

# **COIMBATORE INSTITUTE OF TECHNOLOGY**

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

**COIMBATORE - 641 014, TAMILNADU, INDIA**

**DIAMOND JUBILEE**

(1956 - 2016)



**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**  
**M.E. EMBEDDED AND REAL TIME SYSTEMS**

**Curriculum and Syllabi**

**Under Choice Based Credit System**

( For the students admitted during 2019 - 2020 and onwards )

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# **COIMBATORE INSTITUTE OF TECHNOLOGY**

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

## **VISION AND MISSION OF THE INSTITUTE**

### **VISION**

The Institute strives to "inculcate a sound knowledge in engineering along with realized social responsibilities to enable its students to combat the current and impending challenges faced by our country and to extend their expertise to the global arena".

### **MISSION**

The mission of CIT is to "impart high quality education and training to its students to make them world - class engineers with a foresight to the changes and problems, and pioneers to offer innovative solutions to benefit the nation and the world at large".

# **COIMBATORE INSTITUTE OF TECHNOLOGY**

(Government Aided Autonomous Institution Affiliated to Anna University, Chennai)

## **DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING**

### **VISION AND MISSION OF THE DEPARTMENT**

#### **VISION**

To empower graduates with "capabilities of Academic, Technical and Professional competence and to nurture them in the emerging fields of research, and innovative product development".

#### **MISSION**

The mission of the Electrical and Electronics Engineering program is to:

1. To make the students more active in using basic engineering and technology of the course by deep teaching learning method
2. To train the students to create new product development procedures by agile based learning and master the operation of systems engineering
3. To inculcate the ethics on realizing the importance of engineering, technology development and research on society and their future

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING  
COIMBATORE INSTITUTE OF TECHNOLOGY**

**PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)**

**Graduates of the ERTS programme will be able to fulfil all of the following Programme Educational Objectives for the curriculum :**

1. The engineers of Embedded and Real Time Systems possess technical and professional knowledge to design and develop systems.
2. The engineers acquire skills to provide optimal solutions for the challenges in the industry.
3. The graduates practice high ethical and technical standards and contribute for the advancement of society through scientific research.

**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING  
COIMBATORE INSTITUTE OF TECHNOLOGY**

**PROGRAM OUTCOMES (POs) AND PROGRAM SPECIFIC OUTCOMES**

<b>POs</b>	<b>PO Statements</b>
PO1	An ability to independently carry out research / investigation and development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document
PO3	An ability to design system solutions meeting the techno commercial and socio - economic needs

<b>PSOs</b>	<b>PSO Statements</b>
PSO1	An ability to select appropriate techniques to modernize the existing infrastructure in line with the industry standards
PSO2	An ability to apply concepts in Engineering analysis and design

# COIMBATORE INSTITUTE OF TECHNOLOGY

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## DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Curriculum from the Academic Year 2019 - 2020 onwards

Under Choice Based Credit System

Specialization : Embedded And Real Time Systems

### Semester I

Course Code	Course Name	L	T	P	C	Category
19MA11	Linear Algebra and Stochastic Processes	4	0	0	4	FC
19MER11	Real Time Operating Systems	3	1	0	4	PC
19MER12	Embedded Processors	3	0	0	3	PC
19MER13	Wireless Communication Sensors	3	0	0	3	PC
19MA14	Electromagnetic Interference and Compatibility	3	0	0	3	PC
	<b>ELECTIVE I</b>	3	0	0	3	PE
19MER14	Embedded Processors Laboratory	0	0	4	2	PC
	<b>Total</b>				<b>22</b>	

### Semester II

Course Code	Course Name	L	T	P	C	Category
19MA21	Automation and Industrial Internet of Things	3	0	0	3	PC
19MA22	Robotics Technology and Intelligence	3	0	0	3	PC
19MER21	Embedded System Design using FPGA	3	0	0	3	PC
	<b>ELECTIVE II</b>	3	0	0	3	PE
	<b>ELECTIVE III</b>	3	0	0	3	PE
	<b>ELECTIVE IV</b>	3	0	0	3	PE
19MER22	FPGA based Embedded System Design Laboratory	0	0	4	2	PC
19MAEE01	Feasibility Report Preparation	0	0	4	2	EEC 1
	One Credit Course				1	OCC1
	<b>TOTAL</b>				<b>23</b>	

### Semester III

Course Code	Course Name	L	T	P	C	Category
	<b>ELECTIVE V</b>	3	0	0	3	PE
	<b>ELECTIVE VI</b>	3	0	0	3	PE
	<b>OPEN ELECTIVE I</b>	3	0	0	3	OE
	One Credit Course				1	OCC 2
	<b>TOTAL</b>				<b>10</b>	

**Semester IV**

Course Code	Course Name	L	T	P	C	Category
19MER41	PROJECT - DISSERTATION	0	0	36	18	EEC2
	<b>TOTAL</b>				<b>18</b>	

**TOTAL CREDITS: 73**

(Note : FC - Foundation Course; PC - Professional Core; PE - Professional Elective; OC - Open Elective; EEC - Employability Enhancement Course; OCC - One Credit Course)

**LIST OF PROFESSIONAL ELECTIVES**

Course Code	Course Name	L	T	P	C	Category
	<b>EMBEDDED CONTROL OF INDUSTRIAL SYSTEMS</b>					
19MERE01	Intelligent Controllers for Power Quality Enhancement	3	0	0	3	PE
19MERE02	Embedded Control of Industrial Drives	3	0	0	3	PE
19MERE03	Design of Green Transportation System	3	0	0	3	PE
19MERE04	Embedded Sensors Networks	3	0	0	3	PE
	<b>ARCHITECTURE AND PROGRAMMING</b>					
19MERE05	Modeling and Design of Embedded Systems	3	0	0	3	PE
19MERE06	Multicore Architecture	3	0	0	3	PE
19MERE07	System Simulation and Modeling	3	0	0	3	PE
	<b>ELECTRONIC SYSTEM DESIGN</b>					
19MAE10	Digital System Design and Testing	3	0	0	3	PE
19MAE11	Synthesis and Optimization of Digital Circuits	3	0	0	3	PE
19MAE12	Computer Vision	3	0	0	3	PE
19MAE13	High Performance Computer Architecture	3	0	0	3	PE
	<b>EXPERT SYSTEMS</b>					
19MAE14	Cryptography and Block Chain Technologies	3	0	0	3	PE
19MAE15	Augmented Reality	3	0	0	3	PE
19MAE16	Data science & Analytics	3	0	0	3	PE
19MAE17	Network Virtualization	3	0	0	3	PE
19MAE18	Soft Computing	3	0	0	3	PE
19MAE19	Edge Computing	3	0	0	3	PE
19MAE20	Computer Security	3	0	0	3	PE

**LIST OF OPEN ELECTIVES**

S.No.	Course Code	Course Name	L	T	P	C	Category
1	19MEROE01	Design of Green Transportation System	3	0	0	3	OE
2	19MEROE02	Embedded Sensor Networks	3	0	0	3	OE
3	19MAOE04	Digital System Design and Testing	3	0	0	3	OE
4	19MAOE05	Data Science & Analytics	3	0	0	3	OE

**LIST OF ONE CREDIT COURSES\***

S.No.	Course Code	Course Name	C	Category
1	19MAOC01	Essential of Research	1	OCC
2	19MAOC02	Data analysis in EXCEL	1	OCC
3	19MAOC03	Educational Technology	1	OCC
4	19MAOC04	Industrial IoT on Google cloud platform	1	OCC
5	19MAOC05	Behavioral Psychology	1	OCC
6	19MAOC06	Battery Management Systems	1	OCC
7	19MAOC07	Communication Network for IoT	1	OCC
8	19MAOC08	Digital Twin Technology	1	OCC

\* One Credit Courses opted from Industry / NPTEL / Institute / Department

# 19MA11 - LINEAR ALGEBRA AND STOCHASTIC PROCESSES

L	T	P	C
4	0	0	4

## ASSESSMENT : THEORY

### COURSE OBJECTIVES

*The goal of this course is for students*

- *To acquire sound knowledge of techniques in explaining the fundamental concepts of Linear Algebra and their role in modern mathematics and applied contexts.*
- *To Apply Linear and Nonlinear Problems will be applied by them in the process field related to modern engineering.*
- *To inculcate an idea of probability in differential physical problems.*
- *To enrich the concepts of stochastic process those are vital for the study of Electrical engineering fields.*
- *To incorporate the ideas of special random process that is imperative for the effective understanding of electrical engineering fields.*

### COURSE OUTCOMES

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

- CO1** : *Assimilate the ideas of Linear Algebra and an ability to apply them.*
- CO2** : *Improve the facility in Linear and Nonlinear Programming problems.*
- CO3** : *Fluency in Applied Probability using standard distribution methods, including the ability to find distribution for the given natural problems.*
- CO4** : *Establish the knowledge about stochastic processes.*
- CO5** : *Demonstrate accurate and efficient use of special random processes.*

### LINEAR ALGEBRA

Vector spaces - Subspaces - Basis and Dimension - Linear transformation - Rank and Nullity - Inner product space - Gram Schmidt process - Least square problems. (12)

### LINEAR AND NONLINEAR PROGRAMMING PROBLEMS

Linear Programming Problems - Simplex method - Big M technique - Duality - Simple Problems Game Theory - Non linear programming problems - Graphical Solution - Kuhn - Tucker conditions with nonnegative Constraints. (12)

### APPLIED PROBABILITY

Probability - Axioms - Conditional Probability - Baye's theorem - One and Two dimensional random variables - Expectation - Conditional expectation - Correlation - Probability Distributions - Binomial, Poisson, Uniform Exponential, Normal and Weibull distributions - Chebyshev's inequality - Central limit theorem. (12)

### STOCHASTIC PROCESSES

Classification of random processes - Strictly and wide sense stationary processes - Ergodic process - Auto correlation - Cross correlation - Properties and problems - Power spectral density functions. (12)

### SPECIAL RANDOM PROCESSES

Markov process - Poisson process - Gaussian process - Linear time invariant systems - Linear system with random inputs - Auto correlation and cross correlation functions of input and output. (12)

**TOTAL : 60**

## TEXT BOOKS

1. *Gilbert Strang, "Introduction to Linear Algebra", Fifth Edition (2016), Wellesley - Cambridge Press.*
2. *Hamdy A. Taha, "Operations Research : An Introduction", Tenth edition (2019), Pearson Education.*
3. *Roy D. Yates and David J Goodman, "Probability and Stochastic Processes" - A friendly Introduction for Electrical and Computer Engineers, John Wiley & Sons, New Delhi, (2014).*

## REFERENCES

1. *David C Lay, "Linear Algebra and its applications" ,Pearson Education, Seventh Edition (2014)*
2. *KantiSwarup, P.K. Gupta and Man Mohan, "Introduction to Management science :Operations Research" Sultan Chand and Sons Publishers, Nineteenth Edition (2017)*
3. *Maurice Sasieni, Arthur Yaspan, "Operations Research: Methods and Problems", Literary Licensing, LLC, United states, (2013).*
4. *Sheldon M. Ross, "Introduction to Probability models", Academic Press, Eleventh Edition(2014)*
5. *Saeed Ghahramani, "Fundamentals of Probability with Stochastic Processes", CRC Press, Taylor & Francis Group, Fourth Edition(2018).*

# 19MER11 - REAL TIME OPERATING SYSTEMS

L	T	P	C
3	1	0	4

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

To hone the students in problem solving, and to study the issues related to the design and analysis of systems with Real - time constraints and to learn the features of Real time OS.

### COURSE OUTCOMES

**CO1** : The students can develop the knowledge about Schedulability analysis.

**CO2** : The students can apply various real time algorithms in Real - time programming environments.

**CO3** : The students can improve the Knowledge about real time communication and databases.

**CO4** : The students can implement the RTOS development tools in real time systems.

### REAL TIME SYSTEMS

Introduction to real time computing - Concepts; Example of real - time applications - Structure of a real time system - Characterization of real time systems and tasks - Hard and Soft timing constraints - Design Challenges - Performance metrics - Prediction of Execution Time : Source code analysis, Micro - architecture level analysis, Cache and pipeline issues - Programming Languages for Real - Time Systems. **(9+3)**

### KERNEL STRUCTURES

Real time OS - Threads and Tasks - Structure of Microkernel - Time services - Scheduling Mechanisms Communication and Synchronization - Event Notification and Software interrupt. **(9+3)**

### SCHEDULING

Task assignment and Scheduling - Task allocation algorithms - Single - processor and Multiprocessor task scheduling - Clock - driven and priority - based scheduling algorithms - Fault tolerant scheduling. **(9+3)**

### COMMUNICATION AND NETWORKING

Real Time Communication - Network topologies and architecture issues - protocols - contention based, token based, polled bus, deadline based protocol, Fault tolerant routing. RTP and RTCP. **(9+3)**

### PRIORITIES AND ISSUES

Real time Databases - Transaction priorities - Concurrency control issues - Disk scheduling algorithms - Two phase approach to improve predictability. **(9+3)**

**TOTAL : 60**

### TEXT BOOK

1. C.M. Krishna, Kang G. Shin - " Real Time Systems", International Edition, McGraw Hill Companies, Inc., New York, 1997.

### REFERENCES

1. Philip A. Laplante, "Real Time Systems Design and Analysis - An Engineers Handbook", IV Edition - IEEE Press, IEEE Computer Society Press, 2012.

2. Jean J Labrosse, "MicroC/OS - II the Real Time Kernel" II Edition, CMP Books, 2002.

# 19MER12 - EMBEDDED PROCESSORS

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVE

To provide an exposure to the students on microcontrollers, their architecture and choose appropriate microcontroller for a real time application. To impart a thorough understanding about the programming techniques.

## COURSE OUTCOMES

The students can

**CO1** : learn to develop the hardware for embedded system application based on the processors.

**CO2** : Incorporate suitable microcontroller along with appropriate interfacing circuits and implement the same for an application with software programs.

**CO3** : Explore the features of the microcontrollers and provide apt solutions for any embedded application.

## PIC MICROCONTROLLER - ARCHITECTURE

PIC Architecture - RISC Architecture - Program Memory Organization - Branch, Call and Time Delay Loop - PIC I/O Port Programming - AL Instructions and Programs - PIC Bank Switching, Table Processing, Macros and Modules - PIC Configuration Registers - PIC Hardware Connection - ROM Loaders. (9)

## PIC INTERFACING

Timer Programming Timers 0 and 1 - Programming Timers 2 and 3 - Serial Port Programming - Interrupt Programming - Erasing and Writing to Flash - Reading and Writing Data to EEPROM - Standard and Enhanced CCP Modules - Compare Mode Programming - Capture Mode Programming - PWM Programming - ECCP Programming. (9)

## ARM ARCHITECTURE

ARM7TDMI Programmers Model - Processor Modes - Program Status Registers - Vector Table - Assembler Rules and Directives - Predefined Register Names - Macros - Assembler Operators - Literals - Load and Store Instructions Operand Addressing - Endianness - ARM rotation Scheme - Loading Constants and Addresses into Registers. (9)

## ARM PROGRAMMING

Data processing operations - Loops and Branches - LUT - Jump tables - Binary Searches - LDM/STM Instruction Full/Empty Ascending/Descending Stacks - Subroutines - Passing Parameters: In Registers, By Reference, On The Stack - ARM APCS - Exception Handling - Memory Mapped Peripherals - LPC2104 - LPC 2132 - Thumb Instruction Set - Thumb Programmers Model - Thumb Branch Instructions - Thumb Data Processing instructions - Thumb single register data transfer - Thumb multiple register data transfer instructions Thumb implementation. (9)

## EMBEDDED APPLICATIONS

ADC, DAC and sensor interfacing - LCD and Keyboard Interfacing - calculator with keypad - Relays and Optoisolators - Stepper Motor Interfacing - DC Motor Interfacing - PWM motor control with CCP - DC Motor Control with ECCP (9)

**TOTAL : 45**

## REFERENCES

1. Muhammad Ali Mazidi, "PIC Microcontrollers and Embedded Systems Using Assembly and C for PIC18", Pearson Education, 2016.
2. William Hohl, "ARM Assembly Language", CRC Press, Second Edition, 2015.

3. *John B. Peatman, "Design with PIC microcontrollers", Pearson Education, Singapore - 1998.*
4. *Andrew Sloss, Dominic Symes, and Chris Wright, "ARM System Developer's Guide Designing and Optimizing System", the Morgan Kaufmann Series, 2004.*
5. *Steve Furber, "ARM System - on - Chip Architecture", Addison - Wesley Professional; II Edition 2000.*
6. *ARM Architecture Reference manual, ARM Limited, 2014.*

# 19MER13 - WIRELESS COMMUNICATION SENSORS

L	T	P	C
3	0	0	3

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

To expose the students to different channel models, analyse the errors in channels during wireless communication and study the different sensor network simulators

### COURSE OUTCOMES

At the end of the course the students will be able to:

- CO1** : To understand the different parameters and channels in wireless communication, analyse the channel for errors and codes to control errors
- CO2** : To design the wireless system that are highly time bounded with reduced noise and improved efficiency
- CO3** : To incorporate certain sensor network developing tools and understand the underwater and video sensing networks

### PATH LOSS, SHADOWING AND MULTIPATH CHANNEL MODELS

Free - Space Path Loss, Two - Ray Model, Simplified Path Loss, Shadow Fading, Path Loss and Shadowing, Cell Coverage Area, Time - Varying Channel Impulse, Narrowband fading models, Autocorrelation, Cross Correlation, and Power Spectral Density, Envelope and Power Distributions, Level Crossing Rate and Average Fade Duration, Wideband Fading Models, Power Delay Profile, Coherence Bandwidth, Doppler Power Spectrum and Channel Coherence - Capacity in AWGN, Flat Fading, Selective Fading Channels. (9)

### BER ANALYSIS OF WIRELESS CHANNELS & ERROR CONTROL CODING

Error Probability for BPSK, QPSK and QAM in AWGN Channel, BER analysis of Fading Channels. Linear block codes - Polynomial representation of codes - Cyclic codes - Convolutional codes - Viterbi decoding algorithm - Other decoding methods of convolutional codes, Galois fields, BCH codes, Reed Solomon codes, Interleaving and Concatenated codes, Turbo codes, Low - Density Parity - Check codes. (9)

### WIRELESS SYSTEM DESIGN

Cellular System Design, Frequency Reuse in Cellular Systems, Co - channel Interference and its impacts, Erlang - D formula, Trunking efficiency, MIMO, Receiver Sensitivity, Link Budget, Noise Figure, Radio Planning, Wireless Communication System Design Flow, Design Considerations - High Level View of Wireless Communication Systems, 4G Physical Layer Systems, Case Studies from 4G Communication System. (9)

### WIRELESS, UNDERWATER AND VIDEO SENSOR NETWORKS

Sensor actor co - ordination problem, hierarchical sensor actor co - ordination mechanism, underwater WSN applications, Difference between USN and Terrestrial sensor network, USN protocol stack, MAC design, vector based routing design, hardware prototype design, software design and system testing, Panoptes, Cyclops, VSN calibration. (9)

### SENSOR NETWORK SIMULATORS AND CASE STUDIES

Basic WSN energy model, simulation based energy modeling, Giomosim - sensor sim, TOSSIM, power TOSSIM, power state module and analysis tools, MATLAB simulation of airport baggage handling system, Tele healthcare (ECG sensor and RF communication hardware) - light control(illumimots sensor and calibration) (9)

**TOTAL : 45**

## REFERENCES

1. Haesik Kim, *"Wireless Communications System Design"*, John Wiley & Sons, 2015
2. Andreas F Molisch , *"Wireless Communications"*, John Wiley & Sons, 2012
3. K.J. Ray Liu, Beibei Wang, *"Wireless AI : Wireless, Sensing, Positioning, IOT and communications"*, Cambridge University Press, 1st Edition, 2019.
4. Theodore S Rappaport, *"Wireless Communications"*, Pearson Education, Asia , New Delhi, 2009
5. David Tse and Pramod Viswanath, *"Fundamentals of Wireless Communication"*, Cambridge University Press, 2005.
6. Sitharama Iyengar S, Nandan Parmeshwaran, Balkrishnan N and Chuka D, *"Fundamentals of Sensor Network Programming, Applications and Technology"*, John Wiley & Sons, 2011.
7. Fei Hu and Xiaojun Cao, *"Wireless Sensor Networks Principles and Practice"*, CRC Press, 2010.

# 19MA14 - ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVE

*To learn the concepts, coupling principles, control and measurement techniques involved in the field of Electromagnetic Interference and Compatibility.*

## COURSE OUTCOMES

- CO1** : *At the end of the course, student will acquire knowledge in the Real - world EMC design constraints and make appropriate tradeoffs to achieve the most cost - effective design that meets all requirements.*
- CO2** : *Student can able to design electronic systems and high speed Printed Circuit boards without Errors or problems related to electromagnetic compatibility.*
- CO3** : *Student can understand the Measurement techniques for emission and about EMC standards.*

## EMI/EMC CONCEPTS

Concepts of EMI and EMC - Definitions and Units of parameters - Electromagnetic environment - Mechanisms of EMI generation - Practical experiences and concerns - Natural and Nuclear sources of EMI: Celestial Electromagnetic Noise, Lightning Discharge, Electrostatic Discharge, Electromagnetic Pulse - EMI from apparatus and circuits: Noise from Relays and Switches, Nonlinearities in circuits. (9)

## EMI COUPLING PRINCIPLES

Conducted, radiated and transient coupling - Common ground impedance coupling - Common mode and ground loop coupling - Differential mode coupling - Near field cable to cable coupling - Field to cable coupling - Power mains and Power supply coupling - Cross talk in transmission lines - Transients in transmission lines. (9)

## EMI CONTROL TECHNIQUES

Shielding - Filtering - Grounding - Electrical Bonding - EMI Suppression Cables - EMC connectors - Isolation transformer - Transient suppressors and Surge Suppression Devices. (9)

## EMC DESIGN OF PCBS

Component selection and mounting; Choice of resistors, inductors, capacitors, diodes, integrated circuits and voltage regulators, PCB trace impedance - Routing - Crosstalk control - Zoning - Grounding - VIAs connection - Line terminations. (9)

## EMI MEASUREMENTS AND STANDARDS

Open area test site Measurements - Measurement Precautions - Anechoic Chamber - TEM cell - Reverberating Chamber, GTEM cell - Comparison of test facilities - Civilian standards: CISPR, FCC, EN - Military standards: MIL 461/462. (9)

**TOTAL : 45**

## REFERENCES

1. V.P.Kodali, "Engineering EMC principles, Measurements and Technology", IEEE Press, Network, Wiley - Blackwell, Second Edition, 2016.
2. Clayton R. Paul, "Introduction to Electromagnetic compatibility" John Wiley & Sons, 2014.
3. David A. Weston, "Electromagnetic compability: Methods, Analysis, Circuits and Measurements" 3<sup>rd</sup> Edition, CRC Press, Septmber 29, 2016.
4. Henry W.Ott, "Noise Reduction Techniques in Electronics System", John Wiley and Sons, Newyork, 1998.
5. Bernhard Keiser, "Principles of Electromagnetic Compatibility", Artech house, 3<sup>rd</sup> Edition, 1994.
6. DonR.J. White Consultant Incorporate, "Handbook of EMI/EMC - Vol I - 1985", John Wiley and Sons, Newyork, 1988.

## 19MER14 - EMBEDDED PROCESSORS LABORATORY

L	T	P	C
0	0	4	2

### ASSESSMENT : PRACTICAL

#### COURSE OBJECTIVE

*Students can obtain a thorough understanding about the architecture and interfacing techniques of microcontroller.*

#### COURSE OUTCOMES

**CO1** : *Students can interface peripheral devices with embedded processors.*

**CO2** : *Students can choose appropriate microcontroller for the design specification with reference to a real time problem.*

**CO3** : *Students can troubleshoot embedded based hardware devices*

#### LIST OF EXPERIMENTS

1. Interface matrix keypad with microcontroller and display the key pressed on seven segment display.
2. Microcontroller based analog signal interface with LCD display.
3. Signal Generation - PWM, saw tooth, triangle waveform using microcontroller.
4. Analog sensor Interfacing and display the sensor input using microcontroller.
5. Serial communication of data using microcontroller.
6. Speed Control of Stepper Motor using microcontroller.
7. Implementation of Traffic Control System using microcontroller.
3. Modeling Microwave Oven
4. Chopper based motor speed Control using microcontroller.
5. Design of Microcontroller based motor speed control:
  - i) Changing the Firing Angle
  - ii) Thyristor Control
  - iii) Commutation
6. Design and experimental execution of a microcontroller based smart solar tilting system.
7. Modeling of an semi - automatic and fully automatic washing machine.
8. Congestion - free elevator control using microcontroller.
9. Interfacing computer system with IoT2040 Gateway and some basic commands used in IoT2040 Gateway in linux.
10. Sending analog value from IoT2040 Gateway to thing speak cloud and monitoring from thing speak account using internet.

# 19MA21 - AUTOMATION AND INDUSTRIAL INTERNET OF THINGS

L	T	P	C
3	0	0	3

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

The objective of this course is to acquaint students with sound knowledge base and skill sets to develop the necessities of Industrial internet of things based automation system design including automated process, assembly, control, communication and security with the modern cutting edge innovative technologies through Career Focus Areas as required by the smart manufacturing in industries.

### COURSE OUTCOMES

- CO1** : Get a understanding of what all is required for IoT and industrial automation Components.
- CO2** : Understand the architecture, emerging industrial infrastructure and challenges involved in deployment of IoT based industrial automation
- CO3** : Understand the concepts, programming and hardware design of Programmable Logic Controllers for smart automation and also discuss the network standards, interfacing and communication techniques.
- CO4** : Design and develop a suitable IIoT controller for automated system involving for smart manufacturing.
- CO5** : Discuss the fundamental requirements of process control systems and describe the architecture of various distributed control systems of IIoT and analysis the security issues and applications of IIoT in DCS

### INDUSTRIAL AUTOMATION: SENSORS, ACTUATORS AND SCADA

History and evolution of automation: Plants to Parts - Plant Layout - Types of automation - Transducer: Sensor and Actuator - Sensors - Types of sensors, sampling, analog to digital conversion, selection criteria of sensor and ADC - Data acquisition, storage and analytics - Real time analytics - Actuators - Types - Characteristics - Control of Actuators - Analog & Digital I/O Modules, SCADA System and RTU - IEDs - Analysis of Automated Flow Lines - material handling function - Automated Storage Systems - Product identification system: Barcode, RFID etc., - Concept of Data, Information, Knowledge and Wisdom - Understanding fundamental nuances between IoT and Big data - Usage of IoT data in various business domains. (9)

### INDUSTRIAL INTERNET OF THINGS

Concept and definitions - Embedded Systems - Computer Networks - M2M (Machine to Machine Communication) - Internet of Everything (IoE) - Machine Learning - Distributed Computing, - Artificial Intelligence - Industrial automation - Interoperability - Identification - localization - Communication, Software Defined Assets - Understanding IT and OT convergence: Evolution of IIoT - OT Components: Industrial control system, PLC, SCADA, DCS - IT Components: Hardware - Software - People ,Processes IIoT Adoption - Market statistics, early adopters, Roadmap - Business opportunities: Product + Service model - Development, deployment and monetization of applications as service - Use cases (9)

### PROGRAMMABLE LOGIC CONTROLLERS AND INDUSTRIAL COMMUNICATION SYSTEMS

Introduction - Relay logic - Block diagram of PLCs - hardware design - Logic Functions - Input & Output Modules - Programming of PLC Systems - Timer & Counter Instructions - Typical PLC Programming Exercises for Industrial Applications - smart PLCs Principles of interface, serial interface and its standards - parallel interfaces and buses - Characteristic features of industrial networks - Low level networks and their features - Field bus architecture - Use of field buses in industrial plants, functions, international standards, performance - HART network - PROFIBUS - PA: Basics, architecture, model, network design and system configuration - MODBUS - CAN BUS - Wireless Sensor Area Networks - Sensor nodes - WSN communication technologies - Bluetooth, zig bee and Wi - Fi - Cellular communication and LPWAN technologies - Applications. (9)

### DESIGN AND DEVELOPMENT OF IIOT SYSTEMS

IIoT reference architectures - Standardization initiatives - Interoperability issues - Industrial Internet Reference Architecture from Industrial Internet Consortium (IIC) - IIoT design considerations - Architectures Device, Network and Cloud - Centralized vs. distributed architectures - Networks, communication technologies and protocols - Industry 4.0: Smart factory initiative - Product, process and people integration - Smart factories and cyber physical systems - Design principles - Challenges. (9)

## DISTRIBUTED CONTROL SYSTEMS AND APPLICATIONS

Functional Requirements, Configurations - Distributed Control Systems - IIoT in DCS - Industrial cloud platforms - Industrial Gateways - Commercial Gateways solutions from Intel, Cisco - Cloud based Gateway solutions - Industrial IoT security - Industrial IoT and Security - Standards and Best practices - Common vulnerabilities - Remote health monitoring of the plant - Attack surfaces - Cyber security for Industrial Control Systems.

Automation, Control and IIoT Applications in Petroleum Refineries - Cement Plant - Thermal Power Plant - Pharmaceutical Industries - Steel plant - Water Treatment Plant - Automobile Industries - Smart Energy Management. (9)

**TOTAL : 45**

## REFERENCES

1. M.P.Grover, "Automation, Production Systems and Computer Integrated Manufacturing" Pearson Education Limited, New Delhi, 2015.
2. Clarence W. De Silva, "Sensors and actuators : Control System Instrumentation" CRC Press, 2007
3. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things" Academic Press, 1 Edition, June 2016.
4. Cuno Pfster, "Getting Started with the Internet of Things" Published by O'Reilly Media, Inc.2011.
5. Jose Cecilio, and Pedro Furtado, "Wireless Sensors in Industrial Time - Critical Environments" Springer International Publishing, Switzerland 2014.
6. Tyson Macaulay and Bryan Singer "Cyber Security for Industrial Control Systems" CRC Press, 2011.
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8. John W.Webb and Ronald A. Resis, "Programmable Logic Controllers", Prentice Hall of India Pvt.Ltd., New Delhi, 2009
9. Junaid Ahmed Zubairi and Athar Mahboob, "Cyber Security Standards, Practices and Industrial Applications: Systems and Methodologies" Information Science Reference (an imprint of IGI Global), USA, 2012.
10. S. M. Muyeen and Saifur Rahman, "Communication, Control and Security Challenges for the Smart Grid" The Institution of Engineering and Technology, London, United Kingdom, 2017.
11. Hasan Derhamy, "Architectural Design Principles for Industrial Internet of Things" Doctoral Thesis, Industrial Electronics, Luleå University of Technology, New Zealand, 2009.
12. Krishna Kant, "Computer - Based Industrial Control", Prentice Hall of India Pvt. Ltd., New Delhi, 2009.

# 19MA22 - ROBOTICS TECHNOLOGY AND INTELLIGENCE

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVE

To introduce the fundamentals of robotics, analysis and control of industrial robots with intelligence.

## COURSE OUTCOMES

**CO1** : They will be able to work with variety of sensors in Robotic systems.

**CO2** : They will be able to analyze the components of any Robotics system.

**CO3** : They are able to study the applications of Robotics in industries.

## INTRODUCTION

Robotics - basic components - classification - specifications, Robotic sensors - proximity and range sensors, ultrasonic sensor, touch and slip sensor. Vision system - image processing and analysis - data reduction, segmentation, feature extraction and object recognition. Robotic drives and actuators - electric, hydraulic, pneumatic - selection. (9)

## ROBOT END EFFECTORS AND TRAJECTORY PLANNING

End effectors - classification - mechanical, magnetic, vacuum and adhesive grippers. Gripper force analysis and gripper design. Work space analysis and motion analysis - pick and place operation, continuous path motion, interpolated motion, and straight line motion - manipulator kinematics - kinematic equation using homogeneous transformation and robot dynamics. (9)

## ROBOT CONTROL

Control of robot manipulator - state equations - constant solutions - linear feedback systems, single - axis PID control - PD gravity control - computed torque control, variable structure control - impedance control. (9)

## ROBOT INTELLIGENCE AND TASK PLANNING

Artificial Intelligence - techniques - state space - search problem reduction - predicate logic means and end analysis - problem solving - robot learning - task planning - basic problems in task planning - AI in robotics and Knowledge Based Expert System in robotics. (9)

## INDUSTRIAL ROBOTICS

Robot cell design and control - cell layouts - multiple robots and machine interference - work cell design - Work cell control - interlocks - error deduction and recovery - work cell controller - robot cycle time analysis. Safety in robotics, Applications of robot and future scope. (9)

**TOTAL : 45**

## REFERENCES

1. Fu, K.S., Gonzalez RC., and Lee C.S.G., "Robotics Control, Sensing Vision and Intelligence", McGraw Hill, 1987.
2. Robert J Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, New Delhi, 2013.
3. Deb. S. R, "Robotics Technology and Flexible Machine Design", Tata McGraw Hill, 2010.
4. Mikell. P. Groover, Michell Weis, Roger. N. Nagel, Nicolous G. Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw Hill, Int 2012.
5. Richard D Klafter Thomas A.Chmielewski and Michael Negin, "Robotic Engineering: An Integrated approach", Prentice Hall of India, New Delhi, 2010.

6. Nagrath I.J., Mittal R.K., "Robotics and Control", Tata McGraw Hill, Sixth reprint, 2007.
7. Corke, Peter, "Robotics, Vision and Control Fundamental Algorithms in MATLAB", Springer, 2017.
8. Siciliano, Bruno, Khatib, Oussama, "Springer Handbook of Robotics", Springer, 2016
9. Mark R Miller, Rex Miller, "Robots and Robotics: Principles, Systems, and Industrial Applications", McGraw - Hill Education, 2017
10. Kevin M. Lynch and Frank C. Park, "Modern Robotics: Mechanics, Planning, and Control", Cambridge University Press, 2017

# 19MER21 - EMBEDDED SYSTEM DESIGN USING FPGA

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVE

*Students can understand the concepts of FPGA and the need for FPGA in embedded systems.*

## COURSE OUTCOMES

**CO1** : *Students can learn the concepts of FPGA.*

**CO2** : *Students can design embedded system with appropriate FPGA based on applications*

**CO3** : *Students can write Verilog code for combinational and sequential logics*

**CO4** : *Students can design a communication module using Verilog.*

**CO5** : *Students can design a motor control module using Verilog*

## FPGA ARCHITECTURE AND OVERVIEW

Embedded system design flow - Robot Control System - Digital Design Platforms - Microprocessor based Design - Single - chip Computer/Microcontroller - based Design - Application Specific Standard Products (ASSPs) - Design Using FPGA - robotic rover application - FPGA Devices - FPGA and CPLD - Architecture of a SPARTAN - 3ETM FPGA - Floor Plan and Routing - Timing Model for a FPGA - FPGA Power Usage. **(9)**

## EMBEDDED SYSTEM DESIGN

FPGA - based Embedded Processor - Design Re - use Using On - chip Bus Interface - Creating a Customized Microcontroller - Robot Axis Position Control - FPGA - based Signal Interfacing and Conditioning - Motor Control Using FPGA - Case Studies for Motor Control - Prototype Using FPGA - FPGA Design Test Methodology. **(9)**

## VERILOG CONSTRUCTS

VLSI Design flow - behavioral style, the dataflow style, and structural style - Data types - Constants - Assignment Statement - Operators - Conditional Expressions - Statement types - Vector operations - Bit selects - Functions - Gate level modeling. **(9)**

## VERILOG MODELING COMBINATIONAL CIRCUITS

Combinational logic - Adders - Multiplexers - Decoders - Comparator - Parity Generators - ALU - Three state gate - UART model. **(9)**

## VERILOG MODELLING SEQUENTIAL CIRCUITS

Modelling Latches and Flip flops - Sequential logic - Memory - Registers - Counters - Modeling FSM design Synchronous and Asynchronous - Shift Register - Test bench verification. Stepper motor control, servo motor control. **(9)**

**TOTAL : 45**

## REFERENCES

1. *Rahul Dubey, "Introduction to Embedded System Design Using Field Programmable Gate Arrays" Springer - Verlag London Limited, 2009*
2. *John F. Wakerly, "Digital Design Principles and Practices", Pearson Education, Asia, III Edition, 2003.*
3. *Blaine Readler, "Verilog by Example: A Concise Introduction for FPGA Design", Full Arc Press, 2011.*
4. *J. Bhasker, "A Verilog HDL Primer, Third Edition Hardcover", Star Galaxy Publishing; 3<sup>rd</sup> Edition, 2005.*
5. *M. Rafiqzaman, Stevan A. McNinch, "Digital Logic with an Introduction to Verilog and FPGA Based Design", Wiley, 1<sup>st</sup> Edition, 2019.*

# 19MER22 - FPGA BASED EMBEDDED SYSTEM DESIGN LABORATORY

L	T	P	C
0	0	4	2

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : PRACTICAL

## COURSE OBJECTIVE

*Students can design and demonstrate logical operation in embedded system with FPGA.*

## COURSE OUTCOMES

**CO1** : *Students can learn the concepts of FPGA programming and implementation.*

**CO2** : *Students can design logical relations to be implemented in FPGA based on applications*

**CO3** : *Students can write Verilog code test it on FPGA for combinational and sequential logics*

**CO4** : *Students can design and demonstrate communication module in FPGA based system using Verilog.*

**CO5** : *Students can design and demonstrate motor control module in FPGA based system using Verilog*

## LIST OF EXPERIMENTS

Language : Verilog

Software : Xilinx

FPGA Board : Spartan 3E, Spartan 6

1. Encoders and decoders
2. Adders
3. Counters and shift register
4. Wallace Multiplier
5. 4 - bit ALU
6. Quadrature Encoder Interface
7. UART module
8. Control of dc servo motor
9. Control of stepper motor
10. Capture module

# 19MAEE01 - FEASIBILITY REPORT PREPARATION

L	T	P	C
0	0	4	2

## ASSESSMENT : PRACTICAL

### COURSE OBJECTIVE

*This course will focus on research proposal writing covering the objective, problem formulation, solution, methodology, budget and outcome.*

### COURSE OUTCOMES

- CO1** : *To understand the research grants that will fit with organization's strategies and capabilities, and develop systems for continuously identifying the best prospects.*
- CO2** : *To recognize the importance of secondary and internal research in the planning process and data, according to that each method of research is recognized. And will be able to budget appropriately for a given project.*
- CO3** : *To write professional grant proposals for corporate, private foundations and government grants in a way to maximize the chance of getting approved.*

### COURSE CONTENTS

This course will include the following areas:

1. Philosophy and process of conducting needs assessment
2. Parts of a proposal: Introduction, Problem Statement, Goals and Objectives, Methodology
3. Public and private funding sources: Foundation and public perspectives
4. Development of strategic program plan
5. Solutions
6. Literature review focused on evidence to support program
7. Budgeting
8. Building an effective grant writing team: collaboration and how it works
9. Submitting the grant proposal

### REFERENCES

1. Soraya M. Coley, Cynthia A. Scheinberg, "Proposal Writing Effective Grantsmanship for Funding", SAGE Publications, Fifth Edition, 2016
2. Dr. Beverly A. Browning, "Grant Writing For Dummies", John Wiley & Sons, 5th Edition, 2014.

# 19MERE01 - INTELLIGENT CONTROLLERS FOR POWER QUALITY ENHANCEMENT

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

*The objective of this course is to provide with overall understanding of various power quality phenomenon, definitions, their origin, industrial survey, monitoring, international standards and mitigation methods. It also includes various compensation techniques and to develop intelligent controllers for power quality mitigations applicable to various custom power devices.*

### COURSE OUTCOMES

- CO1** : *Understand the real causes of the power quality; distinguish between various categories of power quality problems and their impacts on performance and their economics.*
- CO2** : *Apply the knowledge of mathematics, and modern technological tools to solve the harmonics generation and other power quality issues in the power distribution networks and to develop an intelligent control algorithm for effective mitigation.*
- CO3** : *Introduce to apply economical solution techniques for power quality migration, various compensation methods using dedicated embedded controllers*

### QUALITY OF POWER DELIVERY AND CONVENTIONAL MITIGATION METHODS

Electric Power Quality - State of the Art on Power Quality - Classification of Power Quality Problems - Causes of Power Quality Problems - Effects of Power Quality Problems on Users - Classification of Mitigation Techniques for Power Quality Problems - Equipments Used to Enhance Power Quality - Power Quality Standards - Power Quality Monitoring - Future Directions and Opportunities for Power Quality Enhancement: Power Quality Sensitivity - Utility Based Versus Customer Based Correction - Interconnection Standards - Power Quality Performance Requirements and Validation. **(8)**

### SHUNT COMPENSATION

Passive and Active Shunt Compensation - Classification of Passive and Active Shunt Compensators - Principle of Operation and design of Passive Shunt Compensators - Introduction to Custom Power Devices - DSTATCOMs - Classification of DSTATCOMs - Generating Reference Currents Using Instantaneous PQ Theory - Principle of Operation, Control, design and analysis of DSTATCOMs - Development of embedded controller for DSTATCOM. **(9)**

### SERIES COMPENSATION

Passive and Active Series Compensation - Classification of passive and Active Series Compensators - Principle of Operation and design of Passive Series Compensators - Dynamic Voltage Restorer(DVR) - Rectifier Supported DVR - DC Capacitor Supported DVR - DVR Structure: Output Feedback Control of DVR using embedded controller. **(9)**

### UNIFIED POWER QUALITY CONDITIONER

UPQC Configurations - Principle of Operation and Control of Unified Power Quality Compensators - Analysis and Design of Unified Power Quality Compensators - Modelling, Simulation, and Performance of UPQCs **(7)**

### HARMONIC MITIGATION

Nonlinear Loads - Classification of Nonlinear Loads - Harmonic Propagation in the power systems and its effects - mitigation of harmonics - passive filters - limitations.

Active Power Filters - Shunt and Series Active Filters - Classification - Principle of Operation and Control of Shunt and Series Active Power Filters - Analysis and Design of shunt and Series Active Power Filters

Hybrid Power Filters - Classification of Hybrid Power Filters - Principle of Operation and Control of Hybrid Power Filters - Analysis

and Design of Hybrid Power Filters

Development intelligent controller for active and hybrid power filters.

(12)

TOTAL : 45

## REFERENCES

1. Bhim Singh, Ambrish Chandra and Kamal Al - Haddad, "Power quality problems and mitigation techniques" John Wiley and Sons Ltd, 2015
2. Arindam Ghosh and Gerard Ledwich "Power Quality Enhancement Using Custom Power Devices" Springer International Edition, 2011.
3. Math H. J. Bollen, "Understanding Power Quality Problems, Voltage Sags and Interruptions" Wiley India Pvt. Ltd. - new Delhi, 2011.
4. E. Acha, V.G.Agelidis, O.Anaya - Lara, T.J.E. Miller, "Power Electronic Control in Electrical Systems" Newnes an Imprint of Elsevier, 2006.
5. Grzegorz Benysek, "Improvement in the Quality of Delivery of Electrical Energy using Power Electronics Systems" Springer - Verlag London Limited 2007.
6. Math H. J. Bollen, "Understanding Power Quality Problems, Voltage Sags and Interruptions" Wiley India Pvt. Ltd. - new Delhi, 2011.
7. E. Acha, V.G.Agelidis, O.Anaya - Lara, T.J.E. Miller, "Power Electronic Control in Electrical Systems" Newnes an Imprint of Elsevier, 2006.
8. Grzegorz Benysek, "Improvement in the Quality of Delivery of Electrical Energy using Power Electronics Systems" Springer - Verlag London Limited 2007.

# 19MERE02 - EMBEDDED CONTROL OF INDUSTRIAL DRIVES

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVE

*To facilitate the students to understand the impact of electric drives with embedded systems in the control of modern industries and to afford innovative solutions by addressing their needs.*

## COURSE OUTCOMES

*At the end of the course the students will be able to:*

**CO1** : *Understand the models, new innovations required Electro - Mechanical systems via a roadmap - driven development process as required by modern industries.*

**CO2** : *Improve the embedded software development skills required for industrial drive systems*

**CO3** : *Develop an innovation attitude for the design, modeling, and development industrial drives systems.*

## INTRODUCTION

Electrical Drives - driving forces and evolving technologies - advantages and application range of electric drives - energy savings through drive system - elements of drive system - drive characteristics - load dynamics and steady state stability - multi-quadrant operation - electric motors for drives - power electronic converters for drives - Modern trends in industrial drives and control - Motor Control Sensors - Evaluation of microcontrollers for motor control - Selection of suitable control device for drives. **(9)**

## DC MOTOR DRIVES

Introduction to DC - motor drives - speed control of DC motor drive with controlled rectifiers and choppers - speed control using inner current loop and outer speed loop - design of current loop with pole - zero cancellation - simulation of DC drives - Embedded controller based implementation of DC drives - converter structure - modes of operation - control variable algorithm - initialization of ADC/Timers/Interrupts - voltage/ current sensing and comparison - PWM signal generation - Case study. **(9)**

## INDUCTION MOTOR DRIVES

Induction Motor Drives: Reference frame theory - transformation of variables from stationary to arbitrary reference frame - PWM inverter fed induction motor drives - Vector control - open loop and closed loop PWM control - sensor less IM drives : a study - direct torque and flux control - space vector PWM control. Embedded controller based speed control implementation for IM drives: system components - sensors - controllers - current/speed measurements - scaling operation - control algorithm of speed measurement during high - speed/low speed regions - development of closed loop control block - Case study. **(9)**

## SYNCHRONOUS MOTOR DRIVES

Open loop VSI fed drive and its characteristics - Self control - Torque control - Torque angle control - Power factor control - Brush less excitation systems - Starting methods - Field oriented control - Design of closed loop operation of Synchronous motor drive systems. PM Synchronous Motor Drives: Types and torque developed in PMSM - Stationary and rotor reference frame modeling of PMSM - PMSM control system - Case study. **(9)**

## SPECIAL MACHINES DRIVES

Switched Reluctance Motor drive: Fundamentals and control of SRM drives - open loop and closed control - Closed loop torque and speed control - Implementation of speed control algorithm using TMS 320F28335 processor.

Brush less DC Motor Drives: Principals of operation - torque generation - open loop and closed control of BLDC drive - Case study.

Stepper Motor Drives: Types and basic operation - stepper motor drive system - Implementation of control algorithm using MC68HC11E9 Microcontroller.

Introduction FPGA based implementation for Electric Drive Systems

(9)

TOTAL : 45

## REFERENCES

1. Bose B K, "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pvt. Ltd, New Delhi, 2014.
2. Ion Boldea and Nasar S A, "Electric Drives", CRC Press LLC, New York, 2008.
3. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC Motor Drives" CRC Press, Taylor & Francis Group, 2010.
4. Richard Valentine, "Motor Control Electronics Handbook" McGraw Hill, New York, 2006.
5. Hamid A. Tallyat, Steven Campbell, "DSP - Based Electromechanical Motion Control", SRS Press, 2004
6. G.K. Dubey, "Power Semiconductor Controlled Drives" John Wiley and Sons, New York, 1999.
7. G.K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, edition, 2010.
8. Vedam Subramaniam, "Electrical Drives and Applications", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.
9. Qian Cheng & Lei Yuan, "Vector Control of an Induction Motor based on a DSP", Master of Science Thesis, Chalmers University of Technology, Sweden, 2011.
10. Data Manual of "TMS320 F 28335 Digital Signal Controllers", released by Texas Instruments (2012) available in <http://www.ti.com/DSC>.
11. Bob King and Edgar Saenz, "Stepper Motor Control with an MC68 HC 11E9 Microcontroller", released by Free Scale Semiconductor document (AN 1285/D) available in <http://www.freescale.com/AN1245/D>.
12. M.N. Cirstea, et.al, "Neural and Fuzzy Logic Control of Drives and Power Systems" Newnes - An imprint of Elsevier Science, Oxford, 2012.

# 19MERE03 / 19MEROE01 - DESIGN OF GREEN TRANSPORTATION SYSTEM

L	T	P	C
3	0	0	3

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

*The objective of this course is to provide and develop a detailed description of green transportation engineering, sustainability assessment, environmental benefits, alternate fuel based vehicle design, economic aspects of electric vehicle, legislative compliances, performance analysis and real time safety issues.*

### COURSE OUTCOMES

*At the end of the course the student will be able to:*

- CO1** : *Understand the complexity of an automobile system as a whole unit and to define the functionalities of various components in electric/hybrid/plug-in hybrid vehicles.*
- CO2** : *Introduce the components of elective vehicles such as electric motors, batteries and power converters and able to design their industrial models as a sub system of complete transportation.*
- CO3** : *Design solar PV and fuel cell based electric vehicles according to the international standards and to perform various testing on the vehicle to serve up for the society and environment.*

### INTRODUCTION

Introduction to alternate vehicles - limitations in conventional vehicles-Vehicle classification and architecture - hybrid electric vehicles - plug-in hybrid electric vehicles --need for electric vehicles- vehicle dynamics -propulsion power - velocity and acceleration performance -Roll over - Yaw control-Well to Tank (WTT) and Tank to Wheel (TTW) energy transport - tire-road force mechanics - power train configurations -tractive effort- sizing methodology of power train components -vehicle braking system -EV design considerations- research challenges in electric vehicle - electric vehicle market analysis. **(8)**

### ARCHITECTURE OF EV AND ITS COMPONENTS

Functional blocks of EV System-Motor drives - brushless DC motors -permanent magnet synchronous machines - switched reluctance machines - multi quadrant operation-Battery based energy storage: Introduction to battery - electrical and thermal parameters -types of battery- battery efficiency and capacity - electric circuit and empirical modelling of battery systems - charging and discharging performance - heavy duty traction batteries-super capacitors-Power converters: DC-DC converters - non-isolated and isolated DC-DC converters - DC-AC converters-PWM control -Motoring and regenerative braking - design of closed loop control-Types of charging stations-specifications-Design of Level 1 and Level 2 and Level 3 charging stations-comparison **(12)**

### SOLAR PV BASED EV DESIGN

Modelling of PV system - solar-sun related parameter estimation - irradiation measurement on moving vehicle - array temperature distribution - charge controllers - MPPT algorithm - up hill motoring operation-Downhill regenerative operation -power converter topologies - high efficiency micro controllers for power converters - closed loop motor control - design example of solar PV based electric vehicle. **(9)**

### FUEL CELL BASED EV DESIGN

Introduction to fuel cell- basic fuel cell structure and characteristics - Fuel cell types and comparison - electric circuit model of fuel cell - conventional and advanced hydrogen storage system - fuel cell processing technology and transportation -fuel cell emission - Design example of fuel cell based electric vehicle: Selection of FC stack - FC controller - power converters - battery pack and motors - safety issues for hydrogen based electric vehicles. **(9)**

### EV- PERFORMANCE AND SAFETY ISSUES

Electric vehicle verses IC engine vehicle comparison: efficiency comparison - pollution comparison - capital and operating cost comparison -GHG emission -emission standards and comparison - United Nations Framework Convention on Climate Change

(UNFCCC) - Kyoto protocol -UNFCCC Paris climate change summit (COP 21) - legislation and standardizations for electric vehicles - Initiatives of Government of India:National Electric Mobility Mission Plan (NEMMP) 2020-FAME-I & II- EV performance testing-safety requirements of electric vehicles.

(7)

TOTAL : 45

## REFERENCES

1. Ali Emadi, MehrdadEhsani, "Vehicular Electric Power Systems" Marcel Dekker, Inc., New York, 2014.
2. Iqbal Hussain, "Electric & Hybrid Vehicles - Design Fundamentals", Second Edition, CRC Press, 2011.
3. SandeepDhameja, "Electric Vehicle Battery Systems" Newnes, an imprint of Elsevier, 2013.
4. J.M. Miller, "Propulsion Systems for Hybrid Vehicles", Institution of Electrical Engineers (IEE), London, UK, 2004.
5. R. Stone and J.K. Bell, "Automotive Engineering Fundamentals", SAE International, Warrendale, PA, 2004.
6. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.
7. Eric ForstaThacher, "A Solar Car Primer - A guide to the design and construction of solar-powered racing vehicles", Springer International Publishing Switzerland, 2015.
8. Hybrid and electric vehicle solutions guide - released by Texas Instruments, 2011 available in [www.ti.com/hev](http://www.ti.com/hev).
9. Indian vehicle emission standards: <https://www.dieselnet.com/standards/in/2wheel.php>
10. Zero Emission Vehicles (ZEVs):Towards a Policy Framework [https://niti.gov.in/writereaddata/files/document\\_publication/EV\\_report.pdf](https://niti.gov.in/writereaddata/files/document_publication/EV_report.pdf)
11. National Electric Mobility Mission Plan (NEMMP) 2020-<https://dhi.nic.in/writereaddata/Content/NEMMP2020.pdf>.

# 19MERE04 / 19MEROE02 - EMBEDDED SENSOR NETWORKS

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVE

To introduce the basic concepts of Embedded Sensor Networks, the current, diverse research on sensor networks in a comprehensive manner and expose the fundamental issues in designing and analyzing sensor network information processing systems.

## COURSE OUTCOMES

The students will gain knowledge

**CO1** : About information processing techniques with the architecture of different layers in a sensor network

**CO2** : About the communication subsystem, sensor tasking and control, and data management.

**CO3** : About various platform to implement WSN.

## INTRODUCTION

Over view of sensor networks - Constraints and Challenges - Advantages of sensor networks - Sensor Network Applications - Collaborative Processing - Key definitions in sensor networks - Tracking scenario - Problem formulation - Sensing model - Collaborative Localization - Bayesian Estimation - Distributed representation and interference of states - Tracking multiple objects - State Space Decomposition - Data Association - Sensor models - performance comparison and metrics. (9)

## NETWORKING SENSORS

Key assumptions - Medium access control - A survey of MAC protocols for WSN - S - MAC Protocol - IEEE 802.15.4 standard and Zig Bee - Energy efficient design of wireless sensor nodes - General Issues Geographic, Energy - Aware Routing - Unicast Geographic Routing - Routing on a curve - Energy Minimizing Broadcast - Energy Aware Routing to a Region - Attribute based routing - Directed Diffusion - Rumor Routing Geographic Hash table. (9)

## INFRASTRUCTURE ESTABLISHMENT

Topology control - Clustering - Time synchronization - Clocks and Communication Delays - Interval Methods Reference Broadcasts - Localization and Localization Services - Ranging Techniques - Range Based Localization Algorithms - Location Services - Task driven sensing - Role of sensor nodes and Utilities Information based Sensor Tasking - Sensor Selection - IDSQ - Cluster leader based Protocol - Sensor tasking in tracking relations - Joint Routing and Information aggregation - Moving Centre of Aggregation - Multistep Information Aggregation - Multistep Information Directed Routing - Sensor Group Management. (9)

## SENSOR NETWORK DATABASE

Sensor Database Challenges - Querying the physical environment - Query Interfaces - Cougar Sensor Database - Probabilistic Queries - In - network aggregation - Query Propagation and Aggregation - Tiny DB Query Processing - Query processing Scheduling and Optimization - Data centric storage - Data indices and range queries - Distributed Hierarchical aggregation - Multi resolution Summarization - Partitioning the summaries - Fractional Cascading - Locality Preserving Hashing - Temporal data - Data Aging - Indexing Motion Data. (9)

## SENSOR NETWORK PLATFORMS AND TOOLS

Sensor Node Hardware - Sensor network programming challenges - Node level software platforms Operating system Tiny OS - Node level simulators - State centric programming - Applications - Core challenges - Research directions - Tiered architectures - Distributed signal processing - Monitoring and Debugging - Security and Privacy. (9)

**TOTAL : 45**

## REFERENCES

1. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks An Information Processing Approach", Morgan Kaufmann Publishers, 2004.
2. Ian F. Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks" John Wiley, 2011.
3. Yingshu Li, My T. Thai, Weili Wu, "Wireless Sensor Networks and Applications" Springer 2008
4. Holger Karl & Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005.
5. C.S. Raghavendra, Krishna M. Sivalingam and Taieb Znati, "Wireless Sensor Networks Springer Publishers, 2006.

# 19MERE05 - MODELING AND DESIGN OF EMBEDDED SYSTEMS

L	T	P	C
3	0	0	3

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

To model, design, analyze and verify an Embedded system and to understand the concepts of cyber physical systems in Embedded systems

### COURSE OUTCOMES

Students will be able to

**CO1** : Understand the design process and distinguish various state machine models

**CO2** : Design various models, analyze and verify Embedded systems related to its physical processes

**CO3** : Analyze the designed models quantitatively

### INTRODUCTION

Cyber Physical Systems as Embedded Systems - Applications - The Design Process - Modeling Dynamic behaviour - Continuous dynamics and discrete dynamics. (9)

### STATE MACHINES

Composition of State Machines - Concurrent Composition - Hierarchical State Machines - Concurrent Models of Computation - Structure of Models - Synchronous - Reactive Models - Dataflow Models of Computation - Timed Models of Computation - automatic model based test generation from UML state machine (9)

### DESIGN OF EMBEDDED SYSTEMS

Embedded Processors - Types of Processors - Parallelism - Memory Architectures - Memory Hierarchy - Memory Models - Input and Output - I/O Hardware - Sequential Software in a Concurrent World - The Analog/Digital Interface (9)

### ANALYSIS AND VERIFICATION

Invariants and Temporal Logic - Invariants - Linear Temporal Logic Equivalence and Refinement - Models as Specifications - Type Equivalence and Refinement - Language Equivalence and Containment - Simulation - Bisimulation - Reachability Analysis and Model Checking - Open and Closed Systems - Reachability Analysis - Abstraction in Model Checking - Model Checking Liveness Properties (9)

### QUANTITATIVE ANALYSIS

Problems of Interest - Programs as Graphs - Factors Determining Execution Time - Basics of Execution Time Analysis - Other Quantitative Analysis Problems. (9)

**TOTAL : 45**

### REFERENCES

1. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems - A Cyber - Physical Systems Approach", 1 Edition (www.LeeSeshia.org), 2011.
2. Axel Jantsch, "Modeling Embedded Systems and SoC's: Concurrency and Time in Models of computation", morgan kaufman publishers,2001
3. Wayne Wolf, "Computers as Components: Principles of Embedded Computer Systems Design", Morgan Kaufman Publishers, 2004.
4. David E Simon, "An embedded software primer", Pearson Education Asia, 2001.
5. Justyna Zander, Ina Schieferdecker, Pieter J. Mosterman, "Model - Based Testing for Embedded Systems", CRC press,2012

# 19MERE06 - MULTI CORE ARCHITECTURE

L	T	P	C
3	0	0	3

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

*Understand the challenges in parallel & multi thread processing and execution of the various processes*

### COURSE OUTCOMES

*Students will be able to*

**CO1** : *Learn various processes within multicore capabilities*

**CO2** : *Understand different memory organization and the protocols*

**CO3** : *Develop a programming model for open MP and MPI Programming*

### SUPERSCALAR PROCESSORS

Multicore drivers & challenges - Fundamentals of Superscalar Processor Design, Introduction to Multicore Architecture - memory hierarchy design - Chip Multiprocessing, homogeneous Vs heterogeneous design - SMP - Multicore Vs Multithreading. (9)

### MEMORY ORGANIZATION

Shared memory architectures - synchronization - Memory organization - Cache Memory - Cache Coherency Protocols - Basic cache optimizations - Design of Levels of Caches. (9)

### MULTICORE PROGRAMMING MODEL

Shared memory model - message passing model - transaction model - Open MP and MPI Programming - task scheduling algorithm for multi core processor. (9)

### POWERPC ARCHITECTURE

RISC design - PowerPC ISA - PowerPC Memory Management - Power 5 Multicore architecture design - Power 6 Architecture - RISC exceptions(synchronous, asynchronous precise, imprecise). (9)

### PROGRAMMING SUPPORT FOR MULTI - CORE/MANY - CORE PROCESSORS

Cell Broad band engine architecture, PPE (Power Processor Element), SPE (Synergistic processing element), Cell Software Development Kit, Programming for Multicore architecture - Shared memory model - message passing model - transaction model - Open MP and MPI Programming. - Threading API for Microsoft Win 32/MFC thread API (9)

**TOTAL : 45**

### REFERENCES

1. *"Multi - Core Programming Increasing Performance through Software Multi - threading", Shameem Akhter Jason Roberts, Intel PRESS*
2. *Hennessey & Paterson, "Computer Architecture A Quantitative Approach", Harcourt Asia, Morgan Kaufmann, 1999.*
3. *Joseph JaJa, Introduction to Parallel Algorithms, Addison - Wesley, 1992.*
4. *IBM Journals for Power 5, Power 6 and Cell Broadband engine architecture.*
5. *Richard Y. Kain, "Advanced Computer Architecture: A System Design Approach", PHI, 1999.*
6. *Rohit Chandra, Ramesh Menon, Leo Dagum, and David Kohr, Parallel Programming in Open MP, Morgan Kaufmann, 2000.*
7. *Kai Hwang, "Advanced Computer Architecture: Parallelism, Scalability and Programmability" McGrawHill, 1993*

# 19MERE07 - SYSTEM SIMULATION AND MODELING

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVE

*To understand the concepts of simulation of a system and modeling to learn its behaviour.*

## COURSE OUTCOMES

**CO1** : *Students can understand the concepts in simulation*

**CO2** : *Students can develop a model to represent the system and to test for functionality.*

**CO3** : *Students can learn various methods to determine the performance of a system.*

## SYSTEM AND SYSTEM ENVIRONMENT

Concept of a system - continuous and discrete systems - models of a system - modeling approaches - advantages and disadvantages of simulation systems - steps in simulation study - point estimates, confidence interval. Simulation Examples: Simulation of Queuing systems, Simulation of Inventory System, simulation examples. (9)

## MATHEMATICAL MODELS

Statistical Models - Concepts - Distribution - exponential, Poisson, Uniform, Weibull - Empirical distribution - Normal distribution - building on empirical distribution - rejection method - Queuing Models - Characteristics - Notation - Queuing Systems - Markovian Models - Markovian - Non Markovian models - Discrete and Continuous time Markov Chains - Markov reward models - Semi Markov models - Markov regenerative models. (9)

## RANDOM NUMBERS AND RANDOM VARIATE GENERATION

Properties of random numbers - Generation of pseudo - random numbers Techniques for generating random numbers - Tests for Random Numbers - Random - Variate Generation: Inverse transform technique; Acceptance Rejection technique; Special properties. (9)

## ANALYSIS OF SIMULATION DATA

Data Collection - Identifying the distribution with data - Parameter estimation - Goodness of Fit Tests - Fitting a non - stationary Poisson process - Selecting input models without data - Output analysis for terminating simulations - Output analysis for steady - state simulations. (9)

## VERIFICATION, CALIBRATION, VALIDATION AND OPTIMIZATION

Model Building - Verification of Simulation Models - Calibration and Validation of Models - Validation of Model Assumptions - Validating Input - Output Transformations - optimization via Simulation. (9)

**TOTAL : 45**

## REFERENCES

1. *Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol: Discrete - Event System Simulation, 5<sup>th</sup> Edition, Pearson Education, 2010.*
2. *Lawrence M. Leemis, Stephen K. Park: Discrete - Event Simulation: A First Course, Pearson Education, 2006.*
3. *Averill M. Law: Simulation Modeling and Analysis, 4<sup>th</sup> Edition, Tata McGraw - Hill, 2007.*
4. *Geoffrey Gordon, "Systems Simulation", 2<sup>nd</sup> Edition, Prentice Hall, India, 2002.*

# 19MAE10 /19MAOE04 - DIGITAL SYSTEM DESIGN AND TESTING

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVES

- To realize and design hazard free circuits and to familiarize the practical issues of sequential circuit Design.
- To gain knowledge about different fault diagnosis, testing methods and to estimate the performance of digital systems
- To analyze synchronous and asynchronous sequential circuits

## COURSE OUTCOMES

**CO1** : With the knowledge of state table and flow table students can design a synchronous and asynchronous sequential circuit after applying state and flow table minimization technique.

**CO2** : The students can diagnose a digital circuit for faults using suitable testing methods.

**CO3** : The students can design the digital system using VHDL

## SEQUENTIAL CIRCUIT DESIGN

Analysis of clocked synchronous sequential circuits and modeling - State diagram, state table, state table assignment and reduction - design of synchronous sequential circuits - design of iterative circuits - ASM chart and realization using ASM. (9)

## ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN

Analysis of asynchronous sequential circuit - flow table reduction - races - state assignment - transition table and problems in transition table - design of asynchronous sequential circuits - Static, dynamic and essential hazards - data synchronizers - mixed operating mode asynchronous circuits - designing vending machine controller. (9)

## FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS

Fault table method - path sensitization method - Boolean difference method - D algorithm - Tolerance techniques - The compact algorithm - Fault in PLA - Test generation - DFT schemes - Built in self test. (9)

## SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES

Programming logic device families - Designing a synchronous sequential circuit using PLA/PAL - Realization of finite state machine using PLD - FPGA - Xilinx FPGA - Xilinx 4000. (9)

## SYSTEM DESIGN USING VHDL

VHDL operators - Arrays - concurrent and sequential statements - packages - Data flow - Behavioural - structural modeling - compilation and simulation of VHDL code - Test bench - Realization of combinational and sequential circuits using HDL - Registers - counters - sequential machine - serial adder - Multiplier - Divider - Design of simple microprocessor. (9)

**TOTAL : 45**

## REFERENCES

1. Charles H.Roth Jr "Fundamentals of Logic Design" Thomson Learning 2004.
2. Nripendra N Biswas "Logic Design Theory" Prentice Hall of India, 2001.
3. Parag K.Lala "Fault Tolerant and Fault Testable Hardware Design" B S Publications, 2002.
4. Parag K.Lala "Digital system Design using PLD" B S Publications, 2003.
5. Charles H Roth Jr."Digital System Design using VHDL" Thomson learning, 2004.
6. Douglas L.Perry "VHDL programming by Example" Tata McGraw Hill, 2006.

# 19MAE11 - SYNTHESIS AND OPTIMIZATION OF DIGITAL CIRCUITS

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVES

- To understand the compilation techniques for hardware models, Architectural - level synthesis and optimization, including scheduling, resource sharing.
- To know the Logic - level synthesis and optimization techniques for combinational and synchronous sequential circuits.
- To gain a knowledge in Library binding algorithms

## COURSE OUTCOMES

The students can:

**CO1** : Design a microelectronic circuit applying the suitable scheduling and resource sharing techniques.

**CO2** : Implement a two, multiple level sequential logic circuit after optimization

**CO3** : Implement circuit with specific cell libraries

## CIRCUITS AND MODELS

Microelectronics - Microelectronic Design Styles - Design of Microelectronic Circuits - Computer - Aided Synthesis and Optimization - Computer - Aided Simulation - Computer - Aided Verification Testing and Design for Testability - Graphs - Undirected Graphs - Directed Graphs - Perfect Graphs - Combinatorial Optimization - Decision and Optimization problems Algorithms - Tractable and Intractable Problems - Fundamental Algorithms - Graph Optimization Problems and Algorithms - The Shortest and Longest Path Problems (9)

## ARCHITECTURAL - LEVEL SYNTHESIS AND OPTIMIZATION

Hardware Modeling - Structural, Behavioral Hardware Languages, HDLs Used for Synthesis, Abstract Models Compilation and Behavioral Optimization. Architectural Synthesis - Area and Performance Estimation - Strategies for Architectural Optimization - Data - Path Synthesis - Control - Unit Synthesis - Synthesis of Pipelined Circuits. (9)

## SCHEDULING ALGORITHMS

Scheduling without Resource Constraints - Scheduling with Resource Constraints - Scheduling Algorithms for Extended Sequencing Models - Scheduling Graphs with Alternative Paths - Scheduling Pipelined Circuits - Resource Sharing and Binding: Sharing and Binding for Resource - Dominated Circuits - Sharing and Binding for General Circuits - Concurrent Binding and Scheduling - Resource Sharing and Binding for Non - Scheduled Sequencing Graphs - The Module Selection Problem - Resource Sharing and Binding for Pipelined Circuits - Sharing and Structural Testability. (9)

## LOGIC - LEVEL SYNTHESIS AND OPTIMIZATION

Two - Level Combinational Logic Optimization: Logic Optimization Principles - Operations on Two - Level Logic Covers - Algorithms for Logic Minimization - Symbolic Minimization and Encoding Problems - Minimization of Boolean Relations - Multiple - Level Combinational Logic Optimization: Models and Transformations for Combinational Networks - The Algebraic Model - Boolean Model - Synthesis of Testable Networks - Rule - Based Systems for Logic Optimization Sequential Logic Optimization: Sequential Circuit Optimization Using State - Based Models - Sequential Circuit Optimization Using Network Models - Implicit Finite - State Machine Traversal Methods. (9)

## CELL - LIBRARY BINDING

Problem Formulation and Analysis - Algorithms for Library Binding - Covering Algorithms Based on Structural Matching - Covering Algorithms Based on Boolean Matching - Covering Algorithms and Polarity Assignment - Concurrent Logic Optimization and

Library Binding - Testability Properties of Bound Networks - Specific Problems and Algorithms for Library Binding - Look - Up Table FPGA's - Anti - Fuse - Based FPGA - Rule - Based Library Binding - Comparisons of Algorithmic and Rule - Based Library Binding - State of the Art and Future Trends: Synthesis Systems - Growth of Synthesis in the Near and Distant Future. (9)

**TOTAL: 45**

## **REFERENCES**

1. *Giovanni De Micheli, "Synthesis and optimization of Digital Circuits", Tata McGraw - Hill, 2017*
2. *John Paul Shen, Mikko H. Lipasti, "Modern processor Design", Tata McGraw Hill, 2013.*

# 19MAE12 - COMPUTER VISION

L	T	P	C
3	0	0	3

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

To introduce the fundamentals of image formation, major ideas and techniques of computer vision and pattern recognition for standstill and moving objects.

### COURSE OUTCOMES

At the end of the course the student will be able to

**CO1** : Understand the basic concepts of image formation and segmentation techniques

**CO2** : Obtain the mathematical model of the given camera

**CO3** : Construct a 3D model from the captured images.

**CO4** : Apply different pattern recognition on the images and do comparative study analysis.

**CO5** : Realize the concepts of motion analysis for human motion and moving objects.

### IMAGE FORMATION

Overview and State - of - the - art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing, Image representation and modeling. (9)

### IMAGE SEGMENTATION

Region Growing, Edge Based approaches to segmentation, Graph - Cut, Mean - Shift, MRFs, Texture Segmentation; Object detection, Image filtering, Image as vectors. (9)

### CAMERA MODELS

Camera geometry - Epipolar Geometry, Depth estimation and multi camera views, Camera calibration, calibrated 3D reconstruction, Stereo & Multi - view Reconstruction. (9)

### PATTERN RECOGNITION

Clustering: K - Means, K - Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un - supervised, Semi - supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non - parametric methods. Face Detection. (9)

### MOTION ANALYSIS

Human and computer vision - Human Motion Recognition, Background Subtraction and Modeling, Optical Flow, KLT, Spatio - Temporal Analysis, Dynamic Stereo; Motion parameter estimation. Shape from X - Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges. (9)

**TOTAL : 45**

### REFERENCES

1. Manas Kamal Bhuyan, " Computer Vision and Image Processing : Fundamentals and Applications", CRC Press, 1<sup>st</sup> Edition, 2019.
2. E.R. Davies, "Computer Vision : Principles, Algorithms, Applications, Learning", Academic press, 2017.
3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer - Verlag London Limited 2011.

4. *Computer Vision: A Modern Approach*, D. A. Forsyth, J. Ponce, Pearson Education, 2003.
5. *Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.*

# 19MAE13 - HIGH PERFORMANCE COMPUTER ARCHITECTURE

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVE

*The objective is to make the student understand and appreciate the fundamental issues and tradeoffs involved in the design of high performance computers.*

## COURSE OUTCOMES

**CO1** : *The learner is exposed to the concepts of Pipelining and Parallelism*

**CO2** : *The students learn the issues in memory organization and optimization methods.*

**CO3** : *Students appreciate the need for Vector processing and RISC Architecture*

## PROCESSOR DATA PATH

Introduction - CPU Performance factors - Evaluating CPU Performance - Building a Data path - Multicycle Implementation - Exceptions - Microprogramming (9)

## PIPELINING

Overview of pipelining - Pipelined Data path - Data Hazards - Forwarding - Branch Hazards - Dynamic Branch Prediction - Pipeline using HDL - Advanced Pipelining - Pentium 4 Pipeline (9)

## PARALLELISM

Classes of computers - Trends - Dependability - Quantitative principles - Instruction Level Parallelism - Reducing Branch Cost - Dynamic scheduling - Hardware based speculation - Advanced Speculation - Limitations of ILP for Realizable Processors. (9)

## MEMORY HIERARCHY DESIGN

Basics of Cache - Measuring performance - Optimization of Cache performance - Virtual Memory - Page faults - TLB - Protection with virtual memory (9)

## VECTOR PROCESSING AND RISC ARCHITECTURE

Vector Processor: Architecture - Issues - Effectiveness of Compiler Vectorization - Vector performance. RISC Architecture: Survey of RISC Architectures - SPARC, PA - RISC (9)

**TOTAL : 45**

## REFERENCES

1. *David A. Patterson, John J. Hennessy, "Computer Organization and Design - The Hardware / Software Interface", Third Edition, Morgan Kaufmann Publishers, 2005.*
2. *John J. Hennessy, David A. Patterson, "Computer Architecture - A Quantitative Approach", Fourth Edition, Morgan Kaufmann Publishers, 2006.*
3. *Carl Hamacher, Zvonko Vranesic and Safwat Zakv, "Computer Organization", McGraw Hill, 2002.*
4. *Kai Hwang and Faye Briggs, "Computer Architecture and Parallel Processing", McGraw Hill International Edition, Singapore 2000.*

# 19MAE14 - CRYPTOGRAPHY AND BLOCK CHAIN TECHNOLOGIES

L	T	P	C
3	0	0	3

## ASSESSMENT : THEORY

### PREREQUISITE

*Expertise In Programming, Basic Knowledge Of Computer Security, Cryptography, Networking, Concurrent Or Parallel Programming, Computer Systems Security.*

### COURSE OBJECTIVE

*To provide exposure to the students on Cryptography and Block Chain Technologies and their real time applications*

### COURSE OUTCOMES

*After successful completion of this course, the students will be able to*

- CO1** : *Understand the basics of cryptography and Block chain Technologies*
- CO2** : *Understand the concepts of Symmetric key cryptography, Public key cryptography, Digital signatures and hash functions.*
- CO3** : *Understand the structure of a block chain and its advantages over a simple distributed database.*
- CO4** : *Understand the concepts of Ethereum and Smart Contracts and to compare them with bitcoin scripting.*
- CO5** : *Apply the concepts of cryptography and Block chain Technologies in various fields.*

### INTRODUCTION

Need for Distributed Record Keeping, Modeling faults and adversaries, Byzantine Generals problem, Consensus algorithms and their scalability problems, Technologies Borrowed in Block chain - hash pointers, consensus, byzantine fault - tolerant distributed computing, and digital cash. (9)

### CRYPTOGRAPHY

Cryptography - Brief history, and goals of cryptography, Symmetric - key cryptography, Public - key cryptography, Digital Signatures - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof, Hash functions, Collision resistant hash, public key crypto, verifiable random functions, Zero - knowledge systems. (9)

### BLOCK CHAIN 1.0

Bit coin block chain, the challenges, and solutions, proof of work, Proof of stake, alternatives to Bit coin consensus, Bit coin scripting language and uses. (9)

### BLOCK CHAIN 2.0

Ethereum and Smart Contracts, The Turing Completeness of Smart Contract Languages and verification challenges, using smart contracts to enforce legal contracts, comparing Bit coin scripting vs. Ethereum Smart Contracts (9)

### APPLICATIONS

Internet of Things, Medical Record Management System, Domain Name Service and future of Cryptography and Block chain (9)

**TOTAL : 45**

### REFERENCES

1. *Draft version of "S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, 'Blockchain Technology: Cryptocurrency and Applications', Oxford University Press, 2019.*
2. *Josh Thompson, 'Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing Platform, 2017.*
3. *Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).*
4. *DR. Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger,"Yellow paper. 2014. • Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts*

# 19MAE15 - AUGMENTED REALITY

L	T	P	C
3	0	0	3

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

*To acquire knowledge about augmented reality and to realize its benefits and features in various fields*

### COURSE OUTCOMES

*By the end of the course the student will be able to*

**CO1** : *Understand the concept of augmented reality*

**CO2** : *Effectively design and benefits of AR.*

**CO3** : *Incorporate of Geo - location with AR*

**CO4** : *Apply AR for real - time applications*

### INTRODUCTION TO AUGMENTED REALITY

Augmented Reality History - Definition of Augmented Reality - Augmented Reality features - Mixed Reality Continuum - MAR Market, Actors and Value Chain - MAR System Architecture - mobile AR for android and iOS - Application vs. Browser. **(8)**

### AUGMENTED REALITY CONCEPTS AND HARDWARE

Two - Step Process of Augmented Reality Applications - Augmented Reality Hardware - Sensor - Roles of Sensors - Tracking - processor - Processor System Architectures - display - Stationary visual displays - Visual displays that move with the participant's head - Visual displays that move with the participant's hand or other parts of his or her body - other sensory displays - Haptics - Smell (Olfaction) - Other Senses - Stereo Displays - Display - Characteristics of Displays - Techniques. Computer Graphics - Dimensionality - Depth Cues - Registration and Latency. **(10)**

### AUGMENTED REALITY DIMENSION AND INTERACTION

Introduction to 3D objects in ARAF - advanced 3D modeling technique - Vuforia Overview: Interface, Navigation, Terminology, Image Targeting, Custom Images - Recognition process with Vuforia - Use of Vuforia descriptor in ARAF - Real World - Manipulation - Navigation - Mobile Augmented Reality. **(9)**

### AUGMENTED REALITY WITH GEOLOCATION

Create an AR Quiz using the authoring tool - Geolocation in ARAF - A basic example: Image PROTO - Enriching a prototype: add user interaction - Map PROTO - MapMarker PROTO - MapOverlay PROTO - MapPlayer PROTO - An example of a functional map in ARAF. **(9)**

### APPLICATION

Pokemon GO and its effect on AR & Augmented Reality Gaming - Survey of Current AR Games - ARKit GPS Template - Augmented Reality Wearable Survey of Augmented Reality Wearables, AR for Medical and Psychotherapy Bio - sensing and AR with the server - The future of augmented reality. **(9)**

**TOTAL : 45**

### REFERENCES

1. *Augmented Reality: Principles & Practice - 12 Oct 2016 by Schmalstieg / Hollerer*
2. *Jetzt bewerten, "Virtual Reality & Augmented Reality in Industry", Springer, 2<sup>nd</sup> Edition, 2009.*

# 19MAE16 / 19MAOE05 - DATA SCIENCE AND ANALYTICS

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVE

*To introduce and explore the decision making based on analysis of acquired data*

## COURSE OUTCOMES

*By the end of the course the student will be able to*

**CO1** : *Acquire knowledge about the need for data science and analytics*

**CO2** : *Understanding of data analysis algorithms*

**CO3** : *Need for data visualization*

## INTRODUCTION

Data Science : - Data Types - Big Data Overview - Different Data Structures - Data architecture - Data acquisition - Data analysis - Descriptive Analysis - Predictive Analysis - Prescriptive Analysis - Data Visualization Charts - Data archiving - Data Analytics Lifecycle Phase : - Discovery - Data Preparation - Model Planning - Model Building - Communicate Results - Operationalize - Global Innovation Network and Analysis **(9)**

## PROBABILITY AND STATISTICS

Application towards Data Analysis - Bayes' Theorem - Random Variables - Probability Density Functions - Properties of Distributions: - Binomial, Poisson, Uniform, Exponential, Normal, Chi - Square, T and F - Introduction to Sampling and Hypothesis **(9)**

## TIME SERIES ANALYSIS

Overview of Time Series Analysis - Hypothesis test - Variance and Correlation analysis - Simple Linear Regression - Forecasting Techniques - Auto Regressive Moving Average (ARMA) model - Auto Regressive Integrated Moving Average (ARIMA) Model - Getting to know MapReduce - MapReduce Execution Pipeline - Runtime Coordination and Task Management - MapReduce Application **(9)**

## DATA ANALYSIS

Introduction to Artificial Intelligence, Introduction to Machine Learning, and Deep Learning in Data Science - Clustering - K - means - Association Rules - Apriori Algorithm - Validation and Testing - Classification - Decision Trees - Naïve Bayes - Diagnostics of Classifiers **(9)**

## BASIC DATA ANALYTIC METHODS USING R

Basic Data Analytics using R - R Graphical User Interfaces - Data Import and Export - Attribute and Data Types - Descriptive Statistics - Exploratory Data Analysis - Visualization Before Analysis - Visualizing a Single Variable - Examining Multiple Variables - Data Exploration Versus Presentation. **(9)**

**TOTAL : 45**

## REFERENCES

1. *U. Dinesh Kumar, " Business Analytics", Wiley, 2018*
2. *Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data ", EMC Education Services John Wiley & Sons, 2015*
3. *Lars Nielsen, " A Simple Introduction to Data Science", New Street Communications, LLC, 2015*

# 19MAE17 - NETWORK VIRTUALIZATION

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

## COURSE OBJECTIVE

*To understand the concepts of virtualization and its feature in the design of Virtual Machine products.*

## COURSE OUTCOMES

*Students will be able to*

*Understand about Computing Virtualization tools, applications and techniques.*

**CO1** : *Understand Server virtualization and virtualization platform.*

**CO2** : *Understand the technologies of Virtualization and Network virtualization.*

**CO3** : *Understand the concepts of virtualization storage.*

**CO4** : *Study the virtual machine products*

## OVERVIEW OF VIRTUALIZATION

Basics of Virtualization - Virtualization Types - Desktop Virtualization - Network Virtualization Server and Machine Virtualization - Storage Virtualization - System - level or Operating Virtualization - Application Virtualization - Virtualization Advantages - Virtual Machine Basics - Taxonomy of Virtual machines - Process Virtual Machines - System Virtual Machines - Hypervisor - Key Concepts. **(9)**

## NETWORK CONSOLIDATION

Hardware Virtualization - Virtual Hardware Overview - Server Virtualization - Physical and Logical Partitioning - Types of Server Virtualization - Business cases for Server Virtualization - Uses of Virtual server Consolidation - Planning for Development - Selecting server Virtualization Platform. **(9)**

## NETWORK VIRTUALIZATION

Design of Scalable Enterprise Networks - Virtualizing the Campus WAN Design - WAN Architecture - WAN Virtualization - Virtual Enterprise Transport Virtualization - VLANs and Scalability - Theory Network Device Virtualization Layer 2 - VLANs Layer 3 VRF Instances Layer 2 - VFIs Virtual Firewall Contexts Network Device Virtualization - Data - Path Virtualization Layer 2: 802.1q - Trunking Generic Routing Encapsulation - Ipv6 L2TPv3 Label Switched Paths - Control - Plane Virtualization - Routing Protocols - VRF - Aware Routing Multi - Topology Routing. **(9)**

## VIRTUALIZING STORAGE

SCSI - Speaking SCSI - Using SCSI buses - Fiber Channel - Fiber Channel Cables - Fiber Channel Hardware Devices - iSCSI Architecture - Securing iSCSI - SAN backup and recovery techniques - RAID - SNIA Shared Storage Model - Classical Storage Model - SNIA Shared Storage Model - Host based Architecture - Storage based architecture - Network based Architecture - Fault tolerance to SAN - Performing Backups - Virtual tape libraries. **(9)**

## VIRTUAL MACHINES PRODUCTS

Xen Virtual machine monitors - Xen API - VMware - VMware products - VMware Features - Microsoft Virtual Server - Features of Microsoft Virtual Server. **(9)**

**TOTAL : 45**

## TEXT BOOKS

1. William von Hagen, *Professional Xen Virtualization*, WroxPublications, January, 2008.
2. Chris Wolf, Erick M. Halter, and *Virtualization: From the Desktop to the Enterprise*, APress 2005.

3. *Kumar Reddy, Victor Moreno, Network virtualization, Cisco Press, July, 2006.*
4. *James E. Smith, Ravi Nair, Virtual Machines: Versatile Platforms for Systems and Processes, Elsevier/Morgan Kaufmann, 2005.*

## **REFERENCES**

1. *Ken gray, Thomas. D. Nadeau Network function virtualization, Morgan Kaufmann, 2016.*
2. *David Marshall, Wade A. Reynolds, Advanced Server Virtualization: VMware and Microsoft Platform in the Virtual Data Center, Auerbach Publications, 2006.*

# 19MAE18 - SOFT COMPUTING

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

To learn the basic concepts of genetic algorithms, search techniques, fuzzy logic, neural networks, neuro - fuzzy modelling systems, and their applications.

### COURSE OUTCOMES

After completing this course the students will be able to

**CO1** : Optimize single objective and multi objective problems using genetic algorithm.

**CO2** : Apply basics of Fuzzy logic and neural networks

**CO3** : Apply soft computing techniques to solve a wide variety of real world problems.

### GENETIC ALGORITHMS

Introduction to genetic algorithms (GA) - goals of optimization - differences and similarities between genetic algorithm and traditional methods - schemata - terminology of GA - strings, structure, parameter set - coding - fitness function - data structures - GA operators - algorithm. **(8)**

### MODERN SEARCH TECHNIQUES

Simulated annealing - introduction - algorithm - applications. Tabu search - introduction - algorithm - applications. Particle swarm optimization algorithm. AI search algorithm - Predicate calculus - Rules of inference - Semantic networks - Frames - Objects - Hybrid models - Applications. **(9)**

### FUZZY LOGIC

The concept of uncertainty and associated solutions - fuzzy sets - basic properties and characteristics of fuzzy sets - fuzzy set operations - fuzzy reasoning - applications of fuzzy logic - Fuzzy matrices - Fuzzy functions - Decomposition - Fuzzy automata and languages - Fuzzy control methods - Fuzzy decision making. **(9)**

### ARTIFICIAL NEURAL NETWORKS

Basics of artificial neural networks (ANN) - characteristics of ANN - models of neuron - topology - basic learning laws - types. Kohonen self organizing network - back propagation network - learning curves - applications of ANN to engineering problems - Hopfield network. **(9)**

### NEURO - FUZZY MODELLING

Neuro - Fuzzy modelling - adaptive neuro - fuzzy inference systems, neuro - fuzzy controller - feedback control, expert control, back propagation through time and real - time recurrent learning, reinforcement learning control, gradient - free optimization - Classification and Regression Trees - Data clustering - Evolutionary computation. **(10)**

**TOTAL : 45**

## REFERENCES

1. N.P.Padhy, S.P.Simon, "Soft Computing with MATLAB Programming", Oxford University Press, 2015.
2. Dr.S.NSivanandam and Dr.S.N.Deepa, "Principles of SoftComputing", 2<sup>nd</sup> Edition, Wiley - India, 2011.
3. Deb, K, "Optimization for Engineering Design", PHI Learning (P) Ltd., New Delhi, 2012.
4. Timothy J.Ross, "Fuzzy Logic with Engineering applications", Wiley; 4<sup>th</sup> Edition, 2016.

5. *Goldberg, D.E., "Genetic Algorithms in Search, Optimization, and Machine Learning", Addison - Wesley, 1989.*
6. *LaureneFausett, "Fundamentals of Neural Networks", Prentice Hall, 1994.*
7. *Jang J.S.R., Sun C.T. and Mizutani E, "Neuro - Fuzzy and Soft computing", Prentice Hall 1998.*
8. *Fred Glover, Manuel Laguna, "Tabu Search", Kluwer Academic Publishers, 1997.*
9. *M.Tim Rose, "Artificial Intelligence Application Programming", First Edition, Charles River Media Publication, 2<sup>nd</sup> Edition, 2005.*
10. *S.Rajasekaran and A.Vijayalakshmi Pai, "Neural networks, Fuzzy logic and Genetic algorithms", Prentice Hall of India Ltd, New Delhi, 2017.*
11. *Nils J.Nelsson, "Artificial Intelligence - A New Synthesis", HarcourtAsia Ltd., 1998.*

# 19MAE19 - EDGE COMPUTING

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

To provide an in - depth and comprehensive knowledge of the Edge Computing fundamental issues, technologies, applications and implementations.

### COURSE OUTCOMES

**CO1** : The Students can articulate the main concepts, key technologies, strengths, and limitations of edge computing and the possible applications for state - of - the - art edge computing

**CO2** : The students can identify the architecture and infrastructure of edge computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.

**CO3** : The students can understand the core issues of edge computing such as security, privacy, and interoperability.

### INTRODUCTION

History of Centralized and Distributed Computing - Overview of Distributed Computing, Cluster computing, Grid computing. Technologies for Network based systems - System models for Distributed and cloud computing - Software environments for distributed systems and clouds. (9)

### EDGE RESOURCES

Introduction to Edge Computing - issues and challenges - Properties - Characteristics - Service models, Deployment models. Cloud resources: Network and API - Virtual and Physical computational resources - Data - storage. Virtualization concepts - Types of Virtualization - Introduction to Various Hypervisors - High Availability (HA)/Disaster Recovery (DR) using Virtualization, Moving VMs. (9)

### NETWORKS AND SERVICES

Service models - Infrastructure as a Service (IaaS) - Resource Virtualization: Server, Storage, and Network - Case studies. Platform as a Service (PaaS) - Cloud platform & Management: Computation, Storage - Case studies. Software as a Service (SaaS) - Web services - Web 2.0 - Web OS - Case studies - Anything as a service (XaaS). (9)

### PROGRAMMING

Programming and Software Environments - Parallel and Distributed Programming paradigms - Programming on Amazon AWS and Microsoft Azure - Programming support of Google App Engine - Emerging Cloud software Environment. (9)

### STANDARDS AND PRIVACY

Cloud Access: authentication, authorization and accounting - Cloud Provenance and meta - data - Cloud Reliability and fault - tolerance - Edge Security, privacy, policy and compliance - Edge federation, interoperability and standards. (9)

**TOTAL : 45**

### REFERENCES

1. Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, "Distributed and cloud computing from Parallel Processing to the Internet of Things", Morgan Kaufmann, Elsevier - 2012
2. Barrie Sosinsky, "Cloud Computing Bible" John Wiley & Sons, 2010
3. Tim Mather, SubraKumaraswamy, and ShahedLatif, Cloud Security and Privacy an Enterprise Perspective on Risks and Compliance, O'Reilly 2009

# 19MAE20 - COMPUTER SECURITY

L	T	P	C
3	0	0	3

## PRE - REQUISITES

Consent of the Instructor

## ASSESSMENT : THEORY

### COURSE OBJECTIVE

*The purpose of this course is to underlying concepts and foundations of computer security, basic knowledge about security - relevant decisions in designing IT infrastructures, techniques to secure complex systems and practical skills in managing a range of systems, from personal laptop to large - scale infrastructures.*

### COURSE OUTCOMES

*After completing this course the students will be able to*

**CO1** : *Able to identify security risks and take preventive steps*

**CO2** : *Investigate cybercrime and collect evidences*

**CO3** : *Able to use knowledge of forensic tools and software*

### DIGITAL SECURITIES

Introduction, Types of Attacks, Digital Privacy, Online Tracking, Privacy Laws, Types of Computer Security risks ( Malware, Hacking, Pharming, Phishing, Ransomware, Adware and Spyware, Trojan, Virus, Worms, WIFI Eavesdropping, Scareware, Distributed Denial - Of - Service Attack, Rootkits, Juice Jacking), Antivirus and Other Security solution, Password, Secure online browsing, Email Security, Social Engineering, Secure WIFI settings, Track yourself online, Cloud storage security, IOT security, Physical Security Threads (9)

### ONLINE ANONYMITY

Anonymous Networks - Tor Network, I2P Network - Freenet - Darknet - Anonymous OS - Tails - Secure File Sharing - VPN - Proxy Server - Connection Leak Testing - Secure Search Engine - Web Browser Privacy Configuration - Anonymous Payment (9)

### CRYPTOGRAPHY AND SECURE COMMUNICATION

Cryptographic Functions - Types - Digital Signature - The Difference Between Digital Signatures and Electronic Signatures - Cryptographic Systems Trust Models - Cryptographic Key generation Using Gpg4win/gpg4usb - Disk Encryption - Windows Bit Locker and Open Source Tools - Multitask Encryption Tools - Attacking Cryptographic Systems, Countermeasure - Securing Data in Transit - Cloud Storage Encryption - DNS Traffic and Email communication - Secure IM and video calls (9)

### NETWORK DEFENSES

Network defense tools - Secure protocols - Firewalls - VPNs, Tor, I2P, - Intrusion Detection and filters - Host - Based IDS vs Network - Based IDS - Dealing with unwanted traffic - Denial of service attacks. - Mobile platform security models - Android, iOS Mobile platform security models - Detecting Android malware. (9)

### SECURITY RISK MANAGEMENT

Introduction - Risk Management - Information Security - Risk Assessment - Information Security Risk Assessment - Case Studies - Risk Assessment in Practice - The Trusted Computing Architecture - Introduction to Trusted Computing - TPM Provisioning - Exact Mechanics of TPM. (9)

**TOTAL : 45**

### REFERENCES

1. *William Stallings, Network Security Essentials: Applications and Standards, Prentice Hall, 4<sup>th</sup> Edition, 2010.*
2. *Michael T. Goodrich and Roberto Tamassia, Introduction to Computer Security, Addison Wesley, 2011.*
3. *William Stallings, Network Security Essentials: Applications and Standards, Prentice Hall, 4<sup>th</sup> Edition, 2010.*
4. *Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 2001.*