M.Tech (Full Time) – EMBEDDED SYSTEM TECHNOLOGY

Curriculum & Syllabus

(2013 – 2014)

Faculty of Engineering & Technology
SRM University
SRM Nagar, Kattankulathur – 603 203

M.TECH - EMBEDDED SYSTEM TECHNOLOGY
(FULL TIME)
Curriculum & Syllabus
Batch 2013 – 2014 and onwards

SI.No	Category	No. of Credits			
		I Semester	II Semester	III Semester	IV Semester
1	Core Courses	12	12	-	-
2	Elective Courses	3	6	9	-
3	Supportive Courses	3	-	-	-
4	Interdisciplinary Elective	-	3	-	-
5	Seminar	-	-	1	-
6	Project Work	-	-	6*	16**
	Credits per semester	18	21	16	16
Total Credits to be earned for the award of M.Tech degree- 71					

*Project Work -Phase I **Project Work -Phase II

Core courses

Course code	Course Title	L	T	P	C
EM2001	Digital System Design and Testing	3	1	0	4
EM2002	Microprocessors & Microcontrollers	3	0	2	4
EM2003	Embedded Systems Software	3	1	0	4
EM2004	Signal Processing for Embedded Systems	3	1	0	4
	OR				
EM2005	Real Time Operating Systems	3	1	0	4
EM2006	Embedded System Architecture	3	1	0	4
	OR				
EM2007	Microprocessor Architecture	3	1	0	4
EM2008	VLSI Design Methodologies and Programming in HDL	3	0	2	4
	OR				
EM2009	FPGA Design	3	0	2	4

Program Electives

Course Code	Course Title	L	T	P	C
EM2101	Computer architecture	3	0	0	3
EM2102	Embedded Linux	3	0	0	3
EM2103	Principles of Distributed Embedded Systems	3	0	0	3
EM2104	Communication Network Processors	3	0	0	3
EM2105	Embedded Wireless Sensor Networks	3	0	0	3
EM2106	Wireless & Mobile Communications	3	0	0	3
EM2107	Embedded Control Systems	3	0	0	3
EM2108	Intelligent Systems	3	0	0	3
EM2109	Digital Image Processing	3	0	0	3
EM2110	Multimedia systems	3	0	0	3
EM2111	DSP Integrated Circuits	3	0	0	3
EM2112	Real Time Systems	3	0	0	3
EM2113	Electronic Product design and reliability engineering	3	0	0	3

Supportive Courses

Course Code	Course Title	L	T	P	C
MA2009	Applied Mathematics (Embedded/ Communication Systems)	3	0	0	3
VL2113	Fundamentals and applications of MEMS	3	0	0	3
VL2112	Reliability Engineering	3	0	0	3

Other courses

Course code	Course Title	L	T	P	C
EM2047	Seminar	0	0	1	1
EM2049	Project Work – Phase I	0	0	12	6
EM2050	Project Work – Phase II	0	0	32	16

CONTACT HOUR/CREDIT:
L: Lecture Hours per week **T: Tutorial Hours per week**
P: Practical Hours per week **C: Credit**

EM2001		L	T	P	C
	DIGITAL SYSTEM DESIGN AND TESTING	**3**	**1**	**0**	**4**
	Total Contact Hours – 60				
	Prerequisite:Nil				
PURPOSE					
Learning design of digital circuits is a fundamental necessity for designing embedded systems. This subject provides necessary instruments to achieve that goal.					
INSTRUCTIONAL OBJECTIVES					
1.	To impart knowledge on the theory of logic and logic functions.				
2.	To design digital circuits.				
3.	To learn fault diagnosis and testability algorithms.				

UNIT I - ADVANCED TOPICS IN BOOLEAN ALGEBRA (13 hours)
Shannon's Expansion theorem, Consensus theorem, Reed-Muller Expansion, Multiplexer logic as function generators, Design of static hazard-free and dynamic hazard-free logic circuits, Threshold logic, Symmetric functions.

UNIT II - SEQUENTIAL CIRCUIT DESIGN (12 hours)
Counters and Registers, Mealy and Moore machines, clocked synchronous sequential circuit design procedure-state diagrams-state table-state reduction-state assignment, Incompletely Specified Sequential Machines.

UNIT III - DESIGN WITH PROGRAMMABLE LOGIC DEVICES (11 hours)
Basic concepts, PROM as PLD, Programmable Array Logic (PAL), Programmable Logic Array (PLA), Design of combinational and sequential circuits using PLS's, Complex PLD (CPLD), Introduction to Field Programmable Gate Arrays (FPGA), Xilinx FPGAs - Xilinx 3000 series and 4000 series FPGA.

UNIT IV - FINITE STATE MACHINES (FSM) (12hours)
State Machine (SM) charts, Derivation of SM charts, Realization of SM charts, Linked State Machines, Architectures centered around Non-registered PLDs, State machine designs centered around shift registers, One-hot design method, Application of one-hot method.

UNIT V - FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS (12hours)

Introduction, Principle of Testing, Test generation basics, Test generation algorithms – Fault table method – Path Sensitization method – Boolean difference method – D-Algorithm.

REFERENCES

1. Charles H. Roth,Jr and Lizy Kurian John, "*Principles of Digital Systems Design using VHDL*", CENGAGE Learning, 2009.
2. Charles. H. Roth, Jr, "*Digital Systems Design using VHDL*", CENGAGE Learning, 2010.
3. R. F. Tinder, "*Engineering Digital Design*", Academic Press, 2000.
4. Zvi Kohavi, "*Switching and Finite Automata Theory – 3rd Edition*", Cambridge Press, 2010.
5. Parag K.Lala, "*Digital circuit testing and testability*", Allied Publishers, 1997

		L	T	P	C
EM2002	**MICROPROCESSORS AND MICRO CONTROLLERS**	**3**	**0**	**2**	**4**
	Total Contact Hours – 75				
	Prerequisite:Nil				
PURPOSE					
To enable the student to understand the RISC (ARM) and CISC (Pentium) processors, which will be useful for designing high end embedded systems.					
INSTRUCTIONAL OBJECTIVES					
1.	To learn RISC and CISC architectures of processors.				
2.	To learn ARM processor and its programming with Embedded C.				
3.	To learn to use ARM development tools and carry out experiments				

UNIT I - MICROPROCESSOR ARCHITECTURE (9 hours)

Instruction set - Data formats - Instruction formats - Addressing modes - Memory Hierarchy - register file - Cache - Virtual memory and paging - Segmentation - Pipelining - The instruction pipeline - pipeline hazards - Instruction level parallelism - reduced instruction set - Computer principles - RISC versus CISC - RISC properties - RISC evaluation - On-chip register files versus cache evaluation.

UNIT II - HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM (9 hours)

The software model - functional description - CPU pin descriptions - RISC concepts - bus operations - Super scalar architecture - pipelining - Branch prediction - The instruction and caches - Floating point unit - protected mode operation - Segmentation - paging - Protection - multitasking - Exception and interrupts - Input/Output - Virtual 8086 model - Interrupt processing - Instruction types - Addressing modes - Processor flags - Instruction set - Basic programming the Pentium Processor.Lab exercise.

UNIT III - HIGH PERFORMANCE RISC ARCHITECTURE(9 hours)

ARM: The ARM architecture - ARM organization and implementation - The ARM instruction set - The thumb instruction set - Basic ARM Assembly language program - ARM CPU cores.

ARM DEVELOPMENT ENVIRONMENT

The AMULET asynchronous ARM Processors. Embedded Operating Systems - Principle Components – Application case study – **VLSI Ruby II** Advanced communication processor – **nuvoTon Cortex M0 (Nu-LB-NUC140)** Microcontroller processor & its supporting tools.Lab exercise

UNIT IV - INTRODUCTION TO EMBEDDED C AND APPLICATIONS (9 hours)

C-looping structures – Register allocation – Function calls – Pointer aliasing – structure arrangement – bit fields – unaligned data and endianness – inline functions and inline assembly – portability issues. Embedded Systems programming in C – Binding & Running Embedded C program in Keil IDE – Dissecting the program -Building the hardware. Basic techniques for reading & writing from I/O port pins – switch bounce - LED Interfacing using Embedded C.Lab exercise

UNIT V: EMBEDDED OPERATING SYSTEMS(sEOS): (9 hours)

Basics of sEOS – Timer Design consideration using sEOS- Multistate system design. Implementation of Traffic light sequencing using onchip UART for RS-232 communication- memory requirements. Case study – Intruder alarm system. HyperTerminal based control-packet based control for LED interfacing- Security challenges and authentication ptocess for Embedded Systems.

Practicals (30 hours)

RFERENCES

1. Daniel Tabak, "*Advanced Microprocessors-SIE*", Tata McGraw Hill. Inc., 2011.
2. James L. Antonakos, "*The Pentium Microprocessor*", Pearson Education, 2002.
3. Steave Furber, "*ARM system - on - chip architecture*", Addison Wesley, 2000.
4. Andrew N. Sloss, Dominic Symes, Chris Wright and John Rayfield, "*ARM System Developer's Guide*, *Designing and Optimizing System Software*", Elsevier, 2004.
5. David Seal, "*ARM Architecture Reference Manual*", Pearson Education, 2007.
6. Michael J. Pont, "*Embedded C*", Addison Wesley, 2002.
7. Jivan S. Parab, Vinod G. Shelake, Rajanish K.Kamot, and Gourish M.Naik, "*Exploring C for Microcontrollers- A Hands on Approach*", Springer, 2007.

		L	T	P	C
EM2003	**EMBEDDED SYSTEMS SOFTWARE**	**3**	**1**	**0**	**4**
	Total Contact Hours – 60				
	Prerequisite:Nil				
PURPOSE					
Introduce the student with software concepts used in embedded systems.					
INSTRUCTIONAL OBJECTIVES					
1.	To learn C language and assembly programming.				
2.	To learn Object orientation for programming and C++.				
3.	To learn software modeling fundamentals.				

UNIT I - INTRODUCTION TO ASSEMBLY LANGUAGE AND DATAREPRESENTATION IN C (12 hours)

Assembly language programming – macros - Data representation – Twos complement, fixed point and floating point number formats –Low level programming in C: Primitive data types – Pointers – Structures – Unions – Dynamic memory allocation – Functions – recursive functions - Linked lists.

UNIT II - PROGRAMMING IN C (12 hours)

Register usage conventions – Typical use of addressing options – Instruction sequencing – Procedure call and return – Functions – recursive functions -

Parameter passing – Retrieving parameters – Everything in pass by value – Temporary variables – threads – preemptive kernels – system timer – scheduling.

UNIT III - OBJECT ORIENTED PROGRAMMING (10 hours)
Object oriented analysis and design - C++ classes and objects – functions – data structures - examples.

UNIT IV - UNIFIED MODELING LANGUAGE (14 hours)
Connecting the object model with the use case model – Key strategies for object identification – UML basics. Object state behavior – UML state charts – Role of scenarios in the definition of behavior – Timing diagrams – Sequence diagrams – Event hierarchies – types and strategies of operations – Architectural design in UML concurrency design – threads in UML.

UNIT V - EMBEDDED SOFTWARE DEVELOPMENT TOOLS AND RTOS (12 hours)
The compilation process – libraries – porting kernels – C extensions for embedded systems – emulation and debugging techniques – RTOS - system design using RTOS .

REFERENCES

1. Daniel W. Lewis, "*Fundamentals of embedded software where C and assembly meet*", Pearson Education, 2002.
2. Bruce Powel Douglas, "*Real time UML, second edition: Developing efficient objects for embedded systems*", 3^{rd} Edition 1999, Pearson Education.
3. Steve Heath, "*Embedded system design*", Elsevier, 2003.
4. David E. Simon, "*An Embedded Software Primer*", Pearson Education, 2003.
5. E. Balaguruswamy, "*Object oriented programming with C++*", Tata McGraw Hill, 2011.

		L	T	P	C
EM2004	**SIGNAL-PROCESSING FOR EMBEDDED SYSTEMS**	**3**	**1**	**0**	**4**
	Total Contact Hours – 60				
	Prerequisite:Nil				
PURPOSE					
Signal Processing is an upcoming embedded field wherein many small					

systems and robots are built with signal processing functions. This course gives an idea of signal processing concepts for embedded systems.	
INSTRUCTIONAL OBJECTIVES	
1.	To learn DSP basics.
2.	To know about typical DSP applications and their theory.
3.	To learn DSP programming methods for small systems and related issues.

UNIT I - OVERVIEW OF DSP (15 hours)

Digital signal processing basics – processing models for dsp – common filters – adaptive digital systems – non-linear systems.

UNIT II - DSP APPLICATIONS-I (10 hours)

Spectral analysis and modulation – RLS estimation, pseudo-inverse. Kalmann filter – data compression methods, Hufmann algorithm, LZW coding, Vocoder, LPC, MP3 coding.

UNIT III - DSP APPLICATIONS – II (10 hours)

Error correcting codes and channel coding, Hamming distance and error correction, CRC, Reed Solomon codes, convolution codes, Viterbi decoding, interleaving – practical issues in using DSP.

UNIT IV - DSP PROGRAMMING (15 hours)

Overview of DSP algorithms – DSP architectures – optimizing DSP software – RTOS for DSP, testing and debugging DSP systems – embedded DSP software design using multicore SoC architectures.

UNIT V - DSP PROGRAM OPTIMIZATION AND GUIDELINES: (10 hours)

Software performance engineering - code optimization – algorithm development guidelines.

REFERENCES

1. Dag Stranneby, William Walker, "*Digital Signal Processors and applications*", Elsevier, 2003.
2. Robert Oshana, "*DSP Software Development Techniques for embedded real time applications*", Elsevier, 2006.

EM2005		L	T	P	C
	REAL TIME OPERATING SYSTEMS	**3**	**1**	**0**	**4**
	Total Contact Hours – 60				
	Prerequisite:Nil				

PURPOSE	
Real time operating systems are being widely used in many embedded systems. This course deals with the basics and typical RTOSs.	
INSTRUCTIONAL OBJECTIVES	
1.	To learn fundamentals of operating system.
2.	To study implementation aspects of real time concepts.
3.	To study example RTOSs and applications.

UNIT I - RTOS PROGRAMMING FUNDAMENTALS: (12 hours)
Tasks and Task states – Semaphores – Shared data – Message queues, Mail boxes and pipes – Memory management – Interrupt routines – Encapsulating semaphore and queues.

UNIT II - RTOS FUNDAMENTALS: (10 hours)
Task management – Dual role of time – Intertask communication - Process input/output.

UNIT III - REAL TIME SCHEDULING: (11 hours)
Schedulability problem: classification, schedulability test, worst case execution time (WCET) - static scheduling: - dynamic scheduling: dependent tasks, independent tasks.

UNIT IV - REAL TIME OPERATING SYSTEMS: (18 hours)
VX works - uCOS – POSIX standards - RT Linux – device drivers - Real time library of Keil IDE - RTOS Porting to a Target.

UNIT V - RTOS APPLICATION DOMAINS: (9 hours)
Case studies : Free-RTOS architecture - Embedded RTOS for voice over IP – RTOS for fault Tolerant Applications – RTOS for Control Systems.

REFERENCES

1. David Simon, “*An Embedded software premier*”, Pearson education, 2007.
2. Hermann Kopetz, ”*Real–Time systems – Design Principles for distributed Embedded Applications*”, Second Edition, Springer 2011.
3. Micro C OS II reference manual.
4. VX works Programmers manual.
5. Keil Real Time library documentation – .
6. Doug Abbott, “*Linux for embedded and real time applications*”, Elsevier Science, 2003.
7. “Getting started with RT-Linux”, FSM Labs., Inc.,
8. Web site:

		L	T	P	C
EM2006	**EMBEDDED SYSTEM ARCHITECTURE**	**3**	**1**	**0**	**4**
	Total Contact Hours – 60				
	Prerequisite				
	NIL				

PURPOSE	
To familiarize the student with the architecture of embedded systems in general.	
INSTRUCTIONAL OBJECTIVES	
1.	To learn the rationale and concepts for designing embedded systems.
2.	To know about typical engineering issues of software development.

UNIT I - INTRODUCTION TO EMBEDDED SYSTEMS (13 hours)

Embedded system model – embedded standards – block diagrams – powering the hardware - embedded board using von Neuman model. EMBEDDED processors: ISA architecture models – application specific ISA models – general purpose ISA models – instruction level parallelism.

UNIT II - PROCESSOR HARDWARE (12 hours)

Internal processor design: ALU – registers – control unit - clock – on chip memory – processor i/o – interrupts – processor buses – processor performance.

UNIT III - SUPPORT HARDWARE (12 hours)

Board memory: ROM – RAM – cache – auxiliary memory – memory management – memory performance – board buses: arbitration and timing – PCI bus example – integrating bus with components – bus performance.

UNIT IV - SOFTWARE (11 hours)

Middleware and applications: PPP – IP middleware – UDP – Java . application layer: FTP client – SMTP – HTTP server and client.

UNIT V - ENGINEERING ISSUES OF SOFTWARE (12 hours)

Design and development: architectural patterns and reference models – creating the architectural structures – documenting the architecture – analyzing and evaluating the architecture – debugging testing, and maintaining.

REFERENCES

1. Tammy Noergaard, *“Embedded system architecture”*, Elsevier, 2006.
2. Jean J. Labrosse, *“Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C”,* The publisher, Paul Temme, 2011.

		L	T	P	C
EM2007	**MICROPROCESSOR ARCHITECTURE**	**3**	**1**	**0**	**4**
	Total Contact Hours – 60				
	Prerequisite:Nil				

PURPOSE	
To familiarize the student with the design and operating issues of microprocessor architectures.	
INSTRUCTIONAL OBJECTIVES	
1.	To analyze the historical development of microprocessor architectures.
2.	To know about processor working principles.
3.	To learn multiprocessor architectures.

UNIT I - BASICS (12 hours)

Performance metrics and evaluation – pipelining – caches – virtual memory and paging.

UNIT II – SUPERSCALAR PROCESSORS (13 hours)

Instruction pipelining – register renaming – reorder buffer – reservation stations. Overview of Pentium P6 micro-architecture – VLIW/EPIC processors.

UNIT III - INSTRUCTION HANDLING (13 hours)

Branch prediction, instruction fetching, register renaming, instruction scheduling, memory access instructions, back-end optimizations.

UNIT IV - CACHE HIERARCHY (10 hours)

L1 cache access – hiding memory latencies – large higher level caches – main memory.

UNIT V - MULTIPROCESSING (12 hours)

Multiprocessor organization – cache coherency – synchronization – relaxed memory models – single processor multithreading – general purpose multithreaded chip multiprocessors – special purpose multithreaded chip multiprocessors – technological limitations.

REFERENCES

1. Jean-Loup Baer, "*Microprocessor Architecture, from simple pipelines to chip multiprocessors*", Cambridge University Press, First edition, 2010.
2. Kai Hwang & Naresh Jotwani, "*Advanced Computer Architecture*", McGraw –Hill, Inc. 2011.

<table>
<tr><td rowspan="4">EM2008</td><td></td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>VLSI DESIGN METHODOLOGIES AND PROGRAMMING IN HDL</td><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="5">Total Contact Hours – 75</td></tr>
<tr><td colspan="5">Prerequisite : Nil</td></tr>
<tr><td colspan="6">PURPOSE</td></tr>
<tr><td colspan="6">As the hardware is becoming more customizable it is essential for the embedded designer to know the fundamentals of VLSI design, to implement special function circuits used in embedded systems. Hence this course is offered.</td></tr>
<tr><td colspan="6">INSTRUCTIONAL OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="5">To learn analysis of MOS transistor with all its relevant aspects to the static and dynamic operation.</td></tr>
</table>

2.	To know principles of low power CMOS circuit design.
3.	To learn basic hierarchical modeling concepts used in digital design.
4.	To learn the four levels of abstraction – behavioral dataflow gate-level and switch-level.

UNIT I - MOS TRANSISTOR THEORY (9 hours)

MOS transistor theory introduction - Ideal V-I characteristics - second order effects- CMOS logic - CMOS fabrication and layout - VLSI design flow.

UNIT II - CIRCUIT CHARACTRIZATION AND PERFORMANCE ESTIMATION (9 hours)

CMOS inverter - DC transfer characteristics- Delay estimation - logical effort - Power dissipation - scaling - latch up.

UNIT III - COMBINATIONAL AND SEQUENTIAL CIRCUIT DESIGN (9 hours)

Static CMOS - ratioed circuits - differential cascode voltage switch logic- Dynamic circuit - domino logic-pass transistor circuits - CMOS D latch and edge triggered flipflop - Schmitt trigger.Lab exercises.

UNIT IV - HDL PROGRAMMING USING BEHAVIORAL AND DATA FLOW MODELS (9 hours)

Verilog introduction - Typical design flow-Modules and ports-instances – components –lexical conventions - number specification - strings – identifiers and keywords –data types - System tasks and compiler directives - behavioral modeling - dataflow modeling - RTL - Gate level modeling - programs for combinational and sequential.Lab exercises

UNIT V - HDL PROGRAMMING WITH STRUCTURAL AND SWITCH LEVEL MODELS (9 hours)

Tasks and functions –difference between tasks and functions-switch level- MOS switches - CMOS switches- examples - CMOS NAND and NOR – MUX using transmission gate – CMOS flipflop.

Practicals (30 hours)

REFERENCES

1. Neil H.E Weste, David Harris, Ayan Banenjee, "*CMOS VLSI Design*", 3rd Edition, Pearson,2004.
2. Sung Mu Kang , Yusuf Leblebici "*CMOS Digital Integrated Circuits*", 3rd Edition, Tata Mc-Graw Hill, 2002.
3. Samir Palnitkar, "*Verilog HDL*", 2nd Edition, Pearson, 2004.

<table>
<tr><td rowspan="4">EM2009</td><td></td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>FPGA DESIGN</td><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="5">Total Contact Hours – 75</td></tr>
<tr><td colspan="5">Prerequisite :Nil</td></tr>
<tr><td colspan="6">PURPOSE</td></tr>
<tr><td colspan="6">Complex and faster embedded systems can be made with FPGAsAs. This course introduces the design concepts of using FPGAs.</td></tr>
<tr><td colspan="6">INSTRUCTIONAL OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="5">To learn FPGA architectures.</td></tr>
<tr><td>2.</td><td colspan="5">To learn and use design flow for using FPGA.</td></tr>
<tr><td>3.</td><td colspan="5">To learn programming of FPGA with practical circuits.</td></tr>
</table>

UNIT I - INTRODUCTION TO ASICS, CMOS LOGIC AND ASIC LIBRARY DESIGN (9 hours)

Types of ASICs - Design Flow - CMOS transistors, CMOS design rules - Combinational Logic Cell - Sequential logic cell - Data path logic cell - transistors as resistors - transistor parasitic capacitance - Logical effort - Library cell design - Library architecture.

UNIT II - PROGRAMMMBLE LOGIC CELLS AND I/O CELLS (9 hours)

Digital clock Managers-Clock management- Regional clocks- Block RAM – Distributed RAM-Configurable Logic Blocks-LUT based structures – Phase locked loops- Select I/O resources –Anti fuse - static RAM - EPROM and EEPROM technology.

UNIT III - DEVICE ARCHITECTURES (9 hours)

Device Architecture-Spartan 6 -Vertex 4 architecture- Altera Cyclone and Quartus architectures.

UNIT IV - DESIGN ENTRY AND TESTING (9 hours)

Logic synthesis using HDL- Types of simulation –Faults- Fault simulation - Boundary scan test - Automatic test pattern generation. Built-in self test. – scan test.Lab exercises.

UNIT V - FLOOR PLANNING, PLACEMENT AND ROUTING (9 hours)

System partition - FPGA partitioning - partitioning methods - floor planning - placement - physical design flow - global routing - detailed routing - special routing - circuit extraction – DRC.

Practicals (30 hours)

REFERENCES

1. M.J.S. SMITH, "*Application Specific Integrated Circuits*", Pearson Education, 2006.
2. Ronald Sass and Andrew G. Schmidt, "*Embedded systems design with platform FPGAs: Principles and practices*", Morgan Kaufmann, 2010.
3. Design manuals of Altera, Xilinx and Actel.

		L	T	P	C
EM2101	**COMPUTER ARCHITECTURE**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite :Nil				
PURPOSE					
To introduce students with general concepts of computer architecture basics to enable them to use the processors effectively.					
INSTRUCTIONAL OBJECTIVES					
1.	To familiarize with fundamentals of computer design.				
2.	To learn parallel and pipeline architectures.				
3.	To learn principles of parallel programming.				

UNIT I - PROCESSOR AND MEMORY HIERARCHY (9 hours)

Multiprocessors and Multicomputers – Multivector and SIMD computers – Architectural Development Tracks – Processors and Memory Hierarchy – Advanced Processor Technology – Superscalar and vector Processor – Memory Hierarchy technology-Virtual memory technology.

UNIT II - FUNDAMENTALS OF COMPUTER DESIGN (9 hours)

Elements of modern computers-System attributes to performance-Bus, Cache and Shared memory-Bus Systems – Cache Memory Organizations – Shared memory Organization – Sequential and weak consistency models.

UNIT III - PARALLEL AND SCALABLE ARCHITECTURES

(9 hours)

Multiprocessor System Interconnects – Cache Coherence and Synchronization Mechanisms – Message-Passing Mechanisms – Vector Processing Principles – Multivector Multiprocessors – Performance-Directed Design Rules – Fujitsu VP2000 and VPP500 – SIMD Computer Organizations – Implementation models – The MasPar MP-1 Architecture-Latency - Hiding Techniques – Principles of Multithreading – Scalable and Multithreaded Architectures - The Tera Multiprocessor System.

UNIT IV - PIPELINING AND SUPER SCALAR TECHNIQUES

(9 hours)

Introduction – Basics of a RISC Instruction set – Implementation of five stage Pipeline for a RISC processor – Performance issues – hurdle of pipelining – simple implementation of MIPS – extending the MIPS pipeline to handle multicycle operations – cross cutting issues.

UNIT V - SOFTWARE FOR PARALLEL PROGRAMMING

(9 hours)

Parallel programming models – parallel languages and compliers – code optimization and scheduling – scalar optimization with basic blocks – code generation and scheduling – trace scheduling compilation – parallelization and wave fronting – software pipelining – parallel programming environments – Y-MP, Paragon and CM-5 environments – synchronization and multiprocessing modes – principles of synchronization - multiprocessor execution modes – shared-variable program structures – locks for protected access – semaphores and applications – message-passing program development.

REFERENCES

1. Kai Hwang & Naresh Jotwani, "*Advanced Computer Architecture*", McGraw –Hill, Inc. 2011.
2. John L. Hennessey and David A. Patterson, "*Computer Architecture: A Quantitative Approach*", 3rd Edition, Morgan Kaufmann, 2003.

		L	T	P	C
EM2102	**EMBEDDED LINUX**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite :Nil				

PURPOSE	
To enable the student to learn developing Linux based embedded applications.	
INSTRUCTIONAL OBJECTIVES	
1.	To learn fundamentals of embedded linux.
2.	To learn to use GNU tool chain.
3.	To learn to implement embedded linux applications.

UNIT I - LINUX FUNDAMENTALS (9 hours)

Introduction - host-target development setup - hardware support - development languages and tools – RT linux.

UNIT II - INITIALIZATION (9 hours)

Linux kernel and kernel initialization - system initialization – hardware support - bootloaders.

UNIT III - DEVICE HANDLING (9 hours)

Device driver basics - module utilities - file systems - MTD subsystems – busybox.

UNIT IV - DEVELOPMENT TOOLS (9 hours)

Embedded development environment - GNU debugger - tracing & profiling tools - binary utilities - kernel debugging - debugging embedded Linux applications - porting Linux - Linux and real time - SDRAM interface.

UNIT V - DEVICE APPLICATIONS (9 hours)

Asynchronous serial communication interface - parallel port interfacing - USB interfacing - memory I/O interfacing - using interrupts for timing.

REFERENCES

1. Karim Yaghmour, Jon Masters, Gillad Ben Yossef, Philippe Gerum, "*Building embedded linux systems*", O'Reilly, 2008.
2. Christopher Hallinan, "*Embedded Linux Primer: A practical real world approach*", Prentice Hall, 2007.

3. Craig Hollabaugh, "*Embedded Linux: Hardware, software and Interfacing*", Pearson Education, 2002.
4. Doug Abbott, "*Linux for embedded and real time applications*", Elsevier Science, 2003.

		L	T	P	C
EM2103	**PRINCIPLES OF DISTRIBUTED EMBEDDED SYSTEMS**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite :Nil				

PURPOSE	
To introduce the design concepts of distributed embedded systems and CAN network, which is widely used in automotive and industrial embedded systems.	
INSTRUCTIONAL OBJECTIVES	
1.	To understand the design principles of distributed embedded systems.
2.	To learn CAN and CANopen networking.
3.	To learn to design CAN network based systems.

UNIT I - REAL-TIME ENVIRONMENT (9 hours)
Real-time computer system requirements – classification of real time systems – simplicity – global time – internal and external clock synchronization – real time model.
Real – time communication – temporal relations – dependability – power and energy awareness – real –time communication – event triggered – rate constrained – time triggered.

UNIT II - REAL-TIME OPERATING SYSTEMS (6 hours)
Inter component communication – task management – dual role of time – inter task interactions – process input/output – agreement protocols – error detection.

UNIT III - SYSTEM DESIGN (12 hours)
Scheduling problem - static & dynamic scheduling – system design – validation – time–triggered architecture.

UNIT IV - INTRODUCTION TO CAN **(9 hours)**
Introduction to CAN Open – CAN open standard – Object directory – Electronic Data Sheets & Devices.

UNIT V - CAN STANDARDS **(9 hours)**
Configuration Files – Service Data Objectives – Network management CAN open messages – Device Profile Encoder.

REFERENCES

1. Hermann Kopetz, "*Real–Time systems – Design Principles for distributed Embedded Applications*", 2nd Edition, Springer 2011.
2. Glaf P.Feiffer, Andrew Ayre and Christian Keyold, "*Embedded Networking with CAN and CAN open*", Copperhill Media Corporation, 2008.

<table>
<tr><td rowspan="4">EM2104</td><td></td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>COMMUNICATION NETWORK PROCESSORS</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Total Contact Hours – 45</td></tr>
<tr><td colspan="5">Prerequisite :Nil</td></tr>
<tr><td colspan="6">PURPOSE</td></tr>
<tr><td colspan="6">There is a need for designing hardware and software for data communication devices. This course aims at equipping the student with necessary knowledge and design principles for network equipment like routers, bridges etc,.</td></tr>
<tr><td colspan="6">INSTRUCTIONAL OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="5">To familiarize embedded communication devices.</td></tr>
<tr><td>2.</td><td colspan="5">To understand the functions of each communication layer of ISO standard.</td></tr>
<tr><td>3.</td><td colspan="5">To learn network processors.</td></tr>
</table>

UNIT I - OVERVIEW OF DATA NETWORKS **(6 hours)**
End point: Data Modems, Serial interfaces, ISDN interface – Communication: Types of switching, Types of error: single and burst error, Error detection, redundancy check: Longitudinal, vertical, and cyclic error correction, architecture of computer network - Overview of OSI reference model – Network components: Routers, Bridges and Gateways.

UNIT II - COMMUNICATION SOFTWARE DESIGN **(12 hours)**
Ecosystem - embedded communications software - software partitioning - module and task decomposition - Partitioning case study - Protocol software -

debugging protocols - tables and other data structures - table access routines - Buffer and timer management - Management software – device & router management – CLI based management & HTTP based management - Agent to protocol interface – device to manager communication – system setup, boot & post-boot configuration – saving and restoring the configuration.

UNIT III - MULTI-BOARD DESIGN (9 hours)

Multiboard common architectures for communication equipment – Single board, chassis and rack-based designs - Components of a multi board designs – RTOS support for distribution – data structure and state machine changes for distribution – failures and fault tolerance in multi board systems.

UNIT IV - DESIGN PRINCIPLES OF SCHEDULING (9 hours)

Processor scheduling – Multiprocessor scheduling – Limited packet processing capacity in routers – real time scheduling on multiprocessors – Multithreaded Packet processors – random external memory accesses.

UNIT V - COMMUNICATION PROCESSOR ARCHITECTURES (9 hours)

The TRIBE Architecture – Tribe pipeline – Quantum Flow Processor - Introduction – Architecture of quantum flow processor – ASR 1000 series router – QFP residing on distributed line cards – High level packet flow – Packet Processors Engines – Packet Processor Engine resources - QFP Buffer, Queue and scheduling.

REFERENCES

1. Behrouz A. Forouzan, "*Data Communications and Networking*", 4th Edition, Mc-Graw Hill.
2. T. Sridhar , "*Designing Embedded Communications Software*", CMP books, 2003.
3. Mark A. Franklin, Patrick Crowley, Haldun Hadimioglu and Peter Z. Onufryk., "*Network Processor Design – Issues and Practices*", Elsevier, 2005.
4. "*The CISCO Quantum Flow Processor*", CISCO's Next Generation Network Processor Manual.

		L	T	P	C
EM2105	**EMBEDDED WIRELESS SENSOR NETWORKS**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite : Nil				
PURPOSE					
Wireless sensor networks are an becoming an important application of embedded systems, giving scope for unique designs and applications. This course is aimed at imparting knowledge on wireless sensor networks and practical implementation.					
INSTRUCTIONAL OBJECTIVES					
1.	To understand the concepts of sensor networks.				
2.	To learn implementation issues and techniques wireless sensor nodes.				

UNIT I - INTRODUCTION TO WSN (9 hours)

Introduction to WSN-Challenges for WSNs - Characteristic requirements - Required mechanisms - Single-node architecture -Hardware components-Energy consumption of sensor nodes-Operating systems and execution environments-Some examples of sensor nodes.

UNIT II - NETWORK ARCHITECTURE (9 hours)

Sensor network scenarios- Optimization goals and figures of merit- Design principles for WSNs, Service interfaces of WSNs- Gateway concepts.

UNIT III - SENSOR NETWORK IMPLEMENTATION (9 hours)

Sensor Programming- Introduction to TinyOS Programming and fundamentals of Programming sensors using nesC- Algorithms for WSN – Techniques for Protocol Programming.

UNIT IV - PROGRAMMING MODELS (9 hours)

An Introduction to the Concept of Cooperating Objects and Sensor Networks- System Architectures and Programming Models.

UNIT V - CASE STUDIES (9 hours)

Wireless sensor networks for environmental monitoring, Wireless sensor networks with mobile nodes, Autonomous robotic teams for surveillance and monitoring, Inter-vehicle communication networks.

REFERENCES

1. Holger karl, Andreas Willig, "*Protocols and architectures for wireless sensor networks*", John Wiley,2005.
2. Liljana Gavrilovska, Srdjan Krco, Veljko Milutinovic , Ivan Stojmenovic,Roman Trobec, "*Application and Multidisciplinary Aspects of Wireless Sensor Networks*", Springer-Verlag, London Limited 2011.
3. Michel Banâtre, Pedro José Marrón, Anibal Ollero, Adam Wolisz, "*Cooperating Embedded Systems and Wireless Sensor Networks* ", John Wiley & Sons, Inc .2008.
4. Seetharaman Iyengar, Nandhan, "*Fundamentals of Sensor Network Programming Applications and Technology*" , John Wiley & Sons, Inc.2008.

		L	T	P	C
EM2106	**WIRELESS AND MOBILE COMMUNICATIONS**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite :Nil				
PURPOSE					
To introduce the concepts of mobile wireless communication systems.					
INSTRUCTIONAL OBJECTIVES					
1.	To make the student learn fundamentals of wireless communications.				
2.	To learn about the systems which operate on wireless principles.				

UNIT I - INTRODUCTION **(9 hours)**

Wireless Transmission-signal propagation-spread spectrum-Satellite Networks-Capacity Allocation-FAMA-DAMA-MAC.

UNIT II - MOBILE NETWORKS **(9 hours)**

Cellular Wireless Networks-GSM-Architecture-Protocols-Connection Establishment-Frequently Allocation-Routing-Handover-Security-GPRA.

UNIT III - WIRELESS NETWORKS **(9 hours)**

Wireless LAN-IEEE 802.11 Standard-Architecture-Services-AdHoc Network- HiperLan - Blue Tooth.

UNIT IV - ROUTING (9 hours)

Mobile IP-DHCP- AdHoc Networks-Proactive and Reactive Routing Protocols-Multicast Routing.

UNIT V - TRANSPORT AND APPLICATION LAYERS (9 hours)

TCP over Adhoc Networks-WAP-Architecture-WWW Programming Model-WDP-WTLS-WTP-WSP-WAE-WTA Architecture-WML-WML scripts.

REFERENCES

1. Kaveh Pahlavan, Prasanth Krishnamoorthy, "*Principles of Wireless Networks*", PHI/Pearson Education, 2003.
2. Jochen Schiller, "*Mobile communications*", PHI/Pearson Education, Second Edition, 2003.
3. William Stallings, "*Wireless communications and Networks*", PHI/Pearson Education, 2002.
4. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "*Principles of Mobile computing*", Springer, New york, 2003.
5. C.K.Toh, "*AdHoc mobile wireless networks*", Prentice Hall, Inc, 2002.
6. Charles E. Perkins, "*Adhoc Networking*", Addison-Wesly, 2001.

		L	T	P	C
EM2107	**EMBEDDED CONTROL SYSTEMS**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite: Nil				

PURPOSE

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

INSTRUCTIONAL OBJECTIVES

1.	To learn the basics of control systems.
2.	To learn control theory as used in embedded systems.
3.	To learn application of control systems
4.	To learn I/O devices used in control systems.

UNIT I - CONTROL SYSTEM BASICS (9 hours)

Z-transforms – performance requirements - block diagrams - analysis and design - sampling theory – difference equations.

UNIT II - CONTROL SYSTEM IMPLEMENTATION (9 hours)

Discretization method – Fixed point mathematics – Nonlinear controller elements – Gain scheduling – Controller implementation and testing in Embedded Systems. - a case study of robotic control system.

UNIT III - CONTROL SYSTEM TESTING (9 hours)

Software implications - Controller implementation and testing in embedded systems - Measuring frequency response.

UNIT IV - INPUT DEVICES (9 hours)

Keyboard basics - Keyboard scanning algorithm - Character LCD modules - LCD module display Configuration - Time-of-day clock - Timer manager - Interrupts - Interrupt service routines - Interrupt-driven pulse width modulation. Triangle waves analog vs. digital values - Auto port detect - Capturing analog information in the timer interrupt service routine - Automatic, multiple channel analog to digital data acquisition.

UNIT V - OUTPUT DEVICES AND SENSORS (9 hours)

H Bridge – relay drives - DC/ Stepper Motor control – optical devices.

Linear and angular displacement sensors: resistance sensor – induction displacement sensor – digital optical displacement sensor – pneumatic sensors. Speed and flow rate sensors : electromagnetic sensors – fluid flow sensor – thermal flow sensor. Force sensors: piezoelectric sensors – strain gauge sensor – magnetic flux sensor – inductive pressure sensor – capacitive pressure sensor. Temperature sensors: electrical – thermal expansion – optical

Case Study- Examples for sensor, actuator, control circuits with applications.

REFERENCES

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

		L	T	P	C
EM2108	**INTELLIGENT SYSTEMS**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite : Nil				

PURPOSE	
Intelligent system concepts are becoming more relevant in the embedded systems. To give an overview of design principles and applications this course is offered.	
INSTRUCTIONAL OBJECTIVES	
1.	To learn basic intelligent system concepts.
2.	To learn neural networks.
3.	To learn fuzzy logic and its implementation methods.

UNIT I - INTRODUCTION AND BASIC CONCEPTS (9 hours)

Introduction- Humans and Computers, the structure of the brain, learning in machines, the differences. The basic neuron- Introduction, modeling the single neuron, learning in simple neurons, the perception: a vectorial perspective, the perception learning rule, proof, limitations of perceptrons.

UNIT II - MULTILAYER NETWORKS (9 hours)

The multi layer perceptron: Introduction, altering the perception model, the new model, the new learning rule, multi layer perception algorithm, XOR problem. Multi layer feed forward networks, error back propagation training algorithm: problems with back propagation, Boltzman training, Cauchy training, combined back propagation, Cauchy training.

UNIT III - RESONANT NETWORKS AND APPLICATIONS (9 hours)

Hop-field networks: recurrent and bi-directional associative memories, counter propagation network, Artificial Resonance Theory (ART) Application of neural network: Hand written digit and character recognition-Traveling sales man problem, a neuro-controller.

UNIT IV - FUZZY SET THEORY (9 hours)

Introduction to fuzzy set theory: Fuzzy set vs Crisp set, properties of fuzzy sets, operations on fuzzy set – fuzzy compliments, fuzzy intersection- T-norms, fuzzy union- t- co-norm, fuzzy relations.

UNIT V - FUZZY LOGIC AND SYSTEMS (9 hours)

Fuzzy Logic: Classical logic, multi valued logic, fuzzy propositions, fuzzy quantifiers, linguistic hedges and their inferences.
Fuzzy systems: fuzzy controllers, fuzzy systems and neural networks, fuzzy neural networks, fuzzy automata, fuzzy dynamic system.

REFERENCES

1. G.J.Klir & Bo Yuan, "*Fuzzy Sets and Fuzzy Logic Theory and Applications*", Prentice Hall of India, 2009.
2. Timothy S.Ross, "*Fuzzy Logic with engineering applications*", Weily India Pvt. Ltd., 2011..
3. Kosko B, "*Neural Networks and Fuzzy Systems: A dynamical system approach to machine intelligence*", Prentice Hall of India, 2009.
4. R Beale & T Jackson, "*Neural Computing, An Introduction*", Adam Hilger, 1990.
5. Rao V.B and Rao H.V., "*C++, Neural Networks and Fuzzy Logic*", BPB Publications, 2003.
6. Simon Kendal, Malcolm Creen, "*An Introduction to Knowledge Engineering*", Springer-Verlag Limited, 2007.

		L	T	P	C
EM2109	**DIGITAL IMAGE PROCESSING**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite :Nil				
PURPOSE					
Since image processing is an upcoming embedded field wherein many small systems and robots are built with image processing functions we give in this subject an idea of image processing concepts.					
INSTRUCTIONAL OBJECTIVES					
1.	To learn basic Image processing operations and concepts.				
2.	To learn multi resolution analysis.				
3.	To study video processing.				

UNIT I - FUNDAMENTALS OF IMAGE PROCESSING (9 hours)

Introduction - Steps in image processing systems - Image acquisition - Sampling and Quantization - Pixel relationships - Color fundamentals and models, File formats, Image operations – Arithmetic and Morphological.

UNIT II - IMAGE ENHANCEMENT (9 hours)

Spatial Domain: Gray level Transformations - Histogram processing - Spatial filtering smoothing and sharpening. Frequency Domain: Filtering in frequency domain - DFT, FFT, DCT - Smoothing and sharpening filters – Homomorphic Filtering.

UNIT III - IMAGE SEGMENTATION AND FEATURE ANALYSIS (9 hours)

Detection of Discontinuities - Edge operators - Edge linking and Boundary Detection - Thresholding - Region based segmentation - Morphological Watersheds - Motion Segmentation.

UNIT IV - OBJECT RECOGNITION (10 hours)

Introduction – Pattern and Pattern Class – Selection Measurement Parameters – Approaches – Types of Classification – Bayes, Template matching, Non parametric density estimation, Neural Network approach – Applications.

UNIT V - VIDEO PROCESSING (8 hours)

Real time image and Video processing – parallelism – Algorithm simplification strategy – Hardware platforms – DSP, FPGA, GPU, General purpose processors.

REFERENCES

1. Rafael C. Gonzalez and Richard E. Woods, "*Digital Image Processing*", 3rd Edition, Pearson Eduction, 2009.
2. Nasser Kehtarnavaz, Mark Noel Gamadia, "*Real-time image and video processing: from research to reality*", Morgan Claypool publishers, 2006.
3. S. Jayarman, S. Esakkirajan, T. Veerakumar, "*Digital Image Processing*", Tata McGraw Hill, 2010.
4. Anil K. Jain, "*Fundamentals of Digital Image Processing*", Pearson Education, 2003.
5. Milan Sonka, Vaclav Hlavac and Roger Boyle, "*Image Processing, Analysis and Machine Vision*", 2nd Edition, Thomson, 2007.

<table>
<tr><td rowspan="4">EM2110</td><td></td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>MULTIMEDIA SYSTEMS</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Total Contact Hours – 45</td></tr>
<tr><td colspan="5">Prerequisite :Nil</td></tr>
<tr><td colspan="6">PURPOSE</td></tr>
<tr><td colspan="6">Multimedia applications are coming in to the arena of embedded systems. With future applications in mind this course on multi media systems is offered.</td></tr>
<tr><td colspan="6">INSTRUCTIONAL OBJECTIVES</td></tr>
<tr><td>1.</td><td colspan="5">To learn multimedia principles.</td></tr>
<tr><td>2.</td><td colspan="5">To learn knowledge and user understanding.</td></tr>
<tr><td>3.</td><td colspan="5">To study text, sound and image applications.</td></tr>
</table>

UNIT I - MULTIMEDIA (9 hours)
Introduction – Multimedia modalities, Channels and Medium – Interaction – Communicative Interaction – Objects and Agents – Channels of Communication – Artificial Languages – Natural Communication – Meta-languages – Components of Interactive Multimedia Systems.

UNIT II - KNOWLEDGE AND USER UNDERSTANDING(9 hours)
Knowledge – Basic idea of knowledge – A working definition – Knowledge representation – Knowledge Elicitation – Know about user applying user knowledge – acquiring user knowledge – User profiling – User modeling.

UNIT III - INTERACTION, INTERFACE & SEMIOTICS(9 hours)
Traditional HCI – Modalities and the interface – Interface channels – Functionality and usability – Visual appearance and Graphic design – Multimedia content – Semiotics – Idea of a Sign – Complex Signs – Semiotics and Media.

UNIT IV - TEXT AND SOUND (9 hours)
Visual Perception of Text – Images on Page – Meaning and Text Readability – Text and the Screen – Modality of Sound – Channels of Communication – Combining Sound Channels – Technology of Sound – MIDI.

UNIT V - IMAGES **(9 hours)**

Psychology of vision – Representational Images – Juxtaposition of Images – Perception of Motion – Constructing a Shot – Shots into narrative – Modern languages of film and television.

REFERENCES

1. Mark Elsom-Cook, "*Principles of Interactive Multimedia*", McGraw Hill, International Edition 2001.
2. Simon Kendal, Malcolm Creen, "*An Introduction to Knowledge Engineering*", Springer-Verlag Limted, 2007.

EM2111		**L**	**T**	**P**	**C**
	DSP INTEGRATED CIRCUITS	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite				
	EM2008 / EM2009				
PURPOSE					
To impart knowledge of VSLI implementation of DSP circuits.					
INSTRUCTIONAL OBJECTIVES					
1.	To learn implementation of DSP in VLSI.				

UNIT I - DSP IC'S AND VLSI CIRCUIT TECHNOLOGIES(9 hours)

Standard digital signal processors, Application specific IC's for DSP, DSP systems, DSP system design, Integrated circuit design. MOS transistors, MOS logic, VLSI process technologies, Trends in CMOS technologies.

UNIT II - DIGITAL SIGNAL PROCESSING **(9 hours)**

Digital signal processing, Sampling of analog signals, Selection of sample frequency, Signal-processing systems, Frequency response, Transfer functions, Signal flow graphs, Filter structures, Adaptive DSP algorithms, DFT-The Discrete Fourier Transform, FFT-The Fast Fourier Transform Algorithm, Image coding, Discrete cosine transforms.

UNIT III - DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS (9 hours)

FIR filters, FIR filter structures, FIR chips, IIR filters, Specifications of IIR filters, Mapping of analog transfer functions, Mapping of analog filter structures, Multirate systems, Interpolation with an integer factor L, Sampling rate change with a ratio L/M, Multirate filters. Finite word length effects -Parasitic oscillations, Scaling of signal levels, Round-off noise, Measuring round-off noise, Coefficient sensitivity, Sensitivity and noise.

UNIT IV - DSP ARCHITECTURES AND THEIR SYNTHESIS (9 hours)

DSP system architectures, Standard DSP architecture, Ideal DSP architectures, Multiprocessors and multicomputers, Systolic and Wave front arrays, Shared memory architectures. Mapping of DSP algorithms onto hardware, Implementation based on complex PEs, Shared memory architecture with Bit – serial PEs.

UNIT V - ARITHMETIC UNITS AND IC DESIGN (9 hours)

Conventional number system, redundant Number system, Residue Number System. Bit-parallel and Bit-Serial arithmetic, Basic shift accumulator, Reducing the memory size, Complex multipliers, Improved shift-accumulator. Layout of VLSI circuits, FFT processor, DCT processor and Interpolator as case studies.

REFERENCES

1. Lars Wanhammer, "*DSP Integrated Circuits*", Academic press, New York, 1999.
2. Robert J. Schilling, "*Fundamentals of Digital Singal Processing using MATLAB*", Perason Education, 2010.
3. A.V.Oppenheim et.al, "*Discrete-time Signal Processing*", Pearson education, 2000.
4. Emmanuel C. Ifeachor, Barrie W. Jervis, "*Digital signal processing – A practical approach*", 2^{nd} Edition, Pearson edition, Asia, 2011.
5. Keshab K.Parhi, "*VLSI digital Signal Processing Systems design and Implementation*", Wiley India, 2007.

		L	T	P	C
EM2112	**REAL TIME SYSTEMS**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite :Nil				

PURPOSE
The concepts of real time systems and their analysis is very essential for embedded systems this course if offered.

INSTRUCTIONAL OBJECTIVES	
1.	To learn real time aspects of OS, memory communication of systems.
2.	To study reliability evaluation methods.

UNIT I - INTRODUCTION TO TASK SCHEDULING (9 hours)
Introduction - Issues in Real Time Computing, Structure of a Real Time System, Task classes, Performance Measures for Real Time Systems, Task Assignment and Scheduling – Classical uniprocessor scheduling algorithms, RM algorithm with different cases-Priority ceiling- precedence constraints- using of primary and alternative tasks.

UNIT II - UNI AND MULTI PROCESSOR SCHEDULING(9 hours)
Uniprocessor scheduling of IRIS tasks, Task assignment, Utilization balancing – Next fit- Bin packing- Myopic off-line - Focused addressing and bidding- Buddy strategy- Fault Tolerant Scheduling.-Aperiodic scheduling - Spring algorithm, Horn algorithm- Bratley. - Sporadic scheduling.

UNIT III - REAL TIME COMMUNICATION (9 hours)
Introduction – VTCSMA – PB CSMA- Deterministic collision resolution protocol- DCR for multi packet messages- dynamic planning based- Communication with periodic and aperiodic messages.

UNIT IV - REAL TIME DATABASES (9 hours)
Basic Definition, Real time Vs General purpose databases, Main Memory Databases, Transaction priorities, Transaction Aborts, Concurrency control issues, Disk Scheduling Algorithms, Two-phase Approach to improve Predictability, Maintaining Serialization Consistency, Databases for Hard Real Time System.

UNIT V - REAL-TIME MODELING AND CASE STUDIES(9 hours)
Petrinets and applications in real-time modeling, Air traffic controller system – Distributed air defense system.

REFERENCES

1. C.M. Krishna, Kang G. Shin, *"Real Time Systems"*, Tata McGraw - Hil, 2010.
2. Giorgio C. Buttazzo , *"Hard real-time computing systems: predictable scheduling algorithms and applications"* **,** Springer, 2008.
3. C. Siva Ram Murthy, G. Manimaran, *"Resource management in real-time systems and networks"*, PHI, 2009.

		L	T	P	C
EM2113	**ELECTRONIC PRODUCT DESIGN AND RELIABILITY ENGINEERING**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite :Nil				
PURPOSE					
To impart knowledge on electronic product design focusing on EMC reliability and prototyping.					
INSTRUCTIONAL OBJECTIVES					
1.	To study EMC principles.				
2.	To learn reliability techniques for electronic products.				
3.	To study prototype engineering.				

UNIT I - EMISSION AND INTERFERENCE (8 hours)
Conducted, radiated emission – cross talk – shielding theory.

UNIT II - EMC TESTING AND DESIGN (10 hours)
RF emissions – immunity tests – low frequency techniques – EMC compliance. Electromagnetic coupling – PCB layout and grounding – choice of circuit configurations, components – special EMC techniques – shielding method

.

UNIT III - RELIABILITY MATHEMATICS (8 hours)
Rules of probability – distribution functions – statistical confidence – goodness of FIT – point process. - Statistical experiments.

Statistics and definitions – exponential, lognormal, Weibull distributions – system reliability - failure distribution functions - Prediction confidence and assessing risk.

UNIT IV- ELECTRONIC SYSTEM RELIABILITY (9 hours)
Electronic products: definitions – failure physics – bath tub curve. Reliability of electronic components: device failure modes – circuit and system aspects – reliability in design – parameter variation and tolerances – design for production, test and maintenance.

UNIT V-PRODUCT DESIGN (10 hours)
System design – design phases – design styles – design of safety critical systems – design diversity – design for maintainability.
System engineering – architecturing and engineering judgment – documentation – human interface – packaging and enclosures – grounding and shielding - circuit design – circuit layout – power – cooling – product integration, production and logistics.

REFERENCES

1. Tim Williams, “*EMC for product designers*”, 4th Elsevier, 2007.
2. Milton Ohring, “*Reliability of materials and devices*”, Elsevier, 1998.
3. Patrick D.T. O'Connor, David Newton, Richard Bromley, “*Practical Reliability Engineering*”, Wiley, 2002.
4. Kim R. Fowler, “*Electronic Instrument Design: Architecturing for the life cycle*”, Oxford University press, 2006.
5. Hermann Kopetz, “*Real–Time systems – Design Principles for distributed Embedded Applications*”, 2nd Edition, Springer 2011.
6. Clayton R. Paul, “*Introduction to EMC*”, John Wiley & Sons, 2006.

		L	T	P	C
MA2009	**APPLIED MATHEMATICS** (Embedded/ Communication Systems)	**3**	**0**	**0**	**3**
	Total Contact hours – 45				
	Prerequisite:Nil				
PURPOSE					

To develop analytical capability and to impart knowledge in Mathematical and Statistical methods and their applications in Engineering and Technology and to apply these concepts in engineering problems they would come across.
INSTRUCTIONAL OBJECTIVES

1.	At the end of the course, Students should be able to understand Mathematical and Statistical concepts, Discrete Fourier transform, Z transform, queueing theory concepts and apply the concepts in solving the engineering problems.

UNIT I – BOUNDARY VALUE PROBLEMS (9 hours)

Solution of initial and boundary value problems - Characteristics - D'Alembert's Solution - Significance of Characteristic curves - Laplace transform solutions for displacement in a long string - a long string under its weight - a bar with prescribed force on one end - free vibration of a string.

UNIT II - SPECIAL FUNCTIONS (9 hours)

Series solutions - Bessel's equation - Bessel Functions - Legendre's equation - Legendre Polynomials - Rodrigue's formula - Recurrence relations - Generating Functions and orthogonal property for Bessel functions of the first kind.

UNIT III – DISCRETE TRANSFORMS (9 hours)

Discrete Fourier Transforms and its properties - Fourier series and its properties - Fourier representation of finite duration sequences - Z-transform - Properties of the region of convergence - Inverse Z-transform - Z-transform properties.

UNIT IV - RANDOM VARIABLES (9 hours)

Review of Probability distributions - Random variables -Moment generating functions and their properties - Functions of Random variables.

UNIT V – QUEUEING THEORY (9 hours)

Single and Multiple server Markovian Queuing models - Customer impatience - Queuing applications.

REFERENCES

1. Veerarajan T, *"Mathematics IV"*, Tata McGraw Hill, 2000. (Unit II Chapter 3 Section 3.4 Unit I Chapter 5)
2. Grewal B.S., *"Higher Engineering Mathematics"*, Khanna Publishers. 34th Edition (Unit II - Chapter 17 Section 17.3, Unit III Chapter 15)

3. Sankara Rao K., *"Introduction to Partial Differential Equations"*, PHI, 1995 (Unit II - Chapter 1, Section 1.3, Chapter 6 Section 6.13)
4. Veerajan T, *"Probability, Statistics and Random Processes"*, 2004 (Unit IV - Chapter 1,2,3,4 Unit V - Chapter 5)
5. Taha H.A., *"Operations Research - An introduction"*, 7th edition, PH, 1997
6. Churchil R.V., *"Operational Mathematics"*. Mc Graw Hill, 1972
7. Richard A. Johnson, Miller and Freund : *"Probability and Statistics for Engineers"*, 5th edition, PHI, 1994
8. Narayanan S., Manicavachagom Pillai T.K. and Ramanaiah G., *"Advanced Mathematics for Engineering Students"*, Vol. II S. Viswanathan & Co.

		L	T	P	C
VL2113	**FUNDAMENTALS AND APPLICATIONS OF MEMS**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite : Nil				

PURPOSE

MEMS technology offers many exciting opportunities in miniaturization of elements in a wide range of applications. MEMS based sensors and actuators are constantly introduced into new products and new markets are expected to become affected by MEMS technology in the near future. The diversity and complexity of this technology demands a wide knowledge base from a prospect researcher. The goal of this course is to provide the student the needed background to comprehend existing technology, the tools to execute MEMS fabrication and the expertise to approach the development of new MEMS tools.

INSTRUCTIONAL OBJECTIVES

1.	To familiarize with MEMS Materials and Scaling Laws in Miniaturation.
2.	To revive various concepts of Engineering Mechanics and Thermo fluid Engineering for Microsystems Design.
3.	To study Microsystems Fabrication Process.
4.	To familiarize with Microsystems Design, Assembly and Packaging.
5.	To explore on various Case Study of MEMS Devices.

UNIT I - OVERVIEW OF MEMS AND MICROSYSTEMS, MEMS MATERIALS AND SCALING LAWS IN MINIATURATION (9 hours)

MEMS and Microsystems - Microsystems and microelectronics, Microsystems and miniaturization, Working principle of micro system - Micro sensors, Micro actuators, MEMS with Micro actuators. Materials For MEMS - Substrate and wafer, silicon as a substrate material, silicon compound, silicon Piezo-resistors, Gallium Arsenide, quartz, Piezoelectric crystals, polymers and packaging Materials. Scaling Laws in Miniaturization- Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer

UNIT II - ENGINEERING MECHANICS AND THERMOFLUID ENGINEERING FOR MICROSYSTEMS DESIGN (9 hours)

Atomic structure of matter, Ions and ionization, Molecular theory of matter and intermolecular forces, Doping of semiconductors, Diffusion process, Plasma physics, Electrochemistry, Static bending of thin plates, Mechanical vibration analysis, Thermo mechanical analysis, Overview of finite element analysis, Thermo fluid Engineering-Characteristics of Moving Fluids, The Continuity Equation, The Momentum Equation, Incompressible Fluid Flow in Microconduits, Overview of Heat Conduction in Micro Structures.

UNIT III - MICROSYSTEMS FABRICATION PROCESS (9 hours)

Fabrication Process - Photolithography, Ion implantation, Oxidation, Chemical vapor deposition (CVD), Physical vapor deposition, Deposition by Epitaxy, Etching. Manufacturing Process - Bulk Micromachining, Surface Micromachining and LIGA Process.

UNIT IV - MICROSYSTEMS DESIGN, ASSEMBLY AND PACKAGING (9 hours)

Micro system Design - Design consideration, process design, Mechanical design, Mechanical design using MEMS. Mechanical packaging of Microsystems, Microsystems packaging, interfacings in Microsystems packaging, packaging technology, selection of packaging materials, signal mapping and transduction.

UNIT V - CASE STUDY OF MEMS DEVICES (9 hours)

Case study on strain sensors, Temperature sensors, Pressure sensors, Humidity sensors, Accelerometers, Gyroscopes , RF MEMS Switch, phase shifter, and smart sensors. Case study of MEMS pressure sensor Packaging.

REFERENCES

1. *"MEMS and Microsystems: design , manufacture, and nanoscale Engineering,"* 2nd Edition, by Tai-Ran Hsu, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
2. Chang Liu, "*Foundations of MEMS*", Pearson Indian Print, 1st Edition, 2012.
3. Gabriel M Rebeiz, *"RF MEMS - Theory Design and Technology"*, John Wiley and Sons, 2004.
4. Julian W Gardner, *"Microsensors MEMS and smart devices"*, John Wiley and sons Ltd, 2001.

		L	T	P	C
VL2112	**RELIABILITY ENGINEERING**	**3**	**0**	**0**	**3**
	Total Contact Hours – 45				
	Prerequisite : Nil				
PURPOSE					
For any system reliability is an essential parameter. For evaluating reliability of designs, it is necessary to know reliability analysis methods.					
INSTRUCTIONAL OBJECTIVES					
1.	To learn basics of reliability evaluation methods				
2.	To understand its application to electronic circuit.				
3.	To understand the various Failure modes of many electronic components.				

UNIT I - RELIABILITY AND RATES OF FAILURE (9 hours)

Statistical distribution , statistical confidence and hypothesis testing ,probability plotting techniques - Weibull, extreme value ,hazard, binomial data; Analysis of load - strength interference , Safety margin and loading roughness on reliability.

UNIT II - STATISTICAL EXPERIMENTS (9 hours)

Statistical design of experiments and analysis of variance Taguchi method, Reliability prediction, Reliability modeling, Block diagram and Fault tree

Analysis ,petric Nets, State space Analysis, Monte Carlo simulation, Design analysis methods - quality function deployment, load strength analysis, failure modes, effects and criticality analysis.

UNIT III - ELECTRONIC SYSTEMS AND SOFTWARE RELIABILITY (9 hours)

Reliability of electronic components, component types and failure mechanisms, Electronic system reliability prediction, Reliability in electronic system design; software errors, software structure and modularity, fault tolerance, software reliability, prediction and measurement, hardware/software interfaces.

UNIT IV - RELIABILITY TESTING (9 hours)

Test environments, testing for reliability and durability, failure reporting, Pareto analysis, Accelerated test data analysis, CUSUM charts, Exploratory data analysis and proportional hazards modeling, reliability demonstration, reliability growth monitoring.

UNIT V - RELIABILITY IN MANUFACTURE AND MAINTENANCE (9 hours)

Control of production variability, Acceptance sampling, Quality control and stress screening, Production failure reporting; preventive maintenance strategy, Maintenance schedules, Design for maintainability, Integrated reliability programmes , reliability and costs, standard for reliability, quality and safety, specifying reliability, organization for reliability.

REFERENCES

1. Lewis, *"Introduction to Reliability Engineering"*, Wiley International,2nd Edition, 1996.
2. Patrick D.T. O'Commer, David Newton and Richard Bromley, *"Practical Reliability Engineering"*, John Wiley & Sons, 4th Edition, 2002.

		L	T	P	C
EM2047	**SEMINAR**	**0**	**0**	**1**	**1**
PURPOSE					
To train the students in preparing and presenting technical topics.					
INSTRUCTIONAL OBJECTIVE					
The student shall be capable of identifying topics of interest related to the program of study and prepare and make presentation before an enlightened audience.					

The students are expected to give at least two presentations on their topics of interest which will be assessed by a committee constituted for this purpose. This course is mandatory and a student has to pass the course to become eligible for the award of degree. Marks will be awarded out of 100 and appropriate grades assigned as per the regulations

		L	T	P	C
EM2049	**PROJECT WORK PHASE I (III semester)**	**0**	**0**	**12**	**6**
EM2050	**PROJECT WORK PHASE II (IV semester)**	**0**	**0**	**32**	**16**
PURPOSE					
To undertake research in an area related to the program of study					
INSTRUCTIONAL OBJECTIVE					
The student shall be capable of identifying a problem related to the program of study and carry out wholesome research on it leading to findings which will facilitate development of a new/improved product, process for the benefit of the society.					

M.Tech projects should be socially relevant and research oriented ones. Each student is expected to do an individual project. The project work is carried out in two phases – Phase I in III semester and Phase II in IV semester. Phase II of the project work shall be in continuation of Phase I only. At the completion of a project the student will submit a project report, which will be evaluated (end semester assessment) by duly appointed examiner(s). This evaluation will be based on the project report and a viva voce examination on the project. The method of assessment for both Phase I and Phase II is shown in the following table:

Assessment	Tool	Weightage
In- semester	I review	10%
	II review	15%
	III review	35%
End semester	Final viva voce examination	40%

Student will be allowed to appear in the final viva voce examination only if he / she has submitted his / her project work in the form of paper for presentation / publication in a conference / journal and produced the proof of acknowledgement of receipt of paper from the organizers / publishers.

AMENDMENTS

S.No.	Details of Amendment	Effective from	Approval with date