IK GUJRAL PUNJAB TECHNICAL UNIVERSITY

Scheme and Syllabus
of
Master of Technology
(EMBEDDED SYSTEMS)

Batch 2016

Semester-I								
Course Code	**Course Title**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	External		
MTRM-101	Research Methodology	3	1	0	50	100	150	4
MTED-102	Advanced Digital System Design	3	1	0	50	100	150	4
MTED-103	Data Communication Network	3	1	0	50	100	150	4
MTED-104	Software Technology	3	1	0	50	100	150	4
MTED-105	Designing with Power Devices	3	1	0	50	100	150	4
MTED-106	Lab – I	0	0	4	100		100	2
	Total	**15**	**5**	**4**	**350**	**500**	**850**	**22**

Semester-II								
Course Code	**Course Title**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	External		
MTED-201	Embedded System Design	3	1	0	50	100	150	4
MTED-202	Real Time Operating System	3	1	0	50	100	150	4
MTED-203	Advanced Microprocessor and Microcontroller	3	1	0	50	100	150	4
MTED-	Elective-I	3	1	0	50	100	150	4
MTED-	Elective-II	3	1	0	50	100	150	4
MTED-204	Lab – II	0	0	4	100		100	2
	Total	**15**	**5**	**4**	**350**	**500**	**850**	**22**

Semester-III								
Course Code	**Course Title**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	External		
MTED-	Elective-III	3	1	0	50	100	150	4
MTED-	Elective-IV	3	1	0	50	100	150	4
MTED-301	Project	0	0	4	100	50	150	4
MTED-302	Seminar	0	0	2	50	-	50	1
MTED-303	Dissertation(Synopsis)	0	0	6	-	-	-	S/US
	Total	**6**	**2**	**12**	**250**	**250**	**500**	**13**

Semester-IV								
Course Code	**Course Title**	**L**	**T**	**P**	**Marks Distribution**		**Total Marks**	**Credits**
					Internal	External		
MTED-303	Dissertation	0	0	20	-	-	-	S/US
	Total	**0**	**0**	**20**	**-**	**-**	**-**	**-**

S-Satisfactory, US-Unsatisfactory

LIST OF ELECTIVES

Elective-I
MTED-205 Advanced Computer Architecture
MTED-206 Advanced Digital Signal Processing
MTED-207 Embedded System for Wireless and Mobile Communication System

Elective-II
MTED 208 Sensor Technology and MEMS
MTED 209 Soft Computing
MTED 210 Advanced Sensor and Actuators

Elective-III
MTED-304 Digital Image Processing
MTED-305 Industrial Automation
MTED-306 Embedded Wireless Sensor Networks
MTED-307 Cryptology and Crypto Chip Design

Elective-IV
MTED-308 System on Chip
MTED-309 Hardware and Software Co-Design
MTED-310 Medical Electronics and Instrumentation
MTED-311 Autotronics

MTRM-101 RESEARCH METHODOLOGY

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

METHODS OF RESEARCH: Nature and Objectives of research; historical, descriptive and experimental. Study and formulation of research problem. Scope of research and formulation of hypotheses; Feasibility, preparation and presentation of research proposal.

INTRODUCTION TO STATISTICAL ANALYSIS: Measures of central tendency and dispersion: mean, median, mode, range, mean deviation and standard deviation. Regression and correlation analysis. Probability and probability distributions; Binomial, Poisson, Geometric, Negative binomial, Uniform, Exponential, Normal and Log-normal distribution. Basic ideas of testing of hypotheses; Tests of significance based on normal, t and Chi-square distributions. Analysis of variance technique.

DESIGN OF EXPERIMENTS: Basic principles, study of completely randomized and randomized block designs. Edition and tabulation of results, presentation of results using figures, tables and text, quoting of references and preparing bibliography. Use of common softwares like SPSS, Mini Tab and/or Mat Lab. For statistical analysis.

BOOKS RECOMMENDED:

- Borth Wayne C., *The Craft of Research*, Chicago Guides to Writing Edition and Publishing.
- Johnson R.A., *Probability and Statistics*, PHI, New Delhi.
- Meyer P.L., *Introduction to Probability and Statistical Applications*, Oxford, IBH.
- Hogg, R.V. and Craig A.T., *Introduction to Mathematical Statistics*, MacMillan.
- Goon, A.M., Gupta, M.K. and Dasgupta, *Fundamentals of Statistics*, Vol. I: World Press.
- Gupta, S.C. and Kapoor V.K., *Fundamentals of Mathematical Statistics*, Sultan Chand and Sons.

MTED-102 ADVANCED DIGITAL SYSTEM DESIGN

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

INTRODUCTION TO DIGITAL DESIGN: Number Systems, Signed, Unsigned number, 1"s Complement, 2"s Complement, Binary Operations - Addition, Subtraction using 1"s & 2"s Complement etc., Code converters-Excess-3, Gray Code.

LOGIC CIRCUIT DESIGN: Universal Gates, Karnaugh Maps, Minimization of Logic Functions-Sum of Products, Product of Sum, Minimization of Logic Circuit.

HARDWARE DECRIPTION LANGUAGE: Introduction to VHDL, Design Units, Modeling styles- Behavioral, Structural and Concurrent, VHDL based digital design flow, Data objects, Data types, Delay models- Delta, Inertial, & Transport, Concurrent statements, Sequential statements, Process statements, Conditional & Selective signal assignments, Generate statements, Signal and Variable assignments, Synthesis of statements, Loops- for loop, while loop, Subprograms – Functions, Procedures, Generic, Package, IEEE standard logic library, Test bench, Component declaration, Instantiation, Configuration- declaration & specification.

FINITE STATE DESIGN: Review of Moore and Mealy state machines, Finite state machines, Representation, Design steps, FSM code structure, Synthesis of FSMs.

ASYNCHRONOUS SEQUENTIAL CIRCUIT: Analysis & Synthesis of asynchronous digital circuits, State Reduction, State Assignment, Hazards.

TESTING OF DIGITAL SIGNALS: Introduction, Types of faults, Fault modeling, Path sensitization Testing algorithms-D-frontier and PODEM, Linear Feedback Shift Register, Built in Self Test.

FPGA PROTOTYPING: Introduction, Elements of FPGA, FPGA Implementation of following circuits –Full Adder, Subtractor, Decoder, Encoder, Data Selector, Ripple Carry Adder, Arithmetic Logic Unit, ROM, 4X4 Key board controller.

BOOKS RECOMMENDED:

- Stephen Brown, Zvonko Vranesic , *Fundamentals of Digital Logic with VHDL design*, Tata McGraw Hill.
- Fletcher., *Digital Design Principles*
- Morris Mano , *Logic and Computer Design Fundamentals*, Patience Hall
- J. Bhasker, *VHDL Primer*, Pearson Education.
- Charles H. Roth , *Digital System Design Using VHDL*, CL Engineering
- John Wakerley, *Digital System Design*, Patience Hall
- Douglas Perry, *VHDL*, 3rd Edition, Tata McGraw Hill
- Zainalabedin Navabbi , *VHDL*, McGraw Hill Education

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MTED-103 DATA COMMUNICATION NETWORK

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

INTRODUCTION: Components of network, Topologies, WAN / LAN, OSI – ISO layered Architecture, Modulation and Demodulation, Bit error rates, Line coding, Error correcting codes.

DATA LINK LAYER: Design issues, CRC technique and sliding window techniques, Performance analysis of sliding window techniques, Framing formats, Case Study, HDLC protocols, Medium access control, CSMA / CD, Token ring and token bus, FDDI, Wireless LAN, Performance analysis of MAC protocols, Bridges

NETWORK LAYER: Circuit switching, packet switching, Design issues, IP addressing and IP diagram, Routers and gateways, Routing, Sub netting, CIDR, ICMP, ARP, RARP, Ipv6, QoS.

TRANSPORT LAYER: TCP and UDP, Error handling and flow control, Congestion control, TCP Retransmission, Timeout, Socket Abstraction.

APPLICATION LAYER: Simple Mail Transfer Protocol (SMTP), File Transfer Protocols (FTP), telnet, World Wide Web (WWW), Hypertext Transfer Protocol (HTTP), Domain name service (DNS), Security, Multimedia applications like VOIP and Teleconferencing.

BOOKS RECOMMENDED:

- Behrouz A. Forouzan, *Data Communication and Networking*, 4th Edition Tata McGraw-Hill, 2006
- Alberto Leon-Garcia and Indra Widjaja, *Communication Networks - Fundamental Concepts and Key architectures*, 2nd Edition, Tata McGraw-Hill, 2004.
- William Stallings, *Data and Computer Communication*, 8th Edition, Pearson Education, 2007.
- Larry L. Peterson and Bruce S. Davie, *Computer Networks – A Systems Approach*, 4th Edition, Elsevier, 2007.
- Nader F. Mir, *Computer and Communication Networks*, Pearson Education, 2007.

MTED-104 SOFTWARE TECHNOLOGY

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

SOFTWARE TECHNOLOGY: Software Architectures, Software development Tools, Software Development Process Life Cycle and its Model, Software Analysis, Design and Maintenance.

INTRODUCTION TO DATA REPRESENTATION: Data representation , Two's complement, Fixed point and Floating Point Number Formats ,Manipulating Bits in Memory, I/O Ports, Low level programming in C ,Primitive data types , Arrays, Functions , Recursive Functions, Pointers, Structures & Unions ,Dynamic Memory Allocation ,File handling ,Linked lists, Queues, Stacks.

MIXING C AND ASSEMBLY: C and assembly, Programming in assembly ,Register Usage Conventions ,Typical use of Addressing Options, Instruction Sequencing , Procedure Call and Return , Parameter passing ,Retrieving Parameters , Everything in pass by value ,Temporary variables .

INPUT/OUTPUT PROGRAMMING: I/O Instructions, Synchronization, Transfer Rate & Latency, Polled Waiting Loops, Interrupt Driven I/O, Writing ISR in Assembly and C, Non Maskable and Software Interrupts

MEMORY MANAGEMENT: Direct Memory Access, Local and Global Scope, Automatic and Static Allocation, Distinguishing Static from Automatic Object Creation, Initialization and Destruction, Dynamic Allocation

UNIFIED MODELING LANGUAGE: 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.

SOFTWARE TOOLS: DJGPP C/C++ compiler, linker, loader and utilities, The ASM assembler, µCOS-II Preemptive Kernel, Multi C Non-Preemptive Kernel.

BOOKS RECOMMENDED:

- Daniel W.Lewis, *Fundamentals of embedded software where C and assembly meet*, Pearson Education.
- Bruce Powel Douglas, *Real time UML, second edition: Developing efficient objects for embedded systems* (The Addison Wesley Object technology series), 2nd edition 1999, Addison Wesley
- Hassan Gomma, *Designing concurrent, distributed, and real time applications with UML*, Pearson Education, 2000
- C.M. Krishna, Kang G. Shin, *Real Time Systems*, McGraw – Hill International Editions, 1997
- By Albert M. K. Cheng , *Real-time systems: scheduling, analysis, and verification*, Wiley

MTED-105 DESIGNING WITH POWER DEVICES

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

POWER SEMICONDUCTOR DEVICES: General characteristics of Power devices such as GTOs, Power BJT, Power MOSFET, IGBT, MCT.

TRANSFORMER DESIGN: Fundamentals, Selection of core material, Insulating material and wires, Design Methodology of pulse transformers, High Frequency transformers, Design of Transformers for PWM converters

COILS: Fundamentals, Selection of core material, Insulating materials and wires, Design of inductors for power frequency, Radio frequency & High frequency

SWITCH MODE POWER SUPPLIES: Basic regulators, Buck, Boost, Buck Boost, Derived topologies, flyback, forward, Push-pull, half & full bridge converter, Special converters like Cuk‟ converter, PWM control techniques, Study of PWM control ICs Design of base derive circuits, Design of input section, output section & control section, Thermal design concepts, EMI/EMC considerations, Protection circuit design for power supplies.

UPS AND OTHER POWER SUPPLIES : Concept of Uninterrupted power supplies, Inverter preferred (online UPS), Line preferred UPS system (offline UPS system), Line interactive UPS system, Reliability of UPS system, Solar cells as power source devices & their characteristics.

BOOKS RECOMMENDED:

- George Chryssis, *High frequency switching power supplies: theory & design*, McGraw Hill Book Co. 1984 (Text)
- K.Kitsum, *Switch mode power conversion –basic theory and design*, Marcel Deckker Inc 1984.
- N.Radhakrishnan and S.R.Bhat, *Design and technology of low power transformers and inductors*, CEDT, July 1998.

MTED-106 LAB - I

Internal Marks: 100 **L T P**

Total Marks: 100 **0 0 4**

Module 1

1. Using C Pointers, Arrays, Structures and Union develop programs.
2. Write programs on File Handling.
3. Create a linked list ADT with functions for Creation, Insertion, Deletion & Searching.
4. Write programs to implement stack and queue.
5. Try examples by Embedding Assembly code in C and observe the performance.
6. Develop programs to perform Data Conversion from one form to another.
7. Write a sequence of Intel protected-mode instructions to implement functions in assembly.
8. Develop programs to implement ISR in Assembly and C.
9. Develop C functions to implement Polled Waiting Loops, FIFO queue.
10. Develop programs to implement Dynamic Memory Allocation, Recursive Functions.

Module 2

1. Design and Implementation of following features in Counter:-Counter with Asynchronous reset & clear signal, Synchronous Counter, Mod 10 Counter, FSM.
2. Design and Implementation of ALU with following features:-Addition,
3. Subtraction, Multiplication, Division, Square, Factorial, AND, OR, EXOR, EXNOR, Increment, Decrement, 1‟s Complement, 2‟s Complement etc.
4. Design and Implementation of 8 X 8 Key board controller.
5. Design and Implementation of Shift Register with following features:-Parallel in Serial out, Serial in Parallel out, Parallel in Parallel out, Serial in Serial out, Universal Shift Register.
6. Design and Implementation of Hardware Multiplier.
7. Design and Implementation of Universal Asynchronous Transmitter & Receiver.

MTED-201 EMBEDDED SYSTEM DESIGN

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

INTRODUCTION AND EXAMPLES OF EMBEDDED SYSTEMS: Concept of Embedded System Design: Design challenge, Processor technology, IC technology, Design technology, Trade-offs.

CUSTOM SINGLE PURPOSE PROCESSOR HARDWARE, GENERALPURPOSE PROCESSOR: Introduction, basic architecture, operation, super-scalar and VLSIIW architecture, application specific instruction set processors (ASIPS), microcontrollers, digital signal processors, selecting a microprocessor.

MEMORY: Introduction, Memory writes ability, Storage performance, Tradeoff s, Common memory types, Memory hierarchy and cache.

AVR 8515 MICROCONTROLLER: Architecture and Programming in assembly and C. Interfacing Analog and digital blocks, Analog-to-Digital Converters (ADCs), Digital to-Analog, Converters (DACs)., Communication basics and basic protocol concepts, Microprocessor interfacing: I/O addressing, Port and Bus based, I/O, Memory mapped I/O, Standard I/O interrupts, Direct memory access, Advanced communication principles parallel, serial and wireless, Serial protocols I2C, Parallel protocols PCI bus, Wireless protocol IrDA, blue tooth.

DIFFERENT PERIPHERAL DEVICES: Buffers and latches, Crystal, Reset circuit, Chip select logic circuit, timers and counters and watch dog timers, Universal asynchronous receiver, transmitter (UART), Pulse width modulators, LCD controllers, Keypad controllers. Design tradeoffs due to thermal considerations and Effects of EMI/ES etc.

SOFTWARE ASPECT OF EMBEDDED SYSTEMS: Challenges and issues in embedded software development, Co-design.

EMBEDDED SOFTWARE DEVELOPMENT ENVIRONMENTS: Real time operating systems, Kernel architecture: Hardware, Task/process control subsystem, Device drivers, File subsystem, system calls, Embedded operating systems, Task scheduling in embedded systems: task scheduler, first in first out, shortest job first, round robin, priority based scheduling, Context switch: Task synchronization: mutex, semaphore, Timers, Types of embedded operating systems, Programming languages: assembly languages, high level language.

DEVELOPMENT FOR EMBEDDED SYSTEMS: Embedded system development process, Determine the requirements, Design the system architecture, Choose the operating system, Choose the processor, Choose the development platform, Choose the programming language, Coding issues, Code optimization, Efficient input/output, Testing and debugging, Verify the software on the host system, Verify the software on the embedded system.

BOOKS RECOMMENDED:

- Frankvahid/Tony Givargis, *Embedded System Design- A unified Hardware/software Introduction*.
- David E Simon, *An embedded software primer*, Pearson education Asia, 2001.
- Dreamteach Software team, *Programming for Embedded Systems*, AVR 8515 manual
- J.W. Valvano, *Embedded Microcomputor System: Real Time Interfacing*
- Jack Ganssle, *The Art of Designing Embedded Systems*, Newnes, 1999.

MTED-202 REAL TIME OPERATING SYSTEM

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

Operating Systems Concepts: Overview of OS services and goals, Introduction to Embedded Operating Systems, Process and Thread concept, Scheduling, Process Synchronization Mechanisms and Deadlocks, Mutual Exclusion, Memory Management, Paging and Segmentation, File System Management.

Linux Operating system and Architecture: Installation, Configuring and Compiling kernel, Linux Kernel Internals, Shell Programming, System Call Interface, Processes and Signal, POSIX thread concepts, IPC Mechanism (Pipes, FIFOs, Semaphore, Shared Memory, Message Queues and Sockets).

Advanced Linux Programming: Memory Management, Interrupt Handling, Timers, Introduction to Kernel Module Programming and Device Drivers, Module Concept, Linking a Module to a Kernel.

Fundamentals of Real Operating Systems: Issus in Real Time Computing, Structure of Real Time Systems, Performance measures for Real Time Systems, Introduction to Real Time Database, Various Types of Real Time Operating Systems, Real-time Versus Conventional Operating System.

Real Time Kernel: Installation, Configuring and Compiling RT linux Kernel, Real time FIFO, Creation of RT linux threads, Inter process communication between RT Task and Linux Process.

BOOKS RECOMMENDED:

- Abraham Silberschatz Peter B. Galvin, G.Gagne, *Operating System Concepts*, 6th Edition, Wesley Publishing
- Mark Mitchell, Jeffery Oldham , *Advanced Linux Programming*, Techmedia Publication
- Jean J. Labrossy , *μC/OS-II, The real time Kernel*, Lawrence: R & D Publications.
- Charles Crowley, *Operating Systems-A Design Oriented approach*, McGraw Hill 1997
- C.M. Krishna, Kang, G.Shin, *Real Time Systems*, McGraw Hill, 1997
- Tanenbaum, *Distributed Operating Systems*, Pearson Education
- Raymond J.A.Bhur, Donald L.Bailey, *An Introduction to Real Time Systems*, PHI 1999

MTED-203 ADVANCED MICROPROCESSOR AND CONTROLLER

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

THE PIC18 MICROCONTROLLERS: History and Features, PIC18 Architecture ,Assembly Language Programming: Branch, Call and Time Delay Loop PIC18 I/O Port Programming Arithmetic, Logic Instructions and Programs, Bank Switching, Table Processing, Macros, and Modules, PIC18 Programming in C,PIC18 Hardware Connections and ROM Loaders, PIC18 Interfacing: PIC18 Timer Programming in Assembly and C, Serial Port Programming in Assembly and C Interrupt Programming in Assembly and C, LCD and Keyboard Interfacing, ADC, DAC, and Sensor Interfacing, SPI Protocol and DS1306 RTC Interfacing, Motor Control: Relay, PWM, DC, and Stepper Motors

ARM PROCESSORS: Introduction, History of ARM Processors, Basic Architecture and organization of Cortex-M3 processor, ARM Processor (Cortex-M3) Fundamentals: Registers, Application Program Status Register: Current Program Status Register, Pipeline (3-stage pipeline ARM organization, 5-stage pipeline ARM organization), ARM instruction execution, Exceptions, Interrupts and Vector Table. Cortex_M3 Instruction Set: Introduction, Exceptions, Conditional execution, Branch and Branch with Link (B, BL) and exchange (BX, BLX), ARM instructions, Software Interrupt (SWI), Unused instruction space, Thumb Instruction Set Support for System Development Memory faults, The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA), The JTAG boundary scan test architecture, The ARM debug architecture, Signal processing support.

BOOKS RECOMMENDED:

- John B. Peatman, *Design with PIC Micro controller*, Pearson Education, 1988
- Andrew N. Sloss, Donimic Symes, Chris Wright, *ARM System Developer's Guide*
- Steave Furber, *ARM system - on - chip architecture*, Addison Wesley, 2000
- Joseph Yiu, *The Definitive Guide to the ARM Cortex-M3*, 2nd edition. Netherlands: Newnes, 2009
- Jonathan W Valvano , *Embedded Systems: Introduction to ARM Cortex™-M3 Microcontroller*, Volume1,.CreateSpace Independent Publishing Platform, 2012.
- Muhammad Ali Mazidi, Rolin D. McKinlay , *PIC Microcontroller* , Danny Causey Pearson Education

MTED-204 LAB - II

Internal Marks: 100 **L T P**

Total Marks: 100 **0 0 4**

1. Simple programs for sorting a list of numbers in ascending and descending order.
2. Sorting a list without destroying the original list.
3. Code conversion - Binary to Gray/Gray to Binary.
4. Program for addition of BCD numbers.
5. Interface an LED array and 7-segment display
6. Interfacing of PIC18 with LCD
7. Interfacing of PIC18 with Keyboard Interfacing
8. Interfacing of PIC18 withADC, DAC □
9. Interfacing of PIC18 with temperature Sensor
10. Interfacing of PIC18 with DS1306 RTC
11. Interfacing of PIC18 with DC Motor Control
12. Interfacing of PIC18 with Stepper Motors

MTED-205 ADVANCED COMPUTER ARCHITECTURE

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

FUNDAMENTALS OF COMPUTER DESIGN: Fundamentals of Computer design, Changing faces of computing and task of computer designer, Technology trends, Cost price and their trends, measuring and reporting performance, Quantitative principles of computer design, Amdahl's law. Instruction set principles and examples- Introduction, classifying instruction set- memory addressing type and size of operands, Operations in the instruction set.

PIPELINES: Introduction, basic RISC instruction set, Simple implementation of RISC instruction set, Classic five stage pipe lined RISC processor, Basic performance issues in pipelining, Pipeline hazards, and Reducing pipeline branch penalties. Memory Hierarchy Design: Introduction, review of ABC of cache, Cache performance, Reducing cache miss penalty, Virtual memory.

INSTRUCTION LEVEL PARALLELISM: The Hardware Approach: Instruction-Level parallelism, Dynamic scheduling, Dynamic scheduling using Tomasulo's approach, Branch prediction, High performance instruction delivery- Hardware based speculation. ILP Software Approach: Basic compiler level techniques, Static branch prediction, VLIW approach, Exploiting ILP, Parallelism at compile time, Cross cutting issues - Hardware verses Software.

MULTI PROCESSORS AND THREAD LEVEL PARALLELISM: Multi Processors and Thread level Parallelism- Introduction, Characteristics of application domain, Systematic shared memory architecture, Distributed shared memory architecture, Synchronization.

INTER CONNECTION AND NETWORKS: Introduction, Interconnection network media, Practical issues in interconnecting networks, Examples of inter connection, Cluster, Designing of clusters. Intel Architecture: Intel IA-64 ILP in embedded and mobile markets Fallacies and pit falls.

BOOKS RECOMMENDED:

- John L. Hennessy, David A. Patterson, *Computer Architecture: A Quantitative Approach*, 3rd Edition, an Imprint of Elsevier.
- John P. Shen and Miikko H. Lipasti, *Modern Processor Design : Fundamentals of Super Scalar Processors*
- Kai Hwang, Faye A.Brigs , *Computer Architecture and Parallel Processing*, MC Graw Hill.

MTED-206 ADVANCED DIGITAL SIGNAL PROCESSING

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

TRANSFORMATIONS: Review of Fourier Transforms, Z-Transforms, Discrete Fourier Transform, Fast Fourier Transform, Convolution and Correlation.

DESIGN OF DIGITAL FILTERS: Introduction to filter design, types of digital filters, choosing between, fir and iir filters, filter design steps, effect of finite register length in filter design, realization of IIR digital filters and FIR digital filter, design of iir filters from continuous time filters, design of fir filters by windowing.

SPECTRUM ESTIMATION: Non-parametric methods correlation method, co-variance estimator, performance analysis of estimators, consistent estimators, ar, ma, ARMA signal modeling parameter estimation using Yule-walker method.

LINEAR ESTIMATION AND PREDICATION: Maximum likelihood criterion efficiency of estimator, least mean squared error criterion, recursive estimators, and linear predications.

MULTIRATE DIGITAL SIGNAL PROCESSING: Mathematical description of change of sampling rate, interpolation and decimation, continuous time model, direct digital domain approach, interpolation and decimation by an integer factor, single and multistage realization, applications of sub band coding.

ADAPTIVE FILTERS: Applications of Adaptive Filters, Adaptive Direct Form FIR Filters: The LMS Algorithm, Adaptive Lattice Ladder Filters, Recursive Least Squares Lattice Ladder Algorithms.

DSP CHIPS: Introduction to fixed point and floating point processors, ADSP21xx and TMS320Cxx-Architecture, Memory, Addressing Modes, Interrupts, Applications. Comparison of ADSP21xx and TMS320Cxx series.

BOOKS RECOMMENDED:

- Emmanuel C.Ifeachor Barrie W.Jervis, *Digital Signal Processing*, Pearson Education Asia
- Proakis, Manolakis, *Digital Signal Processing principles, algorithms, and applications*", Prentice Hall India.
- S.K.Mitra , *Digital Signal Processing*, Tata-Mcgraw Hill.
- ADSP 2181 manuals
- Keshab K. Parhi, *VLSI DSP Systems; Design & implementation*, Wiley InterScience Publishers.
- John G. Proakis, Charles M. Rader, Fuyun Ling, Chrysostomos L. Nikias, Marc Moonen, Ian k. Proudler, *Algorithms for statistical signal processing*, Pearson Education Asia.

MTED-207 EMBEDDED SYSTEM FOR WIRELESS AND MOBILE COMMUNICATION SYSTEMS

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

INTRODUCTION TO WIRELESS TECHNOLOGIES: WAP services, Serial and Parallel Communication, Asynchronous and synchronous Communication, FDM, TDM, TFM, Spread spectrum technology.

INTRODUCTION TO BLUETOOTH: Specification, Core protocols, Cable replacement protocol

BLUETOOTH RADIO: Type of Antenna, Antenna Parameters, Frequency hoping

BLUETOOTH NETWORKING: Wireless networking, wireless network types, devices roles and states, adhoc network, scatter net Connection establishment procedure, notable aspects of connection establishment, Mode of connection, Bluetooth security, Security architecture, Security level of services, Profile and usage model: Generic access profile (GAP), SDA, Serial port profile, Secondary bluetooth profile Hardware: Bluetooth Implementation, Baseband overview, packet format, Transmission buffers, Protocol Implementation: Link Manager Protocol, Logical Link Control Adaptation Protocol, Host control Interface, Protocol Interaction with layers

PROGRAMMING WITH JAVA: Java Programming, J2ME architecture, Javax. bluetooth package Interface, classes, exceptions, Javax. obex Package: interfaces, classes Bluetooth services registration and search application, bluetooth client and server application, Overview of IrDA, Home RF, Wireless LANs, JINI

BOOKS RECOMMENDED:

- C.S.R. Prabhu and A.P. Reddi , *Bluetooth Technology*; PHI
- Rappaport , *Wireless communication*, Pearson
- Schiller , *Mobile communication*, Pearson
- C.Y.Lee , *Mobile communication*, McGraw Hill.

MTED-208 SENSOR TECHNOLOGY AND MEMS

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

INTRODUCTION: Historical Development of Microelectronics, Evolution of Micro sensors, Evolution of MEMS, Emergence of Micro machines, Sensor Systems, Sensors types and classification, Mechanical Sensors, Acoustic Sensors, Magnetic Sensors, Thermal Sensors, Optical sensors Chemical Sensors, Radiation Sensors and Biosensors. Micro sensors, Sensors based on surface-acoustic wave devices. Review Of Fabrication Techniques (Lithography, PVD,CVD,RIE)

MICROMACHINING TECHNIQUES: Introduction to Bulk Micromachining, Isotropic and Orientation-Dependent Wet Etching, Dry Etching, Buried Oxide Process, Silicon Fusion Bonding, Sacrificial Layer Technology, Surface Micromachining using Plasma Etching, ,Combined 1C Technology and Anisotropic Wet Etching, Processes Using Both Bulk and Surface Micromachining, Adhesion Problems in Surface Micromachining, Surface Versus Bulk Micromachining

SMART SENSORS AND MODELING: Introduction to Smart Sensors, Integrated Smart sensors and smart systems, MEMS and NEMS devices, Elastic structures in MEMS and NEMS, Modeling of Thermal Elastic systems, Electrostatic- elastic systems, magnetically actuated systems, Microfluidics (Membrane Pumps, Nanolithography, Nano jets)

BOOKS RECOMMENDED:

- John A. Pelesko and David H. Bernstein , *Modeling MEMS and NEMS*, Chapman & Hall/CRC
- Vikas Choudhary and Krzysztof Iniewski, *MEMS Fundamental Technology and Applications*, CRC press
- Julian W. Gardner ,Vijay K. Varadan, *Micro sensors, MEMS and Smart devices*, John Wiley & Sons, Ltd
- Gerard C.M. Meijer, *Smart Sensor Systems*, 2008, John Wiley & Sons, Ltd.
- Ristic L (ed), *Sensor Technology and Devices*, Artech House, London, 1994.
- Sze S.M. (ed), *Semiconductor Sensors*, John Wiley, New York, 1994 Wise
- K.D. (Guest Editor), *Integrated Sensors, Micro p-actuators and micro-systems*
- MEMS, Special Issue of proceedings of IEEE, Vol. 86, No.8, August 1998.

MTED-209 SOFT COMPUTING

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

INRODUCTION: History of development in neural networks, neural network characteristics, Artificial neural network technology, Model of a neuron, topology, learning, types of learning, supervised, unsupervised and reinforcement learning.

SUPERVISED LEARNING: Basic hop field model, the perceptron, linear reparability, Basic learning laws, Hebb's rule, Delta rule, Widroff and Huff LMS learning rule, correlation learning rule, In star and out star learning rules. Unsupervised learning, competitive learning, K mean clustering algorithm, Kolwner's feature maps

RADIAL BASIS FUNCTION: Basic learning laws in RBF network, recurrent networks, recurrent back propagation, Real time recurrent learning algorithm.

COUNTER PROPAGATION NETWORKS: Introduction to counter propagation networks, CMAC networks, ART networks, Application of neural networks, pattern recognition, optimization, associative memories, vector quantization, control.

FUZZY LOGIC: Basic concepts of fuzzy logic, Fuzzy logic crisp set, Linguistic variable, Membership functions, Operation of fuzzy set, Fuzzy IF-THEN rules, Variable inference techniques, Defuzzification techniques, Basic fuzzy inference algorithm, Application of fuzzy logic, Fuzzy system design, Implementation of fuzzy system, Useful tools supporting design.

SUPPORT VECTOR MACHINES: Introduction, Support Vector classification, Support Vector regression, applications.

BASICS OF GENETIC ALGORITHMS: Evolution of Genetic and Evolutionary Algorithms, Applications.

BOOKS RECOMMENDED:

- Berkin R and Trubatch, *Fuzzy System Design Principles*, Prentice Hall
- Cristianini N and Taylor JS, *An Introduction to Support Vector Machines (and other Kernel –*
- *based learning methods),* Cambridge University Press
- Kosko B, *Nueral Networks and Fuzzy Logic*, Prentice Hall
- Haykin S, *Neural Networks*, Pearson Education
- Anderson JA, *An Introduction to Neural Networks*, Prentice Hall
- Sivanandam S and Deepa SN, *Principles of Soft Computing*, Wiley India

MTED-210 ADVANCED SENSOR AND ACTUATORS

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

MEASUREMENT TERMINOLOGY: Input and output, range, accuracy, precision, resolution, sensitivity, linearity, repeatability, reproducibility, calibration and traceability, Testing, quality assurance and safety.

TRANSDUCERSANDSENSORS: Sensors and transducers: Temperature sensors, resistive sensors, capacitive sensors, electrostatic sensors, piezoelectric sensors, ultrasonic sensors, radiological sensors and MEMS. Optical sensing techniques: Common electromagnetic sensors, IR sensors, passive IR sensors, photo-resistive sensors, photovoltaic sensors, photodiodes, photoelectric detectors, solid state lasers, CCD and CMOS sensors.

SMART SENSORS: Primary Sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing , Data Communication, Standards for Smart Sensor Interface, The Automation Sensors Applications: On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Sensors for environmental Monitoring.

ACTUATORS: Pneumatic and Hydraulic Actuation Systems, Actuation systems, Pneumatic and hydraulic systems, Directional Control valves, Pressure control valves , Cylinders, Servo and proportional control valves, Process control valves , Rotary actuators Mechanical Actuation Systems. Electrical Actuation Systems, Electrical systems, Solid-state switches Solenoids, D.C. Motors, A.C. motors, Stepper motors.

EMERGING TOPICS: Introduction to sensor networks, sensor fusion, soft and intelligent sensors. System on module, Virtual instrumentation, Intelligent instrumentation, Fault tolerance, Real time systems introduction, reference model, scheduling approaches.

BOOKS RECOMMENDED:

- D. Patranabis, *Sensors and Transducers*, PHI Learning Private Limited.
- W. Bolton, *Mechatronics*, Pearson Education Limited.
- D. Patranabis , *Sensors and Actuators*, 2nd Ed., PHI, 2013.

MTED-304 DIGITAL IMAGE PROCESSING

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

FUNDAMENTALS OF IMAGE PROCESSING: Introduction, Steps in image processing systems, Image acquisition, Sampling and Quantization, Pixel relationships, Color fundamentals and models, File formats, Image operations, Arithmetic, Geometric and Morphological.

IMAGE ENHANCEMENT: 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, Homo-morphic filtering

IMAGE SEGMENT ATION AND FEATURE ANALYSIS: Detection of Discontinuities, Edge operators, Edge linking and Boundary Detection, Thresholding, Region based segmentation, Morphological Watersheds, Motion Segmentation, Feature Analysis and Extraction.

MULTI RESOLUTION ANALYSIS AND COMPRESSIONS: Multi Resolution Analysis: Image Pyramids, Multi resolution expansion, Wavelet Transforms, Image compression: Fundamentals Models, Elements of Information, Error free compression, Lossy Compression, Compression Standards.

APPLICATION OF IMAGE PROCESSING: Image classification, Image recognition, Image understanding, Video motion analysis, Image fusion, Steganography, Digital compositing Mosaics, Colour Image Processing

BOOKS RECOMMENDED:

- Rafael C.Gonzalez and Richard E.Woods, *Digital Image Processing*, 2nd Edition, Pearson Education, 2003.
- Milan Sonka, Valclav Halavac and Roger Boyle, *Image Processing, Analysis and Machine Vision*, 2 nd Edition, Thomson Learning, 2001
- Anil K.Jain, *Fundamentals of Digital Image Processing*. Pearson Education, 2003

MTED-305 INDUSTRIAL AUTOMATION

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

COMPUTER BASED CONTRO: Implementing control system using computer or microprocessor; computer based controller: hardware configuration and software requirements.

DISTRIBUTED CONTROL SYSTEM: Meaning and necessity of distributed control; hardware components of DCS; DCS software.

INTRODUCTION PROGRAMMABLE LOGIC CONTROLLER (PLC): What is PLC? PLC versus microprocessor/microcontroller/computer, advantages and disadvantages of PLC, architecture and physical forms of PLC

BASIC PLC FUNCTIONS: Registers: holding, input and output registers; Timers and timer functions; counters and counter functions

INTERMEDIATE PLC FUNCTIONS: Arithmetic functions: addition, subtraction, multiplication, division and other arithmetic functions; Number comparison and conversion.

DATA HANDLING FUNCTIONS OF PLC: Skip function and applications; master control relay function and applications; jump with non-return and return; data table, register and other move functions.

BIT FUNCTIONS OF PLC: Digital bit functions and applications; sequencer functions and applications.

ADVANCED FUNCTIONS OF PLC: Analog input and output functions, analog input and output modules, analog signal processing in PLC; PID control function, network communication function.

PLC PROGRAMMING: PLC programming languages, ladder programming, mnemonic programming and high level language programming.

SCADA: Supervisory control versus distributed control; Layout and parts of SCADA system, detailed block schematic of SCADA system; Functions of SCADA system: data acquisition, monitoring, control, data collection and storage, data processing and calculation, report generation; MTU: functions, single and dual computer configurations of MTU; RTU: functions, architecture / layout; MTU-RTU communication and RTU-field device communication.

BOOKS RECOMMENDED:

- Johnson CD, *Process Control Instrumentation Technology*, Prentice Hall
- Webb JW and Reis RA, *Programmable Logic Controllers*, Prentice Hall
- Hackworth JR and Hackworth FD, "*Programmable Logic Controllers*," Pearson Edition
- Boyer SA, *Supervisory Control and Data Acquisition (SCADA)*, International Society of Automation

MTED-306 EMBEDDED WIRELESS SENSOR NETWORKS

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

ISSUES IN AD HOC WIRELESS NETWORKS: Medium Acces Scheme-Routing-Multicasting-Transport Layer Protocols-Self Organization-Security-Addressing and Service Discovery Energy management-Scalability-Deployment Considerations, Ad Hoc Wireless Internet. Sensor Networks Comparison with Adhoc wireless networks- Challenges for WSNs - Difference between sensor networks and Traditional sensor networks –Types of Applications –Enabling Technologies for Wireless Sensor Networks – Single Node Architectures –Hardware Components – Energy Consumption of Sensor Nodes, Issues in Designing a Multicast Routing Protocol. OS for WSN

SENSOR NETWORK ARCHITECTURE DATA DISSEMINATION: Flooding and Gossiping- Data gathering Sensor Network Scenarios –Optimization Goals and Figures of Merit – Design Principles for WSNs- Gateway Concepts – Need for gateway – WSN to Internet Communication – Internet to WSN Communication –WSN Tunneling.

MAC PROTOCOLS FOR SENSOR NETWORKS: Location Discovery-Quality of Sensor Networks-Evolving Standards-Other Issues- Low duty cycle and wake up concepts- The IEEE 802.15.4 MAC Protocols Energy Efficiency

APPLICATION OF SENSOR NETWORKS: Geographic Routing Mobile nodes, Routing Gossiping and Agent based Unicast Forwarding-Energy Efficient Unicast- Broadcast and Multicast Geographic Routing-Mobile nodes-Security-Application Specific Support - Target detection and tracking-Contour/ edge detection-Field Sampling.

BOOKS RECOMMENDED:

- C.S.R. Prabhu and A.P. Reddi , *Bluetooth Technology*; PHI
- Rappaport , *Wireless communication*, Pearson
- Schiller , *Mobile communication*, Pearson
- C.Y.Lee , *Mobile communication*, McGraw Hill.

MTED-307 CRYPTOLOGY AND CRYPTO CHIP DESIGN

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

BASIC CONCEPTS: Information system reviewed, LAN, MAN, WAN, Information flow, Security mechanism in OS, Targets: Hardware, Software, Data communication procedures. Threats to Security: Physical security, Biometric systems, monitoring controls, Data security, systems, security, Computer System security, communication security.

Encryptions Techniques: Conventional techniques, Modern techniques, DES, DES chaining, Triple DES, RSA algorithm, Key management, Message Authentication and Hash Algorithm: Authentication requirements and functions secure Hash Algorithm, NDS message digest algorithm, digital signatures, Directory authentication service

Firewalls and Cyber laws: Firewalls, Design Principles, Trusted systems, IT act and cyber laws, Virtual private network. Future Threats to Network: Recent attacks on networks, Case study.

APPLICATIONS: AES algorithm, Crypto chip design: Implementation of DES, IDEA AES algorithm, development of digital signature chip using RSA algorithm.

BOOKS RECOMMENDED:

- William Stalling, *Cryptography and Network Security*, Pearson Education, 2005
- Charels P. Pfleeger, *Security in Computing*, Prentice Hall, 2006
- Jeff Crume, *Inside Internet Security*, Addison Wesley, 2000.

MTED-308 SYSTEM ON CHIP

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

SYSTEM ON CHIP DESIGN: Technology Challenges in System on a Chip (SOC) components. SoC Design Methodology , Moving to System-on-Chip Design, Overview of the SOC Design Process, Canonical SoC Design, System Design Flow, System Architecture, Components of the system, Hardware & Software, Processor Architectures, System Architecture and Complexity. Parameterized Systems-on-a-Chip , System-on-a-chip Peripheral Cores .

MEMORY DESIGN FOR SOC: Overview of SOC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split Caches, Multilevel Caches, Virtual to real translation, SOC Memory System, Models of Simple Processor –memory interaction.

DESIGNING COMMUNICATIONS NETWORKS: Basic Architectures, SOC Standard Buses. Interconnect Customization and Configuration: Interconnect latency modeling, Inter Connect Architectures, Introduction to AMBA bus. Concept of PLB-processor local bus and OPB-on chip peripheral bus. Network on Chip.

VERIFICATION: System Level, Block Level and Hardware/Software Co-verification, SOC components: emulation, co-simulation, Physical Verification.

APPLICATION STUDIES / CASE STUDIES: AES algorithms, Image compression, VOIP, antenna for SOC etc

BOOKS RECOMMENDED:

- Wayone Wolf, *Modern VLSI Design: SOC Design*, Patience Hall
- Prakash Rashnikar, Peter Paterson, Lenna Singh, *System-On-A-Chip Verification methodology & Techniques*, Kluwer Academic Publishers.
- Alberto Sangiovanni Vincentelli, *Surviving the SOC Revolution: A Guide to Platform- based Design*, Kluwer Academic Publishers.
- Ricardo Reis, *Design of System on a Chip: Devices and Components*, 1st Ed, Springer, 2004

MTED-309 HARDWARE AND SOFTWARE CO-DESIGN

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

CO- DESIGN ISSUES: Co- Design Models, Architectures, Languages, a Generic Co-design Methodology. Co- Synthesis Algorithms: Hardware software synthesis algorithms: hardware – software partitioning distributed system co-synthesis.

PROTOTYPING AND EMULATION: Prototyping and emulation techniques, prototyping and emulation environments, future developments in emulation and prototyping architecture specialization techniques, system communication infrastructure Target Architectures: Architecture Specialization techniques, System Communication infrastructure, Target Architecture and Application System classes, Architecture for control dominated systems (8051-Architectures for High performance control), Architecture for Data dominated systems (ADSP21060, TMS320C60), Mixed Systems.

COMPILATION TECHNIQUES AND TOOLS FOR EMBEDDED PROCESSOR ARCHITECTURES: Modern embedded architectures, embedded software development needs, compilation technologies, practical consideration in a compiler development environment.

DESIGN SPECIFICATION AND VERIFICATION: Design, co-design, the co-design computational model, concurrency coordinating concurrent computations, interfacing components, design verification, implementation verification, verification tools and interface verification

LANGUAGES FOR SYSTEM: Level Specification and Design-I: System – level specification, design representation for system level synthesis, system level specification languages, Languages for System – Level Specification and Design-II: Heterogeneous specifications and multi-language co-simulation, the cosyma system and lycos system.

BOOKS RECOMMENDED:

- Jorgen Staunstrup, Wayne Wolf , *Hardware / Software Co- Design Principles and Practice*, Springer, 2009.
- Giovanni De Micheli, Mariagiovanna Sami , *Hardware / Software Co- Design*, Kluwer Academic Publishers , 2002
- Patrick R. Schaumont , *A Practical Introduction to Hardware/Software Co-design* , Springer, 2010

MTED-310 MEDICAL ELECTRONICS AND INSTRUMENTATION

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

HUMAN BODY SUBSYSTEMS: Brief description of neuronal, muscular, cardiovascular and respiratory systems; their electrical, mechanical and chemical activities.

CARDIOVASCULAR SYSTEM: Measurement of blood pressure, blood flow, cardiac output, cardiac rate, heart sounds; Electrocardiograph, Phonocardiograph, Plethysmograph.

RESPIRATORY SYSTEM: Measurement of gas volume, flow rate, carbon-dioxide and oxygen concentration in exhaled air.

ELECTRICAL ACTIVITY IN NEUROMUSCULAR SYSTEM AND BRAIN: Neuron potential, muscle potential, electromyography, brain potentials, electroencephalograph.

MEDICAL IMAGING: Fundamentals of imaging, Computed tomography, MRI, Nuclear Medicine, Singlephoton emission computed tomography, PET, Ultrasonography, Electrical Impedance, Tomography.

MEDICAL SAFETY: Electrical Safety, Electrical safety codes and standards; Radiation safety, Chemical safety, Biological safety, Fire and explosive safety, Environmental Safety.

ASSISTING AND THERAPEUTIC EQUIPMENTS: Pacemakers, Defibrillators, Ventilators, Nerve and Muscle stimulators, Diathermy, Heart-Lung machine, Infant incubators, Audio meters, Dialyzers.

BOOKS RECOMMENDED:

- Webster JG (Ed.), *Medical Instrumentation, Application and Design*, Wiley India
- Carr JJ and Brown JM, *Introduction to Biomedical Equipment Technology*, Pearson Education
- Waugh A and Grant A, *Ross and Wilson Anatomy and Physiology in Health and Illness*, Elsevier
- Webster JG (Ed.), *Encyclopedia of Medical Devices and Instrumentation*, Vols. 1-4, Wiley
- Bronzino JD (Ed.), *The Biomedical Engineering Handbook*, CRC Press

MTED-311 AUTOTRONICS

Internal Marks: 50 **L T P**

External Marks: 100 **3 1 0**

Total Marks: 150

FUNDAMENTAL OF AUTOMOTIVE ELECTRONICS: Current trends in modern automobiles, Open loop and closed loop systems, Components for electronic engine management, Electronic management of chassis system, Vehicle motion control.

SENSORS AND ACTUATORS: Introduction, basic sensor arrangement, types of sensors such as - oxygen sensors, Crank angle position sensors - Fuel metering / vehicle speed sensor and detonation sensor - Altitude sensor, flow sensor. Throttle position sensors, solenoids, stepper motors, and relays.

ELECTRONIC FUEL INJECTION AND IGNITION SYSTEMS: Introduction, Feed back carburetor systems (FBC) Throttle body injection and multi-port or point fuel injection, Fuel injection systems, injection system controls, Advantages of electronic ignition systems, Types of solid state ignition systems and their principle of operation, Contact less electronic ignition system, Electronic spark timing control.

AUTOMOTIVE ELECTRIC AND ELECTRONIC SYSTEMS: Electrical circuit components: wiring circuits, Printed circuits circuit breaker, symbols and wiring diagrams, Basic electrical Diagnosis and tests.

LIGHTS, SAFETY, DRIVER INFORMATION AND CONTROL DEVICES: Fiber-optic and Computer controlled Lighting, Horn and Horn relay, Vehicle Security systems: seat belts, Air bags, Driver Information and controls: instrument panel, speedometer and odometer Speed Control, Head Up Display, Networks and Multiplexing, Electronic Navigation systems, Cruise control systems.

BOOKS RECOMMENDED:

- Crouse. W.H., *Automobile Electrical equipment*, McGraw Hill Book Co Inc., New York, 1955.
- Crouse. W.H.., *Automotive Mechanics*, McGraw Hill Education Private Limited, 2006.
- Bechtold, *Understanding Automotive Electronic*, SAE, 1998.
- William B.Riddens, *Understanding Automotive Electronics*, 5th Edition, Butterworth, Heinemann Woburn, 1998.