COIMBATORE INSTITUTE OF TECHNOLOGY, COIMBATORE – 641 014
(An Autonomous Institution affiliated to ANNA UNIVERSITY, CHENNAI)
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
REGULATIONS 2023 CHOICE BASED CREDIT SYSTEM

M.E. – EMBEDDED AND REAL TIME SYSTEMS (ERTS)

VISION

To empower the 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. Nurture the talent and creativity of the students by making them to practice and realize the core and allied concepts.
2. Empower the students in the thrust area of electrical engineering through the collaboration with industries and research activities.
3. Inculcate the lifelong learning and ethics on realizing them as responsible engineers for developing the society and their future

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

PEO1: Develop the on-demand technical skills to be a competent professional.

PEO2: Foster creative solutions to real life challenges

PEO3: Practice ethical research of social value.

PROGRAMME OUTCOMES (POs)

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: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
PO4: An ability to use modern tools, professional software platforms, embedded systems for diversified applications.
PO5: An ability to recognize societal challenges and responsibilities and offer engineering solutions

PO6: An ability to participate effectively in a team and lead with a vision to offer solutions globally.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: An ability to select appropriate techniques to modernize the existing infrastructure in line with the industry standards with the industry standards

PSO2: An ability to apply concepts in Engineering analysis and design

MAPPING OF PROGRAMME EDUCATIONAL OUTCOMES WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

PEOs	PROGRAMME OUTCOMES												PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3	3	3									3	
2			3	3		3								3
3					3	3							3	3

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REGULATIONS 2023 - CHOICE BASED CREDIT SYSTEM
CURRICULUM AND SYLLABI

M.E. – EMBEDDED AND REAL TIME SYSTEMS (ERTS)

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23MER111	Higher Engineering Mathematics	BSC	3	1	0	4	4
2	23MER112	System Design & Embedded Controllers	PCC	3	0	0	3	3
3	23MER113	Embedded System Design using FPGA	PCC	3	0	0	3	3
4	23MER114	Electromagnetic Interference and Compatibility	PCC	3	0	0	3	3
5		Elective I	PEC	3	0	0	3	3
PRACTICALS								
6	23MER121	System Design & Embedded controllers Laboratory	PCC	0	0	4	4	2
7	23MER122	Embedded System Design using FPGA Laboratory	PCC	0	0	4	4	2
ONE CREDIT COURSE								
8		Value added course I	OCC				15	1
			TOTAL	**15**	**1**	**8**	**24**	**21**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23MER211	Automotive Embedded System	PCC	3	1	0	4	4
2	23MER212	Robotics Technology and Intelligence	PCC	3	0	0	3	3
3	23MER231	Real Time Operating Systems	PCC	2	0	2	4	3
4		Elective II	PEC	3	0	0	3	3
5		Elective III	PEC	3	0	0	3	3
PRACTICALS								
6	23MER221	Internet of Things Laboratory	PCC	0	0	4	4	2
7	23MER222	Feasibility Report Writing	PCC	0	0	4	4	2
ONE CREDIT COURSE								
8		Value added course II	OCC				15	1
			TOTAL	**16**	**1**	**10**	**25**	**21**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Elective IV	PEC	3	0	0	3	3
2		Elective V	PEC	3	0	0	3	3
3		Elective VI	PEC	3	0	0	3	3
PRACTICALS								
4	23MER341	Project – Phase I	EEC	0	0	6	6	3
ONE CREDIT COURSE								
5		Value added course III	OCC				15	1
			TOTAL	**9**	**0**	**6**	**15**	**13**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1	23MER441	Project – Phase II	EEC	0	0	30	30	15
			TOTAL	**10**	**0**	**30**	**30**	**15**

LIST OF PROFESSIONAL ELECTIVE COURSES:

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	23MERE01	Smart Systems	**PE**	**3**	**0**	**0**	**3**	**3**
2.	23MERE02	Embedded System Security	**PE**	**3**	**0**	**0**	**3**	**3**
3.	23MERE03	Data Science and Analytics	**PE**	**3**	**0**	**0**	**3**	**3**
4.	23MERE04	Intelligent Systems and Control	**PE**	**3**	**0**	**0**	**3**	**3**
5.	23MERE05	Intelligent Controllers for Power Quality Enhancement	**PE**	**3**	**0**	**0**	**3**	**3**
6.	23MERE06	Embedded Control of Industrial Drives	**PE**	**3**	**0**	**0**	**3**	**3**
7.	23MERE07	Design of Green Transportation System	**PE**	**3**	**0**	**0**	**3**	**3**
8.	23MERE08	Embedded Sensor Networks	**PE**	**3**	**0**	**0**	**3**	**3**
9.	23MERE09	Modeling and Design of Embedded Systems	**PE**	**3**	**0**	**0**	**3**	**3**
10.	23MERE10	Multicore Architecture	**PE**	**3**	**0**	**0**	**3**	**3**

11.	23MERE11	System Simulation and Modeling	**PE**	**3**	**0**	**0**	**3**	**3**
12.	23MERE12	Digital System Design and Testing	**PE**	**3**	**0**	**0**	**3**	**3**
13.	23MERE13	Synthesis and Optimization of Digital Circuits	**PE**	**3**	**0**	**0**	**3**	**3**
14.	23MERE14	Computer Vision	**PE**	**3**	**0**	**0**	**3**	**3**
15.	23MERE15	High Performance Computer Architecture	**PE**	**3**	**0**	**0**	**3**	**3**
16.	23MERE16	Cryptography and Block Chain Technologies	**PE**	**3**	**0**	**0**	**3**	**3**
17.	23MERE17	Augmented Reality	**PE**	**3**	**0**	**0**	**3**	**3**
18.	23MERE18	Network Virtualization	**PE**	**3**	**0**	**0**	**3**	**3**
19.	23MERE19	Soft Computing	**PE**	**3**	**0**	**0**	**3**	**3**
20.	23MERE20	Edge Computing	**PE**	**3**	**0**	**0**	**3**	**3**
21.	23MERE21	Computer Security	**PE**	**3**	**0**	**0**	**3**	**3**

SUMMARY

Category; BSC – Basic sciences, HSC– Humanities and Social Sciences, ESC–Engineering sciences, PCC –Professional Core, PEC- Professional Elective, EEC –Employability Enhancement Course

M.E. EMBEDDED AND REAL TIME SYSTEMS (ERTS)										
Sl. No.	**Subject Area**	**Credits per Semester**								**Credits Total**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
1	HSC									
2	BSC	4								**4**
3	ESC									
4	PCC	13	14							**27**
5	PEC	3	6	9						**18**
6	OEC									
7	EEC			3	15					**18**
8	OCC	1	1	1						**3**
							TOTAL CREDITS			**70**

SEMESTER I

23MER111	HIGHER ENGINEERING MATHEMATICS	L	T	P	C
		3	1	0	4

MODULE I MULTIVARIATE CALCULUS 12

Mean Vectors and Covariance Matrices – Partitioning the Covariance Matrix- Mean Vector and Covariance Matrices for Linear Combination of Random Variables –Multivariate Normal Distribution- Principal Components – Population Principal Components - Principal Components got from Standardised Variables.

MODULE II RELIABILITY 12

Concept of Reliability-Inter Failure Rate- Hazard Rate- Conditional reliability- Mean time to failure-Failure distributions –Exponential distribution- Weibul distribution- System Reliability-System configuration (Series System)-Parallel configuration(Parallel System)- Mixed configuration.

MODULE III QUEUING THEORY 12

Single Server ,Unlimited Model –Multi server Poisson Queue Finite Capacity, Single Server Poisson Queue - Finite Queue, Multi Server Poisson Queue Model.

MODULE IV RANDOM VARIABLES AND PROCESSES 12

Joint distributions — Marginal and conditional probabilities–Covariance–Correlation – Regression - Classification – Stationary Process - Wide Sense Stationary Process-Jointly WSS Processes .

MODULE V GRAPH THEORY 12

Basic Concepts of Graph –Matrix representation of graphs and isomorphism –path circuits and connectedness-Euler and Hamilton paths.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Use the ideas of Multivariate Calculus in solving engineering problems.

CO2: Apply Reliability techniques in solving various application problems.

CO3: Address Queuing Theory in embedded systems technologies.

CO4: Apply Random Variables and Processes in solving practical problems.

CO5: Demonstrate Graph theory and its salient features for embedded systems**.**

TOTAL: 60 PERIODS

REFERENCES:

1. Saeed Ghahramani, “Fundamentals of Probability with Stochastic Processes”, CRC press, Taylor &Fransis Group, USA, 2019.

2. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 44th Edition, New Delhi,

2017.

3. Taha H .A., " Operations Research: An Introduction " , 9th Edition, Pearson Education Asia, New Delhi, 2016.

4. Walpole R.E., Myer R.H., Myer S.L., and Ye, K., " Probability and Statistics for Engineers and Scientists ", 7th Edition, Pearson Education, Delhi, 2002.

5. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	2			1		1	2
2	3	2			1		1	2
3	3	2			1		1	2
4	3	2			1		1	2
5	3	2			1		1	2
Avg.	**3**	2			1		**1**	2

1-low, 2-medium,3-high

23MER112	SYSTEM DESIGN AND EMBEDDED CONTROLLERS	L	T	P	C
		3	0	0	3

MODULE I EMBEDDED C LANGUAGE 9

Introduction to Embedded C Program-/O Operations-Operators and Expressions-Control Statements- Functions-Pointers and Arrays-Structures and Unions-Memory Types-Real Time Methods- Installing the software and loading the Project-Configuring the Simulator-Running the Simulation-Dissecting the program- Real time Constraints-Creating an Embedded System-Real Time Systems and Methods.

MODULE II ATMEL RISC PROCESSORS 9

Architectural Overview-Register File-Memory Access -I/O Memory-timers-UART-Counters-Reset and Interrupt Function-Serial Communication-Standard I/O preprocessor function-Power Down Modes of operation.

MODULE III AVR HARDWARE DESIGN ISSUES 9

Hardware and software Interfacing with AVR- Power Source-Operating Clock Source-Stack operation in Processors-Implementing combinational logic-Expanding I/O-Interfacing A to D Converter-D to A Converter- Implementing a Finite State Machine-Communication Links for AVR Processor-RS 232,RS 422, SPI, IIC bus- PC parallel port-ISA bus-Universal serial bus-IrDA Data Link-CAN Bus.

MODULE IV AVR SYSTEM DEVELOPMENT TOOLS 9

Code vision AVR-Embedded System Design and Software Development-AVR system design with Components Off The Shelf-Prototype Project Development-Specifying the Requirements-Design Description- Code Development-Fabrication-Testing .

MODULE V EMBEDDED SYSTEM DEVELOPMENT 9

Project Development- Design Phase-Build and Test the prototype hardware Phase-System Integration and Software Development Phase-System test phase-Design and Development of Weather Monitoring System- Concept Phase-Definition Phase-Electrical and Operational Specification-Measurement Consideration for the design-Hardware Design-Software Design-Test Phase-Build and test Prototype Hardware Phase-System Integration and Software development Phase.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Develop their programming skills practically.
CO2: Able to apply their software skills in real time applications.
CO3: Create an application based on embedded controllers.

CO4: Understand the architecture of the embedded controllers.

CO5: Interface an embedded controller with the physical environment and develop solutions.

CO6: Design and development solution for any application using Embedded Controllers.

TOTAL: 45 PERIODS

REFERENCES:

1. Barnett, Cox, O'Cull, "Embedded C Programming and Atmel AVR" Cengage Learning India Private Limited, 2019.

2. Dhananjay Gadre, "Programming and Customizing the AVR Microcontroller",Tata Mc Graw Hill Publishers, 2017. Michael J.Pont, "Embedded C", Pearson Education, 2002.

3. Steven F.Barrerr and Daniel. J.Pack , "Microcontroller Programming and Interfacing with Texas Instruments" Texas Instruments

4. W. Wolf, Computers as Components: Principles of Embedded Computing System Design, 2nd Ed.,Burlington, 2008.

5. T Noergaard, Embedded Systems Architecture: A comprehensive Guide for Engineers and Programmers, Elsevier, Oxford, 2005.

6. Embedded Systems: Introduction to Arm® Cortex™-M Microcontrollers,
5th edition By Jonathan W. Valvano

7. TI MSP432 ARM Programming for Embedded Systems by Muhammad Ali Mazidi, SepehrNaimi, Shujen Chen and MisaghSalmanzadeh

8. An Introduction to the Texas Instruments C2000 Real-time Control Microcontrollers by Gautam Iyer

CO-PO&PSO MAPPING

CO	PO						PSO		
	1	2	3	4	5	6	1	2	
1					3				
2					3				
3						3			
4	3								
5						3	3		
Avg.	3				3	3	3		

1-low, 2-medium,3-high

23MER113	EMBEDDED SYSTEM DESIGN USING FPGA	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION 9

FPGA Evolution — PLD and CPLD - Components of an FPGA - Programming Technology - Antifuse Technology - Logic Circuit Representation of FPGA – Structure of Look up table - Introduction to SoC , PSoC.

MODULE II FPGA ARCHITECTURE 9

FPGA Structure: Logic Block - Logic Cluster — Adaptive LUT - Routing Part - Switch Block - Connection Block - I/O Block - DSP Block - Hard Macros - Embedded Memory - Configuration Chain.

MODULE III DESIGN FLOW 9

Design Flow by HDL - HLS Design - IP-Based Design - Design with Processor. Design Methodology - FPGA Design Flow - Technology Mapping - Clustering - Place and Route - Low Power Design Tools. Simulation and Synthesis Concepts - Software tools .

MODULE IV SYSTEM TESTING 9

The testing problem — Testing approaches — External testing and BIST — Online and Offline testing — Application dependent and Independent testing – Logic resources – Programmable Logic blocks – Input- output cells – specialized cores – Diagnosis –Interconnect resources – Embedded Processor based Testing.

MODULE V VERILOG PROGRAMMING 9

Basics of Verilog HDL – Design flow - Abstraction levels – Language conventions - Gate level – Data flow – Behavioural modelling of combinational circuits – Programming Sequential circuits – switch level modelling - Test bench.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: List the concepts of FPGA.

CO2: Describe the internal architecture of FPGA.

CO3: Explain the design flow of system design using FPGA.

CO4: Describe the testing procedure for faults in the system.

CO5: Sketch the usage of software tools for development of Verilog program**.**

TOTAL: 45 PERIODS

REFERENCES:

1. Hideharu Amano, “Principles and Structures of FPGAs”, Springer, 2018 (Unit I, II and III).

2. Suman Lata Tripathi, Sobhit Saxena, Sanjeet K. Sinha, Govind S. Patel “Digital VLSI Design and Simulation with Verilog”, John Wiley, 2022 (Unit IV).

3. Wayne wolf, “ FPGA Based System Design”, Prentice Hall, 2004 (Unit 1 , II)

4. John F. Wakerly, Digital Design Principles and Practices", Pearson Education, Asia, IV Edition, 2016 (Unit IV) .
5. Laung-Terng Wang , Charles E. Stroud , Nur A. Touba , “System-on-chip Test architectures”, Elsevier , 2008, (Unit V).

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	1	2	3	2	1	1	3
2	3	2	3	3	2	1	1	3
3	3	2	3	2	1	1	1	3
4	3	2	3	3	2	1	1	3
5	3	2	2	3	2	1	2	3
Avg.	**3**	**1.8**	**2.6**	**2.8**	**1.8**	**1**	**1.2**	**3**

1-low, 2-medium,3-high

23MER114	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3

MODULE I EMI/EMC CONCEPTS 9

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.

MODULE II EMI COUPLING PRINCIPLES AND MEASUREMENTS 9

Conducted, radiated and transient coupling- Common ground impedance coupling — Common mode and 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 power supply lines- Measurement of Conducted EMI from equipments: Instrumentation for measuring Conducted EMI- Experimental setup for measuring conducted EMI- Measurement of CM and DM Interferences.

MODULE III EMI CONTROL TECHNIQUES 9

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

MODULE IV EMC DESIGN OF PCBS 9

Component selection and mounting; Choice of Resistors, Inductors ,Capacitors, Diodes , Integrated circuits, Voltage regulators and Microcontroller circuits- PCB layout techniques-PCB traces- Grounding techniques- PCB Routers and Routing methods- VIAs connections- Line Terminations.

MODULE V RADIATED EMI MEASUREMENTS AND EMC STANDARDS 9

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.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Illustrate the concepts of Electromagnetic Interference and Compatibility and acquire knowledge about various sources of EMI.

CO2: Criticize the various EMI coupling principles and demonstrate the various techniques of conducted EMI measurements.

CO3: Perceive the various EMI control techniques and make appropriate tradeoffs to achieve the most cost- effective EMC design that meets all requirements in the real world.

CO4: Design electronic systems and high speed Printed Circuit boards without the problems related to electromagnetic compatibility.

CO5: Demonstrate the various measurement techniques for radiated emission and EMC standards**.**

TOTAL: 45 PERIODS

REFERENCES:

1. V.P.Kodali,"Engineering EMC principles, Measurements and Technology",IEEE Press, Newoyrk, Wiley-Blackwell, Second Edition,2016.
2. Clayton R. Paul,"Introduction to Electromagnetic compatibility"John Wiley & Sons,2022.
3. David A. Weston,"Electromagnetic compability: Methods, Analysis, Circuits and Measurments'' Third Edition, CRC Press, 2016
4. Henry W.Ott,"Noise Reduction Techniques in Electronics System",John Wiley and Sons,Newyork,2009 .
5. Bernhard Keiser,"Principles of Electomagnetic Compatibility",Artech house,2008.
6. DonR.J. White Consultant Incorporate,"Handbook of EMI/EMC",John Wiley and Sons, Newyork,2009.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	2	3	2	2	1	1	3
2	3	2	2	2	2	1	1	3
3	3	3	2	3	2	2	2	3
4	3	3	3	3	3	3	3	3
5	3	3	3	3	3	1	1	2
Avg.	**2.7**	**2.5**	**2.7**	**2.8**	**2.8**	**2.3**	**1.5**	**2.7**

1-low, 2-medium,3-high

23MER121	SYSTEM DESIGN AND EMBEDDED CONTROLLERS LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS:

Implementation of the following concepts in Embedded Controllers

1. Configuration of special Function Registers.
2. Interfacing of Basic external peripherals (LEDs, Pushbuttons, Relays, LCD, DC Motors with Motor Drivers, Servo Motors).
3. Implement a serial communication protocol for a real-world application. (Eg. Implement a simple embedded system to control a traffic light over a serial port.).
4. Implement a embedded system for I/O operations.
5. Implement an application with memory related operations.
6. Implement a simple embedded system for a real-world application using Timers and counters .
7. Implement an application with Interrupt Programming.
8. Implementation of PID Controller.
9. Implementation of Finite State Machine.
10. System design using Embedded Controllers.

TOTAL: 60 PERIODS

COURSEOUTCOMES:

After completing the course successfully, the students will be able to,

CO1: Familiarize simulation tools.

CO2: Acquire knowledge about software tools for embedded systems.

CO3: Understand the architecture of embedded controllers

CO4: Alter the configuration of embedded controllers

CO5: Interface the sensors with embedded controllers to suit any particular application

CO6: Propose, design and implement the ideas for measuring, controlling various physical parameters of real world problems.

CO-PO&PSO MAPPING

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1					3				
2					3				
3	3								
4						3			
5							3	3	
6							3	3	
Avg.	3				3	3	3	3	

1-low,2-medium,3-high

23MER122	EMBEDDED SYSTEM DESIGN USING FPGA LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS:

Language: Verilog Software: Xilinx FPGA Board: Spartan 3E, Spartan 6

1. Encoders and decoders
2. Adders
3. Counters
4. 4-bit ALU
5. Interfacing DC motor using PMOD Interface
6. Control of dc servo motor
7. Control of stepper motor
8. Finite state machine
9. Design of combinational circuits
10. Interfacing external devices
11. Shift register
12. Multiplexers and Demultiplexers
13. Testbenches
14. Synthesize for various hardware platforms
15. IP Design example

TOTAL: 60 PERIODS

COURSEOUTCOMES:

After completing the course successfully, the students will be able to,

CO1: Learn the concepts of FPGA programming and implementation.

CO2: Design logical relations to be implemented in FPGA based on applications along with test benches.

CO3: Write Verilog code test it on FPGA for combinational and sequential logics

CO4: Design and demonstrate communication module in FPGA based system using Verilog

CO5: Design and demonstrate motor control module in FPGA based system using Verilog

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	2	3	4	5	6	1	2
1	2	1	2	1	2	2	1	3
2	2	1	2	1	2	3	1	3
3	3	2	2	2	1	3	2	3
4	3	2	2	2	1	2	2	3
5	3	3	2	2	2	2	2	3
Avg.								

1-low,2-medium,3-high

SEMESTER 2

23MER211	AUTOMOTIVE EMBEDDED SYSTEM	L	T	P	C
		3	1	0	4

MODULE I BASIC OF ELECTRONIC ENGINE CONTROL SYSTEMS 9

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Automotive microcontrollers- Electronic control Unit- Hardware & software selection and requirements for Automotive applications — open source ECU- RTOS - Concept for Engine management-Standards; Introduction to AUTOSAR and Introduction to Society SAE- Functional safety ISO 26262- Simulation and modeling of automotive system components.

MODULE II SENSORS AND ACTUATORS FOR AUTOMOTIVES 9

Review of sensors- sensors interface to the ECU, conventional sensors and actuators, Modern sensor and actuators - LIDAR sensor- smart sensors- MEMS/NEMS sensors and actuators for automotive applications.

MODULE III VEHICLE MANAGEMENT SYSTEMS 9

Electronic Engine Control-engine mapping, air/fuel ratio spark timing control strategy, fuel control, electronic ignition- Adaptive cruise control - speed control-anti-locking braking system-electronic suspension - electronic steering , Automatic wiper control- body control system ; Vehicle system schematic for interfacing with EMS, ECU. Energy Management system for electric vehicles- Battery management system, power management system-electrically assisted power steering system-Adaptive lighting system- Safety and Collision Avoidance.

MODULE IV ONBOARD DIAGONSTICS AND TELEMATICS 9

On board diagnosis of vehicles -System diagnostic standards and regulation requirements Vehicle communication protocols Bluetooth, CAN, LIN, FLEXRAY, MOST, KWP2000 and recent trends in vehicle communications- Navigation- Connected Cars technology — Tracking- Security for data communication- dashboard display and Virtual Instrumentation, multimedia electronics- Role of IOT in Automotive systems.

MODULE V ELECTRIC VEHICLES 9

Electric vehicles –Components- Hybrid Electric Vehicle-Plug in Electrical vehicle-Battery Electric Vehicle- Charging station – Aggregators- Fuel cells/Solar powered vehicles- Autonomous vehicles.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Insight into the significance of the role of embedded system for automotive applications.

CO2: Illustrate the need, selection of sensors and actuators and interfacing with ECU.

CO3: Develop the Embedded concepts for vehicle management and control systems.

CO4: Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.

TOTAL:45+15 PERIODS

REFERENCES:

1. William Ribbens, "Understanding Automotive Electronics: An Engineering Perspective ", Butterworth- Heinemann; 8th edition, 2017.

2. Ali Emadi,MehrdadEhsani and John M. Miller, "Vehicular Electric Power Systems: Land, Sea, Air, and Space Vehicles" CRC Press; 1st edition, 2003.

3. *L.Vlacic,M.Parent,F.Harahima, "Intelligent Vehicle Technologies",SAE International,2001.*

4. Ronald K. Jurgen, "Electronic Engine Control Technologies"SAE International; 2nd Edition, 2004.

5. Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive, Springer Vieweg, 5th edition.

6. *Tom Denton, "Automotive Electricals / Electronics System and Components" Elsevier Butterworth- Heinemann, Third Edition,2004.*

7. UweKiencke, Lars Nielsen, "Automotive Control Systems For Engine, Driveline, and Vehicle" Springer Berlin Heidelberg, 2005.

8. "Automotive Electronics Handbook" McGraw-Hill Education; 2nd edition, 1999.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	3	3	3	2	3	3	3
2	3	3	3	3	2	3	3	3
3	3	2	3	3	2	3	2	2
4	3	2	2	3	3	3	2	2
5	3	2	2	3	3	3	2	2
Avg.	**3**	2.4	2.6	3	2.2	3	**2.4**	2.4

1-low, 2-medium,3-high

23MER212	ROBOTICS TECHNOLOGY AND INTELLIGENCE	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION 9

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.

MODULE II ROBOT END EFFECTORS AND TRAJECTORY PLANNING 9

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.

MODULE III ROBOT CONTROL 9

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.

MODULE IV ROBOT INTELLIGENCE AND TASK PLANNING 9

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.

MODULE V INDUSTRIAL ROBOTICS 9

Robot cell design and control - cell layouts - multiple robots and machine interference - work cell 24 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.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Work with variety of sensors in Robotic systems.

CO2: Analyze the components of any Robotics system.

CO3: Study the applications of Robotics in industries.

CO4: Understand the smartness in Smart Factories, Smart cities, smart products and smart services.

CO5: Diagnose an automated system circuit with suitable for the Industries.

TOTAL: 45 PERIODS

REFERENCES:

1. Fu, K.S., Gonzalez RC. & Lee C.S.G., "Robotics Control, Sensing Vision and Intelligence", McGraw Hill, 1987.
2. Robert J Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, New Delhi, 2013.
3. Deb. S. R, "Robotics Technology and Flexible Machine Design", Tata McGraw Hill, 2010.
4. Mikell. P. Groover, Michell Weis, Roger. N. Nagel, Nicolous G. Odrey, "Industrial Robotics Technology, Programming and Applications ", McGraw Hill, Int 2012.
5. Richard D Klafter Thomas A.Chmielewski and Michael Negin, "Robotic Engineering: An Integrated approach", Prentice Hall of India, New Delhi, 2010.
6. Nagrath I.J., Mittal R.K., "Robotics and Control", Tata McGraw Hill, Sixth reprint, 2007.
7. Corke, Peter, “Robotics, Vision and Control Fundamental Algorithms in MATLAB”, Springer, 2017.
8. Siciliano, Bruno, Khatib, Oussama, “Springer Handbook of Robotics”, Springer, 2016.

FURTHER READING: NPTEL

1. https://onlinecourses.nptel.ac.in/noc21_cs79/preview
2. https://onlinecourses.nptel.ac.in/noc20_me03/preview

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	1	2	2	1	2	2	2
2	3	1	3	2	1	2	3	3
3	3	1	3	2	2	2	3	3
4	3	1	3	3	3	2	3	3
5	3	1	3	3	3	3	3	3
Avg.	**3**	1	3	2.4	2.2	2.2	**2.8**	2.8

1-low, 2-medium, 3-high

23MER231	REAL TIME OPERATING SYSTEMS	L	T	P	C
		2	0	2	3

MODULE I REAL TIME SYSTEMS 6

Introduction to real time computing - Concepts; Example of real-time applications - Structure of a real time system - Characterization of real time systems and tasks - Hard and Soft timing constraints - Design Challenges - Performance metrics - Prediction of Execution Time -Cache and pipeline issues.

MODULE II KERNEL STRUCTURES 6

Real time OS - Structure of Microkernel - Time services - Scheduling Mechanisms - Communication and Synchronization - Event Notification and Software interrupt.

MODULE III SCHEDULING 6

Task assignment and Scheduling - Task allocation algorithms - Single-processor and Multiprocessor task scheduling - Clock-driven and priority-based scheduling algorithms- Fault tolerant scheduling.

MODULE IV COMMUNICATION AND NETWORKING 6

Real Time Communication -Network topologies and architecture issues - protocols - contention based, token based, polled bus, deadline-based protocol, Fault tolerant routing.

MODULE V PRIORITIES AND ISSUES 6

Real time Databases - Transaction priorities - Concurrency control issues - Disk scheduling algorithms - Two phase approach to improve predictability.

PRACTICALS 15

1. Task Creation and Scheduling.
2. Task Prioritization.
3. Semaphore Management.
4. Rate Monotonic Analysis.
5. Deadlock Detection and Prevention.
6. RTOS Debugging and Trace Analysis.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: The students can develop the knowledge about Schedulable analysis.

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

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

CO4: The students can implement the RTOS development tools in real time systems able to analyze and optimize system timing to ensure responsiveness and determinism.

CO5: The Students will be proficient in debugging and testing real-time applications, and understand the challenges of testing in real-time environments.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. C.M. Krishna, Kang G. Shin - “Real Time Systems”, International Edition, McGraw Hill Companies, Inc., New York, 2020.
2. Philip A. Laplante, "Real Time Systems Design and Analysis-An Engineers Handbook", II Edition- IEEE Press, IEEE Computer Society Press, 2021.
3. Jean J Labrosse, "MicroC/OS-II the Real Time Kernel" II Edition, CMP Books, 2022.
4. Jane W. S. Liu,"Real-Time Systems”, Pearson,4th Edition,2021.
5. Jean J. Labrosse,"Embedded Systems Building Blocks: Complete and Ready-to-Use Modules in C”, CMP Books, 2nd Edition, 2020.

REFERENCES:

1. Prasad Kulkarni ,"RTOS Programming: Concepts for Embedded Systems”, Packet Publishing 1st Edition, 2021.
2. Qing Li, Caroline Yao "Real-Time Concepts for Embedded Systems”, CMP Books, 1st Edition, 2020.
3. K.C. Wang ,"Real-Time Operating Systems: The Engineering of Real-Time Embedded Systems and Operating Systems Concepts", Prentice Hall ,1st Edition, 2021.
4. Shibaji Paul ,"RTOS Concepts for Beginners" Create Space Independent Publishing Platform 1st Edition,2019
5. Richard Barry ,“Mastering the Free RTOS Real Time Kernel: A Hands-On Tutorial Guide", Real Time Engineers Ltd. Second Edition, 2019.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	1	3	3	3	2	3	2
2	3	1	2	2	2	2	2	3
3	3	1	3	3	2	2	3	3
4	3	1	3	2	2	2	2	3
5	3	1	3	3	2	2	2	3
Avg.	**3**	1	2.8	2.8	2.2	2	**2.4**	2.8

1-low, 2-medium, 3-high

23MER221	INTERNET OF THINGS LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS

1. Small applications interfacing sensors ESP8266,ESP3266 Aurdino with cloud platforms
2. Networking Simulation using CISCO PACKET tracer
3. Temperature and moisture Data uploading in the cloud platform such as ADAFRUIT
4. Uploading Data to different Cloud Platforms
5. Ethical Hacking programs using kali Linux
6. Security Testing Programs
7. Applications using sensors and Aurdino UNO
8. Home Appliances Control
9. Data Analyzing Techniques- SQL- ORACLE
10. Traffic light controller
11. Commercial Building Monitoring
12. Smart irrigation System

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Employ the IoT Components for different applications.

CO2: Use the networking components and LAN, WAN networks.

CO3: Interface the data from sensors.

CO4: Application of IoT for home, commercial buildings using various cloud platforms.

CO5: Perform ethical hacking methods and apply suitable security codes in various IoT applications

TOTAL: 60 PERIODS

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	2	3	4	5	6	1	2
1	1	1	1	3	3	2	1	1
2	1	1	1	3	3	2	1	1
3	1	1	2	2	2	2	1	1
4	3	3	3	3	3	3	2	2
5	3	3	3	3	3	3	2	2
Avg.	1.8	1.8	2	2.8	2.8	2.4	1.4	1.4

1-low, 2-medium, 3-high

23MER222	FEASIBILITY REPORT WRITING	L	T	P	C
		0	0	4	2

COURSEOUTCOMES:

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

CO1: To identify the government and non-governmental organizations providing research grants

CO2: To realize the research grants that fits with organization's strategies and capabilities.

CO3: To recognize the importance of secondary and internal research in the planning process and reviewing the literatures related to the research.

CO4: To estimate the budget appropriately for the project to be developed.

CO5: To write professional grant proposals for corporate, private foundations and government organizations in a way to maximize the chance of getting approved.

TOTAL: 60 PERIODS

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	2	3	4	5	6	1	2
1	3	3	3	1	1	3	2	2
2	3	3	3	1	1	3	2	2
3	3	3	3	1	1	3	2	2
4	3	3	3	1	1	3	2	2
5	3	3	3	1	1	3	2	2
Avg.	3	3	3	1	1	3	2	2

1-low,2-medium,3-high

SEMESTER III

23MER341	PROJECT PHASE I	L	T	P	C
		0	0	6	3

COURSEOUTCOMES:

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

CO1: Analyze the problems in societal and environmental contexts and to provide the technical support for sustainable development without affecting the nature

CO2: Develop practical knowledge within the chosen area of technology for project development with professional ethics

CO3: Identify, analyze, formulate and design a real time project with a comprehensive and systematic approach by using modern tools and to have sustainable environment.

CO4: Take part in a team and as an individual in the development of technical projects and to improve their effective team management and financial management skills through project activities.

CO5: Develop effective communication skills for presentation and plagiarism free technical report preparation.

TOTAL: 90 PERIODS

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	2	3	4	5	6	1	2
1	3		3	2	3		2	2
2	3		3				3	3
3	3		3	3	3		2	
4						3		2
5		3						
Avg.	3	3	3	2.5	3	3	2.3	2.3

1-low,2-medium,3-high

SEMESTER IV

23MER441	PROJECT PHASE II	L	T	P	C
		0	0	30	15

COURSEOUTCOMES:

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

CO1: : Demonstrate the technical skills to provide feasible solutions for real - life problems relevant to the society.

CO2: Analyze, estimate and manage a project within a stipulated project time line and communicate effectively on complex engineering activities

CO3: Apply engineering ethical principles in societal and environmental concepts to realize the importance of project management tools, estimation and costing.

CO4: Enhance the management skills to achieve the project goal by working as a team.

CO5: To develop a product as a solution for complex engineering problems and a need for sustainable development with modern tool usage.

TOTAL: 450 PERIODS

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	2	3	4	5	6	1	2
1	3		3		3		2	1
2	3		3	3	2			
3	3		3		3		2	2
4						3		2
5	3		3	3	3		3	3
Avg.	3		3	3	2.8	3	2.3	2

1-low,2-medium,3-high

.

PROFESSIONAL ELECTIVES

23MERE01	SMART SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I MEMS DEVICES 9

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.

MODULE II INTERFACING SENSOR INFORMATION AND MCU 9

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

MODULE III COMMUNICATION FOR SMART SENSORS 9

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

MODULE IV PACKAGING, TESTING AND RELIABILITY IMPLICATIONS OF SMART SENSORS 9

Semiconductor Packaging- Hybrid Packaging- Packaging for Monolithic Sensors- Reliability Implications Testing Smart Sensors- HVAC Sensor Chip.

MODULE V CONTROL AND IMPLICATIONS OF SMART SENSORS AND STANDARDS 9

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 .

COURSEOUTCOMES

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

CO1: Explore various physical phenomenon behind the operation of different types of sensors and Microsystems.

CO2: Inspect the current state of smart sensors and apply engineering skills to the analysis of Microsystems.

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

CO4: Interpret smartness in Smart Factories, Smart cities, Smart products and Smart services.

CO5: Assess an automated system circuit with suitable testing methods**.**

TOTAL: 45 PERIODS

TEXTBOOKS:

1. "Understanding Smart Sensors", by Randy Frank, Artech House, Third Edition, Boston, 2019.

2."Analysis and design principles of MEMS devices", by MinhangBao, Elsevier Publications, USA, 2020.

3.“Technological Innovations for Smart Systems”, by JavanehRamezani, JavadJassbi, Springer International Publishing, 2017.

4.“Smart Material Systems and MEMS: Design and Development Methodologies”, by Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, John Wiley and Sons Limited, USA, 2006.

REFERENCES:

1. "An Introduction to Micro Electro Mechanical Systems Engineering",by NadimMaluf and Kirt Williams, Second Edition, Artech House Publishers, USA, June 2004.

2. "RF MEMS: Theory, Design, and Technology", by Gabriel M. Rebeiz, Wiley-Interscience; 1st edition, UK, 2002.

3. "Modelling MEMS and NEMS", by John A. Pelesko and David H. Bernstein, CRC Press, UK, 2002.

4. "Micro and Smart Systems" by Ananthasuresh,Wiley Publishers, 2013.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	2	1	2	1	1	1	2	2
2	2	1	2	2	1	1	2	3
3	2	1	2	1	2	2	1	1
4	3	1	3	3	3	2	3	3
5	3	1	3	3	3	2	3	3
Avg.	**2.4**	1	2.4	2	2	1.6	**2.2**	2.4

1-low, 2-medium,3-high

23MERE02	EMBEDDED SYSTEM SECURITY	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO EMBEDDED SYSTEM SECURITY 9

Embedded systems and their security challenges-Security concepts applicable to Embedded devices- Groups, Euclidean algorithm, Extended Euclidean Algorithm, Fermat's and Euler's theorem.

MODULE II THREAT MODELING AND RISK ASSESSMENT 9

Threat Identification-Attack Vectors-Risk Analysis-Risk Mitigation Strategies- Security services, Threat model, Security attacks, Characteristics of good ciphers, Shannon ciphers and perfect secrecy, Crypt Analysis: Linear and differential crypt Analysis.

MODULE III BASIC SYMMETRIC KEY ENCRYPTION 9

Substitution ciphers, Transposition ciphers, Symmetric versus Asymmetric techniques, Block versus stream ciphers, Symmetric cipher model, Data Encryption Standard, Advanced Encryption Standard, Block cipher modes of operation, Use of random numbers, Pseudo Random number generators, Stream ciphers, RC5.

MODULE IV PUBLIC KEY ENCRYPTION 9

Principles of Asymmeric key cryptosystems, Encryption, Key exchange, RSA, Diffie-Hellman, Fields and finite fields, ElGamal, Elliptic curve cryptography.

MODULE V MESSAGE INTEGRITY AND HASHING 9

Requirements and applications of hash functions, Message Digest, SHA-512, Authentication requirements, Authentication functions, Message-Authentication Codes, Hash based MAC - Block cipher based MAC: Data Authentication Algorithm and Cipher-based Message Authentication Code, Digital Signature.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Demonstrate an understanding of security challenges with in embedded systems and the relevant cryptographic principles.

CO2: Identify potential threats and propose mitigation strategies to fortify embedded systems.

CO3: Apply diverse Cryptographic Techniques and implement various cryptographic methods.

CO4: Develop public key encryption and assess their effectiveness.

CO5: Apply hash functions and authentication codes to guarantee message Integrity**.**

CO6: Design and develop a security system for any application using the techniques.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. William Stallings, "Cryptography and Network Security - Principles and Practices", Pearson Edition, Publication, Chennai, 2018.

2. Bernard L Menezes and Ravinder Kumar, "Cryptography, Network Security, and Cyber Laws", Cengage Learning, India, New Delhi, 2018.

REFERENCES:

1. Behrouz A Forouzan and Debdeep Mukhopadhyay, "Cryptography and Network Security", McGraw Hill, Education, Chennai, 2017.
2. David, Mike Kleidermacher, “Embedded System Security: Practical Methods for Safe and secure software and Systems Development”, Newnes Publishers,2012.
3. Klaus Elk, “Security for Embedded Systems: A Practical Guide to Secure and Reliable Software for Embedded Devices”, Newnes Publishers, 2012.
4. Douglas R Stinson, "Cryptography - Theory and Practice", CRC Press, Boca Raton, 2015.
5. Atul Kahate, "Cryptography and Network Security", McGraw Hill Education, New Delhi, 2016 .

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	3	2	2	1	1	1	2
2	2	1	2	1	1	2	2	1
3	2	1	2	2	2	2	1	2
4	2	2	3	2	3	2	2	2
5	2	2	2	1	3	2	1	1
Avg.	**2.2**	**1.8**	**2.2**	**1.6**	**2**	**1.8**	**1.4**	**1.6**

1-low, 2-medium,3-high

23MERE03	DATA SCIENCE AND ANALYTICS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

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.

MODULE II PROBABILITY AND STATISTICS **9**

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 .

MODULE III TIME SERIES ANALYSIS **9**

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.

MODULE IV DATA ANALYSIS **9**

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 .

MODULE V BASIC DATA ANALYTIC METHODS USING R **9**

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.

COURSEOUTCOMES

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

CO1: Interpret about the need for data science and analytics.

CO2: Make use of probability and statistics for data analysis.

CO3: Apply and evaluate time series analyze for data.

CO4: Apply and evaluate data driven models.

CO5: Analyze data using R programming**.**

TOTAL: 45 PERIODS

TEXTBOOKS:

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

REFERENCES:

1. Andrew Park,” Data Science for Beginners”, 2020.
2. Hadley Wickham and Garrett Grolemund,” R for Data Science”Shroff/O'Reilly publisher,2017.
3. Joel Grus,” Data Science from Scratch”,O′Reilly publisher,2015.

CO-PO&PSO MAPPING

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1	3		1	3			3	3	
2	3		1	3			3	3	
3	3		3	3			3	3	
4	3		3	3			3	3	
5	3		3	3			3	3	
Avg.	3		2.2	3			3	3	

1-low, 2-medium,3-high

23MERE04	INTELLIGENT SYSTEMS AND CONTROL	L	T	P	C
		3	0	0	3

MODULE I NONLINEAR CONTROL 9

Norms of signals, vectors, and matrices . Positive definite functions and matrices, Continuous time state — LTI and non-linear state space model . Lyapunov stability theory, Discreate time systems, modelling of different non-linear control systems, Non-linear control strategies .

MODULE II NEURAL NETWORKS 9

Feed-forward networks, Multi-layered Neural Networks (NN), Radial basis function networks, adaptive learning rate, feedback networks — response of recurrent networks, learning algorithms, back propagation through time, real time recurrent learning. Kohonen self-organizing map, system identification using NN, SOM based identification.

MODULE III FUZZY LOGIC 9

Classical Sets, Fuzzy sets — concept of fuzzy number, operations on fuzzy sets, properties of fuzzy sets, membership functions, crisp relation, fuzzy relations, projection of fuzzy relations. Fuzzy rule base and approximate reasoning, system identification using T-S fuzzy models .

MODULE IV CONTROL USING NEURAL NETWORKS 9

Indirect adaptive control using NN — continuous time affine systems, discrete time affine systems, discrete time non-affine system . Direct adaptive control using NN — single input single output affine systems, multi-input multi-output systems . Back-stepping control .

MODULE V FUZZY LOGIC CONTROL 9

Construction of an fuzzy logic control, Fuzzy PD controller, Fuzzy PI controller, Fuzzy PI controller for DC motor, Fuzzy logic control using Lyapunov synthesis. Fuzzy logic control of a mobile robot.

COURSEOUTCOMES

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

CO1: Identify system characteristics – linear and nonlinear and to construct non-linear control.

CO2: Explain feed-forward and feedback neural networks and system identification using neural networks.

CO3: Discuss Fuzzy sets, fuzzy rule base and system identification using fuzzy models.

CO4: Construct indirect and direct adaptive control using Neural Networks for the given system.

CO5: Construct Fuzzy based PI, PD and fuzzy logic control using Lyapunov synthesis for the given system**.**

TOTAL: 45 PERIODS

TEXTBOOKS:

1. “Intelligent systems and control”byLaxmidhar Behera and Indrani Kar,Oxford University press,2009 2.“Intelligent Control of Connected Plug-in Hybrid Electric Vehicles”byAmir Taghavipour, Mahyar Vajedi, Nasser L. Azad,Springer.

REFERENCES:

1. Laxmidhar Behera, Swagat Kumar, Prem Kumar P, Ranjith Ravidranathan Nair and Samart Dutta, “Intelligent Control of Robotic Systems”, CRC Press .
2. Zi-Xing Cai, "Intelligent Control: Principles, Techniques and Applications", World Scientific, https://doi.org/10.1142/3028
3. David W. Pessen, " Intelligent Control Systems ", Wiley India Pvt. Ltd., New Delhi, 2011.
4. Alfred Silva, "Programmable Controllers operation and Application", MY Research Press, 2016.
5. Nazmul Siddique,"Intelligent Control: A Hybrid Approach Based on Fuzzy Logic, Neural Networks and Genetic Algorithms ", Springer, 2013.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	1	2	1	-	-	2	3
2	3	1	2	1	-	-	2	3
3	3	1	2	1	-	-	2	3
4	3	1	2	1	-	-	2	3
5	3	1	2	1	-	-	2	3
Avg.	**3**	1	2	1	-	-	**2**	3

1-low, 2-medium,3-high

23MERE05	INTELLIGENT CONTROLLERS FOR POWER QUALITY ENHANCEMENT	L	T	P	C
		3	0	0	3

MODULE I QUALITY OF POWER DELIVERY AND CONVENTIONAL MITIGATION METHODS **8**

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

MODULE II SHUNT COMPENSATION **9**

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

MODULE III SERIES COMPENSATION **9**

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

MODULE IV POWER QUALITY CONDITIONER **7**

UPQC Configurations – Principle of Operation and Control of Unified Power Quality Compensators-Analysis and Design of Unified Power Quality Compensators- Modelling, Simulation, and Performance of UPQCs .

MODULE V HARMONIC MITIGATION **12**

Nonlinear Loads - Classification of Nonlinear Loads — Harmonic Propagation in the power systems and its effects- mitigation of harmonics- passive filters- limitations Active Power Filters: Shunt and Series Active Filters- Classification- Principle of Operation and Control of Shunt and Series Active Power Filters - Analysis and Design of shunt and Series Active Power Filters- Hybrid Power Filters: Classification of Hybrid Power Filters- Principle of Operation and Control of Hybrid Power Filters- Analysis and Design of Hybrid Power Filters. Development intelligent controller for active and hybrid power filters.

COURSEOUTCOMES

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

CO1: Analyse the real causes of the power quality; distinguish between various categories of power quality problems and their impacts on performance and their economics.

CO2: Apply the knowledge of mathematics, and modern technological tools to solve the harmonics generation and other power quality issues in the power distribution networks and to develop an intelligent control algorithm for effective mitigation.

CO3: Introduce to apply economical solution techniques for power quality migration, various compensation methods using dedicated embedded controllers.

CO4: Design and simulate the series compensators for power quality conditioning the compensators.

CO5: Decide and implement the appropriate filters for harmonic reduction in the electrical distribution.

TOTAL: 45 PERIODS

REFERENCES:

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

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3		2					
2	3		2	3				3
3			3	2			3	3
4	3		2	3			3	
5	3		2				3	3
Avg.	**3**		2.2	2.6			**3**	3

1-low, 2-medium,3-high

23MERE06	EMBEDDED CONTROL OF INDUSTRIAL DRIVES	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO DRIVES 9

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

MODULE II DC MOTOR DRIVES 9

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

MODULE III INDUCTION MOTOR DRIVES 9

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

MODULE IV SYNCHRONOUS MOTOR DRIVES 9

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

MODULE V SPECIAL MACHINES DRIVES 9

Switched Reluctance Motor drive: Fundamentals and control of SRM drives - open loop and closed control- Closed loop torque and speed control - Implementation of speed control algorithm using TMS 320F28335 processor.Brush less DC Motor Drives: Principals of operation - torque generation - open loop and closed control of BLDC drive - Case study.Stepper Motor Drives: Types and basic operation - stepper motor drive system - Implementation of control algorithm using MC68HC11E9 Microcontroller.Introduction FPGA based implementation for Electric Drive Systems.

COURSEOUTCOMES

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

CO1: List the components required for industrial electrical drives.

CO2: Develop a suitable speed control for DC drives using embedded controller.

CO3: Develop a suitable speed control for induction motor drives using embedded controller.

CO4: Develop a suitable speed control for synchronous motor drives using embedded controller.

CO5: Develop a suitable speed control for special machines using embedded controller.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. G.K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2014.
2. Bose B K, "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pvt. Ltd, New Delhi, 2014.

REFERENCES:

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

CO-PO&PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	3	2	3	2	3				1	2	2	3	
2	3	2	2	2	3	1	1					1	3	2	
3	3	2	2	2	3	1	1					1	3	2	
4	3	2	2	2	3	1	1					1	3	2	
5	3	1	1	1	2	2	3	1			2	2	2	2	
Avg.	3	1.8	2	1.8	2.8	1.4	1.8	1			1.5	1.4	2.6	2.2	

1-low, 2-medium,3-high

23MERE07	DESIGN OF GREEN TRANSPORTATION SYSTEM	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION 8

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

MODULE II ARCHITECTURE OF EV AND ITS COMPONENTS 12

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

MODULE III SOLAR PV BASED EV DESIGN 9

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

MODULE IV FUEL CELL BASED EV DESIGN 9

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

MODULE V EV-PERFORMANCE AND SAFETY ISSUES 7

Electric vehicle verses IC engine vehicle comparison: efficiency comparison - pollution comparison - capital and operating cost comparison -GHG emission -emission standards and comparison - United Nations Framework Convention on Climate Change (UNFCCC) - Kyoto protocol -UNFCCC Paris climate change summit (COP 21) - legislation and standardizations for electric vehicles — Initiatives of Government of India: National Electric Mobility Mission Plan (NEMMP) 2020-FAME-I & II- EV performance testing -safety requirements of electric vehicles.

COURSEOUTCOMES

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

CO1: Understand the complexity of an automobile system as a whole unit and to define the functionalities of various components in electric/hybrid/plug-in hybrid vehicles.

CO2: Introduce the components of elective vehicles such as electric motors, batteries and power converters and able to design their industrial models as a sub system of complete transportation.

CO3: Design solar PV based electric vehicles according to the international standards and to perform various testing on the vehicle to serve up for the society and environment.

CO4: Design of fuel cell powered electric vehicles, including power converters, battery pack, motors, controllers and their safety considerations.

CO5: Comparison of performance and safety requirement of electric vehicles with internal combustion engine vehicle.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Ali Emadi, Mehrdad Ehsani, "Vehicular Electric Power Systems" Marcel Dekker, Inc., New York, 2014 .
2. Iqbal Hussain, "Electric & Hybrid Vehicles - Design Fundamentals", Second Edition, CRC Press, 2011.
3. Sandeep Dhameja, "Electric Vehicle Battery Systems" Newnes, an imprint of Elsevier, 2013.

REFERENCES:

1. J.M. Miller, "Propulsion Systems for Hybrid Vehicles", Institution of Electrical Engineers (IEE), London, UK, 2004 .
2. R. Stone and J.K. Bell, "Automotive Engineering Fundamentals", SAE International, Warrendale, PA, 2004.
3. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003 .
4. Eric ForstaThacher, “A Solar Car Primer - A guide to the design and construction of solar-powered racing vehicles", Springer International Publishing Switzerland, 2015 .
5. Hybrid and electric vehicle solutions guide - released by Texas Instruments, 2011 available in www.ti.com/hev.
6. Indian vehicle emission standards: https://www.dieselnet.com/standards/in/2wheel.php

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	1	3	1	2	2	1	2
2	3	3	2	2	2	2	1	2
3	3	2	3	2	3	2	3	2
4	3	2	3	3	3	3	3	2
5	2	2	3	2	3	3	3	2
Avg.	**2.8**	**2**	**2.8**	**2**	**2.6**	**2.4**	**2.2**	**2**

1-low, 2-medium,3-high

23MERE08	EMBEDDED SENSOR NETWORKS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION 9

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

MODULE II NETWORKING SENSORS 9

Key assumptions - Medium access control - A survey of MAC protocols for WSN - S-MAC Protocol - IEEE802.15.4 standard and Zig Bee -Energy efficient design of wireless sensor nodes - General Issues Geographic, Energy-Aware Routing - Unicast Geographic Routing -Routing on a curve-Energy Minimizing Broadcast-Energy Aware Routing to a Region -Attribute based routing-Directed Diffusion-Rumor Routing Geographic Hash table.

MODULE III INFRASTRUCTURE ESTABLISHMENT 9

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

MODULE IV SENSOR NETWORK DATABASE 9

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

MODULE V SENSOR NETWORK PLATFORMS AND TOOLS 9

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

COURSE OUTCOMES

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

CO1: Understand the concepts of Embeeded Sensor Networks, the current diverse research on sensor networks**.**

CO2: Analyze the issues un designing and analyzing sensor network information processing systems.

CO3: Gain knowledge about the architecture of different layers in a sensor network and the sensor tasking.

CO4: Obtain an insight of the handling of sensor database.

CO5: Choose a suitable sensor network system for a given application.

CO6: Develop a sensor network comprising of the choices of sensors, nature of networking, and handling of database.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Wireless Sensor Networks: Principles and Practice", Fei Hu ,Xiaojun Cao. CRC Press, Taylor & Francis Group, 2010.

2. " Wireless Sensor Networks and Applications", Yingshu Li, My T. Thai,Weili Wu,Springer 2008

REFERENCES:

1. "Wireless Sensor Networks: An Information Processing Approach" ,Feng Zhao, Leonidas Guibas, Mogan Kaufmann Publishers, 2004.

2. " Wireless Sensor Networks" ,Ian F. Akyildiz, Mehmet Can Vuran,John Wiley, 2011

3. " Wireless Sensor Networks: A Networking Perspective", Jun Zheng. Abbas Jamalipour, John wiley, 2009

CO-PO & PSO MAPPING

CO	PO						PSO		
	1	2	3	4	5	6	1	2	3
1			2		3	2			
2						3			
3									
4			3					2	
5								2	
6		3	3	3	3	3	3	3	
AVg.		3	2.67	3	3	2.67	3	2.3	

1-low, 2-medium, 3-high

23MERE09	MODELING AND DESIGN OF EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

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

MODULE II STATE MACHINES **9**

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

MODULE III DESIGN OF EMBEDDED SYSTEMS **9**

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

MODULE IV ANALYSIS AND VERIFICATION **9**

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

MODULE V QUANTITATIVE ANALYSIS **7**

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

COURSEOUTCOMES

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

CO1: Describe the process of modeling continuous time and discrete type systems.

CO2: Elaborate on concurrent modeling of cyber physical systems.

CO3: Explain the design process of embedded systems based on the modeling.

CO4: Analyze the designed system for required functionality.

CO5: Perform a quantitative analysis of cyber physical systems.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. E. A. Lee and S. A. Seshia, "Introduction to Embedded Systems -A Cyber - Physical Systems Approach", I Edition (www. LeeSeshia.org), 2011.
2. Justyna Zander, Ina Schieferdecker, Pieter J. Mosterman," Model-Based Testing for Embedded Systems",CRC press,2012.

REFERENCES:

1. Axel Jantsch ," Modeling Embedded Systems and SoC's: Concurrency and Time in Models of computation",morgan khaufman publishers,2001.
2. Wayne Wolf, "Computers as Components: Principles of Embedded Computer Systems Design", Morgan Kaufman Publishers, 2004.

3. David E Simon, "An embedded software primer", Pearson education Asia, 2001.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	1	2	1	2	1	2	2	3
2	1	2	2	3	1	2	2	3
3	2	3	2	3	2	2	1	2
4	2	3	2	1	1	2	1	2
5	2	3	1	1	3	2	2	3
Avg.								

1-low, 2-medium,3-high

23MERE10	MULTICORE ARCHITECTURE	L	T	P	C
		3	0	0	3

MODULE I SUPER SCALAR PROCESSORS 9

Multicore drivers & challenges-Fundamentals of Super scalar Processor Design, Introduction to Multicore Architecture – memory hierarchy design-Chip Multiprocessing, homogeneous Vs heterogeneous design - SMP - Multicore Vs Multithreading .

MODULE II MEMORY ORGANIZATION 9

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

MODULE III MULTICORE PROGRAMMING MODEL 9

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

MODULE IV POWER PC ARCHITECTURE 9

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

MODULE V PROGRAMMING SUPPORT FOR MULTI-CORE / MANY-CORE PROCESSORS 9

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

COURSEOUTCOMES

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

CO1: Understand the fundamental concepts of parallel processing architectures.

CO2: Analyze memory organization and cache coherency in multicore systems.

CO3: Apply parallel programming models for multicore systems.

CO4: Analyze a specific multicore architecture-Power PC.

CO5: Develop software for multicore processors using various programming techniques.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. "Computer Architecture: A Quantitative Approach" by David Patterson and John Hennessy, Morgan Kaufmann Publishers, 2017.
2. "FundamentalsofParallelMulticoreArchitecture"byYanSolihin,Springer,2016.

REFERENCES:

1. "Parallel Programming for Scientific Computing" by Michael Quinn, Cambridge University Press,2009.
2. "The Art of Multicore Programming" by Manoj Kumar, Elsevier, 2010.
3. "Computer Organization and Design: The Hardware/Software Interface" by David Patterson and John Hennessy, Morgan Kaufmann Publishers, 2017.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	2	3	4	5	6	1	2
1	1	1	3	1	1	1	2	3
2	2	2	3	2	1	1	2	3
3	2	2	3	3	1	2	1	3
4	2	2	3	2	1	1	1	2
5	2	2	3	3	1	2	1	3
Avg.	1.8	1.8	3	2.2	1	1.4	1.4	2.8

1-low, 2-medium,3-high

23MERE11	SYSTEM SIMULATION AND MODELING	L	T	P	C
		3	0	0	3

MODULE I SYSTEM AND SYSTEM ENVIRONMENT 9

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

MODULE II MATHEMATICAL MODELS 9

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

MODULE III RANDOM NUMBERS AND RANDOM VARIATE GENERATION 9

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

MODULE IV ANALYSIS OF SIMULATION DATA 9

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

MODULE V VERIFICATION, CALIBRATION, VALIDATION AND OPTIMIZATION 9

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

COURSEOUTCOMES

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

CO1: Learn the advantages and disadvantages of using simulation techniques for system analysis, including steps in conducting a simulation study.

CO2: Acquire knowledge of statistical models and distributions such as exponential, Poisson, Uniform, Weibull, and Normal distributions, and their applications in modeling.

CO3: Gain skills in collecting and analyzing simulation data, including identifying distributions, parameter estimation, and goodness-of-fit tests.

CO4: Develop skills to create and analyze different models of systems using statistical, mathematical, and empirical methods.

CO5: Develop the ability to verify, calibrate, and validate simulation models, ensuring that they accurately represent real-world systems.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol: Discrete-Event System Simulation, 5th Edition, Pearson Education, 2010.
2. Petrescu, C., & David, V. (Eds.). **Modeling and Simulation in Engineering** (2nd ed.). MDPI. ISBN:978-3-0365-8288-7, 2023.

REFERENCES:

1. Lawrence M. Leemis, Stephen K. Park: Discrete – "Event Simulation: A First Course, Pearson Education", 2006.
2. Averill M. Law, "Simulation Modeling and Analysis" , 4th Edition, Tata McGraw-Hill, 2007.
3. Lee, H.-H, "Finite Element Simulations with ANSYS Workbench 2023". SDC Publications. ISBN: 978-1- 63057-615-8, 2023.
4. Yang, X.-S. Introduction to Mathematical Modelling and Computer Simulations. Elsevier. ISBN: 978-0-12- 819546-5, 2024.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	2	3	3	3	2	3	2
2	3	3	2	2	2	2	2	3
3	3	2	3	3	2	2	2	3
4	2	2	3	2	2	2	2	3
5	3	1	3	2	2	2	2	3
Avg.	**2.8**	2	2.8	2.4	2.2	2	**2.2**	2.8

1-low, 2-medium,3-high

23MERE12	DIGITAL SYSTEM DESIGN AND TESTING	L	T	P	C
		3	0	0	3

MODULE I SEQUENTIAL CIRCUIT DESIGN 9

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.

MODULE II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 9

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.

MODULE III FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS 9

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.

MODULE IV SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES 9

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

MODULE V SYSTEM DESIGN USING VHDL 9

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.

COURSEOUTCOMES

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

CO1: Design a synchronous and asynchronous sequential circuit after applying state and flow table minimization technique with the knowledge of state table and flow table.

CO2: Apply suitable testing methods to diagnose a digital circuit for faults.

CO3: Design the synchronous sequential circuits using programmable devices.

CO4: Design the digital system using VHDL.

CO5: Diagonise and test synchronous and asynchronous sequential using VHDL.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. Charles H.Roth Jr "Fundamentals of Logic Design" Thomson Learning 2004.
2. Nripendra N Biswas "Logic Design Theory" Prentice Hall of India, 2001.

REFERENCES:

1. Parag K.Lala "Fault Tolerant and Fault Testable Hardware Design" B S Publications , 2002.

2. Parag K.Lala "Digital system Design using PLD" B S Publications, 2003 .
3. Charles H Roth Jr."Digital System Design using VHDL" Thomson learning, 2004 .
4. Douglas L.Perry "VHDL programming by Example" Tata McGraw Hill, 2006.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	1	3	3	1	2	2	3
2	3	1	3	3	2	1	3	3
3	3	1	3	3	2	1	3	3
4	3	1	3	3	3	2	3	3
5	3	1	3	3	3	1	3	3
Avg.	**3**	1	3	3	2.2	1.4	**2.8**	3

1-low, 2-medium,3-high

23MERE13	SYNTHESIS AND OPTIMIZATION OF DIGITAL CIRCUITS	L	T	P	C
		3	0	0	3

MODULE I CIRCUITS AND MODELS 9

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.

MODULE II ARCHITECTURAL-LEVEL SYNTHESIS AND OPTIMIZATION 9

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.

MODULE III SCHEDULING ALGORITHMS 9

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.

MODULE IV LOGIC-LEVEL SYNTHESIS AND OPTIMIZATION 9

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.

MODULE V CELL-LIBRARY BINDING 9

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.

COURSE OUTCOMES

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

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.

CO4: Develop scheduling algorithm.

CO5: Synthesis and optimize the logic level circuits.

TOTAL: 45 PERIODS

TEXTBOOKS:

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.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	2	3	4	5	6	1	2
1	3	2	2	1	1	1	2	2
2	1	3	3	1	3	1	3	3
3	1	3	3	1	3	1	3	3
4	2	3	3	1	1	1	3	3
5	2	3	3	1	2	1	3	3
Avg.	1.8	2.8	2.8	1	2	1	2.8	2.8

1-low, 2-medium,3-high

23MERE14	COMPUTER VISION	L	T	P	C
		3	0	0	3

MODULE I- IMAGE FORMATION **9**

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.

MODULE II- IMAGE SEGMENTATION **9**

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

MODULE III- CAMERA MODELS **9**

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

MODULE IV -PATTERN RECOGNITION **9**

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.

MODULE V -MOTION ANALYSIS **9**

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

COURSE OUTCOMES

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

CO1: Articulate the fundamental principles and current advancements in image formation techniques.

CO2: Evaluate different segmentation methodologies to improve object detection and image quality.

CO3: Perform camera calibration and 3D reconstruction from calibrated stereo and multi-view setups.

CO4: Apply clustering techniques like K-Means, K-Medoids, and Mixture of Gaussians for image pattern recognition..

CO5: Estimate motion parameters and derive shapes from various cues such as light, texture, color, and edges.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2020.
2. "Computer Vision: A Modern Approach", D. A. Forsyth, J. Ponce, Pearson Education, 2011.
3. "Multiple View Geometry in Computer Vision", Richard Hartley and Andrew Zisserman,

Second Edition, Cambridge University Press, March 2004.

REFERENCES:

1. "Computer Vision: Models, Learning, and Inference" by Simon J. D. Prince, Cambridge University Press, 2012.
2. "Handbook of Mathematical Models in Computer Vision" Nikos Paragios, Yunmei Chen, and Olivier Faugeras, Springer, 2005.
3. IEEE-T PAMI (IEEE Transactions on Pattern Analysis and Machine Intelligence).

CO-PO & PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	1	2	1	1	-	2	2
2	3	1	2	1	1	-	2	2
3	3	1	2	1	1	-	2	2
4	3	1	2	1	1	-	2	2
5	3	1	2	1	1	-	2	2
Avg.	**3**	1	2	1	1	-	**2**	2

1-low, 2-medium, 3-high

23MERE15	HIGH PERFORMANCE COMPUTER ARCHITECTURE	L	T	P	C
		3	0	0	3

MODULE I PROCESSOR DATA PATH 9

Introduction-CPU Performance factors-Evaluating CPU Performance-Building a Data path – Multicycle Implementation-Exceptions-Microprogramming .

MODULE II PIPELINING 9

Overview of pipelining- Pipelined Data path - Data Hazards - Forwarding - Branch Hazards — Dynamic Branch Prediction - Pipeline using HDL - Advanced Pipelining - Pentium 4 Pipeline.

MODULE III PARALLELISM 9

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.

MODULE IV MEMORY HIERARCHY DESIGN 9

Basics of Cache -Measuring performance - Optimization of Cache performance - Virtual Memory — Page faults - TLB - Protection with virtual memory.

MODULE V VECTOR PROCESSING AND RISC ARCHITECTURE 9

Vector Processor: Architecture-Issues-EffectivenessofCompilerVectorization-Vectorperformance.RISC Architecture: Survey of RISC Architectures - SPARC, PA-RISC.

COURSEOUTCOMES

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

CO1: Understand the fundamental concepts of processor design and performance evaluation.

CO2: Analyze and optimize pipelined processor designs.

CO3: Comprehend parallelism in computer architecture and its limitations.

CO4: Analyze memory hierarchy design principles and optimization techniques.

CO5: Evaluate different processing architectures-Vector Processing and RISC.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. "Computer Organization and Design- The Hardware/Software Interface", David A. Patterson, John J. Hennessy, Third Edition, Morgan Kaufmann Publishers, 2005.

2. "Computer Architecture- A Quantitative Approach", John J.Hennessy, DavidA. Patterson, Fourth Edition, Morgan Kaufmann Publishers, 2006.

REFERENCES:

1. "Computer Organization and Embedded Systems." Carl Hamacher, Zvonko Vranesic, and Safwat Zaky, 6th edition, 2012 McGraw-Hill Education .

2. "AdvancedComputerArchitecture:Parallelism,Scalability,Programmability"KaiHwangandNaresh Jotwani,3rd edition, 2015 ,McGraw-Hill Education.

3. “ModernProcessorDesign:FundamentalsofSuperscalarProcessors”,JohnPaulShenandMikkoH. Lipasti, Elsevier, 2013.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	2	3	4	5	6	1	2
1	1	2	3	1	1	1	2	3
2	2	2	3	1	1	1	2	3
3	2	2	3	1	1	1	1	3
4	2	2	3	2	1	1	2	3
5	2	2	3	1	1	1	1	2
Avg.	1.8	2	3	1.2	1	1	1.6	2.8

1-low, 2-medium,3-high

23MERE16	CRYPTOGRAPHY AND BLOCK CHAIN TECHNOLOGIES	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION 9

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.

MODULE II CRYPTOGRAPHY 9

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.

MODULE III BLOCK CHAIN 1.0 9

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.

MODULE IV BLOCK CHAIN 2.0 9

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.

MODULE V APPLICATIONS 9

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

COURSEOUTCOMES

After completing the course successfully, 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 bit coin scripting.

CO5: Apply the concepts of cryptography and Block chain Technologies in various fields.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Draft version of “S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, ‘Block chain Technology: Crypto currency and Applications’, Oxford University Press, 2019.

2. Josh Thompson, ‘Block chain: The Block chain for Beginnings, Guild to Block chain Technology and Block chain Programming’, Create Space Independent Publishing Platform,

2017.
3. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bit coin and Crypto currency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
4. Dr. Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger,"Yellow paper.2014. Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts.

REFERENCES:

1. D. Boneh and V. shoup " A Graduate course in applied cryptography" 2023.
2. Roger wattenhofer, " Block chain science: Distributed ledger technology, inverted forest publication, 2019.
3. Jonathan Katz and Yehuda Lindell " Introduction to modern cryptography, 3rd edition CRC Press, 2020.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	2	2	3	3	2	2	3	3
2	2	2	3	3	3	2	3	3
3	3	2	2	3	3	2	3	3
4	3	3	2	3	2	1	2	3
5	1	1	2	3	2	1	2	2
Avg.	2.2	2	2.4	3	2.4	1.6	2.6	2.8

1-low, 2-medium,3-high

23MERE17	AUGMENTED REALITY	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO AUGMENTED REALITY **9**

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.

MODULE II AUGMENTED REALITY CONCEPTS AND HARDWARE **9**

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.

MODULE III AUGMENTED REALITY DIMENSION AND INTERACTION **9**

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.

MODULE IV AUGMENTED REALITY WITH GEOLOCATION **9**

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- Map Player PROTO- An example of a functional map in ARAF.

MODULE V APPLICATIONS **9**

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.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Understand the concept of augmented reality.

CO2: Effectively design and benefits of AR.

CO3: Incorporate of Geo-location with AR.

CO4: Acquire the technical skills needed to develop AR applications, including knowledge of AR development platforms.

CO5: Apply AR for real-time applications.

TOTAL:45 PERIODS

TEXTBOOKS:

1. Augmented Reality: Principles & Practice – 12 Oct 2016 by Schmalstieg / Hollerer**.**

2. Augmented Reality a Practical Guide Paperback – 2008.

REFERENCES:

1. Augmented Reality: An Emerging Technologies Guide to AR",Greg Kipper and Joseph Rampolla, Syngress, Ist Edition (2012).

2. "Understanding Augmented Reality: Concepts and Applications", Alan B. Craig, Morgan Kaufmann, Ist Edition (2013).

3. "Augmented Reality Law, Privacy, and Ethics: Law, Society, and Emerging AR Technologies",BrianWassom, Syngress, Ist Edition (2014).

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	2	2	1	2	1	2	3	2
2	2	2	2	2	2	2	3	2
3	2	2	2	3	1	3	3	3
4	3	3	2	3	2	3	2	3
5	2	2	2	3	2	3	2	3
Avg.	**2.0**	**2.2**	**2.0**	**2.8**	**2.2**	**3.2**	**2.3**	**2.5**

1-low, 2-medium,3-high

23MERE18	NETWORK VIRTUALIZATION	L	T	P	C
		3	0	0	3

MODULE I OVERVIEW OF VIRTUALIZATION **9**

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.

MODULE II NETWORK CONSOLIDATION **9**

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.

MODULE III NETWORK VIRTUALIZATION **9**

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.

MODULE IV VIRTUALIZING STORAGE **9**

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.

MODULE V VIRTUAL MACHINES PRODUCTS **9**

Xen Virtual machine monitors- Xen API - VMware - VMware products - VMware Features- Microsoft Virtual Server - Features of Microsoft Virtual Server.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Understand about Computing Virtualization tools, applications and techniques.

CO2: Understand Server virtualization and virtualization platform.

CO3: Understand the technologies of Virtualization and Network virtualization.

CO4: Understand the concepts of virtualization storage.

CO5: Study the virtual machine products.

TOTAL:45 PERIODS

TEXTBOOKS:

1. William von Hagen, Professional Xen Virtualization, Wrox Publications, January, 2008.
2. Chris Wolf, Erick M. Halter, and Virtualization: From the Desktop to the Enterprise, A Press 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

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	2	2	3			3	2
2	3	2	2	3			3	2
3	3	2	2	3			3	2
4	3	3	2	2			2	2
5	2	2	2	2			2	2
Avg.	**2.8**	**2.2**	**2**	**2.6**			**2.6**	**2**

1-low, 2-medium,3-high

23MERE19	SOFT COMPUTING	L	T	P	C
		3	0	0	3

MODULE I GENETIC ALGORITHM **9**

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.

MODULE II MODERN SEARCH TECHNIQUES **9**

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.

MODULE III FUZZY LOGIC **9**

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.

MODULE IV ARTIFICIAL NEURAL NETWORKS **9**

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

MODULE V NEURO – FUZZY MODELLING **9**

Neuro -Fuzzy modeling - 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.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

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

CO2: Apply modern search techniques to solve a wide variety of real world problems.

CO3: Apply basics of Fuzzy logic and neural networks to some real word problems.

CO4: Develop Neuro fuzzy models for various applications.

CO5: Identify and select a suitable Soft Computing technology to solve the problem.

TOTAL:45 PERIODS

TEXTBOOKS:

1. “Principles of Soft Computing”, by Dr.S.N Sivanandam and Dr.S.N.Deepa, 2nd edition, Wiley-India, 2011.

2. “Genetic Algorithms in Search, Optimization, and Machine Learning”, by Goldberg, D.E., Addison- Wesley, 1989.
3. “Fuzzy Logic with Engineering applications”, by Timothy J.Ross, Wiley; 4th edition, 2016.

REFERENCES:

1. “Neural networks, Fuzzy logic and Genetic algorithms”, by S.Rajasekaran and A.Vijayalakshmi Pai, Prentice Hall of India Ltd, New Delhi, 2017.
2. “Soft Computing with MATLAB Programming”, by N.P.Padhy, S.P.Simon,Oxford University Press, 2015.
3. “Optimization for Engineering Design”, by De, K, PHI Learning (P) Ltd., New Delhi, 2012.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	1	2	3	2	2	3	2
2	3	1	2	3	2	2	3	2
3	3	1	2	3	2	2	3	2
4	3	1	2	3	2	2	3	2
5	3	1	2	3	2	2	3	2
Avg.	**3**	**1**	**2**	**3**	**2**	**2**	**3**	**2**

1-low, 2-medium,3-high

23MERE20	EDGE COMPUTING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

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.

MODULE II EDGE RESOURCES **9**

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.

MODULE III NETWORKS AND SERVICES **9**

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).

MODULE IV PROGRAMMING **9**

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.

MODULE V STANDARDS AND PRIVANCY **9**

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.

COURSEOUTCOMES

After completing the course successfully, the students will be able to,

CO1: Articulate the main concepts, key technologies, strengths, and limitations of edge computing and the possible applications for state-of-the-art edge computing.

CO2: Identify the architecture and infrastructure of edge computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.

CO3: Understand the core issues of edge computing such as security, privacy, and interoperability.

CO4: Develop skills in programming languages commonly used in edge computing environments, such as Python, C++, or Java.

CO5: Understand network requirements and configurations for optimal edge computing performance.

TOTAL:45 PERIODS

TEXTBOOKS:

1. "Edge Computing: A Primer", Tao Zhang and Larry Peterson, Springer, Ist Edition (2020).
2. "Edge Computing: Models, Technologies, and Applications", Jie Cao, Quan Zhang, and Weisong Shi, Springer, Ist Edition (2019).
3. "Fog and Edge Computing: Principles and Paradigms", RajkumarBuyya and Satish Narayana Srirama, Wiley, Ist Edition (2019).

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.

CO-PO&PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	3	2	3	3	3	2	3	2
2	3	2	2	2	2	2	2	3
3	3	2	3	3	3	2	2	3
4	3	2	2	2	2	2	2	3
5	3	2	3	3	2	2	2	3
Avg.	**3**	2	2.6	2.6	2.4	2	**2.2**	2.8

1-low, 2-medium,3-high

23MERE21	COMPUTER SECURITY	L	T	P	C
		3	0	0	3

MODULE I DIGITAL SECURITIES **9**

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.

MODULE II ONLINE ANONYMITY **9**

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

MODULE III CRYPTOGRAPHY AND SECURE COMMUNICATION **9**

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.

MODULE IV NETWORK DEFENSES **9**

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

MODULE V SECURITY RISK MANAGEMENT **9**

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.

COURSEOUTCOMES

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

CO1: Analyze and evaluate the cyber security needs of an organization.

CO2: Able to identify security risks and take preventive steps

CO3: Investigate cybercrime and collect evidences

CO4: Able to use knowledge of forensic tools and software

CO5: Comprehend and execute risk management processes, risk treatment methods, and performance indicators

TOTAL: 45 PERIODS

TEXTBOOKS:

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.

REFERENCES:

1. William Stallings, Network Security Essentials: Applications and Standards, Prentice Hall, 4th edition, 2010.
2. Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 2001.

CO-PO & PSO MAPPING

CO	PO						PSO	
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**
1	2	2	1	1		3		2
2	3	2		2	1	2	2	
3	3	3		3	1			3
4	2	3	1	2		2	2	
5	3	2		2	1	3		2
AVg.	2.6	2.4	0.4	2	0.6	2	0.8	1.4

1-low, 2-medium,3-high