehicles-power system of an automobile with fuel cell-based drive, and their characteristics

UNIT–III ENVIRONMENT PERCEPTION AND MODELING 9

Road Recognition: Basic Mean Shift Algorithm, Mean Shift Clustering, Mean Shift Segmentation, Mean Shift Tracking, Road Recognition Algorithm -Vehicle Detection and Tracking: Generating ROIs, Multi Resolution Vehicle Hypothesis, Vehicle Validation using Gabor Features and SVM, Boosted Gabor Features – Multiple Sensor Based Multiple Object Tracking.

UNIT–IV AUTOMOTIVE TELEMATICS 9

Electronic Engine Control-engine mapping, air/fuel ratio spark timing control strategy, fuel control, electronic ignition-Vehicle cruise control- speed control-anti-locking braking system-electronic suspension - electronic steering, wiper control; Vehicle system schematic for interfacing with EMS, ECU.

UNIT–V VEHICLE CONTROL AND CONNECTED VEHICLE 9

Vehicle Control: Cruise Control, Antilock Brake Systems, Steering Control and Lane Following, Parking – Connected Vehicles: Vehicle to Vehicle Communication, Vehicle to Infrastructure Communication.

Total: 45 Hours

g. **REFERENCES**

1. Marko Hannikainen, Timo D. Hamalainen and Ville Kaseva, “Low-Power Wireless Sensor Networks: Protocols, Services and Applications”, Newyork Springer, 2012.
2. Philip Levis, David Gay, “Tiny OS Programming”, 1 st Edition, Cambridge University Press, Springer, Cambridge, 2009.
3. Michael Barr, Anthony Massa, “Programming Embedded Systems: With C and GNU Development”, 2nd Edition, O‟reilly Publishers, USA, 2006.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC140	WIRELESS EMBEDDED SYSTEM	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**
The course deals with discussion of the principles, concepts and applications of wireless embedded systems.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Aware about the different wireless nodes - different processors used for the Embedded System Networks	K3
CO2	Describe various interpret of different protocols for interfacing	K2
CO3	Explore the different algorithms on Embedded Processors	K2
CO4	Describe OS based Embedded System for Wireless applications	K2
CO5	Utilize test beds for wireless embedded applications	K3

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	L	L	-	-
CO2	L	L	L	-	-
CO3	L	L	L	-	-
CO4	L	L	L	-	-
CO5	L	L	L	-	-

g. **Course Content:**

UNIT –I INTRODUCTION TO WIRELESS EMBEDDED SYSTEMS 9

Overview of embedded systems, their hardware, hardware/software interface, energy vs. power, and networking.

UNIT–II MICROCONTROLLERS VS. PROCESSORS **9**

MSP430, ARM A and Cortex M, sensors, wireless, duty cycling, flash vs. RAM, one-wire, I2C, SPI, GPIO - Threads and events, hardware considerations, programming models, state management, tasks, protothreads, fibers.

UNIT–III ENERGY AND POWER MANAGEMENT **9**

Energy and power; batteries, sleep current, wakeup latency, triggers, relative power costs and lifetime breakdown, circuit design, clocks, harvesting, markets vs. fundamentals Storage; EEPROM, NOR/NAND flash, [PFM]RAM, blocks, pages, erase, abstractions, delay tolerance, indexing, Sensing; energy considerations, data rates, buffering.

UNIT–IV INTRODUCTION TO WIRELESS TRANSCEIVERS **9**

Introduction to ZIGBEE/BTLE/LORA/WIFI/WIMAX. LORA – Networking, physical layer model, symbols, multipath, LQI/RSSI, channel hopping, FEC, link layer, addressing, acknowledgements, routing, queueing, reliability.

UNIT–V Programming Models **9**

Programming Models; isolation/safety, data centric, databases, scripting, frameworks. TinyOS - Programming mechanism - Application Development – Porting on Microcontroller.

Total: 45 Hours

h. **REFERENCES**

1. Marko Hannikainen, Timo D. Hamalainen and Ville Kaseva, “Low-Power Wireless Sensor Networks: Protocols, Services and Applications”, Newyork,Springer, 2012.

2. Philip Levis, David Gay, “Tiny OS Programming”, 1 st Edition, Cambridge University Press, Springer, Cambridge, 2009.

3. Michael Barr, Anthony Massa, “Programming Embedded Systems: With C and GNU Development”, 2 nd Edition, O‟reilly Publishers, USA, 2006.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC141	MULTIMEDIA ARCHITECTURES	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**
To identify both theoretical and practical aspects in designing multimedia systems surrounding the emergence of multimedia technologies using contemporary hardware and software technologies

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Explain standard Multimedia system architecture	K2
CO2	Compare the various types of compression available both for image and video.	K2
CO3	Explain how the different multimedia components (audio and video) can be strамed over different protocol IP, RTP, RTCP	K2
CO4	Discuss the constraints and solutions needed for Multimedia processing and streaming.	K2
CO5	Explain the different multimedia design component to bring out specific multimedia service	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	H	L	M	M	M
CO2	M	L	M	H	M
CO3	M	L	M	H	H
CO4	M	L	H	H	H
CO5	M	M	H	H	H

g. **Course Content:**

UNIT–I BASICS OF MULTIMEDIA TECHNOLOGY **9**

Multimedia -An introduction: Multimedia application, Multimedia system architecture, Evolving technologies for multimedia system, Defining objects for multimedia systems, Multimedia data interface standards. multimedia devices CD Audio. CD-ROM. CD-presentation devices

UNIT–II IMAGE COMPRESSION & STANDARDS **9**

Making still images: Capturing images; scanning images; computer color models: color palettes; Losyy and lossless compression, JPEG-objectives and architecture: JPEG-DCT encoding and quantization, JPEG statistical coding; JPEG predictive loss less coding; JPEG performance; Overview of video coding standardsMPEG-1, MPEG-2, MPEG-4, MPEG-7.

UNIT–III MULTIMEDIA WEB APPLICATION AND PROTOCOL **9**

Multimedia over IP: RTP, RTCP. Streaming media, Codec and Plugins, VoIP, Text and Voice Chat. Multimedia Communication across networks - packet audio / video, Streaming video across internet

UNIT–IV ARCHITECTURAL AND TELECOMMUNICATION CONSIDERATIONS **9**

Specialized computational processors, memory systems, Multimedia board solutions, LAN/WAN Connectivity, Multimedia transport across ATM networks, Wireless Networks

UNIT–V MULTIMEDIA APPLICATION DESIGN (NITT) **9**

Multimedia Application Classes – Types of Multimedia Systems – Virtual Reality – Components of Multimedia Systems -Multimedia Authoring Systems – Multimedia Authoring Tools - User Interface Design- Mobile Messaging – Hypermedia Message Components - Hypermedia Linking and embedding.

Total : 45 Hours

h. **REFERENCES**

i. Text Book

1. Multimedia system Design Prabhat K. Andleigh Kiran Thakrar Published October, 1995 by Prentice Hall
2. Ralf Steinmetz, Klara Steinmetz, “Multimedia Computing, Communications & Applications”, Pearson education, 2009.
3. Prabat K Andleigh and Kiran Thakrar, “Multimedia Systems and Design”, Prentice Hall India, 2007, New Delhi
4. Web Technology & Design, C.Xavier, New Age International Publication, Delhi
5. Web Technology: A Developer's Perspective, N.P. Gopalan and J. Akilandeswari, PHI Learning, Delhi, 2013

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COURSE CODE	COURSE TITLE	L	T	P	C
2162EC142	BUILDING AUTOMATION	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**
Security of the building and safety of personal are becoming important aspects nowadaysand in near future, it will be in a great demand. Complex infrastructure requires a variety of building automation and control systems. Building Management System (BMS) is computer-based control system installed in building that controls and monitors the total MEP (Mechanical – Electrical – Plumbing) and security structure.
This course 2162EC142 – Building Automation will help the students to understand the various aspects of different systems seen in well-structured building.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Understand Building Management system and Automation.	K2
CO2	Describe various Sensors and Transducers - Automationcomponents in BMS	K2
CO3	Explain control panel and communication such as HVAC and Modbus.	K2
CO4	Describe FAS and Security Systems in Building Automation	K2
CO5	Understand the Energy Management systems.	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	L	L	-	-
CO2	L	L	L	-	-
CO3	L	L	L	-	-
CO4	L	L	L	-	-
CO5	L	L	L	-	-

g. **Course Content:**

UNIT –I INTRODUCTION TO BUILDING MANAGEMENT SYSTEM AND AUTOMATION **6**

Concept and application of Building Management System (BMS) and Automation, requirements and design considerations and its effect on functional efficiency of building automation system, architecture and components of BMS.

UNIT–II AUTOMATION COMPONENTS IN BMS **12**

Temperature Sensors: RTD, Thermistor, Thermocouple, Bimetallic strip - Pressure Sensors: Diaphragm type, piezoelectric sensors – Different types of mounting of pressure sensors in duct, rooms and pipes – Air flow sensor: Anemometer, velocity pressure sensors – Flow sensors: Turbine flow meter, Orifice, Venturi, Pitot tube, ultrasonic flow meter – Different types of mounting for air & water flow meters

UNIT–III CONTROL PANEL AND COMMUNICATION **9**

HVAC system, Components: Heating system, Cooling system, Chillers and AHUS- Concept of district cooling and heating, HVAC Control Panel, Role of automation in HVAC, MCC Basics, Panel components; Communication Basics, Networks, BACNet, Modbus, LON.

UNIT–IV FAS AND SECURITY SYSTEMS **9**

Fire, Fire modes – Fire Alarm Systems components: Field components, panel components – FAS Architectures – Access Components, Access control system Design, Design consideration for the FA system concept of IP enabled fire & alarm system - CCTV camera types and operation – camera selection criteria – CCTV Applications.

UNIT–V ENERGY MANAGEMENT **9**

Bureau of Energy Efficiency (BEE) standard, Energy Savings concept & methods, solar power generation and its integration in buildings, lightning control, Building Efficiency improvement, Green Building (LEED) Concept & Examples.

Total : 45 Hours

h. **REFERENCES**

i. Text Book

1. Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life safety, Security, Access Control, Lightning, Building Management Programs) (Hardcover), Reinhold A. Carlson and Robert A. Di Giandomenico
2. HVAC Systems Design Handbook, Fifth edition, Roger W. Haines.
3. CCTV (Newnes), Vlado Damjanovski (1999).
4. Process Control – Instrument Engineers Handbook by Bela G. Liptak, Chilton book co.
5. Building Control Systems, Application Guide (CIBSE Guide), CIBSE, 2000.
6. Smart Buildings by Jim Sinopoli, Butterworth-Heinemann imprint of Elsevier, 2nd ed., 2010
7. Design of Special Hazards and Fire Alarm Systems, Robert Gagnon, 2007.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC143	INDUSTRIAL AUTOMATION	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**

An introduction to the concepts of automation in industrial sectors by providing an exposure on industrial hardware and software in automatic control system of a medium degree of complexity. It provides an insight on the connection o field devices to an computerized system to create a complete automation.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Acquire the knowledge on continuous & discrete state sequential industrial processes, process variables and their classification	K2
CO2	Acquire the knowledge on PLC program for an automatic control system of a medium degree of complexity	K2
CO3	Analyse the various functions of Programmable Logic Controllers	K2
CO4	Study the various data handling functions in Programmable Logic Controllers.	K2
CO5	Study the fundamentals of SCADA and Distributed Control Systems	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	M	M	-	-
CO2	L	L	L	-	-
CO3	H	M	M	-	-
CO4	H	M	L	-	-
CO5	M	L	L	-	-

g. **Course Content:**

UNIT –I INTRODUCTION TO INDUSTRIAL PROCESSES 9

Nature of Industrial Process: continuous & discrete state sequential process, process variables and their classification. Introduction to Process Control Philosophies: type of relays, ladder logic methodology, ladder symbols.

UNIT–II INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLERS 9

Advantages & disadvantages of PLC with respect to relay logic, PLC architecture, Input Output modules, PLC interfacing with plant, memory structure of PLC. PLC programming methodologies: ladder diagram, STL, functional block diagram, creating ladder diagram from process control descriptions, introduction to IEC61131 international standard for PLC.

UNIT–III PLC PROGRAMMING 9

PLC functions: bit logic instructions, ladder diagram examples, interlocking, latching, inter dependency and logical functions, PLC Timer & Counter functions on-delay timer, off-delay timers, retentive on-delay timers, pulse timers, timer examples, up-counter, down-counter and up-down counter, counter examples, register basics.

UNIT–IV PLC DATA HANDLING 9

data move instructions, table and register moves, PLC FIFO & LIFO functions. PLC arithmetic and logical functions: addition, subtraction, multiplication, division instructions, increment decrement, trigonometric and log functions, AND, OR, XOR, NOT functions, PLC compare and convert functions.

UNIT–V SYSTEM C PROGRAMMING 9

SCADA - Introduction – elements of SCADA – Features of SCADA, Communications in SCADA types and components.

DISTRIBUTED CONTROL SYSTEMS: Evolution – Different architectures – local control unit – Operator Interface – Displays – Engineering Interface, Application of Dcs: DCS Applications in power plants, Iron and steel plants, Chemical plants, Cement plants, paper and pulp industries

Total : 45 Hours

h. **REFERENCES**

i. Text Book

1. S.K. Singh, "Industrial Instrumentation and control" – The McGraw Hill companies 3rd edition – 2009.
2. Curtis D. Johnson "Prentice Process control Instrumentation Technology" – Hall India, 8th edition, 2006
3. Machine- to-machine communications edited by vojislab B. misic, Jelenamisic, CRS press Taylor &francis group – 2015.
4. Stuart A. Boyer, "SCADA supervisory control and data acquisition", ISA Publication.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC144	SENSORS BASED SYSTEMS	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**

An introduction to the conversion of physical parameters to electrical quantity, choosing appropriate sensor by comparing different standards, evaluate the functional characteristics of different sensors , and impart knowledge about advanced sensors for real time application.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	To provide in depth knowledge in physical principles applied in sensing, measurement and calibration.	K2
CO2	To introduce the concept of optical sensing and to know its working principles	K2
CO3	To give a fundamental knowledge on the basic laws based on which the sensors work	K2
CO4	To impart knowledge on design, construction and execution of different sensors.	K2
CO5	To introduce the working of advanced sensors used in real time applications.	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	L	L	-	-
CO2	L	M	M	-	-
CO3	L	L	L	-	-
CO4	M	L	L	-	-
CO5	L	L	L	-	-

g. **Course Content:**

UNIT –I SENSOR CLASSSIFICATION & CHARACTERISTICS 9

Sensor Classification; Performance and Types: Accuracy, Reliability, Precision, linearity, range, Repeatability; Sensor dynamic characteristics: time response & frequency response; Error Analysis characteristics.

UNIT–II OPTICAL SENSORS **9**

Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs.

UNIT–III FUNDAMENTAL PHYSICAL SENSORS **9**

Strain gages, strain gage beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo-resistive and capacitive pressure sensor, optoelectronic pressure sensors, vacuum sensors. Design of signal conditioning circuits for strain gauges, piezo-electric, capacitance and optoelectronics sensors

UNIT–IV POSITION, DIRECTION, DISPLACEMENT AND LEVEL SENSORS **9**

Potentiometric and capacitive sensors, Inductive and magnetic sensor, LVDT, RVDT, eddy current, transverse inductive, Hall effect, magneto resistive, magnetostrictive sensors. Fiber optic liquid level sensing, Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor. Signal condition circuits for reactive and self-generating sensors

UNIT–V ADAVCNED SENSORS FOR REAL TIME APPLICATIONS **9**

Flow sensors: pressure gradient technique, thermal transport, ultrasonic, electromagnetic and Laser anemometer. microflow sensor, coriolis mass flow and drag flow sensor. Temperature sensors- thermoresistive, thermoelectric, semiconductor and optical. Piezoelectric temperature sensor. Acoustic sensors- microphones-resistive, capacitive, piezoelectric, fiber optic, solid state - electrect microphone..

Total : 45 Hours

h. **REFERENCES**

i. Text Book

1 . Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2015, 3rd edition, Springer, New York.

2. Jon. S. Wilson, “Sensor Technology Hand Book”, 2011, 1st edition, Elsevier, Netherland.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC145	WEARABLE EMBEDDED TECHNOLOGY	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**

This course provides the basic understanding of measurement and instrumentation systems and the insight of the resistive sensors and its applications in real life. This course also introduces the concept of classification of sensors such as reactive sensors and self-generating sensors and its applications in real life.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	To provide the overview of flexible electronics technology and the issues with materials processing for thin film electronics	K2
CO2	To expose the students for the materials selection and patterning methods for thin film electronics development.	K2
CO3	To describe the process involved in transferring the flexible electronics from foils to textiles and also the challenges, opportunities and the future of wearable devices.	K2
CO4	To expose the students to the design, challenges of wearable sensors employed for sensing the physical and biological parameters and the process involved in the conversion of conducting and semiconducting fibers to smart textiles	K2
CO5	Describe the taxonomy of the wearable devices and its application	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	L	L	-	-
CO2	L	M	M	-	-
CO3	L	L	L	-	-
CO4	M	L	L	-	-
CO5	L	L	L	-	-

g. **Course Content:**

UNIT –I OVERVIEW OF FLEXIBLE ELECTRONICS TECHNOLOGY 9

History of flexible electronics - Materials for flexible electronics: degrees of flexiblility, substrates, backplane electronics, front plane technologies, encapsulation - Fabrication technology for flexible electronics - Fabrication on sheets by batch processing, fabrication on web by Roll-toRoll processing - Additive printing.

UNIT–II FLEXIBLE ELECTRONICS MATERIALS 9

Fundamental issues for low temperature processing - low temperature amorphous and nanocrystalline silicon - characteristics of low temperature dielectric thin film deposition – low temperature silicon nitride and silicon oxide characteristics - Device structures and materials processing - Device performance - Contacts for the device - Device stability.

UNIT–III TEXTILE BASED FLEXIBLE SENSORS 9

Introduction -Thin film transistors: Materials and Technologies - Review of semiconductors employed in flexible electronics - Thin film transistors based on IGZO - Plastic electronics for smart textiles - Improvements and limitations

.UNIT–IV WEARABLE BIO, CHEMICAL AND INERTIAL SENSORS 9

Introduction-Systems design - Challenges in chemical and biochemical sensing - Application areas -Wearable inertial sensors - obtained parameters from inertial sensors - Applications for wearable motion sensors - Practical considerations for wearable inertial sensor - Application in clinical practice and future scope

UNIT–V SCOPE OF WEARABLE DEVICES 9

Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Case Study: Google Glass, health monitoring, Wearables: Challenges and Opportunities, Future and Research Roadmap.

Total : 45 Hours

h. **REFERENCES**

i. Text Book

1. Michael J. McGrath, Cliodhna Ni Scanaill, Dawn Nafus, “Sensor Technologies: Healthcare, Wellness and Environmental Applications”, 201, 1st Edition, Apress Media LLC, New York.
2. William S. Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, 2011, 1st Edition, Springer, New York.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC146	ANALOG DIGITAL INTERFACE	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**
This course provides the knowledge on basic concepts involved in Analog Digital Interfaces.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	To understand the importance of sampling the input analog signal for digitization and enabling circuit architectures.	K2
CO2	Explain the concepts based on Switched Capacitors and Comparators.	K2
CO3	Discuss the principles Digital to Analog conversion of signals.	K2
CO4	Discuss the principles of Analog to Digital conversion of signals.	K2
CO5	Describe the importance of calibration techniques for achieving precision during data conversion.	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	M	-	-	M	M
CO2	M	-	-	M	M
CO3	M	-	-	M	M
CO4	M	-	-	M	M
CO5	M	-	-	M	M

g. **Course Content:**

UNIT –I SAMPLE AND HOLD CIRCUITS **9**

Sampling switches, Conventional open loop and closed loop sample and hold architecture, Open loop architecture with miller compensation, multiplexed input architectures, recycling architecture switched capacitor architecture.

UNIT–II SWITCHED CAPACITOR CIRCUITS AND COMPARATORS 9

Switched-capacitor amplifiers, switched capacitor integrator, switched capacitor common mode feedback. Single stage amplifier as comparator, cascaded amplifier stages as comparator, latched comparators.

UNIT–III DIGITAL TO ANALOG CONVERSION 9

Performance metrics, reference multiplication and division, switching and logic functions in DAC, Resistor ladder DAC architecture, current steering DAC architecture.

UNIT–IV ANALOG TO DIGITAL CONVERSION 9

Performance metric, Flash architecture, Pipelined Architecture, Successive approximation architecture, Time interleaved architecture.

UNIT–V PRECISION TECHNIQUES 9

Comparator offset cancellation; Op Amp offset cancellation, Calibration techniques, range overlap and digital correction.

Total : 45 Hours

h. **REFERENCES**

Text Book

1. Behzad Razavi, “Principles of data conversion system design”, S. Chand and company Ltd, 2010.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC147	ADVANCED DIGITAL SYSTEM DESIGN	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**

This course familiarize with advanced digital design principles and practice and makes learning to use actual chips for designing practical digital circuits. It also gives an insight on modern design technologies.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Understand the design approaches of Sequential Circuits	K2
CO2	Understand the design approaches of asynchronous sequential Circuits	K2
CO3	Describe different fault diagnosis and testing methods	K2
CO4	Acquire knowledge about the performance estimation of digital systems	K2
CO5	Acquire knowledge about timing analysis of memory and Programmable logic devices	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	L	M	M	-	-
CO2	L	L	L	-	-
CO3	L	M	M	-	-
CO4	L	M	L	-	-
CO5	M	L	L	-	-

g. **Course Content:**

UNIT –I SEQUENTIAL CIRCUIT DESIGN **9**

Analysis of Clocked Synchronous Sequential Networks (CSSN) - Modeling of CSSN – State Assignment and Reduction – Design of CSSN – Design of Iterative Circuits – ASM Chart – ASM Realization, Design of Arithmetic circuits for Fast adder- Array Multiplier.

UNIT–II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 9

Analysis of Asynchronous Sequential Circuit (ASC) – Flow Table Reduction – Races in ASC – State Assignment Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards – Design of Hazard free circuits – Data Synchronizers – Designing Vending Machine Controller – Mixed Operating Mode Asynchronous Circuits. Practical issues such as clock skew, synchronous and asynchronous inputs and switch bouncing.

UNIT–III FAULT DIAGNOSIS & TESTING 9

Fault diagnosis: Fault Table Method – Path Sensitization Method – Boolean Difference Method – Kohavi Algorithm – Tolerance Techniques – The Compact Algorithm. Design for testability: Test Generation – Masking Cycle – DFT Schemes. Circuit testing fault model, specific and random faults, testing of sequential circuits, Built in Self Test, Built in Logic Block observer (BILBO), signature analysis.

UNIT–IV PERFORMANCE ESTIMATION 9

Estimating digital system reliability, transmission lines, reflections and terminations, system integrity, network issues for digital systems, formal verifications of digital system: model checking, binary decision diagram, theorem proving, circuit equivalence.

UNIT–V TIMING ANALYSIS 9

ROM timings, Static RAM timing, Synchronous Static RAM and it's timing, Dynamic RAM timing, Complex Programmable Logic Devices, Logic Analyzer Basic Architecture, Internal structure, Data display, Setup and Control, Clocking and Sampling.

Total : 45 Hours

h. **REFERENCES**

Text Book

1. Charles H.Roth Jr "Fundamentals of Logic Design", Thomson Learning 2004.
2. Nripendra N Biswas "Logic Design Theory" Prentice Hall of India, 2001.
3. Parag K.Lala "An introduction to Logic Circuit Testing" Morgan and claypool publishers, 2009.
4. Stephen D Brown, "Fundamentals of digital logic", TMH publication, 2007.
5. Balabanian, "Digital Logic Design Principles", Wiley publication, 2007.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2162EC148	AUTOMOTIVE REAL TIME EMBEDDED SYSTEM	3	0	0	3

a. **Course Category**
Programme Elective

b. **Preamble**
An exposure to the students to the fundamentals of the building of electronic engine system. Exposes programmable controller for vehicles. It also focusses on the communication inside the vehicles.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Discusses on the basic electronic engine components.	K2
CO2	Discuss the techniques for the design of fuel cell for automotive power	K2
CO3	Discuss the features of the vehicle management system such as ABS, Electronic suspension ,Electronic Braking etc.	K2
CO4	Explains the communication techniques used in the vehicles	K2
CO5	Explains the methods to diagnose the vehicles with electronics.	K2

f. **Correlation of COs with POs**

	PO1	PO2	PO3	PSO1	PSO2
CO1	M	L	L	-	-
CO2	M	L	M	-	-
CO3	H	L	L	-	-
CO4	L	L	L	-	-
CO5	L	L	L	-	-

g. **Course Content:**

UNIT –I BASICS OF ELECTRONIC ENGINE CONTROL SYSTEMS 9

Motivation ,concept for electronic engine controls and management-Standards; introduction to fuel economy- automobile sensors-volumetric, thermal, air-fuel ratio, solenoid ,hall effect-exhaust gas oxygen sensors, Oxidizing catalytic efficiency, emission limits and vehicle performance; advantages of using Electronic engine controls – open and closed loop fuel control; Block diagram of Electronic ignition system and Architecture of a EMS with multi

point fuel injection system, Direct injection; programmed ignition- actuators interface to the ECU; starter motors and circuits - sensors interface to the ECU; Actuators and their characteristics – exhaust gas recirculation.

UNIT–II FUEL CELL FOR AUTOMOTIVE POWER 9

Fuel cell-Introduction-Proton exchange membrane FC (PEM), Solid oxide fuel cell (SOFC)-properties of fuel cells for vehicles-power system of an automobile with fuel cell based drive, and their characteristics

UNIT–III VEHICLE MANAGEMENT SYSTEMS 9

Electronic Engine Control-engine mapping,air/fuel ratio spark timing control strategy, fuel control, electronic ignition-Vehicle cruise control- speed control-anti-locking braking system-electronic suspension - electronic steering , wiper control ; Vehicle system schematic for interfacing with EMS, ECU. Energy Management system for electric vehicles- for sensors, accelerators, brake-Battery management, Electric Vehicles-Electrical loads, power management system-electrically assisted power steering system.

UNIT–IV AUTOMOTIVE TELEMATICS 9

Role of Bluetooth, CAN, LIN and flex ray communication protocols in automotive applications; Multiplexed vehicle system architecture for signal and data / parameter exchange between EMS, ECUs with other vehicle system components and other control systems; Realizing bus interfaces for diagnostics, dashboard display ,multimedia electronics-Introduction to Society of Automotive Engineers(SAE). J1850 message with(IFR) in frame response in protocol-Local Interconnect n/w [LI N], Bluetooth.

UNIT–V ELECTRONIC DIAGNOSTICS FOR VEHICLES 9

System diagnostic standards and regulation requirements –On board diagnosis of vehicles electronic units &electric units-Speedometer, oil and temperature gauges, and audio system.

Total : 45 Hours

h. **REFERENCES**

i. Text Book

1. William B. Ribbens ,"Understanding Automotive Electronics", Elseiver,2012
2. Ali Emedi, Mehrded ehsani, John M Miller , "Vehicular Electric power system- land, Sea, Air and Space Vehicles" Marcel Decker, 2004.
3. L.Vlacic,M.Parent,F.Harahima,"Intelligent Vehicl Technologies",SAE International,2001.
4. Jack Erjavec,Jeff Arias,"Alternate Fuel Technology-Electric ,Hybrid& Fuel Cell Vehicles",Cengage ,2012
5. Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection – Ford
6. Automotive Electricals / Electronics System and Components, Tom Denton, 3 rd Edition, 2004.
7. Uwe Kiencke, Lars Nielsen, "Automotive Control Systems: For Engine, Driveline, and Vehicle", Springer; 1 edition, March 30, 2000 .
8. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 4 th Edition, 2004.
9. Automotive Hand Book, Robert Bosch, Bently Publishers, 1997.
10. Jurgen, R., Automotive Electronics Hand Book.

M.Tech Embedded Systems and Technologies

INDEPENDENT LEARNING

Course Code	Course Name	L	T	P	C
2163EC407	Massive Open Online Course	0	0	0	2
2163MG401	Research Methodology	0	0	0	2
2163GE401	Business Communication	0	0	0	2
2163EC801	Field Study	0	0	0	2
RESEARCH SEMINAR					
2163EC501	Smart Systems for Smart Buildings	0	0	0	2
2163EC502	Smart Vehicular Systems	0	0	0	2
2163EC503	Low Power Embedded SOC Design	0	0	0	2
2163EC504	IoT for Real world Applications	0	0	0	2

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2163MG401	RESEARCH METHODOLOGY	0	0	0	2

a. **Course Category**
Independent Learning

b. **Prerequisite Courses**
Nil

c. **Related Courses**
Nil

d. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Understanding of Research process and types	K1
CO2	Describe the research problem, design the research.	K2
CO3	Classify the data and apply the fix the stat tools for analysis.	K2
CO4	Understand the sampling technique and analyse the data using SPSS.	K1
CO5	Comprehend the information and able to write the report.	K2

e. **Course Content:**

UNIT–I INTRODUCTON **6**

Research-Definition and Significance-the research process-Types of research-Exploratory and casual research-Theoretical and empirical Research –Cross –Sectional and time-series research-Research questions/Problems-Research objectives-Research hypotheses-Characteristics.

UNIT–II RESEARCH DESIGN AND MEASUREMENT **6**

Research design-Definition-Types of research design-exploratory and casual research design-Descriptive and experimental design-Different types of experimental design-Validity of findings-internal and external validity-Variables in research-Measurement and scaling-Different scales-Construction of instrument-Validity and Reliability of instrument.

UNIT–III DATA COLLECTION **6**

Types of data-Primary vs secondary data-Methods of primary data collection-Survey vs Observation-Experiments-Construction of questionnaire and instrument-Validation of questionnaire-Sampling plan-Sample size-Determinants optimal sample size-sampling-techniques-Probability vs Non probability sampling methods.

UNIT–IV DATA PREPARATION AND ANALYSIS **6**

Data preparation –editing –coding-Data entry-Validity of data-Qualitative Vs Quantitative-data analyses –Bivariate and multivariate statistical techniques-Factor analysis-Discriminant analysis-Cluster analysis-multiple regression and correlation-multidimensional scaling-Application of statistical software for data analysis.

UNIT–V REPORT DESIGN,WRITING AND ETHICS IN RESEARCH 6

Research report-Different types-Contents of report-need of executive summary-characterisation-contents of chapter-report writing-the role of audience-redability-comprehension-tone-final proof-report format-title of the report-ethcs n research-ethical behaviour of research-subjectivity and objectively in research.

Total : 30 Hours

f. **REFERENCES**

i. Text Book

1. C.R.Kothari," Research methodology:Methods nad Techniques" 3rd Edition,New Age International Publishers.
2. P.Narayana Reddy and G.V.R.K Acharyulu Research Methodology and statistical Tools 1st edition,Excel Books,New Delhi 2008.
3. S.P Gupta,"Statistical Methods,S.Chand & sons ,New Delhi,2005.
4. Pannerselvam R "Research Methdology" Paperback-PHI ,2nd Edition.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2163GE401	BUSINESS COMMUNICATION	0	0	0	2

a. **Course Category**
Independent Learning

b. **Preamble:**
The purpose of this course is designed to provide self learning experience for students andindividuals to develop in them vital communication skills which should be integral to personal, social and professional interactions. It is a creative and artistic field where one can expertise oneself in all the cutting periphery technologies and thus, having an edge over other proficient career options.

c. **Prerequisite Courses**
Nil

d. **Related Courses**
Nil

e. **Course Outcomes**
Upon the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Knowledge Level (Based on revised Bloom's Taxonomy)
CO1	Develop the art of drafting an excellent business letter oremail, with the appropriate amount of sophistication.	K3
CO2	Make use of the best opportunities in the field of JobRelated Communication.	K3
CO3	Plan and organize the documents for effective writtenCommunication.	K3

f. **Course Content:**

UNIT-I BUSINESS CORRESPONDENCE **10**

Communication – Process of Communication, Barriers in Communication, Written Communication - Business letters (Quotations, Orders, Tenders, Complaint, Responding/reply to enquiry), Email (Email Etiquettes), Minutes, Memorandum, Circular, Notice, Agenda.

UNIT- II JOB RELATED COMMUNICATION **10**

Job Application, Resume Writing, Profile Summary and Employment Interview, Presentation

UNIT- III Report Writing and other business communications **10**

Project writing, Technical Proposal, Report Writing(Business and Technical Report), Journal Writing (Research Article), Technical Description

Total Hours: 30 Hrs

g. **Learning Resources**

i.Text Books :

1.Sharma R C., Mohan Krishna, *Business Correspondence and Report Writing.* 5th ed. Chennai:Mc Graw Hill Education (India) Pvt. Ltd,2016.

ii.References:

1. Padmaja T.V.S., Pfeiffer William Sanborn. *Technical Communication*. 6th ed. Noida: Pearson India Education Services Pvt. Ltd, 2008
2. Anderson V. Paul, *Technical Communication.*6th ed.New Delhi: CengageLearning
3. Kumar Sanjay, Lata Pushp, *Communication Skills.* 2nd ed. New Delhi: Oxford

University Press, 2015

iii.Web Resources:

1.https://saylordotorg.github.io/text_business-communication-for-success/index.html
2.http://www.managementstudyguide.com/communication-flows.htm

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2163EC501	SMART SYSTEMS FOR SMART BUILDINGS	0	0	0	2

a. **Course Category**
Independent Learning-Research Seminar

b. Topics:

- Smart energy auditing system
- Smart energy monitoring system
- Therapeutic lighting system
- Indoor navigation
- Human assist system,
- Entertainment systems
- Smart sensors

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COURSE CODE	COURSE TITLE	L	T	P	C
2163EC502	SMART VEHICULAR SYSTEMS	0	0	0	2

a. **Course Category**
Independent Learning-Research Seminar

b. Topics:

- Autonomous vehicle architectures,
- Charge-on-the-go vehicles,
- Vehicle to vehicle communications,
- Vehicle to infrastructure communications,
- Smart cruise control systems,
- Artificial intelligence for smart vehicles

COURSE CODE	COURSE TITLE	L	T	P	C
2163EC503	LOW POWER EMBEDDED SoC DESIGN	0	0	0	2

a. **Course Category**
Independent Learning-Research Seminar

b. Topics:

- Static and dynamic power consumption in SOC's.
- System level approach such as hardware features and software control using the low-power features.
- Low power techniques and technologies used in the practical SOC's .
- Practical SOC's for various applications such as radio communication, RF Applications image recognition, mobile TV applications, mobile phones.
- Low power design SOC's technologies for practical design projects.

M.Tech Embedded Systems and Technologies

COURSE CODE	COURSE TITLE	L	T	P	C
2163EC504	IoT for REAL WORLD APPLICATIONS	0	0	0	2

a. **Course Category**
Independent Learning-Research Seminar

b. Topics:

- Sensors and wireless communication technology
- IoT Security, Standards, Processors, Event Stream Processing, analytic tools and algorithms, Device (Thing) Management.
- Low-Power, Short-Range IoT Networks, Wide-Area Networks
- Internet technology and Technology on IoT for applications such as smart Home, wearables, connected Cars, Industrial Internet of Things (IIoT), IoT in Healthcare, IoT in agriculture, smart Retail.
- IoT technology for practical design projects.