UNIVERSITY OF CALICUT

M.Tech. DEGREE COURSE
EMBEDDED SYSTEMS

Scheme of Examinations and Syllabi
(With effect from 2010 admissions)

SEMESTER 1

ES 10 101 SYSTEM DESIGN USING EMBEDDED PROCESSORS

Modules	Hours
Module 1 **8-Bit 8051 Microcontroller** Introduction to Embedded Systems. **8-Bit Microcontrollers:** A popular 8-bit Microcontroller (Intel 8051) is covered under this section **Architecture:** CPU Block diagram, Memory Organization, Program memory, Data Memory, Interrupts **Peripherals:** Timers, Serial Port, I/O Port Programming: **Addressing Modes, Instruction Set, Programming** **Microcontroller based System Design** Timing Analysis Case study with reference to 8-bit 8051 Microcontroller. **A typical application design from requirement analysis through concept design, detailed hardware and software design using 8-bit 8051 Microcontrollers.**	10
Module 2 **32- Bit ARM920T Processor Core** **Introduction:** RISC/ARM Design Philosophy, About the ARM920T Core, Processor Functional Block Diagram **Programmers Model:** Data Types, Processor modes, Registers, General Purpose Registers, Program Status Register, CP15 Coprocessor, Memory and memory mapped I/O, Pipeline, Exceptions, Interrupts and Vector table, Architecture revisions, ARM Processor Families. **Cache:** Memory hierarchy and cache memory, Cache Architecture – Basic Architecture of a Cache, Basic operation of a cache controller, Cache and main memory relationship, Set Associativity Cache Policy – Write policy, Cache line replacement policies, allocation policy on a cache miss Instruction Cache, Data Cache, Write Buffer and Physical Address TAG RAM **Memory Management Units:** How virtual memory works, Details of the ARM MMU, Page Tables, Translation Look-aside Buffer, Domains and Memory access	12

permissions **ARM Instruction Set:** Data Processing instructions, Branch instructions, Load - Store instructions, Software Interrupt Instruction, Program Status Register Instruction, Loading Constants **Thumb Instruction Set:** Thumb register usage, ARM-Thumb interworking, Branch instruction, Data processing instructions, Load - store instructions, stack instructions, software interrupt instructions. **Interrupt Handling:** Interrupts, Assigning interrupts, Interrupt latency, IRQ & FIQ exceptions, Basic interrupt stack design and implementation, Non-nested Interrupt handler	
Module 3 **ARM9 Microcontroller Architecture:** A popular ARM9 Microcontroller from Atmel (AT91RM9200) is covered under this section AT91RM9200 Architecture: **Block Diagram, Features, Memory Mapping** **Memory Controller (MC)**, Memory Controller Block Diagram, Address Decoder, External Memory Areas, Internal Memory Mapping **External Bus Interface (EBI)**, Organization of the External Bus Interface, EBI Connections to Memory Devices **External Memory Interface**, Write Access, Read Access, Wait State Management AT91RM9200 PERIPHERALS **Interrupt Controller:** Normal Interrupt, Fast Interrupt, AIC **System Timer (ST):** Period Interval Timer (PIT), Watchdog Timer (WDT), Real-time Timer (RTT) **Real Time Clock (RTC)** **Parallel Input/Output Controller (PIO)**	9
Module 4 AT91RM9200 PERIPHERALS **Universal Synchronous Asynchronous Receiver Transceiver (USART):** Block Diagram, Functional Description, Synchronous and Asynchronous Modes Development & Debugging Tools for Microcontroller based Embedded Systems: ***Software and Hardware tools like Cross Assembler, Compiler, Debugger, Simulator, In-Circuit Emulator (ICE), Logic Analyzer etc.***	8
Total Hours	39

TEXT BOOKS:

[1] Intel Hand Book on “Embedded Microcontrollers”, 1st Edition

[2] Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, “The 8051 Microcontroller and Embedded Systems using Assembly and C”, 2nd Edition, Prentice Hall

[3] ARM Company Ltd. “ARM Architecture Reference Manual– ARM DDI 0100E”

[4] David Seal “ARM Architecture Reference Manual”, 2001 Addison Wesley, England; Morgan Kaufmann Publishers

[5] Andrew N Sloss, Dominic Symes, Chris Wright, “ARM System Developer's Guide - Designing and Optimizing System Software”, 2006, Elsevier

[6] ATMEL Corporation, “AT91RM9200 ARM920T Based Microcontroller Rev. 1768E-ATARM–30-Sep-05”

[7] ARM Company Ltd. “ARM920T Technical Reference Manual (Rev 1) - ARM DDI 0151C”

REFERENCES:

[1] Ayala, Kenneth J “8051 Microcontroller - Architecture, Programming & Applications”, 1st Edition, Penram International Publishing

[2] Steve Furber, “ARM System-on-Chip Architecture”, 2nd Edition, Pearson Education

[3] Predko, Myke, “Programming and Customizing the 8051 Microcontroller”, 1st Edition, McGraw Hill International

[4] Schultz, Thomas W, “C and the 8051 Programming for Multitasking”, 1st Edition, Prentice Hall

[5] Schultz, Thomas W, “C and the 8051: Hardware, Modular Programming and Multitasking”, Vol I, 2nd Edition, Prentice Hall

[6] Stewart, James W, Miao, Kai X, “8051 Microcontroller: Hardware, Software and Interfacing”, 2nd Edition, Prentice Hall

[7] Arnold. S. Berger, “Embedded Systems Design - An introduction to Processes, Tools and Techniques”, Easwer Press

[8] Raj Kamal, “Microcontroller - Architecture Programming Interfacing and System Design” 1st Edition, Pearson Education

[9] P.S Manoharan, P.S. Kannan, “Microcontroller based System Design”, 1st Edition, Scitech Publications

[10] David Calcutt, Fred Cowan, Hassan Parchizadeh, “8051 Microcontrollers – An Application based Introduction”, Elsevier

[11] Ajay Deshmukh, “Microcontroller - Theory & Applications”, Tata McGraw Hill

In addition, manufacturers Device data sheets and application notes are to be referred to get practical and application oriented information.

ES 10 102 ADVANCED DIGITAL SYSTEM DESIGN

Modules	Hours
Module 1 - Introduction to Digital Systems Design. Introduction - Design of Combinational and Sequential Systems - Derivation of state tables and state diagrams - Design using ASM diagrams - Introduction to PLDs - PROM based design - PAL - Arithmetic PAL devices – Study based on PAL22V10, CPLDs (MAX3000a CPLD).	11
Module 2 - FPGA Architectures RAM based FPGAs - Antifuse FPGAs - Selecting FPGAs – CLBs, Input/Output Blocks - Programmable Interconnect (study based on Xilinx and Altera FPGAs only) Study based on Xilinx Spartan IIE - Introduction to System on a Chip	6
Module 3 - VHDL Basics - Introduction to HDL - Entity - Architecture - Basic language elements - Behavioral modeling - Data flow modeling - Structural modeling - Generics and Configurations - Subprograms & Overloading - Packages and libraries - VHDL advanced features - Test Bench - Synthesis Issues.	12
Module 4 - Verilog Basics - Modeling Levels - Data Types - Modules and Ports - Instances - Basic Language Concepts - Dataflow modeling - Behavioral modeling - Gate level modeling Tasks and functions – Modeling Techniques – Logic synthesis with verilog.	10
Total Hours	39

TEXT BOOKS:

1. Parag K. Lala, "Digital System Design using programmable Logic Devices", Prentice Hall, NJ, 1994
2. Geoff Bestock, "FPGAs and programmable LSI; A Designers Handbook", Butterworth Heinemann, 1996
3. Smith, "Application Specific Integrated Circuits", Addison-Wesley, 1997
4. J. Bhasker, "A VHDL Primer", Addison-Weseley Longman Singapore Pte Ltd. 1992

REFERENCE BOOKS

1. Jesse H. Jenkins, "Designing with FPGAs and CPLDs", Prentice Hall, NJ,1994
2. Kevin Skahill, "VHDL for Prgrammable Logic", Addison -Wesley, 1996
3. Z. Navabi, "VHDL Analysis and Modeling of Digital Systems", McGRAW-Hill, 1998
4. Sudhakar Yalamanchili, “Introductory VHDL From Simulation to Synthesis”, Prentice Hall

In addition, manufacturers Device data sheets and application notes are to be referred to get practical and application oriented information.

ES 10 103 EMBEDDED PROGRAMMING

Modules	Hours
Module 1: Embedded OS Fundamentals (Linux) Introduction: Operating System Fundamentals, General and Unix OS Architecture Embedded Linux. Booting Process in Linux GNU Tools: gcc, Conditional Compilation, Preprocessor directives, Command line arguments, Make files	6
Module 2: Embedded C Programming **Review of data types –**scalar types-Primitive types-Enumerated types-Subranges, Structure types-character strings –arrays- Functions **Introduction to Embedded C**-Introduction, Data types Bit manipulation, Interfacing C with Assembly. **Embedded programming issues** - Reentrancy, Portability, Optimizing and testing embedded C programs.	11
Module 3: Embedded Applications using Data structures **Linear data structures**– **Stacks and Queues** Implementation of stacks and Queues- Linked List - Implementation of linked list, Sorting, Searching, Insertion and Deletion, Nonlinear structures	10
Module 4: Embedded Java **Introduction to Object Oriented Concepts**. **Core Java/Java Core**- Java buzzwords, Overview of Java programming, Data types, variables and arrays, Operators, Control statements. **Embedded Java –** Understanding J2ME,Connected Device configuration, Connected Limited device configuration,Profiles,Anatomy of MIDP applications, Advantages of MIDP	12
Total Hours	39

Note: Prior knowledge of basic C programming is necessary to study this subject

TEXT BOOKS:

1. GNU/Linux application programming, Jones, M Tim, Dreamtech press, New Delhi
2. Embedded /Real-Time Systems:concepts, Design and Programming—The Ultimate Reference, Prasad K.V.K.K, DREAMTECH PRESS, NEW DELHI
3. Beginning J2ME-From Novice to Professional-3rd Edition , Sing Li and Jonathan Knudsen,Dreamtech Press, NewDelhi
4. The Complete reference Java2, 5th Edition, Herbert Schildt, TMH
5. Data structures Through 'C' Language, Samiran Chattopadhyay, Debarata Ghosh Dastidar, Matangini Chattopadhyay, DOEACC Society
6. C Programming Language, Kernighan, Brian W, Ritchie, Dennis M, PHI publications
7. C and the 8051 Programming Volume II, Building efficient applications, Thomas W Schultz, Pretice hal

REFERENCE BOOKS:

1. UNIX NETWORK PROGRAMMING, STEVENS, W RICHARD , PH, New Jersey
2. Linux Device Drivers, 2nd Edition, By Alessandro Rubini & Jonathan Corbet, O'Reilly
3. Data Structures Using C- ISRD group, TMH
4. Data structures –Seymour Lipschutz, Schaums Outlines
5. Let us C, Yashwant Kanetkar
6. C Programming for Embedded systems, Zurell, Kirk
7. C and the 8051 Programming for Multitasking – Schultz, Thomas W
8. C with assembly language, Steven Holzner, BPB publication
9. C and the 8051: Hardware, Modular Programming and Multitasking Vol i – Schultz, Thomas W
10. Embedded C, Pont, Michael J
11. Art of C Programming, JONES, ROBIN,STEWART, IAN
12. Kelley, A & Pohl, I;, " A Book on C", Addison – Wesley
13. Advanced Linux Programming Mark Mitchell, Jeffrey Oldham, and Alex Samuel, TECHMEDIA
14. Embedded/ real-time systems: concepts, design and programming black book, Prasad, K V K K, Dreamtech press, New Delhi.

ES 10 104 ADVANCED ENGINEERING MATHEMATICS

Modules	Hours
Module 1 **: Linear Algebra** Linear Equations and Matrix Algebra: Fields; system of linear equations, and its solution sets; elementary row operations and echelon forms; matrix operations; invertible matrices, LU-factorization Vector Spaces: Vector spaces; subspaces; bases ; dimension; coordinates	10
Module 2 : **Transforms and Digital Representations** Linear Systems and Shift invariance, The Laplace Transform, Properties, The Fourier Transform, Properties of Fourier Transform, Fourier Transform of Sequence(Fourier Series) and its properties, Z Transform and its properties, Optical & Modulation transfer function, Random signals, Discrete Random fields, Spectral density function. Digital Arithmetic: Fixed and Floating point representation, IEEE 754 Floating point standards, Floating point arithmetic operations	9
Module3: **Multidimensional Transforms:** Introduction, 2D orthogonal & unitary transforms, Properties of unitary transforms, 1D and 2D- DFT, DCT, Walsh, Hadamard Transform, Haar Transform, Slant Transform, KLT, SVD Transform	10
Module 4: **Wavelet Transform** Wavelet Transform: Continuous: introduction, C-T wavelets, properties, inverse CWT. Discrete wavelet transform and orthogonal wavelet decomposition: examples of WT	10
Total Hours	39

TEXT BOOKS:

1. **"**Linear Algebra and its Applications**"**, David C. Lay, 3rd edition, Pearson Education (Asia) Pte. Ltd, 2005
2. Digital Arithmetic, Milos D. Ercegovac, Tomas Lang, Elsevier
3. "Fundamentals of Digital Image Processing", Anil K. Jain, PHI, New Delhi
4. Digital Signal Processing: a practical approach, Emmanuel C Ifeachor, W Barrie Jervis, Pearson Education (Singapore) Pte. Ltd., Delhi
5. Wavelet transforms-Introduction to theory and applications, Raghuveer M.Rao and Ajit S. Bapardikar, Person Education

REFERENCE BOOKS:

1. Schaum's Outline for Advanced Engineering Mathematics for Engineers and Scientists , Murray R. Spiegel, MGH Book Co., New York
2. Advanced Engineering Mathematics, Erwin Kreyszing, John Wiley & Sons, NEW YORK
3. Advanced Engineering Mathematics, JAIN, R K,IYENGAR, S R K, Narosa, NEW YORK
4. Signal processing with fractals: a Wavelet - based approach, Wornell, Gregory, PH, PTR, NEW JERSEY
5. Wavelet a primer, Christian Blatter, Universities press (India) limited, Hyderabad

ES 10 105 A - ELECTRONIC SYSTEM DESIGN

Modules	Hours
Module 1 Practical Analog & Mixed Signal Circuit Design Issues and Techniques: Passive components: Understanding and interpreting data sheets and specifications of various passive and active components, non-ideal behavior of passive components,. Op amps: DC performance of op amps: Bias, offset and drift. AC Performance of operational amplifiers: band width, slew rate and noise. Properties of a high quality instrumentation amplifier. Design issues affecting dc accuracy & error budget analysis in instrumentation amplifier applications. Isolation amplifier basics. Active filers: design of low pass, high pass and band pass filters. ADCs and DACs: Characteristics, interfacing to microcontrollers. Selecting an ADC. Power supplies: Characteristics, design of full wave bridge regulated power supply. Circuit layout and grounding in mixed signal system.	10
Module 2 Practical Logic Circuit Design Issues and Techniques: Understanding and interpreting data sheets & specifications of various CMOS& BiCMOS family Logic devices. Electrical behavior (steady state & dynamic) of CMOS& BiCMOS family logic devices. Benefits and issues on migration of 5-volt and 3.3 volt logic to lower voltage supplies. CMOS/TTL Interfacing Basic design considerations for live insertion. JTAG/IEEE 1149.1 design considerations. Design for testability, Estimating digital system reliability. Digital circuit layout and grounding. PCB design guidelines for reduced EMI.	10
Module 3 Electromagnetic Compatibility (EMC): Designing for (EMC), EMC regulations, typical noise path, methods of noise coupling, methods of reducing interference in electronic systems. Cabling of Electronic Systems: Capacitive coupling, effect of shield on capacitive coupling, inductive coupling, effect of shield on inductive coupling, effect of shield on magnetic coupling, magnetic coupling between shield and inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, coaxial cable versus shielded twisted pair, ribbon cables. Grounding of Electronic Systems: Safety grounds, signal grounds, single-point ground systems, multipoint-point ground systems, hybrid grounds, functional ground layout, practical low frequency grounding, hardware grounds, grounding of cable shields,	9

ground loops, shield grounding at high frequencies.	
Module 4 Balancing & Filtering in Electronic Systems: Balancing, power line filtering, power supply decoupling, decoupling filters, high frequency filtering, system bandwidth. Protection Against Electrostatic Discharges (ESD): Static generation, human body model, static discharge, ESD protection in equipment design, software and ESD protection, ESD versus EMC. Packaging & Enclosures of Electronic System: Effect of environmental factors on electronic system (environmental specifications), nature of environment and safety measures. Packaging's influence and its factors. Cooling in/of Electronic System: Heat transfer, approach to thermal management, mechanisms for cooling, operating range, basic thermal calculations, cooling choices, heat sink selection.	10
Total Hours	39

TEXT BOOKS

1. Electronic Instrument Design, 1st edition; by: Kim R.Fowler; Oxford University Press.
2. Noise Reduction Techniques in Electronic Systems, 2nd edition; by: Henry W.Ott; John Wiley & Sons.
3. Digital Design Principles& Practices, 3rd edition by: John F. Wakerly; Prentice Hall International, Inc.
4. Operational Amplifiers and linear integrated circuits, 3rd edition by: Robert F. Coughlin; Prentice Hall International, Inc
5. Intuitive Analog circuit design by: Mark.T Thompson; Published by Elsevier

REFERENCES

1. Printed Circuit Boards - Design & Technology, 1st edition; by: W Bosshart; Tata McGraw Hill.
2. A Designer's Guide to Instrumentation Amplifiers; by: Charles Kitchin and Lew Counts; Seminar Materials @ http://www.analog.com
3. Errors and Error Budget Analysis in Instrumentation Amplifier Applications; by: Eamon Nash; Application note AN-539@ http://www.analog.com
4. Practical Analog Design Techniques; by: Adolofo Garcia and Wes Freeman; Seminar Materials@ http://www.analog.com
5. Selecting An A/D Converter; by:Larry Gaddy; Application bulletin @ http://www.Ti.com
6. Benefits and issues on migration of 5-volt and 3.3 volt logic to lower voltage supplies; Application note SDAA011A@ http://www.Ti.com
7. JTAG/IEEE 1149.1 deigns considerations; Application note SCTA029@ http://www.Ti.com
8. Live Insertion; Application note SDYA012@ http://www.Ti.com
9. PCB Design Guidelines For Reduced EMI; Application note SZZA009@ http://www.Ti.com

In addition, National & International journals in the related topics, manufacturer's device data sheets and application notes are to be referred to get practical application oriented information.

ES 10 105 B SOFTWARE ENGINEERING

Modules	Hours
Module 1 - Introduction What is Software Engineering, *The Software Process:* Software life cycle models *Software Requirements:* Functional and non-functional requirements, user requirements, system requirements, SRS. *Requirements Engineering Processes:* Feasibility studies, elicitation and analysis, validation, management. *System Models:* Content model, Data model, Behavioral model, Object Model	10
Module 2 - Architectural Design System structuring, control models, modular decomposition, domain-specific architectures, distributed systems architecture. *Object-oriented Design:* Objects and classes, Object oriented design using UML. *Real-time Software Design:* System design, real time executives. *Design with Reuse:* Component-based development, application families, designs patterns. U*ser Interface Design:* Design principles, user interaction, information presentation, user support, interface evaluation.	10
Module 3 - Implementation and Testing Choice of programming languages *Verification and Validation, Software Testing:* Unit testing, Integration Testing, Validation testing, Systems testing *Software Maintenance:* Legacy systems, software change, software re-engineering, Reverse Engineering.	10
Module 4 *Software Project Management:* Project planning, scheduling, risk management.. *Software Cost Estimation:* Productivity estimation techniques, algorithmic cost modeling, project duration and staffing. *Process Improvement:* Process and product quality, process analysis and modeling, process measurement, process CMM.	9
Total Hours	39

TEXT BOOKS:

1. R. S. Pressman, *Software Engineering*, 6/e, McGraw Hill, 2002.
2. Ian Sommerville, *Software Engineering*, 6/e, Pearson Education Asia, 2001.
3. Shari Pfleeger, Software Engineering:Theory and Practice, Pearson Education 2001.
4. P. Jalote, *An Integrated Approach to Software Engineering*, Narosa, 1993.

ES 10 105 C DATA COMMUNICATIONS AND NETWORKING

Modules	Hours
Module 1 - Overview of Data communication and Networking: Data Communication Fundamentals, Overview of computer networks, Seven-layer architecture, TCP/IP suite of protocols, Circuit Switching and Packet Switching, Subscriber lines, Modems, DSL and ISDN Error Detection and Error Correction - Types of Error - Detection - Error correction	10
Module 2 - Data Link Layer Services and Protocols: Flow Control, Error detection and correction protocols, HDLC, X.25, IEEE 802.x protocols, implementation and performance issues, CSMA/CD, Ethernet, Token Bus and Token Ring, MAC protocols for high-speed LANs and MANs, FDDI, DQDB, HIPPI, Gigabit Ethernet, Wireless Ethernet, Frame Relay, ATM, SMDS and SONET	10
Module 3 - Network and Transport Layers: Internet Protocol IP and IPv6, IP addressing concepts, Mobile IP (MIP), Routing protocols, Shortest path routing, Bellmann-Ford Algorithm, OSPF, BGP and IDRP, TCP and UDP Protocols, IP Multicasting, Multicast routing protocols, Address assignments, Session discovery Network Devices: Switches, Routers, Hubs, Repeaters.	10
Module 4 - Security issues in data communication: Network Security : IP Security, Web Security-SSL/TLS, SET, SHTTP, HTTPS, E-mail Security – Kerberos, S/MIME, PGP Security threats on networks	9
Total Hours	39

TEXT BOOKS:

1. Computer Networks; By: Tanenbaum, Andrew S; Pearson Education Pte. Ltd., Delhi
2. Data And Computer Communications; By: Stallings, William; Pearson Education Pte. Ltd., Delhi

3. Data Communications and Networking, by Forouzan, Behrouz A, TMH
4. Cryptography and Network Security: Principles and Practice, Stallings, William, PH, New Jersey

REFERENCES:

1. TCP/IP Illustrated, Volume 1: The protocols, Addison By W. R. Stevens; Wesley, 1994.
2. TCP/IP Illustrated, Volume 2: The Implementation, By G. R. Wright; Addison Wesley, 1995.
3. TCP/IP Illustrated, Volume 3: TCP for Transactions, HTTP, NNTP, and the Unix Domain Protocols, By W. R. Stevens; Addison Wesley, 1996.
4. SNMP, SNMPV2, SNMPV3, AND RMON 1 AND 2 by Stallings, William; Addison Wesley Longman (Singapore) Pte Ltd., Delhi
5. High - Speed Networks And Internets: Performance And Quality Of Service, by Stallings, William; Pearson Education Pte. Ltd., Delhi

In addition, manufacturers Device data sheets and application notes are to be referred to get practical and application oriented information.

ES10 106(P): SEMINAR

Credits:2

Hours per week 2

Objective: To assess the debating capability of the student to present a technical topic. Also to impart training to students to face audience and present their ideas and thus creating in them self esteem and courage that are essential for engineers.

Individual students are required to choose a topic of their interest from Embedded Systems related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Embedded Systems) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment: 100 marks

ES 10 107 SYSTEM DESIGN USING EMBEDDED PROCESSORS LABORATORY

Maximum Marks – 100

		Hours
	Module 1 - 8-Bit 8051 Microcontroller:	16
	USING 'ASM'	
1.	Connect an LED to Port P1.7 of 8051 in current sinking mode. Write a program to turn ON the LED at the rate of 0.5 sec approx. Hint: Use Software Delay.	
2.	Modify Q1 to toggle LED on successive key press. Hint: Write key detection ISR	
3.	Write a program to generate a PWM waveform of 100 Hz frequency on any one of the digital I/O port. The duty cycle should vary from 0 to 100% in steps of 25%. The waveform on each step should be present for a minimum period of 500 ms.	
4.	Repeat the above program by providing the duty cycle from the PC using the serial port. The current duty cycle in percentage should be displayed in the LCD.	
	USING 'C'	
5.	Connect an LED to Port P1.7 of 8051 in current sinking mode. Write a program to turn ON the LED at the rate of 0.5 sec approx. Hint: Use Software Delay.	
6.	Modify the above program to toggle LED on successive key press. Hint: Write key detection ISR	
7.	Identify the key pressed and display the numeric value assigned to the key on the 7-Segment Display. Hint: Use the Keyboard Map for numeric values	
8.	Develop a 1 sec. Counter, using Timer 0 and display the count value on the 7-Segment Display	
9.	Generate a square wave of 100Hz using onboard DAC.	
10.	Read the input voltage using ADC and display it on LCD. For eg: EEH read from ADC should be displayed as Voltage = 4.76 V.	
11.	a) It is required to continuously monitor and control the temperature in a boiler every '1'second using the 8051 Microcontroller. The temperature has to be kept at a particular set point (50°C) with a tolerance of ± 5°C. It is assumed that the temperature is measured through an RTD sensor and is available in the range of 0V to 5V electrical signal. 0V corresponds to 0°C	

Keyboard Map (Item 7):

S12 **1**	S16 **2**	S20 **3**	S24 **4**
S11 **5**	S15 **6**	S19 **7**	S23 **8**
S10 **9**	S14 **10**	S18 **11**	S22 **12**
S9 **13**	S13 **14**	S17 **15**	S21 **16**

	and 5V corresponds to 100°C. (Use a Trimpot to apply the voltage). An ON/OFF relay connected to a Port bit is used to control the heater element. A PC is used as the monitoring station. b) The temperature has to be sent to the PC every '1' second by the Microcontroller. c) Provision should be given for changing the set point from the PC.	
	Module 2 – ARM920T Processor Core:	12
1.	Write a program to add two numbers stored in r0 and r1 registers and write the result to r2. a. Run the program with breakpoint and verify the result b. Run the program with stepping and verify the content of registers at each stage c. Modify the content of registers in the Tool window and re-run the program to verify the result d. After run, view the different formats of the registers used. Specifically, view the data in hexadecimal, decimal, octal, binary, and ASCII.	
2.	Write a program to multiply two numbers stored in r0 and r1 registers and write the result to r3. a. Put 0xFFFFFFFF and 0x80000000 into the source registers and verify the result. b. Modify the program to use MULS instruction in place of MUL.	
3.	Write an ARM code to implement the following register swap algorithm using only two registers. a.Using arithmetic instructions b.Using logical instructions For example, take the values as a = 0xF631024C and b = 0x17539ABD.	
4.	Write ARM assembly to perform the following array assignment in C: for (i = 0; i <= 10; i++) {a[i] = b[i] + c;} Assume that r3 contains *i*, r4 contains *c*, the starting address of array *a* is in r1, and the starting address of array *b* is in r2.	
5.	Write a program to find the factorial of a number using ARM assembly	
6.	Write a program, which sets up two parameters (r0 and r1) in THUMB state, and makes an interworking call to an ARM subroutine that adds the two parameters together and returns.	
7.	Modify the above program to setup the parameters in ARM state and Addition in Thumb state.	
	Module 3 – ARM9 Microcontroller (AT91RM9200):	16
1.	Write a program to toggle the three LED's connected to AT91RM9200	

	through general PIO a rate of approximately 1 second. (Use software delay). 2. Modify the above program using the system timer to generate 1-second delay. Use polling method. 3. Modify the above program using the system timer to generate 1-second delay using interrupt method. [Hint: use advanced interrupt controller]. 4. Write a program to setup a clock of 24 hour 60 minutes and 60 seconds. Use the RTC available with AT91RM9200 processor	
Module 4 - AT91RM9200 Peripherals :		8
1.	**Design of a real-time data acquisition & control system using the ARM9 Microcontroller** It is required to monitor and control the temperature in a boiler which ranges from 0°C to 100°C every **1second** using the AT91RM9200 Microcontroller. The temperature has to be kept at a set-point of 50°C ± 2° C. The temperature is measured through an RTD sensor and is transmitted through a 4-20 mA two wire transmitter. The 4-20mA is converted to 1 to 5V by 250 ohm terminating resistor. 1 to 5V is available at the analog input port. 1V corresponds to 0°C and 5V corresponds to 100°C. An ON/OFF relay connected to A PIO Port bit is used to control the heater element. A PC is used as the monitoring and control station. Simulate a 10 bit ADC for this application and send the data from 0V to 5V in steps of 0.1V. The same has to be repeated after reaching the maximum value of 5V. 1. The temperature has to be sent to the PC every 1 second in the following protocol format and the same has to be displayed using the LAS software in WISE-96 on the PC.	

STX	**MSL**	**CMD**	**S CMD**	**DATA_LO**	**DATA_HI**	**ETX**
byte 1	Byte 2	byte 3	byte 4	byte 5	byte 6	byte 7

STX	:	Start of Text	02H
MSL	:	Message length, in bytes	
CMD	:	Command byte	90H
SCMD	:	Sub-command byte	00H (Channel no)
DATA_LO	:	Lower byte of data word	
DATA_HI	:	Upper byte of data word	
ETX	:	End of Text	03H

2. Provision should be given for receiving the set-point value of temperature from the PC, and the set point is to be framed in the above protocol format.
3. If the transmitter is switched off or if it sends invalid data, i.e, below 4mA, an error message packet similar to the above one with CMD byte set to 95H should be send to the PC, instead of the data packet.

   Hint: Use a Trimpot to apply the voltage. Use an LED to display the ON/OFF status. ON/OFF control strategy can be used for controlling the power supplied to the heater.

	Total Hours	52

Software used: Keil 'C' Compiler and Assembler for 8051, ADS for ARM9

Platforms used: PC, WISE-51, WISE-196, 8051 Development Boards, ARM9 Boards,

REFERENCES:

[1] Intel Hand Book on “Embedded Microcontrollers”, 1st Edition

[2] Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, “The 8051 Microcontroller and Embedded Systems using Assembly and C”, 2nd Edition, Prentice Hall

[3] ARM Company Ltd. “ARM Architecture Reference Manual– ARM DDI 0100E”

[5] Andrew N Sloss, Dominic Symes, Chris Wright, “ARM System Developer's Guide - Designing and Optimizing System Software”, 2006, Elsevier

[6] ATMEL Corporation, “AT91RM9200 ARM920T Based Microcontroller Rev. 1768E-ATARM–30-Sep-05”

SECOND SEMESTER

ES 10 201 DESIGN OF DIGITAL SIGNAL PROCESSING SYSTEMS

Modules	Hours
Module 1 - Digital Signal Processor: TMS320C6713 or any other popular DSP from Texas Instruments is covered under this module **Architecture:** CPU Architecture, Internal Memory, CPU Data Paths control Programming: Instruction Set and Addressing Modes Code Composer Studio, Code Generation Tools, Code Composer Studio Debug Tools DSP Peripherals: ***Multichannel Buffered Serial Port, Transmission & Reception*** Timers Memory of DSP: Internal Data/Program Memory External Memory Interface	9
Module 2 - Digital Signal Processing Algorithms: Filter Design: FIR Digital filter design. Fourier Transform: DFT, FFT, Spectral Analysis DTMF Speech Processing Algorithms	10
Module 3 - Digital Signal Processing Application: Real-time Implementation: Implementation of Real-time FIR Digital filter using DSP. Implementation of Real-time Fast Fourier Transform applications using the DSP Implementation of DTMF Tone Generation and Detection.	10

Implementation of Speech processing applications	
Module 4 - Current trends in Digital Signal Processor: FPGA Technology DSP Technology Requirements Design implementation Multiply Accumulator (MAC) and Sum of Product (SOP) Implementation of Serial/Parallel Convolver using FPGAs FPGA Based DSP System Design FIR filters FIR Theory Designing FIR filters Direct Window Design method Constant Coefficient FIR Design Direct FIR Design Cooley-Tukey FFT Algorithm implementation using FPGA	10
Total Hours	39

TEXT BOOKS:

1. Digital Signal Processing Implementation Using the TMS320C6000 DSP Platform, 1st Edition; by: Naim Dahnoun
2. DSP Applications using 'C' and the TMS320C6X DSK, 1st Edition; by: Rulph Chassaing
3. Digital Signal Processing: A System Design Approach, 1st Edition; by: David J Defatta J, Lucas Joseph G & Hodkiss William S; John Wiley
4. Digital Signal Processing with Filed Programmable Gate Arrays: 2nd Edition, by: U. Meyer – Base, Springer
5. Real - Time Digital Signal Processing: Implementations, Applications, and Experiments with the TMS320C55X, Kuo, Sen M, Lee, Bob H, John Wiley & Sons Ltd.

REFERENCES:

1. Digital Signal Processing, Third Edition, Sanjit K. Mitra, Tata McGRWA Hill
2. Digital Signal Processing – A Practical Guide for Engineers and Scientists, Steven W Smith, Elsevier
3. Digital Signal Processing - A Student Guide, 1st Edition; by: T.J. Terrel and Lik-Kwan Shark; Macmillan Press; Ltd.
4. Digital Signal Processing Laboratory, B. Preetham Kumar, Taylor & Francis, CCS DSP Applications
5. Introduction to Digital Signal Processing, 1st Edition; by: John G Proakis, Dimitris G Manolakis
6. Digital Signal Processing Design, 1st Edition; by: Andrew Bateman, Warren Yates
7. A Simple approach to Digital Signal processing, 1st Edition; by: Kreig Marven & Gillian Ewers; Wiely Interscience
8. DSP FIRST - A Multimedia Approach, 1st Edition; by: JAMES H. McClellan, Ronald Schaffer and Mark A. Yoder; Prentice Hall
9. Signal Processing First, 1st edition; by: James H. McClellan, Ronald W. Schafer and Mark A. Yoder; Pearson Education
10. Digital Signal Processing, 1st Edition; by: Oppenheim A.V and Schafer R.W; PH
11. Digital Processing of Speech Signals, 1st Edition; by: L.R. Rabiner and Schafer R.W; PH
12. Digital Signal Processing – Architecture, Programming and Applications, by: B. Venkataramani & M.Bhaskar; Tata McGraw Hill
13. A Practical Approach to Digital Signal Processing, by: K. Padmanabhan, S. Ananthi & R.Vijayarajeswaran; New Age International Publishers
14. Theory & Application of Digital Signal Processing, 1st Edition; by: Rabiner L.R & Gold B; PH
15. Digital Signal Processing, 1st Edition; by: P Ramesh Babu,
16. 'C' Language Algorithm for DSP, 1st Edition; by: Paul M. Embree and Bruce Kimble; PH
17. http://hometown.aol.de/uwemeyerbase/indexhtml
18. www.springer.de

In addition, National/ International journals in the field, manufacturers Device data sheets and application notes and research papers in journals are to be referred to get practical and application oriented information.

ES 10 202 EMBEDDED OS & RTOS

Modules	Hours
Module 1 - Embedded OS (Linux) Internals Introduction to Embedded OS Unix/Linux internals: Process Management, File Management, Memory Management, I/O Management Overview of POSIX APIs, Threads – Creation, Cancellation, POSIX Threads Inter Process Communication - Semaphore, Pipes, FIFO, Shared Memory Kernel: Structure, Kernel Module Programming Interfacing: Serial, Parallel, Network, USB Interrupt Handling: Top handling, Bottom handling. Interrupt Handling Case study: Keyboard, Serial, Parallel Device Drivers: Register/Unregistered device, File operation structure. Device Drivers Case study – Serial, Parallel	11
Module 2 – RTOS Real-time concepts, Hard Real time and Soft Real-time, Differences between General Purpose OS & RTOS, Basic architecture of an RTOS, Scheduling Systems, Inter-process communication, Performance Matric in scheduling models, Interrupt management in RTOS environment, Memory management, File systems, I/O Systems, Advantage and disadvantage of RTOS. POSIX standards RTOS Issues - Selecting a Real Time Operating System, RTOS comparative study	8
Module 3 - VxWorks VxWorks Scheduling and Task Management - Realtime scheduling, Task Creation, Intertask Communication, Pipes, Semaphore, Message Queue, Signals, Sockets, Interrupts I/O Systems - General Architecture, Device Driver Studies, Driver Module explanation, Implementation of Device Driver for a peripheral Case study using Vxworks.	12
Module 4 - Real Time Linux Introduction to Real Time Linux, Realtime patches to Standard Linux, RTLinux Architecture, RTCore Basics Real Time Programming: Extensions to POSIX	8

Interprocess Communication and Synchronization - Thread functions, Mutex/Semaphores, RTFIFO, Shared memory Interrupts & IRQ's, Networking and Device Driver programming. Case study - Porting an Embedded OS to ARM Processor	
Total Hours	39

TEXT BOOKS:

1. GNU/LINUX Application Programming, Jones, M Tims, DREAMTECH PRESS, NEW DELHI
2. Embedded /Real-Time Systems: Concepts, Design and Programming—The Ultimate Reference, Prasad K.V.K.K, DREAMTECH PRESS, NEW DELHI
3. Linux Device Drivers, 2nd Edition, By Alessandro Rubini & Jonathan Corbet, O'Reilly
4. VxWorks Programmers Gide
5. VxWorks Reference Mnual
6. Building Embedded Linux Systems, By Karim Yaghmour, O'Reilly
7. Embedded Linux®: Hardware, Software, and Interfacing, By Craig Hollabaugh Ph.D., Addison Wesley

REFERENCES:

1. Embedded Systems Architecture Programming and Design: 2nd Edition; by: Raj Kamal, Tata McGraw Hill
2. Embedded Realtime Systems Programmming, Sriram V Iyer, Pankaj gupta , Tata McGraw Hill
3. Embedded/Real - Time Systems: Concepts, Design and Programming Black Book, Prasad K.V.K.K, Dreamtech Press, New Delhi
4. UNIX Network Programming, Stevens, W Richard , PH, New Jersey
5. Hardware software co-design of Embedded systems, F. Balarin, Chido et al., Kluwer Academic Publishers, May 1997
6. Real-time Systems – Jane Liu, PH 2000
7. Real-Time Systems Design and Analysis: An Engineer's Handbook: Laplante, Phillip A
8. Embedded Software Primer - Simon, David E.
9. Structured Development for Real - Time Systems V1 : Introduction and Tools: Ward, Paul T & Mellor, Stephen J
10. Software Design for Real-Time Systems: Cooling, J E Proceedings of 17the IEEE Real-Time Systems Symposium December 4-6, 1996 Washington, DC: IEEE Computer Society
11. Structured Development for Real - Time Systems V2 : Essential Modeling Techniques: Ward, Paul T & Mellor, Stephen J
12. Structured Development for Real - Time Systems V3 : Implementation Modeling Techniques: Ward, Paul T & Mellor, Stephen J

13. Programming for Embedded Systems Cracking the code - Dreamtech Software Team
14. Tornado API Programmers guide
15. Tornado Users guide
16. www.vxworks.com
17. Proceedings “Real-time systems symposium”; IEE Computer Society Technical committee on Real time systems
18. Specification and Design of Embedded Systems, D. Gajski, F. Vahid, S. Narayan and J. Gong, PH

In addition, manufacturers Device data sheets, IEEE publications and application notes are to be referred to get practical and application oriented information.

ES 10 203 PRODUCT DESIGN & QUALITY MANAGEMENT

Modules	Hours
Module 1 Product Design and Development: I Development processes, Identifying customer needs, Establishing product specifications, Concept generation, Concept selection, Product architecture, Industrial design.	10
Module 2 - Product Design and Development: II Design for Manufacturing, Prototyping, Robust Design, Patents and Intellectual property, Product Development Economics, Managing Product Development Projects.	10
Module 3 - Total Quality Management I Principles and Practices: Definition of quality, Customer satisfaction and Continuous improvement. Tools and Techniques: Statistical Process Control, Quality Systems, Bench Marking.	10
Module 4 - Total Quality Management II Quality Function Deployment, Product Liability, Failure Mode and Effect Analysis, Management Tools.	9
Total Hours	39

Note:
Tutorial sessions include Group Discussions and Team Work

TEXT BOOKS

1. Total Quality Management, Second edition By: Dale H. Besterfield, Pearson Education Asia
2. Product Design & Development; Third edition By: Karl T Ulrich & Steven D Eppinger; Mc Graw Hill

In addition, relevant papers in journals & articles etc. are to be referred to get further information.

ES 10 204 A EMBEDDED APPLICATIONS IN POWER CONVERSION

Modules	Hours
Module 1 Power Converters: Power converter system design. Isolated and Non-isolated dc-dc converters. Inverters with square and sinusoidal output. PWM switching – unipolar and bipolar, sine PWM Practical Converter design considerations: Power semiconducor devices – Power Diodes, BJT, MOSFET, IGBT. MOSFET & IGBT – Ratings, SOA, Switching characteristics, Gate Charge, Paralleling devices. Dos and Don'ts of using Power MOSFETs, Gate drive characteristics & requirements of power MOSFETs and IGBT modules. Design of turn on and turn off snubbers. Magnetic components: Design of high frequency transformer, design of Inductors, design of CTs.	10
Module 2 Design of controllers for Power converters: Micro controllers and DSP based controllers for power conversion. Peripheral interfacing - ADC, Keyboard, LCD display, PWM generation. Design of PWM bridge controller based on low end and high-end controllers. Interfacing of controller output to power module. Designs based on dedicated gate driver ICs. Design of isolated gate drives.	9
Module 3 Design of UPS: Online, off line UPS. Operation & design criteria of AC switch, Operation & design criteria of battery charger, operation & design criteria of inverter, active PFC circuits. Thermal design of power converters.	10
Module 4 DC Motor Drives: Design of adjustable speed DC motor drives, speed control of a separately excited motor, design of closed loop control, design chopper controlled DC motor drive, design of four quadrant chopper. AC Motor Drives: Design of 3 phase PWM VSI inverter, design of v/f control for induction Motor, design of open loop and closed loop control. Vector control of AC motors, space vectors, vector control strategy for induction motor.	10
Total Hours	39

TEXT BOOKS

1. Power Electronics; By: Mohan, Underland, Robbins; John Wiley & Sons
2. Simplified design of Switching Power supplies; By: John D Lenk; EDN series for designers.
3. Design of magnetic components for switched mode power converters; By L Umanad, S.R Bhat; Wiely Eastern ltd.

REFERENCES

1. MOSFET& IGBT Designers manual, International Rectifier
2. UPS design guide, International Rectifier

In addition, relevant papers in journals & articles etc. are to be referred to get further information.

ES 10 204 B MODERN CONTROL SYSTEMS DESIGN

Modules	Hours
Module 1 Review of continuous and discrete time system analysis by Laplace and 'z' transforms; Review of system modeling by transfer function methods; feedback, stability and sensitivity; State space description of systems; Sampling of Systems ; Stability, robustness; Controllability and Observability, State Space Design; Pole Placement; Implementation issues ; CAD tool for control design	8
Module 2 Linear Quadratic (LQ) Control via Dynamic Programming; Review of Probability Theory; Sample Space, Random Variable, Probability Distribution and Density Functions; Correlation Function, Spectral Density; Principle of Least Squares estimation; Stochastic State Estimation (Kalman Filter); CAD tools for control design	10
Module 3 ***Linear Stochastic Control (Linear Quadratic Gaussian (LQG) Problem); Linear Multivariable Control; Tracking Control; Feedforward Control; Robust control design for multivariable systems, with uncertainties. CAD tools for control design.***	11
Module 4 Principles of intelligent control including adaptive, learning, and self-organizing systems. Neural networks and fuzzy logic systems for feedback control. Introduction to discrete event systems and decision-making supervisory control systems.	10
Total Hours	39

TEXT BOOKS:

1. Digital Control of Dynamic Systems; by: Franklin, Powell, Workman; Addison Wesley
2. Modern Control Design with MATLAB and SIMULINK; by: Ashish Tewari; John Wiley & Sons
3. Fuzzy Logic: Intelligence, Control, and Information ; by: John Yen, Reza Langari; Prentice Hall

REFERENCES:

1. Optimal Control Theory: An Introduction; by: Donald E. Kirk; Dover
2. Optimal Control: Linear Quadratic Methods, Anderson, B. D. O. and Moore; J. B., Prentice Hall, 1990
3. Adaptive Control, 2nd Ed., 1995; by: Astrom, K. J. and Wittenmark, B.; Addison Wesley.
4. Multivariable Feedback Design; by: J. M. Maciejowski; Addison-Wesley, 1989.
5. Control and Dynamic Systems, Neural Network Systems Techniques and Applications, Volume 7; by: Cornelius T. Leondes; Academic Press
6. Fuzzy Logic Intelligence, Control and Information; by: John Yen, Reza Langari, Pearson Education.
7. Computer Controlled Systems: Theory and Design, Third Edition; by: K. Åström, B. Wittenmark; Prentice-Hall
8. Advanced Control System Design; by: Bernard Friedland; Prentice-Hall, 1996.

In addition, manufacturers Device data sheets and application notes are to be referred to get practical and application oriented information.

ES 10 205 A HIGH SPEED DIGITAL DESIGN

Modules	Hours
Module 1 **Introduction to high speed digital design.** Frequency, time and distance - Capacitance and inductance effects - High seed properties of logic gates - Speed and power -Modelling of wires -Geometry and electrical properties of wires - Electrical models of wires - transmission lines - lossless LC transmission lines - lossy LRC transmission lines - special transmission lines	10
Module 2 **Power distribution and noise** Power supply network - local power regulation - IR drops - area bonding - onchip bypass capacitors - symbiotic bypass capacitors - power supply isolation - Noise sources in digital system - power supply noise - cross talk - intersymbol interference	8
Module 3 **Signalling convention and circuits** Signalling modes for transmission lines -signalling over lumped transmission media - signalling over RC interconnect - driving lossy LC lines - simultaneous bi-directional signalling - terminations - transmitter and receiver circuits	9
Module 4: **Timing convention and synchronisation** Timing fundamentals - timing properties of clocked storage elements - signals and events -open loop timing level sensitive clocking - pipeline timing - closed loop timing - clock distribution - synchronization failure and metastability - PLL and DLL based clock aligners	12
Total Hours	39

TEXT BOOKS:

5. Howard Johnson and Martin Graham, "High Speed Digital Design: A Handbook of Black Magic by",3rd Edition, (Prentice Hall Modern Semiconductor Design Series' Sub Series: PH Signal Integrity Library), 2006
6. Stephen H. Hall, Garrett W. Hall, and James A. McCall " High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices by ", Wiley , 2007
7. Kerry Bernstein, K.M. Carrig, Christopher M. Durham, and Patrick R. Hansen "High Speed CMOS Design Styles",SpringerWiley 2006
8. Ramesh Harjani "Design of High-Speed Communication Circuits (Selcted Topics in Electronics and Systems)" World Scientific Publishing Company 2006

In addition, manufacturers Device data sheets and application notes are to be referred to get practical and application oriented information.

ES 10 205 B ASIC AND SOC

Modules	Hours
Module 1 **Types of ASICs** – Design flow – Economics of ASICs – ASIC cell libraries – CMOS logic cell data path logic cells – I/O cells – cell compilers.	10
Module 2 **ASIC Library design:** Transistors as resistors – parasitic capacitance – logical effort programmable ASIC design software: Design system – logic synthesis – half gate ASIC, ASIC Construction – Floor planning & placement – Routing	8
Module 3 *System on Chip Design Process:* ***A canonical SoC design, SoC Design Flow – Waterfall vs Spiral, Top-Down versus Bottom-Up. Specification requirements, Types of Specifications, System Design Process, System level design issues- Soft IP vs. Hard IP, Design for Timing Closure- Logic Design Issues, Physical Design Issues; Verification Strategy, On-Chip Buses and Interfaces; Low Power, Manufacturing Test Strategies. MPSoCs. Techniques for designing MPSoCs***	12
Module 4 **SoC Verification**: Verification technology options, Verification methodology, Verification languages, Verification approaches, and Verification plans. System level verification, Block level verification, Hardware/software co-verification, and Static net list verification.	9
Total Hours	39

TEXT BOOKS:

1. “SoC Verification-Methodology and Techniques”, Prakash Rashinkar, Peter Paterson and Leena Singh. Kluwer Academic Publishers, 2001.
2. “Reuse Methodology manual for System-On-A-Chip Designs”, Michael Keating, Pierre Bricaud, Kluwer Academic Publishers, second edition, 2001
3. Smith, "Application Specific Integrated Circuits", Addison-Wesley,2006

In addition, manufacturers Device data sheets and application notes are to be referred to get practical and application oriented information.

ES 206(P): SEMINAR Credits: 2

Hours per week: 2

Objective:To assess the debating capability of the student to present a technical topic. Also to impart training to students to face audience and present their ideas and thus creating in them self esteem and courage that are essential for engineers.

Individual students are required to choose a topic of their interest from Embedded Systems related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Embedded Systems) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his/her seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

Internal continuous assessment : 100 marks

ES 10 207 DESIGN OF DIGITAL SIGNAL PROCESSING SYSTEMS LABORATORY

Maximum Marks - 100

	Hours
Module 1 - DSP Fundamentals using TMS320C6713: Experiment 1: Write a program to implement convolution of x(n) with h(n) using linear convolution and verify the result y(n) as below. x(n) = [1,1,1,1,0.5,0.5,0.5,0.5] , h(n) = [0.3,0.25,0.2,0.15,0.1,0.05] and y(n) == [0.3, 0.55,0.75,0.9,0.85,0.775,0.675,0.6,0.4.0.25,0.15,0.075,0.025] Experiment 2: Write a program for circular convolution of the following inputs x(n) and h(n) and Verify the output y(n) as given below. x(n) = [1,1,1,2,1,1] , h(n) = [1,1,2,1] and y(n) = [6,5,5,6,6,7] Experiment 3: Implement an 8-point DFT for the inputs x(n) and verify the result as X(K). Where, x(n) = [1,1,1,1,1,1,0,0] and X(K) = [6,-0.707-j1.707,1-j,0.707+j0.293,0,0.707-j0.293,1+j,-0.707+j1.707]. Experiment 4: Find IDFT of the sequence X(K) = [11110000]. Verify that x (n) = [0.5,0.125+j0.30175, 0,0.125+j0.05175, 0,0.125-j0.05175, 0,0.125-j0.30175] Experiment 5: Generate the following waveforms using the Codec on DSK and verify the outputs for different frequencies (1KHz, 2KHz etc.) a. Sine wave b. Square wave Experiment 6: Tone Generation using the serial port and Codec of the DSK. 1. Generate a simple tone of a fixed frequency (1 KHz). 2. Generate multiple tones using Codec at frequencies starting from 300Hz to 3 KHz with an increment of 100Hz each tone for duration of 1second using timer interrupt. Experiment 8: Transfer an array of numbers from PC to DSP and get back the Bit Reversed form using Probe point.	12
Module 2 - Digital Signal Processing Algorithms: Experiment 1: Design an FIR Low pass Filter with following specification. fp = 1500Hz, fs = 2000Hz, Pass band attenuation = 0.01dB, Stop band attenuation = 40dB and Fs = 8000 Hz using Kaiser window. Experiment 2: Write programs for DFT, FFT using Matlab	12
Module 3 - Digital Signal Processing Application:	20

Experiment 1: Real-time Implementation of FIR filters 1. Generate the filter coefficients using Kaiser Window for a low pass FIR filter for the specification as given in experiment 1 of module 2. 2. Apply an input signal through a Codec; implement the filter on TMS320C6713 DSK. Vary the input signal frequency and observe the output on an Oscilloscope. 3. Repeat the filter for Band pass and High pass. 4. Repeat the same with hamming window. Experiment 2: Fourier Transform Perform FFT analysis for the signal input through the Codec and display the input signal as well as the FFT output on PC using Probe point facility. Perform FFT operation for 16, 32 and 64-point FFT. Compute the power spectrum X(K) * X(K) = $\|X(K)\|^2 = Xreal^2 + Ximag^2$ and plot the same in PC. Experiment 3: DTMF Tone Generation and Detection and its implementation. Generate DTMF Tones. Detect the DTMF tone input trough the Codec. Implement the program with Geortzel algorithm. Experiment 4: Implementation of Speech processing applications	
Module 4 - Current trends in Digital Signal Processor (any two): Implementation of Serial/Parallel Convolver using FPGAs Implementation of a length four FIR filter using VHDL Designing a four-tap Direct FIR filter using VHDL Cooley - Tukey FFT Algorithm implementation using FPGA	8
Total Hours	52

Software used: Code Composer Studio, Matlab, Xilinx Foundation series

Platforms used: PC, TMS320C6713 Starter Kits, Xilinx/ Altera FPGA Kits

REFERENCES:

1. Digital Signal Processing Implementation Using the TMS320C6000 DSP Platform, 1st Edition; by: Naim Dahnoun
2. DSP Applications using 'C' and the TMS320C6X DSK, 1st Edition; by: Rulph Chassaing
3. Digital Signal Processing with Filed Programmable Gate Arrays: 2nd Edition, by: U. Meyer – Base, Springer
4. Digital Signal Processing: A System Design Approach, 1st Edition; by: David J Defatta J, Lucas Joseph G & Hodkiss William S; John Wiley

5. Real - Time Digital Signal Processing: Implementations, Applications, and Experiments with the TMS320C55X, Kuo, Sen M, Lee, Bob H, John Wiley & Sons Ltd.
6. Digital Signal Processing – Architecture, Programming and Applications, by: B. Venkataramani & M.Bhaskar; Tata McGraw Hill
7. Digital Signal Processing - A Student Guide, 1st Edition; by: T.J. Terrel and Lik-Kwan Shark; Macmillan Press; Ltd.

In addition, National/ International journals in the field, manufacturers Device data sheets and application notes and research papers in journals are to be referred to get practical and application oriented information.

THIRD SEMESTER

ES 10 301A MIXED SIGNAL SYSTEM DESIGN

Topics	Hours
Module 1 Introduction PN Junctions, Bipolar Vs Unipolar Devices, MOS Transistor operation, MOS Transistor as a Switch, NMOS ,PMOS and CMOS Switches, CMOS Inverter AC and DC Characteristics, Analog Signal Processing, Example of Analog Mixed Signal Circuit Design	8
Module 2 Digital Sub Circuits CMOS Logic implementation basics- Logic gates and Flip flops –Transmission Gates, TG based implementation of multiplexers, de-multiplexers, encoders, decoders. Digital Circuits like ALU, Comparator, Parity generator, Timer, PWM,SRAM and DRAM,CAM	10
Module 3 Analog Sub circuits Ideal Operational Amplifier, Inverting and Non-inverting configuration Differential amplifier basics, VCO, PLL, Comparator characteristics, two stage open loop comparator ,Switched capacitor fundamentals, Switched capacitor amplifier	10
Module 4 Data Converters **DAC** : Static &Dynamic Charatersitics,1 Bit DAC, String DAC, Fully Decoded DAC,PWM DAC, Current scaling, voltage scaling DACs **ADC** : Static &Dynamic Characteristics, Nyquist Criteria , Sample & Hold Circuit ,Quantization error, Concept of over sampling, Counting ADC, Tracking ADC, Successive approximation ADC, Flash ADC, Dual Slope ADC **Over sampling Data Converters** : Over sampling fundamentals, Delta – Sigma Converter basics, $\Delta \sum$ Modulator	11
Total Hours	39

REFERENCES:

1. CMOS Analog Circuit Design, 2nd edition; by: Allen, Phillip E, Holberg , Douglas R, Oxford University Press, (Indian Edition
2. D A John, Ken Martin, Analog Integrated Circuit Design, 1st Edition, John Wiley
3. Ken Martin, Digital Integrated Circuit Design, John Wiley
4. Gray Paul R, Meyer, Robert G, Analysis and Design of Analog Integrated Circuits, 3rd edition, John Wiley & Sons.
5. Sedra & Smith, Microelectronics Circuits, 5th Edition, Oxford University Press, (Indian Edition)
6. Jan M. Rabaey, Anantha Chadrakasan, B. Nikolic ,Digital Integrated Circuits – A Design Perspective 2nd Edition, Prentice Hall of India (Eastern Economy Edition).
7. Sung-Mo Kang**,** Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis & Design,2nd Ed, Tata McGraw Hill

ES 10 301B ELECTRONIC INSTRUMENTATION DESIGN

Modules	Hours
Module 1 Architecture of Instrumentation scheme. Static and dynamic characteristics, errors, standards and calibration. Principle and design of various active and passive transducers. Introduction to semiconductor sensors and its applications. Electrical I/O characteristics of sensors/transducers for measurement of temperature, flow, level, pressure, position and motion. Specifications and selection of sensors/transducers for measurement of temperature, flow, level, pressure, position and motion.	8
Module 2 Amplification, attenuation, isolation, multiplexing, filtering, linearization, compensation, simultaneous sampling & transducer excitation. Operational and Instrumentation Amplifiers. Instrumentation amplifiers and Error Budgets, Noise in low level Amplification.	10
Module 3 Analog Signal Acquisition, Conditioning and Processing, Input grounding, Shielding and Termination Practice. Signal conditioning Error Analysis. DC, Sinusoidal and Harmonic Signal Conditioning, Analog Signal Processing, Devices for Data Conversion – Analog Multiplexers, Sample – Holds, D/A and A/D Sampled Data, Inter sample Error and Interpolation, Aliasing of Signal and Noise, Inter sample and Aperture Error, Signal Recovery and Interpolation Conversion System Design with Computer – Assisted Analysis, System Design Considerations, Computer Assisted Interface Analysis Software	12
Module 4 Introduction to smart sensors, Voltage to Frequency Converters and Frequency to Code converters, Data Acquisition methods for multi Channel sensor systems, Smart sensor design, Smart sensor Buses and Interface circuits.	9
Total Hours	39

TEXT BOOKS

1. Measurement and Instrumentation Principles, by: Alan S. Morris, Butterworth-Heinemann
2. Advanced Instrumentation and Computer I/O Design, by: Patrick H. Garrett, IEEE Press
3. Data Acquisition and Signal Processing for Smart Sensors, by: Nikolay V. Kirianaki et al., John Wiley & Sons
4. Microsensors MEMS and Smart Devices, by: Julian W. Gardner, Vijay K. Varadan, et al., John Wiley & Sons

REFERENCES

1. Industrial Instrumentation Principles and Design, 1st edition; by:Tattamangalam. R.Padmanabhan, Springer Verlag.
2. Measurement Systems Application and Design, by: Ernest O. Doebelin, McGraw-Hill Science/Engineering/Math
3. Handbook of Transducers, 1st edition; by: Harry N.Norton, Prentice Hall.
4. Advances in Distributed Sensor Technology; by: S.S.Iyengar, L.Prasad, Hla Min; Prentice Hall PTR
5. Standard Recommended Practises for Instrumentation & Control, Vol 1-3,11th edition; Instrument Society of America.
6. Microsensors: Principles and Applications; by: Gardner, J W, Wiley (1994)
7. Measurement Systems, Application and Design, 4th edition; by: Ernest O.Doebelin, McGraw- Hill.
8. Practical Design Techniques For Sensor Signal Conditioning; Seminar Materials@ http://www.analog.com
9. Data Acquisition Fundamentals; Application Note AN007 @ http://www.ni.com
10. Measurement Systems And Sensors (Hardcover), By: Waldemar Nawrocki , Artech House Publishers
11. Introduction to Instrumentation and Measurements, by: Robert B. Northrop, CRC; 2 edition
12. Microtransducer CAD: Physical and Computational Aspects (Computational Microelectronics) (Hardcover), by: Arokia Nathan (Author), Henry Baltes (Author), Springer

In addition National & International journals in the related topics shall be referred. Manufacturer's device data sheets and application notes are to be referred to get practical application oriented information.

ES 10 301C ROBOTICS AND MACHINE VISION

Modules	Hours
Module 1 - Industrial Robots: Basic Concepts of Robotics, Classification and Structure of Robotic Systems Kinematics Analysis and Coordinate Transformations, Industrial Applications of Robots, and Programming	12
Module 2 - Introduction Machine Vision: Principles of Machine Vision, Vision and factory automation, Human Vision Vs. Machine Vision, Economic Considerations, Machine Vision – System Overview, Image acquisition – Illumination, Image formation and Focusing, Image Detection – Introduction, Types of Cameras; Image Processing and	8

Presentation.	
Module 3 - Image Processing Techniques and Transformations: **Fundamental Concepts of Image Processing, Pixel, Pixel Location. Gray Scale, Quantizing Error and Measurement Error and Histograms. Basic Machine Vision Processing Operators – Monadic one Point Transformations: Identity operator, Inverse Operator, Threshold operator and other operators viz: Inverted Threshold operator, Binary Threshold operator, Inverted Binary Threshold Operator, Gray Scale Threshold and Inverted Gray Scale Threshold Operators; Dyadic Two Point Transformations –Image Addition, Image Subtracting, Image Multiplication; Convolution and Spacial Transformations**	10
Module 4 - Edge Enhancement Techniques and Image Analysis: **Introduction, Digital Filters – Low pass and High Pass filters; Edge Engancement Operators – Laplacian, Roberts Gradient, Sobel and other Local operators. Image Analysis: Thresholding, Pattern Matching and Edge Detection, Back-Propagation Algorithm.**	9
Total Hours	39

TEXT BOOKS:

5. Machine Vision and Digital Image Processing, by Louis J. Galbiati, Jr. Prentice Hall, Englewood Cliffs, New Jersy.`
6. Robotics for Engineers, By, Yoram Koren, McGraw Hill.
7. Robotics and Image Processing – an Introduction, by Janakiraman P. A., Tata McGraw Hill, New Delhi
8. Digital Image Processing and Computer Vision by Robert J.Schalkoff, John Wiley & Sons Inc.

REFERENCES:

1. Industrial Robotics – Technology, Programming and Applications, by Mikell P. Groover, Mitchell Wein, Roger N. Nagel and Nicholas G. Odlrey, McGraw Hill International Edistion.
2. Handbook Of Image Processing Operators by Klette, Reinhard & Zamperoni, Piero; John Wiley & Sons Inc
3. Image Processing, Analysis And Machine Vision by Sonka, Milan Et Al
4. Industrial Robotics by Hodges, Bernard, Jaico Publishing House, Delhi
5. Introductory Computer Visiona dn Image Processing by Adrian Low, McGraw Hill International Editions.

In addition, manufacturers Device data sheets and application notes are to be referred to get practical and application oriented information.

ES 10 302A WIRELESS COMMUNICATION SYSTEMS

Modules	Hours
Module 1 - Introduction to Wireless Systems: Evolution of Wireless Communication, Cordless Telephones, Paging and messaging systems, Cellular Systems, Analog and Digital Cellular, Modulation techniques, Frequencies used and licensing, Spread Spectrum Technologies, Multiple Access Techniques for Wireless Communications, Satellite-based wireless Communications,GPS	9
Module 2 - Cellular Systems: Cellular carriers and Frequencies, Channel allocation, Cell coverage, Cell Splitting, Microcells, Picocells, Handoff, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} Generation Cellular Systems, GSM, CDMA GPRS, EDGE, EVDO CDMA2000, UMTS, WCDMA, LTE, Wireless Web connectivity, Mobile IP, Wireless in local loop (WLL)	10
Module 3 - Radio propagation in Mobile Systems: **Antenna Basics, Cellular and PCS Antennas, MIMO, Mobile Radio Propagation: Free-space propagation model, Two-Ray Model, Outdoor and indoor propagation models, Fading Channels, Raleigh and Ricean Distribution.**	11
Module 4 - Wireless LANs and PANs: Wireless LANs: 802.11,802.11a/b/g, 802.16-WiMAX, UWB Communications , Wireless Personal Area Networks, BlueTooth, BlueTooth Protocol Architecture, IEEE 802.15 standards, ZigBee, Sensor Networks, Interfacing problems and co-existence strategies in Sensor Networks, MAC and Routing protocols in Sensor Networks.	9
Total Hours	39

TEXT BOOKS:

1. Wireless Communications – Principles and Practice; by Theodore S Rappaport, Pearson Education Pte. Ltd., Delhi
2. Wireless Communication Technology; By: Blake, Roy; Delmar, New York.
3. Wireless Communications and Networking; By: Stallings, William; Pearson Education Pte. Ltd., Delhi
4. Bluetooth Revealed; By: Miller, Brent A, Bisdikian, Chatschik; Addison Wesley Longman Pte Ltd., Delhi

REFERENCES:

1. Mobile and Personal Communications Services and Systems; 1st Edition; By: Raj Pandya; PHI, New Delhi
2. Fundamentals of Wireless Communication by Tse David and Viswanath Pramod, Cambridge University press, Cambridge
3. Mobile Communications; By: Schiller, Jochen H; Addison Wesley Longman Pte Ltd., Delhi
4. 3G Networks: Architecture, protocols and procedures based on 3GPP specifications for UMTS WCDMA networks, By Kasera, Sumit, Narang, and Nishit, TATA MGH, New Delhi
5. Mobile Communications Engineering; Theory and Applications, By: Lee, William C Y; MGH, New York
6. Wireless Sensor Networks: information processing by approach, ZHAO, FENG, GUIBAS and LEONIDAS J, ELSEVIER, New Delhi
7. Wireless Network Evolution: 2G to 3G by GARG, VIJAY K, Pearson Education (Singapore) Pte. ltd., Delhi

In addition, manufacturers Device data sheets, IEEE publications and application notes are to be referred to get practical and application oriented information.

ES 10 302B DIGITAL COMMUNICATIONS

Topics	Hours
Module 1 FUNDAMENTAL LIMITS ON PERFORMANCE Uncertainty, Information & Entropy, Source Coding Theorem, Huffman Coding, Discrete Memoryless Channels, Mutual Information, Channel Capacity, Channel Coding Theorem, Differential Entropy and Mutual Information for Continuous Ensembles, Channel Capacity Theorem	9
Module 2 Analog Pulse Modulation: Sampling theorem for band-pass signals, Pulse Amplitude modulation: generation and demodulation, PAM/TDM system, PPM generation and demodulation, PWM, Spectra of Pulse modulated signals, SNR calculations for pulse modulation systems. Waveform coding: quantization, PCM, DPCM, Delta modulation, Adaptive delta modulation-Design of typical systems and performance analysis.	10
Module 3 Digital modulation schemes: Coherent Binary Schemes: ASK, FSK, PSK, MSK. Coherent M-ary Schemes, Calculation of average probability of error for different modulation schemes, Power spectra of digitally modulated signals, Performance comparison of different digital modulation schemes.	10
Module 4 Spread Spectrum Modulation Notion of Spreading Spectrum, PN Sequences, PN Sequence Generator, DS SS, Processing Gain, Probability of Error, Frequency –Hop Sperad Spectrum, Applications	10
Total Hours	39

REFERENCES:

1. Simon Haykin,Communication Systems, 4TH Ed., John Wiley & Sons.
2. Simon Haykin,Digital Communications , 2006, John Wiley & Sons.
3. B.P. Lathi,Modern Digital and Analog Communication, 3rd Ed., Oxford UniversityPress.
4. Sklar, Digital Communication, 2E, Pearson Education.
5. K.Sam Shanmugham,Digital and Analog Communication Systems, John Wiley &Sons
6. R.E. Ziemer and W.H. Tranter,Principles of Communications, JAICO PublishingHouse.
7. H.Taub and Schilling,Principles of Communication Systems, TMH
8. Pierre Lafrance,John G.Proakis,Digital Communications, McGraw Hill.
9. Couch, Analog and Digital Communication.5th Ed,PHI

ES 10 302C VLSI ARCHITECTURE AND DESIGN METHODOLOGIES

1.INTRODUCTION 8

Overview of digital VLSI design methodologies – Trends in IC Technology – Advanced Boolean algebra – Shannon's expansion theorem – Consensus theorem – Octal designation- Run measure – Buffer gates - Gate expander – Reed Muller expansion – Synthesis of multiple output combinational logic circuits by product map method – Design of static hazard free, dynamic hazard free logic circuits.

2.ANALOG VLSI AND HIGH SPEED VLSI 7

Introduction to analog VLSI – realization of neural networks and switched capacitor filters – Sub-micron technology and Gas VLSI Technology.

3.PROGRAMMABLE ASICS 8

Anti fuse – static RAM – EPROM and technology – PREP bench marks – Actel ACT – Xilinx LCA – Altera flex – Altera MAX DC & AC inputs and outputs – Clock and power inputs – Xilinx I/O blocks.

4.PROGRAMMABLE ASIC DESIGN SOFTWARE 7

Actel ACT – Xilinux LCA – Xilinux EPLD – Altera MAX 5000 and 7000 – Altera MAX 9000 – design systems – logic synthesis – half gate – schematic entry – Low level design language – PLA tools – EDIF – CFI design representation.

5.LOGIC SYNTHESIS, SIMULATION AND TESTING 9

Basic features of VHDL language for behavioral modeling and simulation – Summary of VHDL data types – Dataflow and structural modeling – VHDL and logic synthesis – Circuit and layout verification – Types of simulation – Boundary scan test – Fault simulation – Automatic test pattern generation – design examples.

REFERENCES:

1.William I.Fletcher, "An Engineering Approach to Digital Design", Prentice Hall of India.

2.Amar Mukharjee, "Introduction to NMOS and CMOS VLSI System Design", Prentice Hall, 1986.

3.M.J.S. Smith, "Application – specific integrates circuits", Addison Wesley Longman Inc. 1997.

4.Frederick J.Hill and Gerald R.Peterson, "Computer Aided Logical Design with emphasis on VLSI".

ES 10 303(P): Industrial Training

Teaching scheme: 1 hour per week **Credits:** 1

The students have to undergo an industrial training of minimum two weeks in an industry during the semester break after second semester and complete within 15 calendar days from the start of third semester. The students have to submit a report of the training undergone and present the contents of the report before the evaluation committee constituted by the department. An internal evaluation will be conducted for examining the quality and authenticity of contents of the report and award the marks at the end of the semester.

Internal continuous assessment: Marks 50

ES 10 304(P): MASTERS RESEARCH PROJECT (PHASE – I)

Teaching scheme: 22 hours per week **Credits:** 6

Objective:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

The project work should be a project in Embedded system stream. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to do their project outside the parent institute subject to the conditions in clause 10 of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

The student is required to undertake the masters research project phase-I during the third semester and the same is continued in the 4th semester.(Phase-II). Phase-I consists of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester.

Internal Continuous assessment:

First Review:

Guide	50 marks
Evaluation Committee	50 marks

Second review:

Guide	100 marks
Evaluation Committee	100 marks

Total **300 marks**

SEMESTER 4

ES10 401(P) : MASTERS RESEARCH PROJECT PHASE 2

Teaching scheme: 30 hours per week **Credits:** 12

Objectives:
To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the Thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.

Internal Continuous assessment:

First review:

Guide	50 marks
Evaluation committee	50 marks

Second review:

Guide	100 marks
Evaluation committee	100 marks

ES 10 204 C INFORMATION SECURITY

Modules	Hours
Module I - Cryptography Introduction to Cryptography: OSI Security Architecture - Security Services, Security Attacks, Security Mechanism. Introduction to Classical Cryptography. Modern Cryptography: Secret key Cryptography - DES, AES. Public key Cryptography - Diffie-Hellman, RSA, ECC. Introduction to Hash Algorithm, Introduction to Digital Signature, Introduction to PKI.	10
Module II – System Security Introduction - Access Control, Intrusion Detection and Prevention. Firewalls: Firewall Design Principles - Firewall Characteristics, Types of Firewalls. Trusted System. Malicious Soft wares: Virus, Trojan Horse, Ad ware/ Spy ware, Worms, Logic Bomb. Cyber Law and Forensics - IT ACT 2000, Cyber Forensics.	7
Module III - Network Security Introduction to Network Concepts, OSI Layers and Protocols, Network Devices, Network layer Security (IPSec) - IP Security Overview, IPSec Architecture, Authentication header, Encapsulating security Payload, Combining Security Associations, Key management. Transport Layer Security - SSL/TLS, SET. Application Layer Security - Authentication Applications, Kerberos, X. 509 Authentication Services. E-mail Security – PGP, S/MIME.	14
Module IV – Embedded Security Introduction, Types of Security Features – Physical, Cryptographic, Platform. Kinds of Devices – CDC, CLDC. Embedded Security Design, Keep It Simple and Stupid Principle, Modularity Is Key, Important Rules in Protocol Design, Miniaturization of security, Wireless Security, Security in WSN.	8
Total Hours	39

TEXT BOOKS:

1. Cryptography and Network Security: Principles and Practice- William Stallings
2. Practical Embedded Security: Building Secure Resource Constrained Systems - Timothy Stapko, Publisher Newnes.

REFERENCE BOOKS:

1. Cryptography: Theory and Practice – 3rd Ed. SD Stinson, CRC Press.
2. Information Security for Technical Staff-SEI.
3. Guide to firewalls & network security: with intrusion detection & VPNs- HOLDEN, GREG.
4. CISSP: Certified Information Systems Security Professional Study Guide- Stewart, James Michael Et Al.