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. APPLIED ELECTRONICS

Curriculum and Syllabi

Under Choice Based Credit System

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

INDEX

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

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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 AE programme will be able to fulfil all of the following programme educational objectives for the curriculum:

1. The engineers of Applied Electronics, design circuits and develop systems in contemporary and frontier areas of electronics.
2. The enhanced skills of the engineers meet the demands and expectations of automation in various industries.
3. The graduates with professional competency promote and support creative research towards innovative product development.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
COIMBATORE INSTITUTE OF TECHNOLOGY

PROGRAM OUTCOMES (POs) AND PROGRAM SPECIFIC OUTCOMES

POs	PO Statements
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 components meeting the techno commercial and socio-economic needs.

PSOs	PSO Statements
PSO1	An ability to select appropriate techniques to modernize the existing infrastructure in line with the industry standards
PSO	An ability to integrate knowledge from the fields of study and arrive solutions for complex engineering tasks

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Curriculum from the Academic Year 2019 - 2020 onwards

Under Choice Based Credit System

Specialization : Applied Electronics

Semester I

Course Code	Course Name	L	T	P	C	Category
19MA11	Linear Algebra and Stochastic Processes	4	0	0	4	FC
19MA12	Statistical Signal Processing	3	1	0	4	PC
19MER12	Embedded Processors	3	0	0	3	PC
19MA13	Solid State Power Conversion Techniques and Applications	3	0	0	3	PC
19MA14	Electromagnetic Interference and Compatibility	3	0	0	3	PC
	ELECTIVE I	3	0	0	3	PE
19MER14	Embedded Processors Laboratory	0	0	4	2	PC
	TOTAL				**22**	

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
	ELECTIVE II	3	0	0	3	PE
	ELECTIVE III	3	0	0	3	PE
	ELECTIVE IV	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	EEC1
	One Credit Course				1	OCC1
	Total				**23**	

Semester III

Course Code	Course Name	L	T	P	C	Category
	ELECTIVE V	3	0	0	3	PE
	ELECTIVE VI	3	0	0	3	PE
	OPEN ELECTIVE I	3	0	0	3	OE
	One Credit Course				1	OCC2
	TOTAL				**10**	

Semester IV

Course Code	Course Name	L	T	P	C	Category
19MA41	Project - Dissertation	0	0	36	18	EEC2

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
	POWER AND ENERGY					
19MAE01	Design of Smart Grid Systems	3	0	0	3	PE
19MAE02	Power Quality	3	0	0	3	PE
19MAE03	System identification and adaptive control	3	0	0	3	PE
19MAE04	Smart Systems	3	0	0	3	PE
	CONTROL AND AUTOMATION					
19MAE05	Optimal Control	3	0	0	3	PE
19MAE06	Modern Control Theory	3	0	0	3	PE
19MAE07	Robust control	3	0	0	3	PE
19MAE08	Data Acquisition and Control Using LABVIEW	3	0	0	3	PE
19MAE09	Industry 4.0	3	0	0	3	PE
	ELECTRONIC SYSTEM DESIGN					
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
	EXPERT SYSTEMS					
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	19MAOE01	Design for Smart Grid Systems	3	0	0	3	OE
2	19MAOE02	Data Acquisition and Control using LABVIEW	3	0	0	3	OE
3	19MAOE03	Industry 4.0	3	0	0	3	OE
4	19MAOE04	Digital System Design and Testing	3	0	0	3	OE
5	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 Weibulll 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).*

19MA12 - STATISTICAL SIGNAL PROCESSING

L	T	P	C
3	1	0	4

ASSESSMENT : THEORY

COURSE OBJECTIVES

To introduce and explore the relationships between four very important signal processing problems: signal modeling, optimum filtering, spectrum estimation and adaptive algorithms

COURSE OUTCOMES

CO1 *: Knowledge about modeling stationary Systems and estimate Power Spectral Density*

CO2 *: Understanding of Error correcting algorithms*

CO3 *: Need for adaptive systems*

STOCHASTIC PROCESSES AND MODELS

Partial Characterization of Discrete time stochastic process - Mean Ergodic Theorem - Correlation matrix of sine wave plus noise -Stochastic Models : Autocorrelation method - covariance method-WOLD Decomposition - Yule - Walker equations - Power Spectral density - Properties. **(12)**

PARAMETER ESTIMATION THEORY

Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Cramer Rao bound, Efficient estimators; Criteria of estimation: the methods of maximum likelihood and its properties; Baysean estimation: Mean square error and MMSE, Mean Absolute error, Hit and Miss cost function and MAP estimation. **(12)**

POWER SPECTRUM ESTIMATION

Nonparametric models : The periodogram - Barlett's method: Periodogram Averaging - Welch's Method: Averaging Modified Periodograms - Blackman-Tuckey Approach: Periodogram smoothing- The maximum entropy method .

Parametric methods : Autoregressive, Moving average, ARMA methods Frequency estimation : Eigen decomposition of the autocorrelation matrix - Barlett frequency estimation -Autoregressive frequency Estimation. **(12)**

ESTIMATION OF STATIONARY PROCESSES

Wiener Filters : Linear optimum filtering - Principle of orthogonality -Wiener Hopf equations - error performance surface - Levinson -Durbin algorithm - Wiener filter. **(12)**

ESTIMATION OF NON-STATIONARY PROCESSES

Least squares principle - Quadratic forms - Minimum energy principle- Least squares solution - weighted least squares - recursive least squares - Least Mean Squares algorithm - Kalman filter. **(12)**

TOTAL : 45 +15 = 60

REFERENCES

1. *Simon Haykin, Thomas Kailath, "Adaptive Filter Theory", Pearson Education, 4th Edition, 2005.*
2. *Monson H.Hayes,"Statistical Digital Signal Processing and Modeling", Wiley India, 2013.*
3. *M.D.Srinath, P.K. Rajasekaran, R.Viswanathan, "Introduction to Statistical Signal Processing with Applications", Pearson Education, 2003.*
4. *T. Chonavel, Statistical Signal Processing: Modelling and Estimation", Springer, 2002*
5. *Umberto Spagnolini, "Statistical Signal Processing in Engineering", Wiley, 2017*
6. *Anastasia Veloni, Nikolaos Miridakis, Erysso Boukouvala, "Digital and Statistical Signal Processing", CRC Press, 2018*

19MER12 - EMBEDDED PROCESSORS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To provide an exposure to the students on microcontrollers, their architecture and choose appropriate microcontroller for a real time application and 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; ll Edition 2000.*
6. *ARM Architecture Reference manual, ARM Limited, 2014.*

19MA13 - SOLID STATE POWER CONVERSION TECHNIQUES AND APPLICATIONS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To facilitate the students to comprehend the impact of power electronics in the power & energy systems of modern industries and to afford innovative solutions by addressing their needs.

COURSE OUTCOMES

CO1 : *Realize the extensive applications of power electronics in global industrialization*

CO2 : *Analyze the dynamic and steady-state operation of power electronic converters and to provide the solutions required for industries.*

CO3 : *Work autonomously for the design, modeling, development and testing of power electronics systems*

AC-DC CONVERTERS

Analysis of power semiconductor switched circuits with R, L, RL, RC loads.

Single-Phase and Three-Phase AC to DC converters-Half controlled configurations-operating domains of three phase full converters and semi-converters. Reactive power considerations- Design aspects of converters-practical applications. **(9)**

DC TO DC CONVERTERS

Analysis and design of DC to DC converters- Control of DC-DC converters: Buck converters, Boost converters, Buck-Boost converters, Cuk converters- Flyback, Forward, Push-Pull, Half and Full Bridge Converter Topologies - Basic Operation -Waveforms- Introduction to resonant converters- Design aspects of converters- practical applications. **(9)**

DC-AC INVERTERS

Single phase and three phase inverters-Voltage source and Current source inverters- Voltage control and harmonic minimization in inverters- Design aspects of converters- practical applications. **(9)**

AC-AC CONVERTERS

AC to AC power conversion using voltage regulators and cyclo-converters- Consideration of harmonics, introduction to Matrix converters- Design aspects of converters- practical applications. **(9)**

MODELING AND SIMULATION OF POWER ELECTRONIC SYSTEMS

Introduction - Modelling of Power Electronic Systems Elements - Solution Techniques for Time Domain Analysis - State Space Averaging - Hysteresis Band Control-Simulation Process - Mechanics of Simulation- Use of Simulation tools for Design and Analysis - Simulation of Power Electronic Circuits with PSIM, MATLAB-Python for Power Converter Analysis. **(9)**

TOTAL : 45

REFERENCES

1. *M.H.Rashid, "Power Electronics" 3rd Edition Prentice of Hall of India, New Delhi, 2014.*
2. *Mohan, Tore M. Undeland, and William P. Robbins, "Power Electronic Converters, Applications and Design", 3rd Edition John Wiley and Sons, New York, 2011.*
3. *Yuriy Rozanov, Sergey Ryvkin, Evgeny Chaplygin and Pavel Voronin "Power Electronics Basics- operating principles, design, formulas and applications" CRC Press, Taylor & Francis Group, 2015.*

4. *Andrej. M. Trzynadlowsk, "Introduction to Modern Power Electronics", John Wiley and Sons, New York, 2011.*
5. *Jai. P. Agrawal, "Power Electronic Systems Theory and Design", Pearson Education, Asia, New Delhi, 2011.*
6. *Mohammed H.Rashid, "Power Electronics Hand Book", Elsevier- Academic Press, California, USA, III Edition, 2012.*
7. *Robert W. Erickson & Dragon Maksimovic "Fundamentals of Power Electronics" Second Edition, 2009 Springer Science and Business media.*
8. *Haitham Abu-Rub,etal,"Power Electronics for Renewable Energy Systems, Transportation, and Industrial Applications" John Wiley & Sons Ltd, 2014.*

19MA14 - ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

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" Third Edition, CRC Press, Septrmber 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, 3rd Edition, 1994.*
6. *Don R.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.
8. Modeling Microwave Oven
9. Chopper based motor speed Control using microcontroller.
10. Design of Microcontroller based motor speed control:
    - i) Changing the Firing Angle
    - ii) Thyristor Control
    - iii) Commutation
11. Design and experimental execution of a microcontroller based smart solar tilting system.
12. Modeling of an semi-automatic and fully automatic washing machine.
13. Congestion-free elevator control using microcontroller.
14. Interfacing computer system with IoT2040 Gateway and some basic commands used in IoT2040 Gateway in linux.
15. Sending analog value from IoT2040 Gateway to thingspeak cloud and monitoring from thingspeak 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 IIoT 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, 1st Edition, June 2016.*
4. *Cuno Pfster, "Getting Started with the Internet of Things" Published by O'Reilly Media, Inc.2011.*
5. *Jose´Cec?´lio, 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.*
7. *Frank D.Petruzella, "Programmable Logic Controllers", Second Edition, Mc Graw Hill, 2008*
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, Lule?a 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

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. *Robin R. Murphy, " Introduction to AI Robotics (Intelligent Robotics and Autonomous Agent Series", A Bradford Book, 2nd Edition, 2019.*
7. *Nagrath I.J., Mittal R.K., "Robotics and Control", Tata McGraw Hill, Sixth reprint, 2007.*
8. *Corke, Peter, "Robotics, Vision and Control Fundamental Algorithms in MATLAB", Springer, 2017.*
9. *Siciliano, Bruno, Khatib, Oussama, "Springer Handbook of Robotics", Springer, 2016.*
10. *Mark R Miller, Rex Miller, "Robots and Robotics: Principles, Systems, and Industrial Applications", McGraw-Hill Education, 2017.*
11. *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

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; 3rd Edition, 2005.*
5. *M. Rafiquzzaman, Stevan A. McNinch, "Digital Logic with an Introduction to Verilog and FPGA Based Design", Wiley, 1st Edition, 2019.*

19MER22 - FPGA BASED EMBEDDED SYSTEM DESIGN LABORATORY

L	T	P	C
0	0	4	2

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*

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, 5th Edition, 2016*
2. *Dr. Beverly A. Browning, "Grant Writing For Dummies", John Wiley & Sons, 5th Edition, 2014.*

19MAE01 / 19MAOE01 - DESIGN OF SMART GRID SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

Prerequisite : knowledge of power systems, microcontrollers, computer networks, computer programming

COURSE OBJECTIVE

This introductory course gives an insight of emerging concepts, technologies, applications and complex trade-off decisions related to the new intelligent energy grid that supports the green-energy initiatives.

COURSE OUTCOMES

CO1 *: To understand the concepts and technologies of various power generation schemes*

CO2 *: To design a suitable Micro grid*

CO3 *: Applying Internet of Things (IoT) to Micro grid environment*

INTRODUCTION TO DISTRIBUTED POWER GENERATION

Distributed Generation Versus Traditional Power Systems - Working Principle: Thermal Plant - Hydro Plant - Nuclear Plant - Distributed versus Central Station Generation - Micro-Mini Hydel Plants - Micro-Mini Gas Turbine Powered Distributed Generators - Fuel Cells - Bio mass **(9)**

WIND ENERGY SYSTEMS

Principle of wind energy conversion - Nature of wind - Power in the wind - Site selection - Components of Wind Energy Conversion System (WECS) - Classification of WECS - Generating Systems - Synchronizing to the Grid - Generator Control - Load Control - Energy storage - Interconnected. **(9)**

SOLAR PV SYSTEMS

Solar PV Cell- Characteristics and Types - Arrays and Panels - Balance of Systems - DC Power Conditioning Converters - Maximum Power Point Tracking Algorithms - AC Power Conditioners - Synchronized operation with grid supply - Applications - Water pumping, street lighting - economic analysis of PV systems. **(9)**

SMART GRID MEASUREMENTS AND COMMUNICATIONS

Wide Area Measurement : Sensor Networks - Phasor Measurement Units - Communications Infrastructure - Fault Detection and Self-Healing Systems - Applications and Challenges Smart Grid Communications: Two-way Digital Communications Paradigm - Network Architectures - IP-based Systems - Power Line Communications - Advanced Metering Infrastructure - Home Area Networks (HAN) / Home Energy Networks (HEN) - Electric Vehicles and Vehicle-to-Grid Systems **(9)**

SMART GRID COMMERCIALISATION

Interoperability - Standards - Smart Grid Cyber Security - Metering Protocol - Substation Automation Protocol - Standards and Electricity Markets - Wheeling Prices **(9)**

TOTAL : 45

REFERENCES

1. *James Momoh, "Smart Grid : Fundamentals of Design and Analysis", Wiley - IEEE Press, 2015.*
2. *Krzysztof Inieewski, "Smart Grid : Infrastructure and Networking", Tata McGraw Hill, 2012.*
3. *Math H.Bollen, Fainan Hassan, "Integration of Distributed Generation in the Power system", Wiley - IEEE Press, 2011.*
4. *Nur Asvik Hidayathullah, Akhtar kalam, "State of the Art Distributed Generation & Smart Grid Technologies - A Review and Analysis the Impacts of Distributed Generation (DG) on Smart Grid (SG) system", LAP LAMBERT academic publishing, 2012.*

19MAE02 - POWER QUALITY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

This introductory course gives the broad overview of different power quality disturbances and its impact in electric power system.

COURSE OUTCOMES

CO1 : *The students will have thorough understanding of the concept of utility distribution and industrial electric power quality phenomena.*

CO2 : *The students will be able to analyze power quality events.*

CO3 : *They will be able to design and evaluate the solutions to mitigate power quality disturbances.*

INTRODUCTION TO POWER QUALITY

Power Quality definition - Need for power quality - sensitive loads - Nonlinear loads - inter connected power systems - Deregulation - Power quality characteristics - types of power quality problems - Transients: Impulsive, Oscillatory - Voltage Variations-Short, Long Duration-Voltage Imbalance-Waveform Distortions:- DC Offset, Harmonics, Notching, Noise - Power Frequency Variations. Sources of power quality problems- Effects of power quality problems - Responsibilities of the suppliers and user of electrical Power - Power quality standards - Computer Business Equipment Manufacturers Associations (CBEMA) and ITIC curves-Cost of Poor Power Quality. **(8)**

TRANSIENTS

Definition - Power system transient model - Parameters-types - Causes of transients -Sources- Internal Capacitor switching transients- Transients from load switching- External - Lightning transients - Effects of transients- Mitigation- Principles of Protection -Insulation Coordination - Devices for over voltage protection-Standards. **(9)**

SHORT AND LONG DURATION INTERRUPTIONS

Short duration interruptions - Definition - Magnitude, Duration - Causes of voltage sag, swell and interruption-Sources of voltage sag and short interruptions - Voltage during fault and post fault period, Current during fault period - Effects of voltage sag and short interruptions- Overview of mitigation methods(Qualitative treatment only)-Standards and voltage sag indices.

Long duration interruptions-Definition - Failure, Outage, Interruption - Origin of interruptions - Causes of long interruptions - Principles of regulating the voltage - Voltage regulating devices, Applications : Utility side, End-User side -Reliability evaluation - Cost of interruptions. **(12)**

HARMONICS AND GROUNDING

Harmonics-Description of the Phenomena -Parameters- Voltage Distortion - Current Distortion - Definitions and terms -Sources of Current and Voltage - Harmonics Sources - Effects of Harmonics- - Guidelines for harmonics voltage and current limitation-standards and measures IEEE and IEC standards.

Harmonic filters: Harmonic Distortion Evaluations-Devices for Controlling Harmonic Distortion- Passive, Active and hybrid filters (Qualitative treatment only)-Case Studies.Grounding-Definitions and terms -Typical Earthing System- Reasons for grounding - National Electrical Code (NEC) grounding requirements - Utility Power system grounding - End-User power system grounding-Typical Wiring and Grounding Problems-Solutions to Wiring and Grounding Problems **(11)**

POWER QUALITY MONITORING AND SURVEY

Introduction - Power quality monitoring- Monitoring Considerations - Evolution of power quality monitoring- Brief introduction to power quality measurement equipments - Planning, Conducting and Analyzing power quality survey - Assessment of Power Quality Measurement Data - Utility-Customer interface-Introduction to thermo graphy in power quality assessment-Industrial Case Studies-Power Quality Monitoring Standards. **(5)**

TOTAL : 45

TEXT BOOKS

1. *Roger.C. Dugan, Mark.F. McGranagham, Surya santoso, H. Wayne Beaty, "Electrical Power Systems Quality", Tata McGraw Hill, 2012.*
2. *C.Sankaran, "Power Quality" CRC Press, 2011, New York*

REFERENCES

1. *Angelo Baggini, "Handbook of Power Quality" John Wiley & Sons, New York 2011.*
2. *Barry W. Kennedy, "Power Quality Primer" MC Graw Hill Publications, New York. 2006*
3. *M.H.J. Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions", Wiley, 2011.*
4. *J.Arrillage, N.R.Watson and S.Chen, "Power System Quality Assessment", John Wiley&Sons, New York, 2000.*
5. *Derek.A.Paice, "Power Electronic Converter Harmonics", IEEE Industrial Application Society, IEEE Press, New York 1996.*
6. *Short.T.A., "Distribution Reliability and Power Quality", CRC Press Taylor and Francis Group, 2006.*

19MAE03 - SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVES

To make the students the basic concepts of adaptive control techniques, parameter estimation, and identification of linear and non-linear systems.

COURSE OUTCOMES

After completing of this course the students will be able to

CO1 **:** *Model structures and predictors and perform convergence analysis*

CO2 **:** *Identify linear and nonlinear dynamic systems*

CO3 **:** *Design self tuning regulator using adaptive predictive control*

INTRODUCTION

Overview of Systems Identification, Adaptive Control and applications. Parameter Estimation: Least Square, Generalized and Recursive Least Square, Estimator properties including error bounds and convergence, MES, ML and MAP estimators, Nonlinear Least Squares. **(9)**

MODEL STRUCTURES AND PREDICTORS

Recursive Identification of Linear dynamic systems: RLS, ELS, IV, RML, Stochastic Approximation, Extended Kalman Filter, generalized prediction error framework and its application to ARMA and state models, convergence analysis, Time varying parameters. **(9)**

NONLINEAR SYSTEM IDENTIFICATION

Adaptive schemes. Adaptive control theory and applications. Situations when constant gain feedback is insufficient. Robust control. The adaptive control problem. The model following problem. MRAS based on stability theory. Model following when the full state is measurable. Direct MRAS for general linear systems. Prior knowledge in MRAS. MRAS for partially known systems. Use of robust estimation methods in MRAS. **(9)**

SELF-TUNING REGULATORS

The basic idea of indirect self-tuning regulators. Direct Self-tuning regulators. Linear Quadratic STR. Adaptive Predictive control. Prior knowledge in STR. Linear-in the-parameters model. **(9)**

LEAST SQUARES ESTIMATION

Experimental conditions. Recursive estimators. Extended least squares. Robust estimation methods (dead zone, projection). Implementation issues. Nonlinear System Identification Techniques. **(9)**

TOTAL : 45

REFERENCES

1. *K.J. Astrom and B. Wittenmark, Adaptive Control, 2nd Edition, Pearson 2013.*
2. *L. Ljung, System Identification Theory for the user, 2nd Edition, Prentice-Hall, 2007.*
3. *K.S. Narendra and A.M. Annaswamy, Stable Adaptive Systems, Prentice-Hall, 2012.*
4. *Landau and Zito, Digital Control Systems: Design, Identification and Implementation, Springer, 2nd Edition, 2010.*
5. *Boutalis, Y., Theodoridis, D., Kottas, T., Christodoulou, M.A, System Identification and Adaptive Control Theory and Applications of the Neuro fuzzy and Fuzzy Cognitive Network Models, Springer, 2014.*
6. *Karel J. Keesman, System Identification: An Introduction, Springer, 2011.*

19MAE04 - SMART SYSTEMS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

This course presents the fundamentals of modeling & analysis of smart systems. It is designed for engineering students who would like to have a broad understanding of current micro manufacturing processes in preparation to work directly or indirectly in this field.

COURSE OUTCOMES

CO1 : *The students have theoretical understanding of various physical phenomenons behind the operation of different types of sensors and Microsystems*

CO2 : *Students will gain an overview of the current state of smart sensors, to apply engineering skills to the analysis and design of Microsystems.*

CO3 : *The emphasis on the integration of electronics with sensors to provide a smart system on chip with multiple integrated devices.*

MEMS DEVICES

Piezoresistive pressure sensor- Piezoresistive Accelerometer - Capacitive Sensing- Accelerometer and Microphone - Resonant Sensor and Vibratory Gyroscope - Low Power, Low Voltage Sensors- Micro Electro Mechanical Systems Analysis and Design of MEMS Devices- Nano Sensors. **(9)**

INTERFACING SENSOR INFORMATION AND MCU

Amplification and Signal Conditioning- Integrated Signal Conditioning- Digital conversion- MCU Control - MCUs for Sensor Interface- Techniques and System Considerations- Sensor Integration. **(9)**

COMMUNICATION FOR SMART SENSORS

Wireless Data Communications- RF Sensing- Wireless Telemetry Systems- Automotive Protocols- Industrial Networks - Home Automation- MCU Protocols. **(9)**

PACKAGING, TESTING AND RELIABILITY IMPLICATIONS OF SMART SENSORS

Semiconductor Packaging- Hybrid Packaging- Packaging for Monolithic Sensors- Reliability Implications Testing Smart Sensors- HVAC Sensor Chip. **(9)**

CONTROL AND IMPLICATIONS OF SMART SENSORS AND STANDARDS

Control Application using - CISC, RISC, DSP Control. Automated Remote Sensing - Process control over the Internet - Smart Devices in Aircraft Networks - Automotive Safety Network and IEEE 1451 Standards - Industry 4.0 Perspective. **(9)**

TOTAL : 45

REFERENCES

1. *Randy Frank, "Understanding Smart Sensors", Artech House, Second Edition, 2013 Boston.*
2. *MinhangBao, "Analysis and design principles of MEMS devices", Elsevier Publications, 2005, USA.*
3. *Javaneh Ramezani, Javad Jassbi, "Technological Innovations for Smart Systems", Springer International Publishing, 2017.*
4. *Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, "Smart Material Systems and MEMS: Design and Development Methodologies", John Wiley and Sons Limited, 2006, USA.*

5. *NadimMaluf and Kirt Williams, "An Introduction to Micro Electro Mechanical Systems Engineering", Second Edition, Artech House Publishers, June 2004, USA.*
6. *Gabriel M. Rebeiz, "RF MEMS: Theory, Design, and Technology", Wiley-Interscience; 1st Edition, 2002, UK.*
7. *John A. Pelesko and David H. Bernstein, "Modelling MEMS and NEMS", CRC Press, 2002,UK.*
8. *Ananthasuresh, "Micro and Smart Systems" Wiley Publishers, 2013.*
9. *DG Pascual, P. Daponte, U. Kumar, "Handbook of Industry 4.0 and Smart Systems", CRC Press, 1st Edition, 2019.*

19MAE05 - OPTIMAL CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To introduce to the students the basic techniques of optimal control, static and dynamic optimization techniques and dynamic programming with applications to practical examples.

COURSE OUTCOMES

After completing of this course the students will be able to

CO1 *: Optimize the desired parameter using various methods*

CO2 *: Design optimal controller and solve linear regulator problem*

CO3 *: Apply mathematical programming of optimal control techniques to practical systems.*

INTRODUCTION

Calculus of variation based techniques. Pontryagin's principle and control problems with constraints on control function. Dynamic programming. Numerical techniques. Optimal control of distributed parameter systems. **(9)**

STATIC AND DYNAMIC OPTIMIZATION

Parameter optimization. Calculus of Variations: problems of Lagrange. Mayer and Bolza.Euler-Language equation and transversality conditions, Lagrange multipliers. **(9)**

PONTRYAGIN'S MAXIMUM PRINCIPLE

Pontryagin's maximum principle; theory; application to minimum time, energy and control effort problems, and terminal control problem. **(9)**

DYNAMIC PROGRAMMING

Belaman's principle of optimality, multistage decision processes - application to optimal control. Linear regulator problem: matrix Riccati equation and its solution, tracking problem. **(9)**

APPLICATIONS

Computational methods in optimal control. Applications of mathematical programming. Singular perturbations - practical examples. **(9)**

TOTAL : 45

REFERENCES

1. *M. Athans and P.L. Falb, Optimal Control: An Introduction to the Theory and Its Applications, McGraw Hill, 2007.*
2. *S.P. Sethi and G.L. Thompson, Optimal Control Theory, 2nd edition, Kluwer Academic Publishers, 2000.*
3. *D.P. Bertsekas, Dynamic Programming and Optimal Control, Volume II, 4th Edition, Athena Scientific, 2012.*
4. *M. Green, D.E. Johnson and D.J. N. Limebeer, Linear Robust Control, Prentice Hall, 2012.*
5. *Luigi Fortuna, Mattia Frasca, Optimal and Robust Control: Advanced Topics with MATLAB, CRC Press, 2012.*

19MAE06 - MODERN CONTROL THEORY

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To make the students understand modelling, analysis, synthesis and design of control systems using Advanced techniques.

COURSE OUTCOMES

After completing of this course the students will be able to

CO1 *: Model and realize non linear systems using state space approach*

CO2 *: Analyze and synthesize complex control systems for controllability and observability*

CO3 *: Design optimal controller using various methods.*

MODELING

Development of linear state-space models for nonlinear systems using Taylor series approach State diagram, state space and state-trajectory State-space realization of SISO systems using controllable, observable canonical forms (phase-variable approach) - Diagonal and Jordan's canonical forms - realization schematic Similarity transformation - transformation of a given system into different canonical forms. **(9)**

ANALYSIS

Solution of LTI state-equation - state-transition matrix - properties and computational techniques (Laplace Transform technique and infinite series method). Eigen values - Eigen vectors - Diagonalization (diagonal and Jordan's forms using modal and Vander Monde matrix) - Computation of state transition matrix using diagonalization method. Caley-Hamilton Theorem - Concept of minimal polynomial - determination of state transition matrix using Sylvester interpolation formula. Controllability and Observability - Tests - Kalman's decomposition technique. **(9)**

SYNTHESIS

Introduction - relationship between pole location and system's dynamic performance - control specifications - choice of desired closed loop poles based on dominant pole pair approach from controller specifications - regulation and reference tracking problems. State feedback control design and Observer Design (direct substitution, using similarity transformation and Ackermann's formula)- Observer-based state-feedback control - separation principle - minimum order observer -Design of Servo systems - State-feedback control with integral error compensation. Introduction to Eigen structure assignment. **(9)**

STABILITY

Stability concepts - BIBO - Asymptotic stability - stability definitions in state space domain .stability theorems on local and global stability. Lyapunov stability analysis -Krasovskii Method. **(9)**

OPTIMAL CONTROL

Linear quadratic optimal regulator (LQR) problem formulation optimal - regulator design by parameter adjustment (Lyapunov method) - optimal regulator design by Continuous - time Algebraic Riccatti Equation (CARE) . Optimal controller design using LQG framework. **(9)**

TOTAL : 45

REFERENCES

1. *K. Ogata, Modern control engineering, 5th Edition, Prentice Hall of India Pvt. Ltd., ND 2011*
2. *J. Nagrath and M. Gopal, "Control systems Engineering", 5th Edition, New Age International Pvt Limited, New Delhi, 2012*
3. *Biswa Nath Datta, Numerical methods for linear control systems. Elsevier, 2005*
4. *M. Gopal, Digital Control and state variable methods., Tata McGraw Hill, New Delhi, 2012*

19MAE07 - ROBUST CONTROL

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

To make the students the basic concepts of robust control techniques for multi-objective design, time varying and steady state solutions, Optimal State Estimation, Linear Matrix Inequalities.

COURSE OUTCOMES

After completing of this course the students will be able to

CO1 *: Design robust controller for multi-objective using LMI based synthesis*

CO2 *: Find time varying and steady state solution for LQR controllers*

CO3 *: Synthesize controller by solving LMI problem for the given design specifications.*

INTRODUCTION

Optimal controller design and to LMI-based synthesis techniques for such controllers -Modern H2 and H and for multi-objective design. Optimal regulator problem with finite time horizon, Riccati differential equation. **(9)**

TIME-VARYING AND STEADY STATE SOLUTIONS

Algebraic Riccati equation, Hamiltonian system; Kalman's identity, phase margin of LQR controllers, spectral factorization. **(9)**

OPTIMAL STATE ESTIMATION

Kalman filter, LQG control, Generalized plant, review of LQG control; Signal and system norms, computing loop? norms ; Singular value plots, input and output directions; Mixed sensitivity design, H?H2 and H shaping, choice of weighting filters; Case study: design example flight control. **(9)**

LINEAR MATRIX INEQUALITIES

Design specifications as LMI constraints (H2, H? and pole region); Controller synthesis by solving LMI problems, multi-objective design. **(9)**

ROBUST CONTROL OF UNCERTAIN SYSTEMS

Small gain theorem, representation of parameter uncertainty; balanced realization and model order reduction. **(9)**

TOTAL : 45

REFERENCES

1. *K. Zhou, J. Doyle, and K. Glover, Robust and Optimal Control, Prentice-Hall, 2006.*
2. *K. Zhou and J. C. Doyle, Essentials of Robust Control, Prentice Hall, 2006.*
3. *Michael Green, David J. N. Limebeer, Linear Robust Control, 2012.*
4. *Andrzej Bartoszewicz, Robust Control: Theory and Applications, InTech, 2011.*

19MAE08 / 19MAOE02 - DATA ACQUISITION AND CONTROL USING LABVIEW

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

Students can create data acquisition system independently using Lab VIEW and build interactive dashboards to control the real world applications.

COURSE OUTCOMES

After completing of this course the students will be able to

CO1 : *Create a virtual instrument which highlights common functionality of Lab VIEW.*

CO2 : *Get familiarized with common buses such as Serial, GPIB, and SCPI commands and Staircase signal acquisition using NI-DAQmx*

CO3 : *Discover how to measure light intensity and distance and Master Lab VIEW debugging techniques*

CO4 : *Utilize open source microcontroller Arduino and a 32-bit Arduino compatible Uno32 using Lab VIEW programming environment.*

CO5 : *Build a data acquisition application complete with an installer and required drivers*

INTRODUCTION TO LABVIEW

Concepts of graphical programming - Lab View Basics- Lab VIEW menu bar icons- Concept of VIs and sub VI - Display types - Digital and Analog Chart - Oscilloscopic types - Loops - Case and sequence structures - Types of data - Arrays - Formulae nodes - Local and global variables - String and File I/O, Error conditions - Debugging Tools: broken arrow, highlight execution, Set Breakpoint and Probe. **(9)**

ANALYSIS TOOLS AND SIMPLE CONTROL APPLICATIONS

Fourier transform - Power spectrum - Correlation - Windowing and filtering tools - Simple temperature indicator - ON/OFF controller - counter with a gauge - PID controller - CRO emulation - Simulation of a simple second order system - Signal generation. **(9)**

DATA ACQUISITION PROGRAMMING

Data acquisition definition - DAQ Assistant feature- Capturing a triangular signal- DAQ Programming Using Lab VIEW- Capture signal generator waveforms - Staircase signal (USB DAQ version) - Staircase signal (Oscilloscope version) - Oscilloscope functions in Lab VIEW function pallets - Stepping through voltages- Create serial Read-Write sub VI - Power supply voltage steps- Verify Data Acquired. **(9)**

COMMUNICATION BUSES AND DAQ PROGRAMMING

Wired connections and drivers- Serial communication-GPIB- SCPI commands sets-Arduino for Lab VIEW driver installation- Arduino photo sensor board- - Using event manager- Acquiring distance measurements using Parallax USR with an Arduino- Lab VIEW Program - serial communication through USB- Duty cycle and PWM- Simultaneous data acquisition - NI DAQ and the Arduino Uno. **(9)**

LABVIEW FPGA CONTROLLER PROGRAMMING

Introduction to FPGA - advantages of Lab VIEW FPGA functionality- FPGA programming - Optimizing FPGA programming for speed and size through pipelining and parallel execution - FPGA simulation using Desktop execution node and cycle accurate simulation -Testing and Debugging. **(9)**

TOTAL : 45

REFERENCES

1. *Behzad Ehsani "Data Acquisition Using Lab VIEW" Packt Publishing Pvt. Ltd, 2016.*
2. *Jovitha Jerome, "Virtual Instrumentation using Lab VIEW", PHI Learning Pvt. Ltd., 2010.*
3. *Introductory Resources for Lab View FPGA: http://www.ni.com/product-documentation/54587/en/*
4. *Kevin James, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newness publications, 2000.*
5. *Sanjay Gupta and Joseph John, "Virtual Instrumentation using Lab VIEW", Tata McGraw - Hill Inc, 2005.*
6. *Gary W. Johnson, Richard Jennings, "Lab - view Graphical Programming", McGraw Hill Professional Publishing, 4th Edition, 2011.*
7. *Robert H. Bishop, "Learning with Lab - view", Prentice Hall, 1st Edition, 2014.*
8. *Jeffrey Travis, Jim Kring "Lab VIEW for Everyone: Graphical Programming Made Easy and Fun", Prentice Hall, Third Edition, 2006.*

19MAE09 / 19MAOE03 - INDUSTRY 4.0

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

Industry 4.0 approaches the main strategic elements and best practices to understand the paradigm shift driven by the Internet of Things (IoT) toward the Fourth Industrial Revolution and the development of innovative digital business.

COURSE OUTCOMES

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

CO1 *: Understand the smartness in Smart Factories, Smart cities, smart products and smart Services*

CO2 *: Understand the power of Cloud computing and cyber security in a networked industrial System.*

CO3 *: Understand, discuss and define business strategies and plan toward the Fourth Industrial Revolution.*

INTRODUCTION

Introduction - The Various Industrial Revolutions -Defining Industry 4.0 -Main Characteristics of Industry 4.0 - The Value Chain - Industry 4.0 Design Principles - Building Blocks of Industry 4.0 - Smart Manufacturing -Digitalization and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0- Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation- The Journey so far: Developments in USA, Europe, China and other countries. **(9)**

ROAD TO INDUSTRY 4.0

Internet of Things (IoT) - Industrial Internet of Things (IIoT) - Internet of Services- Smart Manufacturing - Advantages of smart manufacturing companies- Smart Factories- Real-World Smart Factories: GE's Brilliant Factory - Siemens' Amberg Electronics Plant (EWA) - Smart Devices and Products- Smart Logistics - Smart Cities - Predictive Analytics. **(9)**

SYSTEM, TECHNOLOGIES FOR ENABLING INDUSTRY 4.0

Cyber physical Security in Industry 4.0 - Secure Manufacturing Information Architecture - Robotic Automation and Collaborative Robots - Support System for Industry 4.0 - Mobile Computing - Cyber Security **(9)**

DATA, INFORMATION, KNOWLEDGE AND COLLABORATION

Resource-based view of a firm - Data as a new resource for organizations- Harnessing and sharing knowledge in organizations- Cloud Computing Basics - Cloud-Based Design and Manufacturing - Defining Cloud-Based Design and Manufacturing (CBDM) - Software Defined Cloud Manufacturing Cloud Computing and Industry 4.0 **(9)**

BUSINESS ISSUES, APPLICATIONS, AND CASE STUDIES

Opportunities and Challenges -Future of Works and Skills for Workers in the Industry 4.0 Era - Strategies for competing in an Industry 4.0 world -Industry 4.0 laboratories- IIoT case studies. **(9)**

TOTAL : 45

REFERENCES:

1. *Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things" APress; 1st ed. edition (28 June 2016).*
2. *Alp Ustundag, Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation, Springer International Publishing AG; 1st ed. 2018.*
3. *Lane Thames, Dirk Schaefer, " Cybersecurity for Industry 4.0: Analysis for Design and Manufacturing" Springer; 1st ed. 2017 edition.*

4. *Acatech, Recommendations for implementing the strategic initiative INDUSTRIE 4.0. Final report of the Industry 4.0 Working Group, 2013.*
5. *Peter C. Evans ja Marco Annunziata, Industrial Internet: Pushing the Boundaries of Minds and Machine", GE, November 26, 2012.*
6. *Industry 4.0 - Opportunities and Challenges of the Industrial Internet, PWC, 2015.*

19MAE10 / 19MAOE04 - DIGITAL SYSTEM DESIGN AND TESTING

L	T	P	C
3	0	0	3

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

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, 1st 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

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 Hamachar, Zvonco 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. o 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

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 CONCEPTSAND 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. *Jet zt bewerten, "Virtual Reality and Augmented Reality in Industry", Springer, 2nd Edition, 2009.*

19MAE16 / 19MAOE05 - DATA SCIENCE AND ANALYTICS

L	T	P	C
3	0	0	3

ASSESSMENT : THEORY

COURSE OBJECTIVE

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

COURSE OUTCOMES

CO1 *: 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, 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

ASSESSMENT : THEORY

COURSE OBJECTIVE

To understand the concepts of virtualization and its features in the design of virtual machine products.

COURSE OUTCOMES

Students will be able to

CO1 *: Understand the key concepts of virtualization platform.*

CO2 *: Apply the virtualization techniques for design of hardware and routing protocols.*

CO3 *: Design 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 - Sever 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 - Ipsec 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

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 interference - 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. Kohenon 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.N Sivanandam and Dr. S.N. Deepa, "Principles of Soft Computing", 2nd 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; 4th 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, 2nd 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", Harcourt Asia Ltd., 1998.*

19MAE19 - EDGE COMPUTING

L	T	P	C
3	0	0	3

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

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3	0	0	3

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, 4th 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, 4th Edition, 2010.*
4. *Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 2001.*