DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

ANNA UNIVERSITY, CHENNAI - 25

VISION:

The vision of the department is to produce analytically proficient and technologically competent Electrical and Electronics Engineers who can serve and take forward the academic, industry and research organizations to newer heights and be effective for building the nation.

MISSION:

- To impart high quality technical education with the state of the art laboratory practice.
- To provide conducive academic ambience to enable best teaching and learning processes.
- To generate resources through research and consultancy projects for pursuing research and developmental activities in emerging areas.
- To associate with academic and industrial organizations for research activities to develop and provide vital and viable solutions for social needs indigenously.
- To develop leadership skills in students with high degree of ethics, morals and values and instill confidence to lead the organization.

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.E. EMBEDDED SYSTEM TECHNOLOGIES (R-2023)

REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM

CURRICULUM AND SYLLABUS I TO IV SEMESTERS

1. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I.	To provide students good foundation in mathematical, scientific, engineering fundamentals and hardware-software programming intelligence.
II.	To develop among students, the ability to develop embedded systems based smart solutions for purpose of system automation
III.	To promote student awareness, for life-long learning and introduce them to professional ethics and code of practice.
IV.	To encourage students, to work in interdisciplinary groups.

2. PROGRAM OUTCOMES (POs)

On successful completion of the M.E. Embedded System Technologies programme, the graduates would have	
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	Be able to design and develop Embedded system automation based on dedicated ICs that have computation, networking and control capacity.
PO5	Skill to work on professional software languages, standard modeling and analysis tools & commercial packages with communication protocols and computation platforms for analysis and design of system automation.
PO6	Develop an innovative smart system with automation as a consumer product through project management and finance with due concerned for socio economic values

3. MAPPING OF PEOs with POs

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
I.	**3**	**1**	**2**	**3**	**3**	**2**
II.	**3**	**2**	**3**	**3**	**3**	**3**
III.	**3**	**2**	**3**	**1**	**2**	**3**
IV.	**2**	**2**	**2**	**3**	**3**	**3**

Mapped with 1, 2, 3 & -, scale: 1-low ; 2-medium ; 3-high

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

PROGRAM ARTICULATION MATRIX

		Course Name	PO1	PO2	PO3	PSO1	PSO2	PSO3
YEAR 2	Semester 1	Embedded System Programming	1	2	1.5	1.5	2.2	2
		Embedded Processor Based System Design	1	-	2	2	1.5	-
		Design of Embedded Systems	2	2	2	2.4	1	2
		VLSI Design and Reconfigurable Architecture	2	1	2	2.4	2	1
		Research Methodology and IPR						
		Professional Elective I						
		Embedded System Laboratory - I	2	2	1.4	1.2	2.5	1.5
		Embedded Programming Laboratory - I	2	1	2	1.67	2.4	1.5
	Semester 2	Real Time Operating System	2	2	1.8	1.5	2.2	1.75
		Embedded System Networking	2.25	2	2.7	3	2.3	1.8
		Automotive Embedded Systems	2.75	2.8	2.4	2.4	2.75	2.2
		Embedded Control for Electric Drives	1.25	1.5	2.7	1	2.7	2
		Professional Elective II						
		Professional Elective III						
		Embedded System Laboratory - II	1.75	2	2.4	2.25	2.75	2.33
		Embedded Programming Laboratory - II	2	2.25	2.4	2.2	2.75	2.25
	Semester 3	Professional Elective IV						
		Professional Elective V						
		Professional Elective VI						
		Project Phase I	2.8	3	3	3	3	3
	Semester 4	Project Phase II	2.8	3	3	3	3	3

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. EMBEDDED SYSTEM TECHNOLOGIES (FULL TIME)
REGULATIONS - 2023
CHOICE BASED CREDIT SYSTEM
CURRICULUM AND SYLLABUS I TO IV SEMESTERS
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ET3101	Embedded System Programming	PCC	2	0	2	4	3
2.	ET3102	Embedded Processor Based System Design	PCC	2	0	2	4	3
3.	ET3151	Design of Embedded Systems	FC	3	0	0	3	3
4.	ET3152	VLSI Design and Reconfigurable Architecture	PCC	3	0	0	3	3
5.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
6.		Professional Elective I	PEC	3	0	0	3	3
PRACTICALS								
7.	ET3111	Embedded System Laboratory - I	PCC	0	0	4	4	2
8.	ET3112	Embedded Programming Laboratory - I	PCC	0	0	4	4	2
			TOTAL	**15**	**1**	**12**	**28**	**22**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ET3201	Real Time Operating System	PCC	2	0	2	4	3
2.	ET3202	Embedded System Networking	PCC	3	0	0	3	3
3.	ET3251	Automotive Embedded Systems	PCC	3	0	0	3	3
4.	ET3252	Embedded Control for Electric Drives	PCC	2	0	2	4	3
5.		Professional Elective II	PEC	3	0	0	3	3
6.		Professional Elective III	PEC	3	0	0	3	3
PRACTICALS								
7.	ET3211	Embedded System Laboratory - II	PCC	0	0	4	4	2
8.	ET3212	Embedded Programming Laboratory - II	PCC	0	0	4	4	2
			TOTAL	**16**	**0**	**12**	**28**	**22**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective IV	PEC	3	0	0	3	3
2.		Professional Elective V	PEC	3	0	0	3	3
3.		Professional Elective VI	PEC	3	0	0	3	3
PRACTICALS								
4.	ET3311	Project Work I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**12**	**21**	**15**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	ET3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 71

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. EMBEDDED SYSTEM TECHNOLOGIES(PART TIME)
REGULATIONS - 2023
CHOICE BASED CREDIT SYSTEM

I TO VI SEMESTERS CURRICULA & SYLLABI
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ET3151	Design of Embedded Systems	FC	3	0	0	3	3
2.	ET3101	Embedded System Programming	PCC	2	0	2	4	3
3.	ET3102	Embedded Processor Based System Design	PCC	2	0	2	4	3
PRACTICALS								
4.	ET3111	Embedded System Laboratory - I	PCC	0	0	4	4	2
			TOTAL	**7**	**0**	**8**	**15**	**11**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ET3201	Real Time Operating System	PCC	2	0	2	4	3
2.	ET3202	Embedded System Networking	PCC	3	0	0	3	3
3.	ET3252	Embedded Control for Electric Drives	PCC	2	0	2	4	3
PRACTICALS								
4.	ET3112	Embedded Programming Laboratory - I	PCC	0	0	4	4	2
			TOTAL	**7**	**0**	**8**	**15**	**11**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ET3152	VLSI Design and Reconfigurable Architecture	PCC	3	0	0	3	3
2.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
3.		Professional Elective I	PEC	3	0	0	3	3
PRACTICALS								
4.	ET3211	Embedded System Laboratory - II	PCC	0	0	4	4	2
			TOTAL	**8**	**1**	**4**	**13**	**11**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ET3251	Automotive Embedded Systems	PCC	3	0	0	3	3
2.		Professional Elective II	PEC	3	0	0	3	3
3.		Professional Elective III	PEC	3	0	0	3	3
4.		Professional Elective IV	PEC	3	0	0	3	3
PRACTICALS								
5.	ET3212	Embedded Programming Laboratory - II	PCC	0	0	4	4	2
			TOTAL	**12**	**0**	**4**	**16**	**14**

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective V	PEC	3	0	0	3	3
2.		Professional Elective VI	PEC	3	0	0	3	3
PRACTICALS								
3.	ET3311	Project Work I	EEC	0	0	12	12	6
TOTAL				**6**	**0**	**12**	**18**	**12**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	ET3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 71

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	ET3151	Design of Embedded Systems	3	0	0	3	I
					TOTAL CREDITS	3	

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	RM3151	Research Methodology and IPR	2	1	0	3	I
					TOTAL CREDITS	3	

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	ET3101	Embedded System Programming	2	0	2	3	I
2.	ET3102	Embedded Processor Based System Design	2	0	2	3	I
3.	ET3152	VLSI Design and Reconfigurable Architecture	3	0	0	3	I
4.	ET3111	Embedded System Laboratory - I	0	0	4	2	I
5.	ET3112	Embedded Programming Laboratory -I	0	0	4	2	I
6.	ET3201	Real Time Operating System	2	0	2	3	II
7.	ET3202	Embedded System Networking	3	3	0	3	II
8.	ET3252	Embedded Control for Electric Drives	2	0	2	3	II
9.	ET3251	Automotive Embedded Systems	3	0	0	3	II
10.	ET3211	Embedded System Laboratory - II	0	0	4	2	II
11.	ET3212	Embedded Programming Laboratory -II	0	0	4	2	II
					TOTAL CREDITS	29	

PROFESSIONAL ELECTIVE COURSES

S. No.	Course Code	Course Title	Category	Periods per Week			Total Contact Periods	Credits
				L	T	P		
PRACTICALS								
1	ET3001	Wireless and Mobile Communication	PEC	3	0	0	3	3
2	ET3067	Unmanned Aerial Vehicle	PEC	3	0	0	3	3
3	ET3061	Machine Learning and Deep Learning	PEC	3	0	0	3	3
4	ET3002	Embedded Computing	PEC	3	0	0	3	3
5	ET3003	Embedded Systems Security	PEC	3	0	0	3	3
6	ET3056	Entrepreneurship and Embedded Product Development	PEC	3	0	0	3	3
7	ET3004	Embedded System for Biomedical Applications	PEC	3	0	0	3	3
8	ET3063	Python Programming for Machine Learning	PEC	3	0	0	3	3
9	ET3005	Edge Data Analytics	PEC	3	0	0	3	3
10	ET3006	Embedded Intelligence	PEC	3	0	0	3	3
11	ET3007	Open Source Software	PEC	3	0	0	3	3
12	ET3060	IoT for Smart Systems	PEC	3	0	0	3	3
13	ET3055	Embedded Networking and Automation of Electrical System	PEC	3	0	0	3	3
14	ET3066	Smart System Design	PEC	3	0	0	3	3
15	ET3064	Reconfigurable Processor and SoC Design	PEC	3	0	0	3	3
16	ET3008	Embedded Linux	PEC	3	0	0	3	3
17	ET3059	Intelligent System Design	PEC	3	0	0	3	3
18	ET3053	Digital Image Processing and Computer Vision	PEC	3	0	0	3	3
19	ET3058	Intelligent Control and Automation	PEC	3	0	0	3	3
20	ET3065	Robotics and Automation	PEC	3	0	0	3	3
21	ET3062	MEMS and NEMS Technology	PEC	3	0	0	3	3
22	ET3054	Embedded Controllers for EV Applications	PEC	3	0	0	3	3
23	ET3057	Information Modelling for Smart Process	PEC	3	0	0	3	3
24	ET3052	Blockchain Technologies	PEC	3	0	0	3	3
25	ET3051	Big Data Analytics	PEC	3	0	0	3	3
26	ET3009	DSP Based System Design	PEC	3	0	0	3	3
27	PW3053	Energy Efficient Buildings	PEC	3	0	0	3	3
28	PS3252	Smart Grid	PEC	3	0	0	3	3
29	PW3052	Electric Vehicles and Power Management	PEC	3	0	0	3	3
30	CO3251	Modern Automation Systems	PEC	3	0	0	3	3

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	ET3311	Project Work I	0	0	12	6	III
2.	ET3411	Project Work II	0	0	24	12	IV
					TOTAL CREDITS	**18**	

SUMMARY

	Name of the Programme: M.E. Embedded System Technologies					
	SUBJECT AREA	**CREDITS PER SEMESTER**				**CREDITS TOTAL**
		I	**II**	**III**	**IV**	
1.	FC	3				3
2.	PCC	13	16			29
3.	PEC	3	6	9		18
4.	RMC	3				3
5.	EEC			6	12	18
6.	**TOTAL CREDIT**	**22**	**22**	**15**	**12**	**71**

ET3101	EMBEDDED SYSTEM PROGRAMMING	LT P C 2 0 2 3

UNIT I BASIC C PROGRAMMING **6**

Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

UNIT II EMBEDDED C **6**

Adding Structure to 'C' Code: Object oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts.

UNIT III C PROGRAMMING TOOL-CHAIN IN LINUX **6**

C preprocessor - Stages of Compilation - Introduction to GCC - Debugging with GDB - The Make utility - GNU Configure and Build System - GNU Binary utilities - Profiling - using gprof - Introduction to GNU C Library- Safer C.

UNIT IV EMBEDDED C++ **6**

Introduction - F unction and Operator Overloading-Inheritance- Hardware Interfacing- Interrupt Handling - Error Handling.

UNIT V ADVANCED PYTHON PROGRAMMING **6**

Python Programming- Functions - Special data types in python - Python Modules and Packages - Creating Modules and Packages - Practical Example - Libraries for Python - Library for Mathematical functionalities and Tools - machine learning frameworks in python.

30 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Hands on laboratory practice/ Mini Project/Assignment/etc)

30 PERIODS

1. Laboratory exercise: Embedded processor/IDE/open source platform to give hands-on training on Embedded C- programming, Python and Embedded C++
2. Assignment: Embedded C++ programming and hardware interfacing
3. Embedded C/C++/python -Programming -based Mini project.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will demonstrate the ability to

CO1: Demonstrate C programming and its salient features for embedded systems

CO2: Deliver insight into various programming languages/software compatible to embedded process development with improved design & programming skills.

CO3: Develop knowledge on C programming in Linux environment.

CO4: Possess ability to write C++ programming for Embedded applications.

CO5: Have improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded programming skills.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES:

1. Paul Deitel and Harvey Deitel, “C How to Program”, 8th Edition, Pearson Education Limited, 2016.
2. Michael J Pont, "Embedded C", Addison-Wesley, An imprint of Pearson Education, 2002.
3. William von Hagen, "The Definitive Guide to GCC", 2nd Edition, Apress Inc., 2006.
4. Gowrishankar S and Veena A, "Introduction to Python Programming", CRC Press, Taylor & Francis Group, 2019.
5. Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015.
6. Steve Oualline, "Practical C programming", O'Reilly Media, 1997.
7. Fabrizio Romano, “Learn Python Programming”, Second Edition, Packt Publishing, 2018.
8. John Paul Mueller, "Beginning Programming with Python for Dummies", 2nd Edition, John Wiley & Sons Inc., 2018.
9. Mark Lutz, "Programming Python", 4th Edition, O’Reilly Media Inc., 2010.
10. Jonathan W. Valvano, ‘Embedded Systems: Introduction to ARM® Cortex™-M Microcontrollers’ 6th Edition,2019, Jonathan W. Valvano.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	-	3	-
CO2	1	-	1	-	2	-
CO3	-	2	-	-	2	-
CO4	1	-	1	1	1	-
CO5	-	-	2	2	3	2
Average	**1**	**2**	**1.5**	**1.5**	**2.2**	**2**

ET3102 EMBEDDED PROCESSOR BASED SYSTEM DESIGN LT P C
2 0 2 3

UNIT I ARM ARCHITECTURE 6

Architecture - Memory organization - Addressing modes -The ARM Programmer's model - Registers - Pipeline - Interrupts - Coprocessors - Interrupt Structure.

UNIT II PERIPHERALS OF ARM MICROCONTROLLER and PROGRAMMING 6

I/O Memory - EEPROM - I/O Ports - SRAM - Timer - UART - Serial Communication with PC - ADC/DAC Interfacing. ARM general Instruction set - Thumb instruction set - Introduction to DSP on ARM - Implementation example of Filters.

UNIT III RISC V Architecture 6

RISC-V Architecture and its significance - memory - Interrupts - Instruction Formats - Data Types and Addressing - Modes - Programming - RISC-V Development Tools.

UNIT IV GPU &TPU Architecture 6

Introduction to GPUs and TPUs - Architecture and Programming Models - Parallel Programming - Applications.

UNIT V DESIGN WITH ARM MICROCONTROLLERS 6

Implementation - Generation of Gate signals for converters and Inverters - Motor Control - Controlling DC/ AC appliances - Measurement of frequency - Standalone Data Acquisition System - ARM Implementation - Simple ASM/C programs - Loops - Look up table - Block copy-Subroutines - Hamming Code.

30 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Hands on laboratory practice/Mini Project/Seminar/etc)

30 PERIODS

1. Laboratory exercise:
   a) Programming with IDE - ARM microcontroller
   b) Advanced Timer Features, PWM Generator.
   c) RTC interfacing with ARM using Serial communication programming, Stepper motor control.
   d) ARM-Based Wireless Environmental Parameter Monitoring System displayed through Mobile device.
   e) I/O Programming with ARM processor: ARM7 / ARM9/ARM Cortex Microcontrollers
   f) I/O Interfacing: Timers/ Interrupts/ Serial port programming/PWM Generation/ Motor Control/ADC/DAC/ LCD/ RTC Interfacing/ Sensor Interfacing
2. Seminar:
   a) ARM and GSM/GPS interfacing
   b) Introduction to ARM Cortex Processor
3. Mini project.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Understand the basics and requirement of processor functional blocks.

CO2: Incorporate I/O hardware interface of a processor-based automation for consumer application with peripherals.

CO3: Observe the specialty of RISC V processor Architecture.

CO4: Understand the need for parallel processing with GPU and TPU.

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors

REFERENCES:

1. Steve Furber, 'ARM system on chip architecture', Addision Wesley,2010.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield 'ARM System Developer's Guide Designing and Optimizing System Software', Elsevier 2007.
3. David Patterson and Andrew Waterman, "The RISC-V Reader: An Open Architecture Atlas", Strawberry Canyon, 2017
5. William Hohl, ' ARMAssebly Language' Fundamentals and Techniques,2009.
6. Rajkamal,"Microcontrollers Architecture, Programming, Interfacing,& System Design,Pearson,2012
7. ARM Architecture Reference Manual, LPC213x User Manual
8. www.Nuvoton .com/websites on Advanced ARM Cortex Processors
9. Edward Kandrot, ' CUDA by Example An Introduction to General-Purpose GPU Programming' Pearson Education-2010.
10. Nick McClure, ' TensorFlow 2.0 Cookbook', Packt,2019

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	-	-	-
CO2	1	-	3	2	-	-
CO3	-	-	1	3	1	-
CO4	1	-	-	1	2	-
CO5	-	-	2	-	-	-
Average	**1**	**-**	**2**	**2**	**1.5**	**-**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3151	DESIGN OF EMBEDDED SYSTEMS	LT P C 3 0 0 3

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 9

Selection of Single-processor Architectures & Multi-Processor Architectures-built in features for embedded Target Architecture -Embedded Coprocessors-DMA- memory devices – Memory management methods-memory mapping, cache replacement policies- Timers and Counting devices, Techniques for enhancing computational throughput: parallelism and pipelining - Software Development tools-IDE, Incircuit emulator, Target Hardware Debugging.

UNIT II EMBEDDED NETWORKING BY PROCESSORS 9

Embedded Networking: Introduction, I/O Device Ports & Buses- multiple interrupts and interrupt service mechanism – Serial Bus communication protocols -RS232 standard–RS485–USB–Inter Integrated Circuits (I2C)- CAN Bus – Device Drivers -Wireless protocol based on Wifi , Bluetooth, Zigbee –IoT application.

UNIT III RTOS BASED EMBEDDED SYSTEM DESIGN 9

Introduction to basic concepts of RTOS- Synchronising and Scheduling in Uniprocessor and Multiprocessor OS- Task, process & threads, interrupt routines ,Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, inter task communication- context switching, interrupt latency and deadline, shared memory, message passing-, Interprocess Communication – synchronization between processes-semaphores,Mailbox, pipes, priority inversion, priority inheritance, comparison of Real time Operating systems:VxWorks, OS for mobile applications.

UNIT IV MODELLING WITH HARDWARE/SOFTWARE DESIGN APPROACHES 9

Modelling -embedded hardware and software development approach -Overview of UML modeling with UML, UML Diagrams- Co-Design & CoSynthesis Approaches for System Specification , modeling –Case examples of one DSProcessor, one automated vending machine.

UNIT V EMBEDDED SYSTEM APPLICATION DEVELOPMENT 9

DSProcessors - Architectural requirement and applications- Computational Features of DSProcessors for signal processing- Shifting , Buffering, IIR/FIR Filtering operation, Addressing Capabilities, Onchip peripherals and Features for External Interfacing& Program Execution–Case example of DSProcessor (TMS320CXX/ TMS320C67xx/ any other)based embedded application using audio, video processing.

TOTAL: 45 PERIODS

NOTE:

Practice through Mini Project/Exercise/Discussions on Design ,Development of embedded Products like : Digital Camera /Adaptive Cruise control in a Car /Mobile Phone / Automated Robonoid /discussions on interface to Sensors, GPS, GSM, Actuators

COURSE OUTCOMES:

At the end of this course, the students will demonstrate the ability

CO1: To understand the functionalities of processor internal blocks, with their requirement.

CO2: Observe that Bus standards are chosen based on interface overheads without sacrificing processor performance

CO3: Understand the role and features of RT operating system, that makes multitask execution possible by processors.

CO4: Understand that using multiple CPU based on either hardcore or softcore helps data overhead management with processing- speed reduction for uC execution.

CO5: Guidelines for consumer product design based on DSP based Embedded processor

REFERENCES:

1. Rajkamal, 'Embedded system-Architecture, Programming, Design', TMH,2011.
2. Steven W.Smith,"The Scientist and Engineers Guide for Digital Signal Processing",Elseiver 2019.
3. Lyla B Das," Embedded Systems-An Integrated Approach",Pearson2013
4. Elicia White,"Making Embedded Systems",O'Reilly Series,SPD,2011
5. Bruce Powel Douglass,"Real-Time UML Workshop for Embedded Systems,Elsevier,2011
6. Advanced Computer architecture , By Rajiv Chopra, S Chand , 2010
7. Jorgen Staunstrup, Wayne Wolf , Hardware / Software Co- Design Principles and Practice, Springer, 2009.
8. Shibu.K.V, "Introduction to Embedded Systems", TataMcgraw Hill,2009
9. Tammy Noergaard, "Embedded System Architecture, A comprehensive Guide for Engineers and Programmers", Elsevier, 2006
10. Peckol, "Embedded system Design",JohnWiley&Sons,2010

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	3	2	1	-
CO2	2	-	1	2	-	-
CO3	-	2	2	3	-	-
CO4	2	-	3	3	-	-
CO5	2	-	1	2	-	2
Average	**2**	**2**	**2**	**2.4**	**1**	**2**

ET3152 VLSI DESIGN AND RECONFIGURABLE ARCHITECTURE LT P C
3 0 0 3

UNIT I CMOS BASICS 9

Moore's Law - MOSFET Scaling, challenges and limits - MOS Transistor Model -Determination of pull up / pull down ratios - CMOS inverter Characteristics CMOS based combinational logic & sequential design - Dynamic CMOS - Transmission Gates - BiCMOS - Low power VLSI

UNIT II CMOS IC FABRICATIONS 9

Materials - Synthesis - Clean Room - Standards - Design Rules and Layout - CMOS fabrications Process and methods - n-well - p-well - Twin Tub - SOI - BiCMOS

UNIT III ASIC AND RECONFIGURABLE PROCESSOR AND SoC DESIGN 9

Introduction to ASIC, ASIC design flow - programmable ASICs - PLDs - reconfigurable processor-Architecture - Reconfigurable Computing, SoC Overview, recent trends in Reconfigurable Processor & SoC, Reconfigurable processor based DC motor control.

UNIT IV ANALOG VLSI DESIGN 9

Introduction to analog VLSI - Design of CMOS 2 stage - 3 stage Op-Amp - High Speed and High frequency op-amps - Super MOS - Analog primitive cells - Neural Chips - Introduction to Reprogrammable Analog Devices.

UNIT V HDL PROGRAMMING 9

Overview of digital design with HDL, structural, data flow and behavioral modeling concepts- logic synthesis-simulation-Design examples, Ripple carry Adders, Carry Look ahead adders, Multiplier, ALU, Shift Registers, Test Bench.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Understand the CMOS Logics and significance.

CO2: Deliver insight into developing CMOS design techniques and IC fabrication methods.

CO3: Explain the need of reconfigurable computing, hardware-software co design and operation of SoC processor.

CO4: Design and development of reprogrammable analog devices and its usage for Embedded applications.

CO5: Illustrate and develop HDL computational processes with improved design strategies.

REFERENCES:

1. Donald G. Givone, "Digital principles and Design", Tata McGraw Hill 2002.
2. Charles H. Roth Jr., "Fundamentals of Logic design", Thomson Learning, 2004.
3. Nurmi, Jari (Ed.) "Processor Design System-On-Chip Computing for ASICs and FPGAs" Springer, 2007.
4. Joao Cardoso, Michael Hübner, "Reconfigurable Computing: From FPGAs to Hardware/Software Codesign" Springer, 2011.
5. Pierre-Emmanuel Gaillardon, Reconfigurable Logic: Architecture, Tools, and Applications, 1st Edition, CRC Press, 2015
6. Mohamed Ismail, TerriFiez, "Analog VLSI Signal and information Processing", McGraw Hill International Editions,1994.
7. William J. Dally / Curtis Harting / Tor M. Aamodt," Digital Design Using VHDL: A Systems Approach, Cambridge University Press,2015.
8. ZainalatsedinNavabi, 'VHDL Analysis and Modelling of Digital Systems', 2n Edition, Tata McGraw Hill, 1998.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	1	-	-
CO2	2	-	2	2	-	-
CO3	-	-	3	3	2	1
CO4	2	-	2	3	1	-
CO5	-	1	1	3	3	1
Average	2	1	2	2.4	2	1

RM3151	RESEARCH METHODOLOGY AND IPR	LT P C 2 1 0 3

UNIT I RESEARCH PROBLEM FORMULATION 9

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the student can

CO1: Describe different types of research; identify, review and define the research problem

CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data

CO3: Explain the process of data analysis; interpret and present the result in suitable form

CO4: Explain about Intellectual property rights, types and procedures

CO5: Execute patent filing and licensing

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

ET3111 **EMBEDDED SYSTEM LABORATORY - I** **LT P C**
0 0 4 2

DOMAIN	EXPERIMENT DETAILS	EQUIPMENT/ SUPPORTS REQUIRED
1.	Programming with CISC Microcontrollers # Assembly programming	CISC Microcontrollers with peripherals; IDE, Board Support Software Tools / Compiler/others
2.	Programming with CISC Microcontrollers # C programming	CISC Microcontrollers with peripherals; IDE, Board Support Software Tools /C Compiler/others
3.	I/O Programming with CISC Microcontrollers I/O Interfacing: Serial port programming/ LCD/Sensor Interfacing /PWM Generation/ Motor Control	CISC Microcontrollers with peripherals; Board Support Software Tools, peripherals with interface
4.	Programming with RISC Microcontrollers: ✓ Assembly ✓ C programming	RISC Microcontrollers with peripherals; IDE, Board Support Software Tools /C Compiler/others
5.	I/O Programming with RISC Microcontrollers I/O Interfacing: PWM Generation/ Motor Control/ADC/DAC/ LCD/Sensor Interfacing	RISC Microcontrollers with peripherals; Board Support Software Tools, peripherals with interface
6.	Wireless Communication for Real time Applications	
7.	Mini Project	

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Experiment insight into various embedded processors of CISC and RISC architecture / computational processors with peripheral interface.

CO2: Understand the fundamental concepts of how process can be controlled with uC.

CO3: Experimenting on programming logic of Processor based on software suites (simulators, emulators)

CO4: Incorporate I/O software interface of a processor with peripherals.

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in interfacing and use of commercial embedded processors

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES:

1. Mohamammad Ali Mazidi&Mazidi "8051 Microcontroller and Embedded Systems", Pearson Education
2. Mohammad Ali Mazidi, RolindMckinley and Danny Causey, "PIC Microcontroller and Embedded Systems", Pearson Education
3. Simon Monk, "Make Action-with Arduino and Raspberry Pi", SPD,2016.
4. Wesley J.Chun, "Core Python Applications Programming", 3rd ed, Pearson,2016
5. Kraig Mitzner, "Complete PCB Design using ORCAD Capture and Layout", Elsevier
6. Vinay K.Ingle,John G.Proakis,"DSP-A Matlab Based Approach",Cengage Learning,2010.
7. Taan S.Elali, "Discrete Systems and Digital Signal Processing with Matlab",CRC Press2009
8. JovithaJerome, "Virtual Instrumentation using Labview" PHI, 2010
9. Woon-Seng Gan, Sen M. Kuo, "Embedded Signal Processing with the Micro Signal Architecture", John Wiley & Sons, Inc., Hoboken, New Jersey 2007
10. Dogan Ibrahim, "Advanced PIC microcontroller projects in C", Elsevier 2008

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	-	-
CO2	-	-	1	1	2	1
CO3	2	3	1	2	3	-
CO4	2	-	2	1	2	-
CO5	-	-	1	1	3	2
Average	2	2	1.4	1.2	2.5	1.5

ET3112 **EMBEDDED PROGRAMMING LABORATORY - I** **LT P C**
0 0 4 2

DOMAIN	EXPERIMENT DETAILS	EQUIPMENT/ SUPPORTS REQUIRED
1.	Programming in Higher Level Languages/Open-Source Platforms	C/C++/Java/Embedded C/Embedded Java/ Compilers &Platforms/cloud
2.	Programming with Arduino Microcontroller Board	Arduino Boards with peripherals; IDE, Board Support Software Tools /Compiler/others
3.	Programming with R-Pi Board	IDE, Basic programming, Board Support Software Tools /Compiler/others
4.	HDL Programming in FPGA processors	Processor Boards with Board Support Tools & Interfaces
4.	Programming & Simulation in Simulators /Tools/others	Simulation Tools as Proteus/ ORCAD
5	Network Simulation studies	NS2/NS3/omnet
6.	Programming & Simulation in Simulators /Tools/others	Simulation Tools as MATLAB /others
7	Mini Project	

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will demonstrate the ability in

CO1: Developing Optimized code for embedded processor

CO2: Understanding the fundamental concepts of how process can be realized using Software Modules

CO3: Circuit and System level simulators to develop solution for embedded based applications.

CO4: Incorporate I/O software interface of a processor with peripherals.

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on Embedded computing and algorithm development with programming concepts.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	2	2	1
CO2	2	-	2	-	3	2
CO3	2	1	3	1	2	2
CO4	2	1	2	2	2	-
CO5	-	-	2	-	3	1
Average	**2**	**1**	**2**	**1.67**	**2.4**	**1.5**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3201	REAL TIME OPERATING SYSTEM	LT P C 2 0 2 3

UNIT I REVIEW OF OPERATING SYSTEMS **6**

Basic Principles - Operating System structures - System Calls - Files - Processes - Design and Implementation of processes - Communication between processes - Introduction to Distributed operating system - Embedded operating systems

UNIT II OVERVIEW OF RTOS **6**

RTOS Task and Task state - Multithreaded Preemptive scheduler - Process Synchronization - Message queues - Mail boxes - pipes - Critical section - Semaphores - Classical synchronization problem - Deadlocks

UNIT III REALTIME MODELS AND LANGUAGES **6**

Event Based - Process Based and Graph based Models - Real Time Languages - RTOS Tasks - RT scheduling - Interrupt processing - Synchronization - Control Blocks - Memory Requirements.

UNIT IV REALTIME KERNEL **6**

Principles - Design issues - Polled Loop Systems - RTOS Porting to a Target - Compar ison and Basic study of various RTOS like - VX works - Linux supportive RTOS - C Executive.

UNIT V APPLICATION DEVELOPMENT **6**

Discussions on Basics of Linux supportive RTOS - uCOS - C Executive for development of RTOS Application - Case study

30 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Hands on laboratory practice/Mini Project/Seminar/etc)

30 PERIODS

LAB EXPERIMENTS

1. Develop a firmware code using a RTOS kernel on a SOC to implement a simple task to blink a led.
2. Using the RTOS kernel explore tasks and inter-task communication methods on a SOC
3. Experiment Task scheduling and task priorities with RTOS kernel.
4. Demonstrate the difference between mutex and semaphores with a RTOS kernel on SOC chip.
5. Using the RTOS kernel implement a multicore programming in which one reads temperature and another core displays value using terminal.
   (Recommended: Free rtos kernel, RP2040 SOC chip)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Outline Operating System structures and types.
CO2: Insight into scheduling, disciplining of various processes execution.
CO3: Illustrate knowledge on various RTOS support modelling
CO4: Demonstrate commercial RTOS Suite features to work on real time processes design.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in RTOS and embedded automation design.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES:

1. Silberschatz, Galvin, Gagne “Operating System Concepts”, 6th ed,John Wiley,2003
2. Charles Crowley, “Operating Systems - A Design Oriented approach” McGraw Hill,1997
3. Raj Kamal, “Embedded Systems- Architecture, Programming and Design” Tata McGraw Hill,2006.
4. Karim Yaghmour, “Building Embedded Linux System”,O’reilly Pub,2003
5. Mukesh Sighal and N G Shi, “Advanced Concepts in Operating System”, McGraw Hill,2000

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	-	2	-
CO2	-	-	2	-	3	1
CO3	2	-	2	1	2	2
CO4	2	2	3	2	1	3
CO5	-	-	1	-	3	1
Average	2	2	1.8	1.5	2.2	1.75

ET3202	EMBEDDED SYSTEM NETWORKING	LT P C 3 0 0 3

UNIT I EMBEDDED PROCESS COMMUNICATION WITH INSTRUMENT BUS 9

Embedded networking: Introduction - Cluster of instruments in System: Introduction to bus protocols - comparison of bus protocols - RS 232C, RS 422, RS 485 and USB standards - ARINC 429- embedded ethernet - MOD bus, LIN bus and CAN bus.

UNIT II EMBEDDED ETHERNET 9

Elements of a network - Inside Ethernet - Building a Network: Hardware options - Cables, Connections and network speed - Ethernet controllers - Inside the internet protocol - Exchanging messages using UDP and TCP - Email for Embedded systems using FTP - Keeping devices and network secure- IPv6, 6LoWPAN

UNIT III WIRELESS COMMUNICATION AND NETWORK 9

Overview of wireless communication- MIMO-OFDM system- Multiple access techniques in wireless communication- Wireless personal area networks- Ad-hoc wireless networks.

UNIT IV WIRELESS EMBEDDED NETWORKING 9

Wireless sensor networks - Introduction - Node architecture - Network topology - Localization - Time synchronization - Energy efficient MAC protocols - SMAC - Energy efficient and robust routing - Data centric routing –wifi- bluethooth-zigbee-LORA- WSN Applications - Home Control - Building Automation - Industrial Automation- advanced wireless technologies.

UNIT V COMMUNICATION FOR LARGE ELECTRICAL SYSTEM AUTOMATION 9

Data Acquisition, Monitoring, Communication, Event Processing, and Polling Principles, SCADA system principles - outage management - Decision support application - substation automation, extended control feeder automation, Performance measure and response time, SCADA Data Models, need, sources, interface

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1 : Analyze the different bus communication protocols used for embedded networking
CO2 : Explain the basic concepts of embedded networking
CO3 : Understand the wireless communication concepts
CO4 : Apply the embedded networking concepts in wireless networks
CO5 : Build a system automation for different applications

REFERENCES:

1. Mohammad Ilyas and ImadMahgoub, “Handbook of sensor Networks: Compact wireless and wired sensing systems”, CRC Press,2005
2. Peter W Gofton, “Understanding Serial Communication”, Sybes International, 2000
3. Jan Axelson “Embedded Ethernet and Internet Complete”, Penram publications
4. Krzysztof Iniewski, “Smart Grid, Infrastructure& Networking”, TMcGH,2012
5. Control and automation of electrical power distribution systems, James Northcote-Green, Robert Wilson, CRC, Taylor and Francis, 2006

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	-	-	3	1
CO2	-	2	-	-	2	1
CO3	3	2	2	3	2	3
CO4	2	-	3	3	-	2
CO5	3	-	3	3	-	2
Average	**2.25**	**2**	**2.7**	**3**	**2.3**	**1.8**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3251	AUTOMOTIVE EMBEDDED SYSTEMS	LT P C 3 0 0 3

UNIT I 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.

UNIT 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.

UNIT 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.

UNIT 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

UNIT V ELECTRIC VEHICLES 9

Electric vehicles – Components - Plug in Electrical vehicle - V2G - Charging station – Aggregators - Fuel cells/Solar powered vehicles - Autonomous vehicles.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability in

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.

REFERENCES:

1. William B. Ribbens, “Understanding Automotive Electronics”, Elseiver,2012
2. Ali Emedi, Mehrdedehsani, John M Miller, “Vehicular Electric power system- land, Sea, Air and Space Vehicles” Marcel Decker, 2004.
3. L.Vlacic, M.Parent, F.Harahima,” Intelligent Vehicle Technologies”, SAE International,2001.
4. Jack Erjavec,JeffArias, “Alternate Fuel Technology-Electric, Hybrid& Fuel Cell Vehicles”, Cengage , 2012.
5. Electronic Engine Control technology - Ronald K Jurgen Chilton’s guide to Fuel Injection - Ford.
6. Automotive Electricals/Electronics System and Components, Tom Denton, 3rd. Edition, 2004.

7. Uwe Kiencke, Lars Nielsen, “Automotive Control Systems: For Engine, Driveline, and Vehicle”, Springer; 1 edition, March 30, 2000.
8. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 4th Edition, 2004.
9. Automotive Hand Book, Robert Bosch, Bently Publishers, 1997.
10. Jurgen, R., Automotive Electronics Hand Book.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	2	1	1	-	2
CO2	2	3	2	2	2	3
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	2
Average	**2.75**	**2.8**	**2.4**	**2.4**	**2.75**	**2.2**

ET3252	EMBEDDED CONTROL FOR ELECTRIC DRIVES	LT P C 2 0 2 3

UNIT I INTRODUCTION ELECTRICAL DRIVES 6

Electric drive and its classifications, Four-quadrant drive, Dependence of load torque on various factors, Dynamics of motor-load combination-Solid State Controlled Drives-Machine learning and optimization techniques for electrical drives- IoT for Electrical drives applications.

UNIT II EMBEDDED PROCESSOR 6

Embedded Processor architecture - RTOS - Hardware/software co-design Programming and optimization with SoC processors - control algorithms implementation for power converter.

UNIT III INDUCTION MOTOR CONTROL 6

Types - Speed control methods - PWM techniques- VSI fed three - phase induction motor- Fuzzy logic Based speed control for three phase induction motor - FPGA based three phase induction motor control.

UNIT IV BLDC MOTOR CONTROL 6

Overview of BLDC Motor - Speed control methods - PWM techniques - ARM processor based BDLC motor control - ANN for BLDC Motor control and operation.

UNIT V SRM MOTOR CONTROL 6

Overview of SRM Motor - Speed control methods - PWM techniques - FPGA based SRM motor control - DNN for SRM Motor control and operation.

30 PERIODS

SKILL DEVELOPMENT ACTIVITIES (Hands on laboratory practice / Seminar/ Mini Project/etc)

30 PERIODS

1. Laboratory exercise: Use any System level simulator/MATLAB/open-source platform to give hands-on training on simulation study on Electric drives and control.
   a. Simulation of four quadrant operation and speed control of DC motor
   b. Simulation of 3-phasee inverter.
   c. Simulation of Speed control of Induction motor using any suitable software package.
   d. Simulation of Speed control of BLDC motor using any suitable software package.
   e. Simulation of Speed control of SRM using any suitable software package
2. Seminar: IoT-based Control and Monitoring for DC Motor/ any Electric drives.
3. Mini project.: Any Suitable Embedded processor-based speed control of Motors (DC/IM/BLDC/PMSM/SRM)

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Interpret the significance of embedded control of electrical drives
CO2: Deliver insight into various control strategy for electrical drives.
CO3: Developing knowledge on Machine learning and optimization techniques for motor control.
CO4: Develop embedded system solution for real time application such as Electric vehicles and UAVs.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system skills required for motor control strategy.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES:

1. R.Krishnan, “Electric Motor Drives - Modeling, Analysis and Control”, Prentice-Hall of India Pvt. Ltd., New Delhi,2010.
2. Vedam Subramanyam, “Electric Drives - Concepts and Applications”, Tata McGraw- Hill publishing company Ltd., New Delhi, 2002
3. K. Venkataratnam, “Special Electrical Machines”, Universities Press, 2014.
4. Steve Furber, “ARM system on chip architecture”, Addision Wesley,2010.
5. Ron Sass and AnderewG.Schmidt, “Embedded System design with platform FPGAs: Principles and Practices”, Elsevier, 2010.
6. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	2	-	2	-
CO2	1	1	3	-	-	2
CO3	2	-	-	-	3	-
CO4	1	2	3	1	-	-
CO5	-	-	-	-	3	-
Average	**1.25**	**1.5**	**2.7**	**1**	**2.7**	**2**

ET3211 **EMBEDDED SYSTEM LABORATORY - II** **LT P C**
0 0 4 2

Sl.No	EXPERIMENT DETAIL	EQUIPMENT/ SUPPORTS REQUIRED
1.	Programming with GPU processor	Basic Programming, Camera interface and Motor control logics
2	Programming with TPU processor	Basic Programming, simple Machine learning Implementation
3.	Programming with Raspberry Pi Microcontroller Board: Study on incircuit Emulators, cross compilers, debuggers	Raspberry Pi Boards with peripherals; IDE, Board Support Software Tools /Compiler/others, camera interface, Vision and Image processing application
4.	I/O Programming with Arduino, Raspberry Pi Microcontroller Boards I/O Interfacing: Timers/ Interrupts/ Serial port programming/PWM Generation/ Motor Control/ADC/DAC/ LCD/ RTC Interfacing/ Sensor Interfacing/IoT Applications	Arduino, Rasp berry Pi Microcontroller Boards with peripherals; Board Support Software Tools, peripherals with interface
5.	Programming with DSP processors	Processor Boards with Board Support Tools & Interfaces
6	Real Time Operating Systems (RTOS)	Implementation of RTOS with CPU/GPU/TPU/RPLD
7	IoT implementation with Embedded Systems	Node MCU, Gate way, Embedded processors
8	Mini Project	

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Experiment and demonstrate with simulators, in programming processor boards, processor interfacing/ designing digital controllers

CO2: Design & simulate Arithmetic, Logic programs, Filters, Signal analysis with simulators/experiments, in programming processor boards, processor interfacing/ Tools.

CO3: Develop real time solution for embedded applications.

CO4: Program and compile in various tools & software domains.

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors and its programmable interfacing.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	1	1	2	1
CO2	-	1	2	-	-	-
CO3	1	-	3	2	3	-
CO4	2	2	3	3	3	3
CO5	3	2	3	3	3	3
Average	**1.75**	**2**	**2.4**	**2.25**	**2.75**	**2.33**

ET3212 **EMBEDDED PROGRAMMING LABORATORY – II** **LT P C**
0 0 4 2

Sl.No	EXPERIMENT DETAIL	EQUIPMENT/ SUPPORTS REQUIRED
1.	Programming in Freeware software/ Platforms	Programming Compilers &Platforms on freeware
2.	Software & Modelling tools ✓ Study on MEMS Tools ✓ Study on process Controller modeling ✓ PLC/SCADA/PCB ✓ one type CAD Tool	Personal Computers, Software & programming/modelling tools
3.	Programming & Simulation in GUI Simulators /Tools/others ✓ Graphical User interface simulations & modeling of instrumentation & controllers	Simulation Tools as Labview /others
4.	Programming & Simulation in Python Simulators/Tools/others	Programming in Python Platform/ Open CV, machine learning and Deep learning Implementation
5	Programming with wired/wireless communication protocol/Network Simulators	Learning Communication Protocols & Support Software Tools for BUS & network communication
6	Linux programming Tool chain	PC with Linux OS
7.	Mobile App Development	Open source platforms
7	Automotive and EV Applications studies.	MATLAB/AUTOSAR/ open source
8	Mini project	

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will demonstrate the ability in

CO1: Developing Optimized algorithms for embedded processor on IDE and compilers.
CO2: Outline the concepts of how process can be realized using Software Modules.
CO3: Compare and analyze device, Circuit and System level simulators/emulators to develop embedded applications.
CO4: Incorporate I/O software interface using IDE and High-level languages with processor.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on Embedded programming concepts.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	1	1	2	1
CO2	-	3	2	2	-	-
CO3	2	3	3	2	3	2
CO4	-	1	3	3	3	3
CO5	-	-	3	3	3	3
Average	**2**	**2.25**	**2.4**	**2.2**	**2.75**	**2.25**

ET3311 **PROJECT WORK I** **L T P C**
0 0 12 6

COURSE OUTCOMES:
At the end of this course, the students will have the ability in

CO1: Design, Development capability in Building Automation for a process through Hardware & Software Tools.
CO2: Interpreting Pre-Requisites insists choice of project title from the embedded domain of research topics for Project work:
CO3: Demonstrate project work to enhance students' capacity to work in Research Areas of the Department interests or of Industrial importance.
CO4: Demonstrate the skill in Oral and Written Communication as presented in the Thesis Book via Viva-Voce Examination
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation with getting skilled up through learning & practicing in Design / development through simulation / experimental analysis with project report submission (relevant to the candidates project area) by individuals.

TOTAL: 180 PERIODS

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	-	-	-	-	-
CO3	3	-	-	-	-	3
CO4	3	3	3	3	3	3
CO5	2	3	3	3	3	3
Average	**2.8**	**3**	**3**	**3**	**3**	**3**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3411	PROJECT WORK II	L T P C 0 0 24 12

COURSE OUTCOMES:

At the end of this course, the students will have the ability in

CO1: Design, Development capability in Building Automation for a process through Hardware & Software Tools.

CO2: Interpreting Pre-Requisites insists choice of project title from the embedded domain of research topics for Project work:

CO3: Demonstrate project work to enhance students' capacity to work in Research Areas of the Department interests or of Industrial importance.

CO4: Demonstrate the skill in Oral and Written Communication as presented in the Thesis Book via Viva-Voce Examination

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation with getting skilled up through learning & practicing in Design / development through simulation / experimental analysis with project report submission (relevant to the candidates project area) by individuals.

TOTAL: 360 PERIODS

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	-	-	-	-	-
CO3	3	-	-	-	-	3
CO4	3	3	3	3	3	3
CO5	2	3	3	3	3	3
Average	**2.8**	**3**	**3**	**3**	**3**	**3**

ET3001	WIRELESS AND MOBILE COMMUNICATION	LT P C 3 0 0 3

UNIT I INTRODUCTION **9**

Wireless Transmission – signal propagation – Free space and two ray models – spread spectrum – Satellite Networks – Capacity Allocation – FDMA –TDMA- SDMA – DAMA

UNIT II MOBILE NETWORKS **9**

Cellular Wireless Networks – GSM – Architecture – Protocols – Connection Establishment – Frequency Allocation – Handover – Security – GPRA.

UNIT III WIRELESS NETWORKS **9**

Wireless LAN – IEEE 802.11 – System Architecture - Protocol Architecture – Physical layer- MAC layer – MAC management – 802.11b – 802.11a – Hiper LAN - Bluetooth

UNIT IV ROUTING **9**

Mobile IP- DHCP – Mobile AdHoc Networks – Proactive and Reactive Routing Protocols – MulticastRouting - WSN routing – LEACH- SPIN- PEGASIS

UNIT V TRANSPORT AND APPLICATION LAYERS **9**

Traditional TCP – Classical TCP improvements - WAP – Architecture – WWW Programming Model –WDP – WTLS –WTP – WSP – WAE – WTA Architecture – WML – WML scripts.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will demonstrate the ability in

CO1: Understand the mobile radio propagation

CO2: Comprehend Cellular communication concepts

CO3: Deployment of distributed Wireless & mobile networks

CO2: Establishment of routing in distributed static & mobile systems

CO5: Understand the wireless IP and TCP.

REFERENCES:

1. Jochen Schiller, " Mobile communications", PHI/Pearson Education, Second Edition, 2003.
2. Kaveh Pahlavan, Prasanth Krishnamoorthy,"Principles of Wireless Networks", PHI/Pearson Education, 2003
3. C. Siva Ram Murthy and B.S. Manoj, "AdHoc Wireless Networks: Architectures and protocols", Prentice Hall PTR, 2004
4. Naveen Chilamkurti, SheraliZeadally, HakimaChaouchi, "Next-Generation Wireless Technologies", Springer, 2013.
5. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles ofMobile computing", Springer, New york, 2003.
6. C.K.Toh, " AdHoc mobile wireless networks", Prentice Hall, Inc, 2002.
7. Charles E. Perkins, " Adhoc Networking", Addison-Wesley, 2001.
8. Erik Dahlman, Stefan Parkvall, Johan Skold, "4G: LTE/LTE-Advanced for Mobile Broadband", Academic Press, 2013.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	1	-	-
CO2	3	3	2	2	-	-
CO3	3	3	2	3	2	2
CO4	-	-	-	-	-	-
CO5	-	-	-	-	-	-
Average	**3**	**3**	**2**	**2**	**2**	**2**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3067	UNMANNED AERIAL VEHICLE	LT P C 3 0 0 3

UNIT I INTRODUCTION TO UAV 9

Overview and background - History of UAV -classification - societal impact and future outlook Unmanned Aerial System (UAS) components - models and prototypes - System Composition - Applications

UNIT II THE DESIGN OF UAV SYSTEMS 9

Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations - Characteristics of Aircraft Types - Design Standards - Regulatories and regulations - Design for Stealth - control surfaces - specifications.

UNIT III HARDWARES FOR UAVs 9

Real time Embedded processors for UAVs – sensors - servos - accelerometer – gyros -actuators - power supply - integration, installation, configuration, and testing - MEMS/NEMS sensors and actuators for UAVs - Autopilot - AGL.

UNIT IV COMMUNICATION PAYLOADS AND CONTROLS 9

Payloads-Telemetry – tracking - Aerial photography - controls - PID feedback- radio control frequency range - modems - memory system – simulation - ground test – analysis - trouble shooting.

UNIT V THE DEVELOPMENT OF UAV SYSTEMS 9

Waypoints navigation - ground control software - System Ground Testing - System In - flight Testing - Mini, Micro and Nano UAVs - Case study: Agriculture- Health- Surveying- Disaster Management and Defense.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability in

CO1: Identify different hardware for UAV.
CO2: Determine preliminary design requirements for an unmanned aerial vehicle.
CO3: Design UAV system.
CO4: Identify and Integrate various systems of unmanned aerial vehicle.
CO5: Design micro aerial vehicle systems by considering practical limitations.

REFERENCES:

1. Reg Austin “Unmanned Aircraft Systems UAV design, development and deployment”, Wiley, 2010.
2. Paul G Fahlstrom, Thomas J Gleason, “Introduction to UAV Systems”, UAV Systems, Inc, 1998
3. Dr. Armand J. Chaput, “Design of Unmanned Air Vehicle Systems”, Lockheed Martin Aeronautics Company, 2001
4. Kimon P. Valavanis, “Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy”, Springer, 2007
5. Robert C. Nelson, “Flight Stability and Automatic Control”, McGraw-Hill, Inc, 1998.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	2	-	-	2
CO2	3	3	3	-	-	2
CO3	3	3	3	3	3	3
CO4	-	-	2	3	3	2
CO5	3	-	3	3	3	3
Average	**2.5**	**3**	**2.6**	**3**	**3**	**2.4**

ET3061	MACHINE LEARNING AND DEEP LEARNING	LT P C 3 0 0 3

UNIT I LEARNING PROBLEMS AND ALGORITHMS 9

Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS 9

Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, Multi-layer neural network, Linear Separability, Hebb Net, Perceptron, Adaline, Standard Back propagation Training Algorithms for Pattern Association - Hebb rule and Delta rule, Hetero associative, auto associative, Kohonen Self Organising Maps, Examples of Feature Maps, Learning Vector Quantization, Gradient descent, Boltzmann Machine Learning.

UNIT III MACHINE LEARNING - FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS 9

Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1 - Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, rain forest algorithm-multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, case study based on CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS 9

State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

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

CO1: Illustrate the categorization of machine learning algorithms.

CO2: Compare and contrast the types of neural network architectures, activation functions

CO3: Acquaint with the pattern association using neural networks

CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks

CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

1. J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A Computational Approach to Learning and Machine Intelligence, 2012, PHI learning
2. Deep Learning, Ian Good fellow, Yoshua Bengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016.
3. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition, 2009.
4. Pattern Recognition and Machine Learning. Christopher Bishop. Springer, 2006.
5. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	1	-	-	-
CO2	2	3	2	-	-	-
CO3	3	-	3	-	3	-
CO4	2	3	3	-	-	-
CO5	3	3	3	-	3	-
Average	**2.2**	**3**	**2.4**	**-**	**3**	

ET3002	EMBEDDED COMPUTING	LT P C 3 0 0 3

UNIT I NETWORK INFRASTRUCTURE 9

Broad Band Transmission facilities -Open Interconnection standards - networking devices Network diagram -Network management - Network Security - Cluster computers.

UNIT II JAVA TECHNOLOGY FOR EMBEDDED SYSTEMS 9

Basic concepts of Java - IO streaming - Object serialization - Networking - Threading - RMI - distributed databases -- Advantages and limitations of Internet - Web architecture for embedded systems - security model for embedded systems.

UNIT III EMBEDDED C++ 9

Enumeration and Class Types, The const and volatile Qualifiers. Nested Constants and Types Function and Operator Overloading, Inheritance, Templates, Language Linkage, Hardware Interfacing Interrupt Handling, Error Handling- Programming - RTOS implementation- Motor Control.

UNIT IV ANDROID FRAMEWORK 9

Android SDK - Access to Hardware - Framework development - Peer-to-Peer communication - Android security design and architecture - Case study.

UNIT V DEVELOPING DISTRIBUTED REAL-TIME SYSTEM APPLICATIONS 9

Developing MATLAB Real-Time Targets - Using the xPC Target - Building various Distributed Real Time Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Deliver insight into involving JAVA concepts& internet based Communication to establish decentralized control mechanism of system

CO2: Interpret the software and hardware architecture for distributed computing

CO3: Develop C++ solution for embedded systems

CO4: Develop Apps based on android SDK

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system computing environment.

REFERENCES:

1. AmitavaGupta , Anil Kumar Chandra and Peter Luksch " Real-Time and Distributed Real-Time Systems Theory and Applications ". CRC Press 2016 International Standard Book Number-13: 978-1-4665-9849-2 (eBook - PDF)
2. Wolfgang Rankl and Wolfgang Effing "Smart Card Handbook" John Wiley & Sons Ltd, Third Edition, 2003
3. Reto Meier "Professional Android application development" Wiley Publishing, Inc, 2009.
4. Joshua "Android hacker's Handbook" John Wiley & sons, 2014
5. Dietel&Dietel, "JAVA how to program", Prentice Hall 1999.
6. SapeMullender, "Distributed Systems", Addison-Wesley, 1993.
7. Jonathan W. Valvano, "Embedded Systems: Introduction to ARM® Cortex™-M Microcontrollers" 6th Edition,2019, Jonathan W. Valvano.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	-	2	2
CO2	2	3	2	-	-	-
CO3	3	1	2	3	2	3
CO4	3	1	2	3	2	3
CO5	2	1	2	-	-	3
Average	**2.4**	**1.5**	**1.8**	**3**	**2**	**2.25**

ET3003 EMBEDDED SYSTEMS SECURITY LT P C
3 0 0 3

UNIT I BACKGROUND AND INTRODUCTION 9

Computer and Network Security Concepts: Computer Security Concepts - The OSI Security Architecture - Security Attacks - Security Services - Security Mechanisms - Fundamentals of Security Design Principles - Attack Surfaces and Attack Trees - A Model for Network Security. Introduction to Number Theory: Divisibility and the Division Algorithm - The Euclidean Algorithm - Modular Arithmetic - Prime Numbers - Fermat's and Euler's Theorems - Testing for Primality - The Chinese Remainder Theorem - Discrete Logarithms.

UNIT II SYMMETRIC CIPHERS 9

Classical Encryption Techniques: Symmetric Cipher Model - Substitution Techniques - Transposition Techniques. Block Ciphers and the Data Encryption Standard (DES): Traditional Block Cipher Structure - The Data Encryption Standard - A DES Example - Strength of DES. Advanced Encryption Standard: Finite Field Arithmetic - AES Structure - AES Transformation Functions - AES Key Expansion - An AES Example - AES Implementation.

UNIT III EMBEDDED SYSTEMS SECURITY 9

Embedded Security Trends - Security Policies - Security Threats. System Software Considerations: The Role of Operating System - Microkernel versus Monolithic - Core Embedded OS Security Requirements - Access Control and Capabilities - Hypervisors and System Virtualization - I/O Virtualization - Remote Management - Assuring Integrity of the TCB.

UNIT IV EMBEDDED CRYPTOGRAPHY AND DATA PROTECTION PROTOCOLS 9

The One-time Pad - Cryptographic Modes - Block Ciphers - Authenticated Encryption - Public Key Cryptography - Key Agreement - Public Key Authentication - Elliptic Curve Cryptography - Cryptographic Hashes - Message Authentication Codes - Random Number Generation - Key Management for Embedded Systems - Cryptographic Certifications. Data Protection Protocols for Embedded Systems: Data-in-Motion Protocols - Data-at-Rest Protocols. Emerging Applications: Embedded Network Transactions - Automotive Security - Secured Android.

UNIT V PRACTICAL EMBEDDED SYSTEM SECURITY 9

Network Communications Protocols and Built-in Security - Security Protocols and Algorithms - The Secured Socket Layer - Embedded Security - Wireless - Application-Layer and Client/Server Protocols - Choosing and Optimizing Cryptographic Algorithms for Resource-Constrained Systems - Hardware Based Security.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Explain the significance of Security.
CO2: Understand the major concepts and techniques related to Cryptography.
CO3: Demonstrate thorough knowledge about the aspects of Embedded System Security.
CO4: Delivers insight onto role of Security Aspects during Data Transfer and Communication.
CO5: Applying the Security Algorithms for Real-time Applications.

REFERENCES:

1. "Cryptography and Network Security Principles and Practice", 7th Edition - Global Edition, William Stallings, Pearson Education Limited, 2017.
2. "Embedded Systems Security - Practical Methods for Safe and Secure Software and Systems Development", David Kleidermacher and Mike Kleidermacher, Newnes (an imprint of Elsevier), 2012.

3. “Practical Embedded Security - Building Secure Resource-Constrained Systems”, Timothy Stapko, Newnes (an imprint of Elsevier), 2008.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	1	1	-
CO2	3	2	2	-	-	2
CO3	1	3	-	1	-	-
CO4	3	1	2	-	3	1
CO5	3	2	3	2	3	3
Average	**2.2**	**1.8**	**2.33**	**1.33**	**2.33**	**2**

ET3056 ENTREPRENEURSHIP AND EMBEDDED PRODUCT DEVELOPMENT LT P C
3 0 0 3

UNIT I INTRODUCTION TO ENTREPRENEURSHIP 9

Entrepreneurial culture and structure - theories of entrepreneurship - entrepreneurial motivation - establishing entrepreneurial systems - financial information and intelligence, rewards and motivation - concept bank - Role of industrial Fairs - Design thinking – IPR- Patent- challenges in entrepreneurship.

UNIT II RESPONSIBILITIES IN ENTREPRENEURSHIP 9

Steps for starting a small industry - selection of type of organization -Incentives and subsidies - Central Govt. schemes and State Govt. Schemes - incentives to SSI -registration, Registration and Licensing requirements for sales tax, CST, Excise Duty - Power - Exploring export possibilities - incentives for exports - import of capital goods and raw materials - Entrepreneurship development programmes in India- Role and Improvement in Indian Economy.

UNIT III CONCEPTS OF PRODUCT DEVELOPMENT 9

Generic product Development Phases - Product Development Process Flows - Basics of Concept Generation - Five Step Method - Creative thinking methods and problem solving - design concepts - Product Architecture - component standardization - Bill of materials-Product development management - Portfolio Architecture – Benchmarking.

UNIT IV APPROACHES FOR NEW PRODUCT DEVELOPMENT 9

Idea Generation - Industrial Design - Brainstorming Methods - SWOT Analysis-Concept Development & Testing - Risk Management Process - Critical Path Analysis & PERT - Reverse Engineering Methodology - need for Involving CAE, CAD, CAM tools - Prototype basics - Rapid Prototyping - Prototyping Techniques - Planning for prototypes - Economic & Cost Analysis

UNIT V ENTREPRENEURSHIP IN EMBEDDED SYSTEM 9

Entrepreneurship opportunities in Embedded system technologies – Design thinking -Embedded system Product development - Entrepreneurial skills for embedded system hardware and software architecture, software and hardware co-design and challenges; problems of entrepreneurship in Embedded system field - case studies: Mobile phone development - automation components - Washing machine - Food Processing system and devices- High Performance embedded computers - Industrial Controllers

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the internal/external factors affecting a business/organization to evaluate business opportunities.

CO2: Demonstrate extemporaneous speaking skills developed through in-class discussion of text materials, case study analyses, and current entrepreneurship-related issues.

CO3: Apply and Relate Key concepts underpinning entrepreneurship and its application in the recognition and exploitation of product/ service/ process opportunities.

CO4: Interpret various aspects of design such as industrial design, design of Consumer specific product, its Reverse Engineering manufacture, economic analysis.

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

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES

1 Kuratko, Enmterpreneurship: A Contemporary Approach, Thomson Learning, 2001.
2 Thomas Zimmerer et.al., Essentials of Entrepreneurship and small business Management 3rd Ed. Pearson Education, 2002.
3 Greene, Entrepreneurship: Ideas in Action, Thomson Learning, Mumbai, 2000
4 Jeffry Timmons, New Venture creation, McGraw Hill, 1999.
5 Gupta and Smivasan, Entrepreneurial Development, New Delhi, Sultan Chand, 1992
6 James K.peckol ," Embedded Systems: A contemporary Design Tool", Wiley,2014.
7 Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition,2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9
8 George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition,4th Edition, 2009, ISBN 978-007-127189-9

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	-	-	-	3
CO2	3	3	-	-	-	-
CO3	3	3	-	-	-	1
CO4	3	3	-	1	-	1
CO5	3	2	3	2	3	3
Average	**3**	**2.6**	**3**	**1.5**	**3**	**2**

ET3004	EMBEDDED SYSTEM FOR BIOMEDICAL APPLICATIONS	LT P C 3 0 0 3

UNIT I INTRODUCTION TO BIOMEDICAL ENGINEERING **9**

Origin of bio potential and its propagation - Resting and Action Potential - Bio signals characteristics -Types of electrodes - Types of transducers and applications - Bio-amplifiers - Types of recorders - components of a biomedical system.

UNIT II WEARABLE HEALTH DEVICES **9**

Concepts of wearable technology in health care - Components of wearable devices – Biosensors - Blood glucose sensors - Head worn - Hand worn - Body worn -pulse oximeter- Cardiac pacemakers - Hearing aids and its recent advancements - wearable artificial kidney.

UNIT III EMBEDDED SYSTEM FOR MEDICAL IMAGE PROCESSING **9**

Introduction to embedded image processing - ASIC vs FPGA - memory requirement - power consumption - parallelism - Design issues in VLSI implementation of Image processing algorithms - interfacing. Hardware implementation of image processing algorithms: Segmentation and compression

UNIT IV EMBEDDED SYSTEM FOR DIAGNOSTIC APPLICATIONS **9**

ICCU patient monitoring system - ECG-EEG-EMG acquisition system - MRI scanner - CT scanner - Sonography.

UNIT V CASE STUDY **9**

Respiratory measurement using spirometer - IPPB unit for monitoring respiratory parameters – ventilators - Defibrillator – Glucometer – Heart - Lung machine.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Demonstrate the fundamental art of biomedical engineering.
CO2: Illustrate about wearable health devices and its importance.
CO3: Implement image processing applications using software and hardware.
CO4: Compare various embedded diagnostic applications.
CO5: Build and analyze of some biomedical equipment.

REFERENCES:

1. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice Hall of India, New Delhi, 2007.
2. John G.Webster, “Medical Instrumentation Application and Design”, 3rd Edition, Wiley India Edition, 2007
3. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
4. L.A Geddes and L.E.Baker, Principles of Applied Biomedical Instrumentation, 3rd Edition, John Wiley and Sons, Reprint 2008.
5. Richard S.Cobbold, Transducers for Biomedical Measurements; Principle and applications-John Wiley and sons, 1992.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	-	-	-
CO2	-	3	2	3	-	-
CO3	-	-	2	-	3	3
CO4	3	1	1	-	2	2
CO5	1	3	3	-	-	-
Average	**1.66**	**2.25**	**2.2**	**3**	**2.5**	**2.5**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3063	PYTHON PROGRAMMING FOR MACHINE LEARNING	LT P C 3 0 0 3

UNIT I INTRODUCTION TO MACHINE LEARNING AND PYTHON 9

Introduction to Machine Learning: Significance, Advantage and Applications - Categories of Machine Learning - Basic Steps in Machine Learning: Raw Data Collection, Pre-processing, Training a Model, Evaluation of Model, Performance Improvement Introduction to Python and its significance - Difference between C, C++ and Python Languages; Compiler and Interpreters - Python3 Installation & Running - Basics of Python Programming Syntax: Variable Types, Basic Operators, Reading Input from User - Arrays/List, Dictionary and Set - Conditional Statements - Control Flow and loop control statements

UNIT II PYTHON FUNCTIONS AND PACKAGES 9

File Handling: Reading and Writing Data - Errors and Exceptions Handling - Functions & Modules - Package Handling in Python - Pip Installation & Exploring Functions in python package - Installing the NumPy Library and exploring various operations on Arrays: Indexing, Slicing, Multi-Dimensional Arrays, Joining NumPy Arrays, Array intersection and Difference, Saving and Loading NumPy Arrays - Introduction to SciPy Package & its functions - Introduction to Object Oriented Programming with Python

UNIT III IMPLEMENTATION OF MACHINE LEARNING USING PYTHON 9

Description of Standard Datasets: Coco, ImageNet, MNIST (Handwritten Digits) Dataset, Boston Housing Dataset - Introducing the concepts of Regression - Linear, Polynomial & Logistic Regression with analytical understanding - Introduction to SciPy Package & its functions - Python Application of Linear Regression and Polynomial Regression using SciPy - Interpolation, Overfitting and Underfitting concepts & examples using SciPy

UNIT IV CLASSIFICATION AND CLUSTERING CONCEPTS OF ML 9

Introduction to ML Concepts of Clustering and Classification - Types of Classification Algorithms - Support Vector Machines (SVM) - Decision Tree - Random Forest - Introduction to ML using scikit-learn - Using scikit-learn, loading a sample dataset, Learning & prediction, interpolation & fitting, Multiclass fitting - Implementation of SVM using Blood Cancer Dataset, Decision Tree using data from csv, Types of Clustering Algorithms & Techniques - K-means Algorithm, Mean Shift Algorithm & Hierarchical Clustering Algorithm - Introduction to Python Visualization using Matplotlib: Plotting 2-dimensional, 3-dimensional graphs; formatting axis values; plotting multiple rows of data in same graph - Implementation of K-means Algorithm and Mean Shift Algorithm using Python

UNIT V INTRODUCTION TO NEURAL NETWORKS AND EMBEDDED MACHINE LEARNING 9

Introduction to Neural Networks & Significance - Neural Network Architecture - Single Layer Perceptron & Multi-Layer Perceptron (MLP) - Commonly Used Activation Functions - Forward Propagation, Back Propagation, and Epochs - Gradient Descent - Introduction to Tensorflow and Keras ML Python packages - Implementation of MLP Neural Network on Iris Dataset - Introduction to Convolution Neural Networks - Implementation of Digit Classification using MNIST Dataset

ML for Embedded Systems: Comparison with conventional ML - Challenges & Methods for Overcoming – TinyML and TensorFlow Lite for Microcontrollers – on-Board AI – ML Edge Devices: Arduino Nano BLE Sense, Google Edge TPU and Intel Movidius

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Develop skill in system administration and network programming by learning Python.

CO2: Demonstrating understanding in concepts of Machine Learning and its implementation using Python.

CO3: Relate to use Python's highly powerful processing capabilities for primitives, modelling etc.

CO4: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

CO5: Apply the concepts acquired over the advanced research/employability skills

REFERENCES:

1. Mark Lutz, “Learning Python, Powerful OOPs”, O’reilly, 2011
2. Zelle, John “M. Python Programming: An Introduction to Computer Science”, Franklin Beedle & Associates, 2003
3. Andreas C. Müller, Sarah Guido, “Introduction to Machine Learning with Python”, O'Reilly, 2016
4. Sebastian Raschka, VahidMirjalili, “Python Machine Learning - Third Edition”, Packt, December 2019

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	3	3	-
CO2	3	1	3	-	3	1
CO3	2	1	2	-	3	3
CO4	3	2	3	3	3	3
CO5	-	-	-		3	-
Average	**2.66**	**1.33**	**2.5**	**3**	**3**	**2.33**

ET3005	EDGE DATA ANALYTICS	LT P C 3 0 0 3

UNIT I INTRODUCTION TO EDGE DATA ANALYTICS 9

Overview of Edge Computing and its significance; Role of Edge Data Analytics in real-time decision-making; Challenges and opportunities in Edge Data Analytics; Edge computing architectures and deployment models - distinction between edge, fog, and cloud layers, edge clouds, mobile edge computing (MEC), and industrial edge computing; Edge devices and sensors for data collection- GPU , TPU based hardware accelerators.

UNIT II EDGE DATA COLLECTION AND PREPROCESSING 9

Data collection techniques at the edge (e.g., IoT devices, sensors) Edge data preprocessing and filtering algorithms Data compression and aggregation techniques for resource-constrained devices Edge-based data cleaning and quality assurance Edge data integration and synchronization with cloud or central servers

UNIT III EDGE DATA ANALYTICS TECHNIQUES 9

Machine learning algorithms for edge data analysis (e.g., classification, regression) Statistical analysis methods for real-time data streams Edge-based anomaly detection and outlier identification Time-series analysis and forecasting at the edge Distributed and parallel computing techniques for edge analytics

UNIT IV EDGE DATA VISUALIZATION AND INTERPRETATION 9

Visualization techniques for edge data analytics Real-time dashboards and data monitoring at the edge Visualization of streaming data from multiple edge devices Interactive visualization tools for edge analytics Visual storytelling and decision support through edge data visualization

UNIT V EDGE DATA SECURITY AND PRIVACY 9

Security challenges in edge data analytics Secure communication protocols for edge devices Privacy-preserving techniques for edge data collection and analysis Access control and authentication in edge computing environments Legal and ethical considerations in edge data analytics

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to understand edge data analytics, including data preprocessing, real-time analytics, distributed computing, and edge computing architectures.
CO2: Able to learn data collection methods and preprocessing techniques specifically designed for edge devices
CO3: Able to learn will gain hands-on experience in developing real-time analytics algorithms for edge devices
CO4: Able to will learn techniques to optimize edge data analytics for resource-constrained environments
CO5: Able to analyze the security and privacy challenges associated with edge data analytics

REFERENCES:

1."Edge Analytics: A Comprehensive Guide for Internet of Things Data Analytics" by Satyajit Das and Taposh Dutta Roy (Published in 2018)
2."Edge Analytics in the Internet of Things: A Hands-on Introduction with Raspberry Pi and Edge Computing" by Madhura Jayaratna (Published in 2020)
3."Edge Analytics for Internet of Things: A Comprehensive Guide to Building Intelligent IoT Solutions" by Kaushik Das (Published in 2019)
4."Edge Computing for Data Analytics: Achieve Local Analytics and AI on Edge Devices" by Chi Harold Liu (Published in 2021)
5."Practical Industrial Internet of Things Security: A practitioner's guide to securing connected industries and supply chains" by Sravani Bhattacharjee, Debashis De, and Mohammad Saiful Islam (Published in 2022)

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	2	2	1
CO2	2	-	2	-	3	2
CO3	2	1	3	1	2	2
CO4	2	1	2	2	2	-
CO5	-	-	2	-	3	1
Average	**2**	**1**	**2**	**1.67**	**2.4**	**1.5**

ET3006	EMBEDDED INTELLIGENCE	LT P C 3 0 0 3

UNIT I INTRODUCTION TO EMBEDDED INTELLIGENCE 9

Overview of embedded intelligence and its significance - Characteristics and challenges of embedded systems - Evolution of embedded intelligence - Role of embedded intelligence in IoT and edge computing.

UNIT II MACHINE LEARNING FOR EMBEDDED INTELLIGENCE 9

Introduction to machine learning in embedded systems -Supervised, unsupervised, and reinforcement learning algorithms, Optimization techniques for resource-constrained systems - Embedded friendly machine learning frameworks and libraries- Edge inference and on-device learning techniques.

UNIT III HARDWARE ARCHITECTURES FOR ML AND DL 9

CPU architectures for ML and DL - Graphics Processing Units (GPUs) for ML and DL Applications - Specific Integrated Circuits (ASICs) for deep learning Field -Programmable Gate Arrays (FPGAs) for deep learning Tensor Processing Units (TPUs) and other specialized accelerators

UNIT IV WEB3 INTEGRATION IN EMBEDDED INTELLIGENCE 9

Introduction to Web3 and its principles - blockchain technology and its applications in embedded systems - Decentralized applications (DApps) and their role in embedded intelligence - Web3 protocols in embedded systems - Web3 integration in embedded intelligence for supply chain management, energy grids, and autonomous vehicles

UNIT V EMBEDDED INTELLIGENCE FOR REAL TIME APPLICATIONS 9

Embedded intelligence in robotics - Perception algorithms for robotic systems - Navigation and path planning in autonomous systems - Embedded intelligence for smart home and Industrial Automation - Cooperative - collaborative automation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to understand the fundamental principles and concepts related to embedded intelligence.

CO2: Able to learn how to apply various machine learning techniques, such as neural networks, decision trees, and support vector machines, to embedded systems.

CO3: Able to learn about hardware architecture for embedded intelligence.

CO4: Able to understand Web 3 technologies, such as blockchain, decentralized applications (DApps), smart contracts, and decentralized storage, and how they can be integrated with embedded intelligence systems

CO5: Able to collaborate effectively with professionals from different disciplines, such as robotics engineering, IoT systems, and AI.

REFERENCES:

1."Embedded Intelligence: Strategies for Developing and Implementing Intelligent Systems" by Robert E. Filman, Daniel P. Siewiorek, and Charles P. Thorpe (Published in 2009)

2."Embedded Intelligence in Vehicles" by SAE International (Published in 2013)

3."Embedded Intelligence: High-impact Strategies - What You Need to Know: Definitions, Adoptions, Impact, Benefits, Maturity, Vendors" by Kevin Roebuck (Published in 2012)

4."Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers" by Jonathan W. Valvano (Published in 2018)

5."Embedded Systems Design: An Introduction to Processes, Tools, and Techniques" by Arnold S. Berger (Published in 2002).

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	3	3	-
CO2	3	1	3	-	3	1
CO3	2	1	2	-	3	3
CO4	3	2	3	3	3	3
CO5	-	-	-		3	-
Average	**2.66**	**1.33**	**2.5**	**3**	**3**	**2.33**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3007 **OPEN SOURCE SOFTWARE** **LT P C**
3 0 0 3

UNIT I INTRODUCTION 9

Open-Source Terminologies: Open-Source Software, Freeware, Shareware, Proprietary Software - Introduction to Open sources - Need of Open Sources - Advantages of Open Sources - Application of Open Sources. Open-source operating systems: LINUX: Introduction - General Overview - Kernel Mode and user mode - Process - Advanced Concepts - Scheduling - Personalities - Cloning - Signals - Development with Linux.

UNIT II OPEN SOURCE DATABASE 9

MySQL: Introduction - Setting up account - Starting, terminating and writing your own SQL programs - Record selection Technology - Working with strings - Date and Time - Sorting Query Results - Generating Summary - Working with metadata - Using sequences - MySQL and Web.

UNIT III OPEN SOURCE PROGRAMMING LANGUAGES 9

PHP: Introduction - Programming in web environment - variables - constants - data types - operators - Statements - Functions - Arrays - OOP - String Manipulation and regular expression - File handling and data storage - PHP and SQL database - PHP and LDAP - PHP Connectivity - Sending and receiving E-mails - Debugging and error handling - Security - Templates.

UNIT IV SOFTWARE DEVELOPMENT USING OPEN SOURCE SYSTEMS 9

Introduction, Objectives, Overview of Open-Source System, Open-source tools, Open source components, Open source methodology, Open Source Software Development Models, The FOSS Philosophy, Social and Cultural Impacts

UNIT V OPEN SOURCE WEB SERVER, TOOLS AND TECHNOLOGIES 9

General Overview of Web Server - Case Study: Apache Web server - Working with Web Server - Configuring and using Apache Web services - Case Study: Apache Tomcat - Open-Source IDE - Wire shark- Modeling Tools - Mozilla Firefox - Wikipedia - Eclipse.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: The student will have a clear understanding about the terms, tools used for Open-source software
CO2: Able to use programming Languages in the open-source category for application development.
CO3: Able to gain improved employability and entrepreneurship capacity
CO4: Able to develop solutions to problems using open-source tools available
CO5: Able to get an insight into the recent trends in embedded system design

REFERENCES:

1. Remy Card, Eric Dumas and Frank Mevel, “The Linux Kernel Book”, Wiley Publications, 2003
2. Steve Suchring, “MySQL Bible”, John Wiley, 2002
3. Rasmus Lerdorf and Levin Tatroe, “Programming PHP”, O’Reilly, 2002
4. Wesley J. Chun, “Core Phython Programming”, Prentice Hall, 2001
5. Martin C. Brown, “Perl: The Complete Reference”, 2nd Edition, Tata McGraw-Hill Publishing Company Limited, Indian Reprint 2009.
6. Steven Holzner, “PHP: The Complete Reference”, 2nd Edition, Tata McGraw-Hill Publishing Company Limited, Indian Reprint 2009.
7. Vikram Vaswani, “MYSQL: The Complete Reference”, 2nd Edition, Tata McGraw-Hill Publishing Company Limited, Indian Reprint 2009.
8. Vivek Chopra, Sing Li, Jeff genender, “Professional Apache Tomcat 6”, Wiley India, 2007

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	3	3	-
CO2	3	1	3	-	3	1
CO3	2	1	2	-	3	3
CO4	3	2	3	3	3	3
CO5	-	-	-		3	-
Average	**2.66**	**1.33**	**2.5**	**1.5**	**3**	**2.33**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3060	IoT FOR SMART SYSTEMS	LT P C 3 0 0 3

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Data streaming and cloud services tools- Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE 9

IoT reference model and architecture - Node Structure - Sensing, Processing, Communication, Powering, Networking - Topologies, Layer/Stack architecture**,** IoT standards, Cloud computing for IoT, Bluetooth, Bluetooth Low Energy beacons.

UNIT III PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT PROTOCOLS 9

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), LoWPAN, Proprietary systems - Recent trends.

UNIT IV IOT PROCESSORS 9

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability.

Embedded processors for IOT: Introduction to Python programming - Building IOT with RASPERRY PI and Arduino.

UNIT V CASE STUDIES 9

Data streaming and cloud services tools Industrial IoT, IoT for Utilities - Home Automation, IOE-Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IoT for Defense - Smart Energy Management system - Smart Sustainable Cities and Smart Buildings.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT
CO3: Explain different protocols and communication technologies used in IoT
CO4: Analyze the big data analytic and programming of IoT
CO5: Implement IoT solutions for smart applications

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti: A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.

8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication, 2013.
9. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
10. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
11. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
12. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, “Smart Grid Technology and Applications”, Wiley, 2015.
13. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	-	-	-
CO2	-	2	-	-	-	-
CO3	1	2	-	1	3	-
CO4	2		3	3	3	3
CO5	3	2	3	3	3	3
Average	**1.75**	**2**	**2.33**	**2.33**	**3**	**3**

ET3055	EMBEDDED NETWORKING AND AUTOMATION OF ELECTRICAL SYSTEM	LT P C 3 0 0 3

UNIT I BUILDING SYSTEM AUTOMATION 9

Sensor Types & Characteristics: Sensing Voltage, Current, flux, Torque, Position, Proximity, Accelerometer - Data acquisition system - Signal conditioning circuit design - Uc Based & PC based data acquisition - uC for automation and protection of electrical appliances -processor based digital controllers for switching Actuators: Stepper motors, Relays -System automation with multi-channel Instrumentation and interface .

UNIT II EMBEDDED NETWORKING OF INSTRUMENT CLUSTER 9

Embedded Networking: Introduction - Cluster of Instruments in System - Comparison of bus protocols - RS 232C - embedded ethernet - MOD bus and CAN bus, LIN BUS - Introduction to WSN - Commercially available sensor nodes - Zigbee protocol - Network Topology Energy efficient MAC protocols - SMAC - Data Centric routing Applications of sensor networks - Database perspective on sensor networks - IoT Applications.

UNIT III AUTOMATION OF SUBSTATION 9

Substation automation - Distribution SCADA system principles - role of PMU, RTU, IEDs, BUS for smart Substation automation- Introduction to Role of IEC 61850, IEEEC37.118 std- Interoperability and IEC 61850 - challenges of Substations in Smart Grid - challenges of Energy Storage and Distribution Systems monitoring - Communication Challenges in monitoring electric utility asset.

.

UNIT IV METERING OF SMART GRID 9

Characteristics of Smart Grid - Generation by Renewable Energy Sources based on solar grid - Challenges in Smart Grid and Microgrids - electrical measurements with AMI - Smart meters for EV plug in electric vehicles power management - Home Area Net metering and Demand side Energy Management applications.

UNIT V SMART METERS FOR PQ MONITORING 9

Power Quality issues of Grid connected Renewable Energy Sources -Smart meters for Power Quality monitoring and Control - Power Quality issues -Surges - Flicker - Interharmonics - Transients - Power Quality Benchmarking - Power Quality Meters- Meter data management In Smart Grid-, communication enabled Power Quality metering

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Demonstrate criteria of choice of sensors, components to build meters.
CO2: Illustrate the demand for BUS communication protocols are introduced
CO3: Analyse the need and standards in Substation automation
CO4: Deployment of PAN for metering networked commercial applications
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded networked communications.

REFERRENCES:

1. Control and automation of electrical power distribution systems, James Northcote-Green, Robert Wilson, CRC, Taylor and Francis, 2006
2. Krzysztof Iniewski," Smart Grid, Infrastructure& Networking", TMcGH,2012
3. Robert Faludi," Building Wireless Sensor Networks,O'Reilly,2011
4. Mohammad Ilyas And Imad Mahgoub, 'Handbook of sensor Networks: Compact wireless and wired sensing systems', CRC Press,2005
5. Shih-Lin Wu,Yu-Chee Tseng,{"Wireless Ad Hoc Networking, PAN, LAN, SAN, Aurebach Pub,2012
6. Sanjay Gupta, "Virtual Instrumentation, LABVIEW", TMH, New Delhi, 2003

7. Ernest O. Doeblin and Dhanesh N Manik, “Measurement Systems - Application and Design”, 5th Edn, TMH, 2007.
8. Bhaskar Krishnamachari, ‘Networking wireless sensors’, Cambridge press 2005

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	2	1
CO2	1	-	2	2	3	1
CO3	3	1	2	-	-	-
CO4	2	-	2	3	3	2
CO5	2	1	2	-	-	3
Average	**2.2**	**1**	**2**	**2**	**2.66**	**1.75**

ET3066	SMART SYSTEM DESIGN	L T P C 3 0 0 3

UNIT I SYSTEM DESIGN OVERVIEW 9

Overview of a smart system - Design Requirements - Hardware and software selection & co-design - Smart sensors and Actuators - Communication protocols used in smart systems - Data Analytics: Need & Types - Open-source Analytics Platform for embedded systems (IFTTT &Thingspeak) - Smart Microcontrollers - Embedded system for Smart card design and development - Recent trends.

UNIT II HOME AUTOMATION 9

Home Automation - Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security - System Architecture - Essential Components - Linux and Raspberry Pi - Design and Real-Time implementation.

UNIT III SMART APPLIANCES AND ENERGY MANAGEMENT 9

Energy Management: Demand-side Load Management: Energy scheduling - Significance of smart appliances in energy management - Embedded and Integrated Platforms for Energy Management - Smart Meters: Significance, Architecture & Energy Measurement Technique - Smart Networks for Embedded Appliances - Security Considerations.

UNIT IV SMART WEARABLE DEVICES 9

Application of Smart Wearables in Healthcare & Activity Monitoring - Functional requirements- Selection of body sensors, Hardware platform, OS and Software platform - Selection of suitable communication protocol. Case Study: Design of a wearable, collecting heart-beat, temperature and monitoring health status using a smartphone application.

UNIT V EMBEDDED SYSTEMS AND ROBOTICS 9

Robots and Controllers components - Aerial Robotics - Mobile Robot Design - Three-Servo Ant Robot - Autonomous Hex copter System.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Understand the concepts of smart system design and its present developments.

CO2: Illustrate different embedded open-source and cost-effective techniques for developing solution for real time applications.

CO3: Acquire knowledge on different platforms and Infrastructure for Smart system design.

CO4: Infer about smart appliances and energy management concepts.

CO5: Apply and improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.

REFERENCES:

1. Thomas Bräunl, Embedded Robotics, Springer, 2003.
2. Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013.
3. Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw- Hill, 2008
4. NilanjanDey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRC press, 2016.
5. Karim Yaghmour, Embedded Android, O'Reilly, 2013.
6. Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress, 2013
7. C.K.Toh, AdHoc mobile wireless networks, Prentice Hall, Inc, 2002.
8. KazemSohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Networks Technology,Protocols, and Applications, John Wiley & Sons, 2007.
9. Anna Ha´c, Wireless Sensor Network Designs, John Wiley & Sons Ltd, 2003.
10. Robert Faludi, Wireless Sensor Networks, O'Reilly, 2011.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	3	2	-	-	-
CO2	2	-	-	-	2	3
CO3	-	-	-	2	3	-
CO4	-	-	-	-	-	-
CO5	-	-	-	-	-	-
Average	**2**	**3**	**2**	**2**	**2.5**	**3**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3064	RECONFIGURABLE PROCESSOR AND SoC DESIGN	LT P C 3 0 0 3

UNIT I RECONFIGURABLE PROCESSORS 9

Introduction to reconfigurable processor - Reconfigurable Computing - Programming elements and Programming Tools for Reconfigurable Processors, ASIC design flow - Hardware/Software Co-design - FPAA Architecture overview - recent trends in Reconfigurable Processor & SoC.

UNIT II FPGA TECHNOLOGIES 9

FPGA Programming technology - Alternative FPGA architectures: MUX Vs LUT based logic blocks - CLB Vs LAB Vs Slices - Fast carry chains - Embedded RAMs - Routing for FPGAs - Circuits and Architectures for Low-Power FPGAs - Physical Design.

UNIT III FPGA ARCHITECTURE 9

Challenges in FPGA processor design-Opportunities of FPGA processor design- Designing Soft-core Processors - Designing Hardcore Processors -hardware/software co design and co-simulation- FPGA to multi core embedded computing - FPGA based on-board computer system.

UNIT IV RECONFIGURABLE SOC PROCESSORS 9

SoC Overview -Architecture and applications of Virtex II pro, Zynq-7000, Excalibur, Cyclone V - A7, E5- FPSLIC- Multicore SoCs.

UNIT V RECONFIGURABLE PROCESSOR AND SOC APPLICATIONS 9

Reconfigurable processor-based DC motor control - digital filter design - mobile phone development - High Speed Data Acquisition - Image Processing application - controller implementation for mobile robot- Crypto-processor.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Illustrate the need of reconfigurable computing and hardware-software co design
CO2: Demonstrate the significance of FPGA technology
CO3: Apply the concept of FPGA technology and understand FPGA architectures.
CO4: Interpret the operation of SoC processor.
CO5: Relate and improve Employability and entrepreneurship capacity due to knowledge up-gradation on reconfigurable computing and SoC design.

REFERENCES:

1. Nurmi, Jari (Ed.) "Processor Design System-On-Chip Computing for ASICs and FPGAs" Springer, 2007.
2. Ian Grout, “Digital system design with FPGAs and CPLDs” Elsevier, 2008
   Joao Cardoso, Michael Hübner, "Reconfigurable Computing: From FPGAs to Hardware/Software Codesign" Springer, 2011.
3. Ron Sass and AnderewG.Schmidt, “Embedded System design with platform FPGAs: Principles and Practices”, Elsevier, 2010.
4. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007
5. Pierre-Emmanuel Gaillardon, Reconfigurable Logic: Architecture, Tools, and Applications, 1st Edition, CRC Press, 2015.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	-	-	-
CO2	-	2	3	-	-	-
CO3	-	-	2	1	2	-
CO4	-	1	3	-	-	-
CO5	-	-	-	-	-	3
Average	**-**	**1.5**	**2.66**	**1**	**2**	**3**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3008	EMBEDDED LINUX	LT P C 3 0 0 3

UNIT I LINUX FUNDAMENTALS 9

Introduction to Linux: A brief History - Features and Advantages of Linux - System and Software Features - Linux's Copyright - The Design Philosophy of Linux - Differences between Linux and Other Operating Systems - Hardware Requirements - Source of Linux Information - Obtaining and Installing Linux: Distributions of Linux - Installing Linux. Working with Linux: Logging in and Logging Out - Linux File System - Directory and File Commands - Other Useful Linux Commands - File Access Permissions - Pipes and Filters - Text Editors - Working with GNOME.

UNIT II CROSS-DEVELOPMENT TOOLCHAIN 9

History of Embedded Linux - Embedded Linux Vs Desktop Linux - Types of Hosts - Types of Host/Target Development Setups - Types of Host/Target Debug Setups - Types of Boot Configurations - System Memory Layout. User space - Architecture of Embedded Linux - Linux Kernel Architecture - Linux Start-Up Sequence. GNU Cross Platform Toolchain.

UNIT III RUNNING LINUX ON EMBEDDED BOARDS 9

Embedded Boards and their Features - Exploring Embedded Linux System: Different Raspberry Pi Boards and their comparison - Embedded Linux Introduction - Managing Linux Systems - Using Git for Version Control - Using Desktop Virtualization. Programming on the Raspberry Pi: Scripting Languages - Dynamically Compiled Languages - C and C++ on the RPi - Overview of Object-Oriented Programming - Interfacing to the Linux OS - Improving the Performance of Python.

UNIT IV CROSS-COMPILATION AND INTERFACING TO THE RASPBERRY PI BUSES 9

Cross-Compilation and the Eclipse IDE: Setting Up a Cross-Compilation Toolchain - Cross-Compilation Using Eclipse - Building Linux. Interfacing to the Raspberry Pi Busses: Introduction to Bus Communication - I2C - SPI - UART - Logic-Level Translation

UNIT V INTRODUCTION TO LINUX DEVICE DRIVERS 9

Device Driver Basics: User Space and Kernel Space - Driver Skeletons - Errors and Message Printing - Module Parameters - Building First Module. Character Device Drivers: Concept behind Major and Minor - Introduction to Device File Operations - Allocating and Registering a Character Device - Writing File Operations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, students will have the following knowledge and skills

CO1: Thorough understanding of Linux and its commands
CO2: Differentiate Embedded Linux from its Desktop counterpart and its internals
CO3: Successfully run Linux on an Embedded Board, Use Eclipse IDE for Cross-compilation
CO4: Able to write a simple device driver in Linux
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded Linux skills.

TEXTBOOKS:

1. Karim Yaghmour, Jon Masters, Gilad Ben-Yossef, and Philippe Gerum, "Building Embedded Linux Systems", O'Reilly Media Inc., 2008.
2. P. Raghavan, Amol Lad and Sriram Neelakandan, "Embedded Linux System Design and Development", Auerbach Publications, Taylor & Francis Group, 2006.
3. Derek Molloy, "Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux", John Wiley & Sons, Inc., 2016.
4. John Madieu, "Linux Device Drivers Development: Develop customized drivers for embedded Linux", Packt Publishing, 2017.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	-	-	-
CO2	1	-	3	2	-	-
CO3	-	-	1	3	1	-
CO4	1	-	-	1	2	-
CO5	-	-	2	-	-	-
Average	**1**	**-**	**2**	**2**	**1.5**	**-**

ET3059	INTELLIGENT SYSTEM DESIGN	LT P C 3 0 0 3

UNIT I INTELLIGENT SYSTEMS AND PYTHON PROGRAMMING 9

Introduction to Machine Learning and Deep Learning - Performance Improvement with Machine Learning - Building Intelligent Systems - Introduction to Python -Python Programming

UNIT II PYTHON FOR ML 9

Python Application of Linear Regression and Polynomial Regression using SciPy - Interpolation, Overfitting and Underfitting concepts & examples using SciPy - Clustering and Classification using Python.

UNIT III EMERGING TRENDS IN HARDWARE ARCHITECTURES FOR DEEP LEARNING 9

Quantization and Precision Reduction Techniques - Hardware aware neural Architecture. Hardware-software co-design for deep learning systems Memory hierarchy and cache optimization for deep learning Parallelization and distributed training of deep learning models Energy-efficient deep learning hardware architectures Hardware acceleration for specific deep learning applications (e.g., natural language processing, computer vision)

UNIT IV PYTHON FOR DL 9

Python Applications for DL - Python for CNN and YOLO

UNIT V CASE STUDIES 9

Development of Intelligent System for Power system protection - Smart Energy - IOE- Motor control - BMS - Intelligent systems for Industry 4.0 and Industry 5.0

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability in

CO1: Able to gain proficiency in the Python programming language and learn how to apply it in the context of intelligent systems

CO2: Able to learn Python libraries such as NumPy, Pandas, and scikit-learn to preprocess data, build and train Machine Learning models, and evaluate their performance

CO3: Able to learn Deep Learning libraries such as TensorFlow or PyTorch to build, train, and evaluate Deep Learning models for tasks such as image classification, natural language processing, and computer vision.

CO4: Able to learn hardware components, such as processors, memory, and accelerators, and how they are integrated.

CO5: Able to learn intelligent systems implementations, examine their design choices, evaluate their performance, and understand the challenges.

REFERENCES:

1."Intelligent Systems: Principles, Paradigms, and Pragmatics" by Rajendra P. Srivastava (Published in 2013)

2."Intelligent Systems: A Modern Approach" by Thomas Bäck, David B. Fogel, and Zbigniew Michalewicz (Published in 2000)

3."Intelligent Systems: Modeling, Optimization, and Control" by Grzegorz Bocewicz and Konrad Jackowski (Published in 2016)

4."Intelligent Systems: Architecture, Design, and Control" by Janos Sztipanovits and Gabor Karsai (Published in 2018)

5."Intelligent Systems: Concepts and Applications" by Veera M. Boddu (Published in 2017)

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	-	-	-	-	-
CO3	3	-	-	-	-	3
CO4	3	3	3	3	3	3
CO5	2	3	3	3	3	3
Average	**2.8**	**3**	**3**	**3**	**3**	**3**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3053 DIGITAL IMAGE PROCESSING AND COMPUTER VISION LT P C
3 0 0 3

UNIT I IMAGE PROCESSING AND VISION BASICS 9

Digital Image Processing - Various Fields that use Image Processing - Fundamentals Steps in Digital Image Processing - Components of an Image Processing System. Applications of Computer Vision - Recent Research in Computer Vision. Introduction to Computer Vision and Basic Concepts of Image Formation: Introduction and Goals - Image Formation and Radiometry - Geometric Transformation - Geometric Camera Models - Image Reconstruction from a Series of Projections.

UNIT II IMAGE PROCESSING CONCEPTS AND IMAGE FEATURES 9

Image Processing Concepts: Fundamentals - Image Transforms –camera pipeline- Image Filtering - Colour Image Processing - Mathematical Morphology - Image Segmentation. Image Descriptors and Features: Texture Descriptors - Color Features - Edge Detection - Object Boundary and Shape Representation - Interest or Cornet Point Detectors - Histogram Oriented Gradients - Scale Invariant Feature Transform - Image Enhancement.

UNIT III IMAGE PROCESSING WITH OPENCV 9

Introduction to OpenCV and Python: Setting up OpenCV - Image Basics in OpenCV - Handling Files and Images - Constructing Basic Shapes in OpenCV. Image Processing in OpenCV: Image Processing Techniques - Constructing and Building Histograms - Thresholding Techniques.

UNIT IV OBJECT DETECTION 9

Models and types - Importance of Object Detection. The Working: Inputs and outputs - Basic Structure - Model Architecture Overview - Object Detection on the Edge. Use Cases and Applications: Video Surveillance - Self-driving Cars. Embedded Boards: Connecting Cameras to Embedded Boards - Simple algorithms for processing Images and Videos.

UNIT V APPLICATIONS AND CASE STUDIES 9

Applications: VLSI implementation of Image processing algorithms - interfacing. Hardware for Vision implementation- Machine Learning algorithms and their Applications in Medical Image Segmentation - Motion Estimation and Object Tracking - Face and Facial Expression Recognition - Image Fusion. Case Studies: Face Detection - Object Tracing - Eye Tracking - Handwriting Recognition with HoG.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Understand the major concepts and techniques in computer vision and image processing
CO2: Infer known principles of human visual system
CO3: Demonstrate a thorough knowledge of Open CV
CO4: Develop real-life Computer Visions Applications.
CO5: Build design of a Computer Vision System for a specific problem.

REFERENCES:

1. "Digital Image Processing", 4th Edition (Global Edition), Rafael C Gonzalez and Richard E Woods, Pearson Education Limited, 2018.
2. "Computer Vision and Image Processing - Fundamentals and Applications", Manas Kamal Bhuyan, CRC Press, 2020.
3. "Mastering OpenCV 4 with Python", Alberto Fernández Villán, Packt Publishing, 2019.
4. "Practical Python and Open CV: Case Studies", 3rd Edition, Adrian Rosebrock, PyImageSearch, 2016.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	2	-	-	-
CO2	2	2	2	2	-	-
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Average	**2.6**	**2.8**	**2.6**	**2.75**	**3**	**2.67**

ET3058 INTELLIGENT CONTROL AND AUTOMATION LT P C
3 0 0 3

UNIT I ARTIFICIAL NEURAL NETWORK AND FUZZY LOGIC 9

ARTIFICIAL NEURAL NETWORK: Learning with ANNs, single-layer networks, multi-layer perceptron's, Back propagation algorithm (BPA) ANNs for identification, ANNs for control, Adaptive neuro controller. Fuzzy Logic Control: Introdu ction, fuzzy sets, fuzzy logic, fuzzy logic controller design, Fuzzy Modelling & identification, Adaptive Fuzzy Control Design.

UNIT II GENETIC ALGORITHM 9

Basic concept of Genetic algorithm and detail algorithmic steps - Hybrid genetic algorithm - Solution for typical control problems using genetic algorithm. Concept on some other search techniques like Tabu search, Ant-colony search and Particle Swarm Optimization

UNIT III HYBRID CONTROL SCHEMES 9

Fuzzification and rule base using ANN-Neuro fuzzy systems-ANFIS-Optimization of membership function and rule base using Genetic Algorithm and Particle Swarm Optimization.

UNIT IV AUTOMATION 9

Introduction to Automation - Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations- Industrial Automation -computer vision for automation- PLC and SCADA based Automation- IoT for automation- Industry 4.0.

UNIT V INTELLIGENT CONTROLLER FOR AUTOMATION APPLICATION 9

Applications of Intelligent controllers in Industrial Monitoring, optimization and control- Smart Appliances- Automation concept for Electrical vehicle- Intelligent controller and Automation for Power System.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability in
CO1: Demonstrate the basic architectures of NN and Fuzzy logics
CO2: Design and implement GA algorithms and know their limitations.
CO3: Explain and evaluate hybrid control schemes and PSO
CO4: Interpret the significance of Automation concepts.
CO5: Develop the intelligent controller for automation applications.

REFERENCES:

1. Laurene V.Fausett, "Fundamentals of Neural Networks, Architecture, Algorithms, and Applications", Pearson Education, 2008.
2. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", Wiley, Third Edition, 2010.
3. David E.Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2009.
4. W.T.Miller, R.S.Sutton and P.J.Webrose, "Neural Networks for Control", MIT Press, 1996.
5. Srinivas Medida, Pocket Guide on Industrial Automation for Engineers and Technicians, IDC Technologies.
6. ChanchalDey and Sunit Kumar Sen, Industrial Automation Technologies, 1st Edition,CRC Press, 2022.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	-	1
CO2	2	2	3	3	3	2
CO3	3	2	2	2	-	-
CO4	3	2	2	2	-	-
CO5	3	-	3	3	-	2
Average	**2.4**	**1.75**	**2.2**	**2.2**	**3**	**1.67**

ET3065	ROBOTICS AND AUTOMATION	LT P C 3 0 0 3

UNIT I INTRODUCTION TO ROBOTICS & AUTOMATION **9**

Overview of Robotics & Automation - Principles and Strategies of Automation System -Hardware and software for Automation - Embedded Processors for Automation-Different Types of Robots - Various Generations of Robots - Asimov's Laws Of Robotics - Key components of a robot - Design Criteria for Selection of a Robot - Role of embedded system in Robotics and Automation - Recent trends.

UNIT II SENSORS AND DRIVE SYSTEMS **9**

Hydraulic, Pneumatic And Electric Drive Systems - Understanding how motor power, current torque, friction co-efficient affect the design of a Robot - Determination of Motor HP and Gearing Ratio - Variable Speed Arrangements. Sensors - Classification based on sensing type (including Optical, Acoustic, Magnetic) - Proximity Sensors - Ranging Sensors - Speed & Displacement Sensing - Tactile Sensors - Vision Sensing - Smart Sensors - MEMS sensors.

UNIT III MANIPULATORS AND GRIPPERS **9**

Introduction to Manipulators - Joints and Degrees of Freedom - Construction of Manipulators - Manipulator Dynamics and Force Control - Electronic And Pneumatic Manipulator Control Circuits - End Effectors - Various Types Of Grippers - Design Considerations.

UNIT IV KINEMATICS AND PATH PLANNING **9**

Kinematic Equations - Forward and Inverse Kinematics - Solution Of Inverse Kinematics Problem - Jacobian based Velocity Kinematics- Various Path Planning Algorithms - Hill Climbing Techniques - Robot Operating System - Simulation and modeling of a simple Path Planning application.

UNIT V CASE STUDIES **9**

Robot Cell Design - Humanoid Robot - Robots in healthcare applications - Robot Machine Interface - Robots in Manufacturing and Non-Manufacturing Applications - Self balancing robots - Micro/nano robots.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Choose suitable embedded boards for robots
CO2: Demonstrate the concepts of robotics & automation and Working of Robot
CO3: Analyze the Function of Sensors and actuators In the Robot
CO4: Develop Program to Use a Robot for a Typical Application
CO5: Apply and improve Employability and entrepreneurship capacity due to knowledge upgradation on Embedded system-based robot development

REFERENCES:

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., "Industrial Robotics", Mc Graw-Hill Singapore, 1996.
2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
3. Deb. S.R., "Robotics Technology And Flexible Automation", John Wiley, USA 1992.
4. Klafter R.D.,Chimielewski T.A., Negin M., "Robotic Engineering - An Integrated Approach", Prentice Hall of India, New Delhi, 1994.
5. Mc Kerrow P.J. "Introduction to Robotics", Addison Wesley, USA, 1991.
6. Issac Asimov "Robot", Ballantine Books, New York, 1986.
7. Barry Leatham - Jones, "Elements of Industrial Robotics" PITMAN Publishing, 1987.
8. MikellP.Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, "Industrial Robotics Technology, Programming And Applications ", McGraw Hill Book Company 1986.

9. Fu K.S. Gonzaleaz R.C. And Lee C.S.G., “Robotics Control Sensing, Vision and Intelligence” McGraw Hill International Editions, 1987

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	-	3	-	-
CO2	-	3	-	-	-	-
CO3	-	-	-	-	-	-
CO4	-	-	-	2	3	1
CO5	-	-	2	1	-	3
Average	**1**	**2.5**	**2**	**2**	**3**	**2**

ET3062 **MEMS AND NEMS TECHNOLOGY** **LT P C**
3 0 0 3

UNIT I INTRODUCTION TO MEMS and NEMS 9

Overview of micro and Nano technologies - Miniaturization significance and advantages -Micro electro mechanical systems and Nano Electro mechanical systems, devices and technologies, Laws of scaling - Survey of materials - Smart Sensors - Applications of MEMS and NEMS.

UNIT II MICRO-MACHINING AND MICROFABRICATION TECHNIQUES 9

Photolithography - material Synthesis techniques - Film deposition - Etching Processes- wafer bonding - Bulk micro machining, silicon surface micro machining - LIGA process.

UNIT III MICRO SENSORS AND MICRO ACTUATORS 9

Transduction mechanisms in different energy domain-Micromachined capacitive, Piezoelectric, piezoresistive and Electromechanical and thermal sensors/actuators and applications

UNIT IV NANOELECTRONICS DEVICES AND NEMS TECHNOLOGY 9

Nano electronics devices and applications – SET– RTD – Memristor – QCA - molecular Electronics - Nano Fabrication techniques - atomic scale precision Engineering- NEMS in measurement, sensing, actuation and systems design.

UNIT V MEMS AND NEMS APPLICATION 9

Micro/Nano Fluids and applications- Bio MEMS- Optical NEMS- Micro and Nano motors-Quantum computing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Explain the material properties and the significance of MEMS and NEMS for industrial automation.
CO2: Demonstrate knowledge delivery on micromachining and micro fabrication.
CO3: Apply the fabrication mechanism for MEMS sensor and actuators.
CO4: Apply the concepts of Nano electronics and NEMS to models, simulate and process the sensors and actuators.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS and NEMS technology.

REFERENCES:

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2006.
2. Marc F madou “Fundamentals of micro fabrication” CRC Press 2002 2nd Edition Marc Madou.
3. M.H.Bao “Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes”,Elsevier, Newyork, 2000.
4. Maluf, Nadim “An introduction to Micro Electro-mechanical Systems Engineering” AR Tech house, Boston 2000.
5. Mohamed Gad - el - Hak “MEMS Handbook” Edited CRC Press 2002 2. Sabriesolomon “Sensors Handbook”, Mc Graw Hill 1998.
6. Tai-Ran Hsu, “MEMS and Microsystems: design, manufacture, and Nanoscale”- 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008
7. Lyshevski, S.E. “Nano- and Micro-Electromechanical Systems: Fundamentals of Nano-and Microengineering “(2nd ed.). CRC Press,2005.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	-	2	-
CO2	3	3	2	-	2	2
CO3	3	3	3	-	2	2
CO4	3	3	3	-	3	2
CO5	3	2	3	2	3	3
Average	**3**	**2.6**	**2.8**	**2**	**2.4**	**2.25**

ET3054	EMBEDDED CONTROLLERS FOR EV APPLICATIONS	LT P C 3 0 0 3

UNIT I EMBEDDED SYSTEM AND ELECTRIC VEHICLES ARCHITECTURE 9

Overview of Electric vehicles - Evolution of Electric Vehicles - Definition and types of EV (BEV, HEV, PHEV) - EV Architecture - EV Components and Subsystems - Advantages and challenges of EV - Comparison of EV with Internal Combustion Engine - Emerging trends in EV Technologies- Embedded System Architecture- Open ECU-AUTOSAR.

UNIT II POWERTRAIN CONTROL AND ENERGY MANAGEMENT SYSTEM IN EV 9

Powertrain Components - Powertrain control and Optimization - Embedded Controllers for motor control- ECU for Energy Management system - Battery Management System (BMS) - Battery State of Charge (SoC) Estimation - Energy Consumption Monitoring - Charging Optimization- ECU for Charging.

UNIT III COMMUNICATION AND CONNECTIVITY IN EV 9

Vehicle-to-Vehicle Technology(V2V) - Vehicle-to-Infrastructure(V2I) Technology Communication - Communication Protocol (CAN, LIN, Ethernet, etc.) - Wireless Charging and Communication for EV - Over the air (OTA) Updates and Remote diagnostics in EV.

UNIT IV FAULT MONITORING AND DIAGNOSTICS IN EV 9

Overview of Fault Monitoring and Diagnostics in EV - Fault detection techniques - Fault Monitoring in Electric Powertrain - Fault Monitoring in Charging Infrastructure - On-board Diagnostics (OBD) with self-check mechanisms - Diagnostics and Reporting - Case studies on fault detection, Diagnosis and Resolution

UNIT V SAFETY, SECURITY AND AUTONOMOUS SYSTEMS IN EV 9

Safety Standards and Regulations for EVs - Functional Safety and ISO26262 in EV -Cybersecurity in EVs - Threats and Countermeasures - Antilock Braking system(ABS) -Electronic Stability Control (ESC) - Advanced driver Assistance systems (ADAS) -Autonomous Driving in EVs.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to understand the principles and components of electric vehicles, including powertrain systems, energy storage systems, motor controllers, and vehicle dynamics.

CO2: Able to learn about the unique requirements and challenges associated with embedded controllers in EV applications.

CO3: able to learn about hardware platforms, such as microcontrollers and microprocessors, as well as communication protocols and interfaces used for control and monitoring of EV.

CO4: Able to gain hands-on experience in developing embedded control algorithms for various EV systems, including motor control, battery management, regenerative braking, and charging systems.

CO5: able to understand the integration of embedded controllers in autonomous electric vehicles

REFERENCES:

1."Embedded Control Systems for Electric Machines" by Jiming Wang, Shan Chai, and Shuxin Zhou (Published in 2011)

2."Electric and Hybrid Vehicles: Design Fundamentals" by Iqbal Husain (Published in 2013)

3."Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure, and the Market" by Gérard-André Capolino (Published in 2010)

4."Embedded Systems for Electric Vehicles" by Jürgen Valldorf and Wolfgang Gessner (Published in 2011)

5."Power Electronics and Electric Drives for Traction Applications" by Gonzalo Abad, J. Miguel Guerrero, and Juan de la Casa (Published in 2016)

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	-	-	-	-	-
CO3	3	-	-	-	-	3
CO4	3	3	3	3	3	3
CO5	2	3	3	3	3	3
Average	**2.8**	**3**	**3**	**3**	**3**	**3**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3057	INFORMATION MODELLING FOR SMART PROCESS	LT P C 3 0 0 3

UNIT I INTRODUCTION TO IMMERSIVE TECHNOLOGIES 9

Introduction on Virtual reality - Augmented reality - Mixed reality - Extended reality - VR Devices - AR Devices - Applications

UNIT II SOFTWARE TOOLS 9

Intro to Unity - Unity editor workspace - Intro to C# and visual studio - Programming in Unity - Intro to Unreal Engine - UE4 Editor workspace - Intro to Blueprint programming - Programming in

UNIT III BUILDING AR AND VR APPLICATIONS 9

AR SDKs for unity and unreal engine - Working with SDKs for unity - Developing AR application in unity - Building AR application Developing VR application in - Building VR application-

UNIT IV UAE 9

DRONE concept - DESIGN, FABRICATION AND PROGRAMMING - Drone Flying and Operation- Applications of Drone for Electrical Infrastructure Development and Monitoring.

UNIT V CASE STUDIES 9

AR, VR ,ER and MR based Applications development for Industrial Automation .

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students will have the ability to

CO1: Able to understand the core concepts and principles behind immersive technologies, such as virtual reality (VR), augmented reality (AR), and mixed reality (MR)

CO2: Able to learn software tools specifically designed for information modeling in the context of smart processes.

CO3: Able to learn the principles and techniques for creating immersive AR/VR experiences, including 3D modeling, interaction design.

CO4: Able to learn about the unique challenges, opportunities, and requirements associated with implementing smart processes in the UAE.

CO5: Able to develop the ability to analyze and evaluate real-world case studies that demonstrate the use of augmented reality (AR), virtual reality (VR), extended reality (ER), and mixed reality (MR) technologies in smart process environments.

REFERENCES:

1."Smart Process: Designing the Future Enterprise" by Peter Fingar and Harsha Kumar (Published in 2009)

2. "Information Modeling and Relational Databases: From Conceptual Analysis to Logical Design" by Terry Halpin, Tony Morgan, and Steve Morgan (Published in 2008)

3."Business Process Modeling, Simulation and Design" by Manuel Laguna and Johan Marklund (Published in 2013)

4."Enterprise Architecture at Work: Modelling, Communication, and Analysis" by Marc Lankhorst (Published in 2016)

5."Smart Business Processes: How to Manage the Process Revolution" by Gil Laware and Keith Harrison-Broninski (Published in 2014)

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	-	-	-	-	-
CO3	3	-	-	-	-	3
CO4	3	3	3	3	3	3
CO5	2	3	3	3	3	3
Average	**2.8**	**3**	**3**	**3**	**3**	**3**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3052	BLOCKCHAIN TECHNOLOGIES	L T P C 3 0 0 3

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN 9

Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain-Hardware architecture for Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY 9

Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency.

UNIT III INTRODUCTION TO ETHEREUM 9

Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.

UNIT IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING 10

Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity - Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types.

UNIT V BLOCKCHAIN APPLICATIONS 8

Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After the completion of this course, student will be able to

CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain

REFERENCES:

1. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Second Edition, Packt Publishing, 2018.
2. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, “Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction” Princeton University Press, 2016
3. Antonopoulos, Mastering Bitcoin, O’Reilly Publishing, 2014. .
4. Antonopoulos and G. Wood, “Mastering Ethereum: Building Smart Contracts and Dapps”, O’Reilly Publishing, 2018.
5. D. Drescher, Blockchain Basics. Apress, 2017.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	-	-	-
CO2	1	-	3	2	-	-
CO3	-	-	1	3	1	-
CO4	1	-	-	1	2	-
CO5	-	-	2	-	-	-
Average	**1**	**-**	**2**	**2**	**1.5**	**-**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3051 **BIG DATA ANALYTICS** **L T P C**
3 0 0 3

UNIT I INTRODUCTION TO BIG DATA 9

Introduction to Big Data Platform - Challenges of Conventional Systems - Intelligent data analysis - Nature of Data - Analytic Processes and Tools - Analysis Vs Reporting - Modern Data Analytic Tools- Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

UNIT II SEARCH METHODS AND VISUALIZATION 9

Search by simulated Annealing - Stochastic, Adaptive search by Evaluation - Evaluation Strategies - Genetic Algorithm - Genetic Programming - Visualization - Classification of Visual Data Analysis Techniques - Data Types - Visualization Techniques - Interaction techniques - Specific Visual data analysis Techniques

UNIT III MINING DATA STREAMS 9

Introduction To Streams Concepts - Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream - Filtering Streams - Counting Distinct Elements in a Stream - Estimating Moments - Counting Oneness in a Window - Decaying Window - Real time Analytics Platform (RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions

UNIT IV FRAMEWORKS 9

MapReduce - Hadoop, Hive, MapR - Sharding - NoSQL Databases - S3 - Hadoop Distributed File Systems - Case Study - Preventing Private Information Inference Attacks on Social Networks - Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE 9

Overview, Programming structures: Control statements - Operators -Functions - Environment and scope issues - Recursion - Replacement functions, R data structures: Vectors - Matrices and arrays - Lists - Data frames - Classes, Input/output, String manipulations

TOTAL:45 PERIODS

COURSE OUTCOMES:

CO1: Understand the basics of big data analytics
CO2: Ability to use Hadoop, Map Reduce Framework.
CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.
CO4: Gain knowledge on R language
CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

REFERENCES:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 3rd edition 2020.
3. Norman Matloff, The Art of R Programming: A Tour of Statistical Software Design, No Starch Press, USA, 2011.
4. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
5. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007.

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	-	-	-
CO2	1	-	3	2	-	-
CO3	-	-	1	3	1	-
CO4	1	-	-	1	2	-
CO5	-	-	2	-	-	-
Avg.	**1**	**-**	**2**	**2**	**1.5**	**-**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ET3009	DSP BASED SYSTEM DESIGN	L T P C
		3 0 0 3

UNIT I REPRESENTATION OF DSP SYSTEM 9

Single Core and Multicore, Architectural requirement of DSPs - high throughput, low cost, low power, small code size, embedded applications. Representation of digital signal processing systems - block diagrams, signal flow graphs, data-flow graphs, dependence graphs. Techniques for enhancing computational throughput - parallelism and pipelining.

UNIT II DSP ALGORITHMS 9

DSP algorithms - Convolution, Correlation, FIR/IIR filters, FFT, adaptive filters, sampling rate converters, DCT, Decimator, Expander and Filter Banks. DSP applications. Computational characteristics of DSP algorithms and applications, Numerical representation of signals-word length effect and its impact, Carry free adders, Multiplier.

UNIT III SYSTEM ARCHITECTURE 9

Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Features for External Interfacing. VLIW architecture. Basic performance issue in pipelining, Simple implementation of MIPS, Instruction Level Parallelism, Dynamic Scheduling, Dynamic Hardware Prediction, Memory hierarchy.Study of FIxed point and floating point DSP architectures

UNIT IV ARCHITECTURE ANALYSIS ON PROGRAMMABLE HARDWARE 9

Analysis of basic DSP Architectures on programmable hardwares. Algorithms for FIR , IIR, Lattice filter structures, architectures for real and complex fast Fourier transforms, 1D/2D Convolutions, Winograd minimal filtering algorithm. FPGA: Architecture, different sub-systems, design flow for DSP system design, mapping of DSP algorithms onto FPGA.

UNIT V SYSTEM INTERFACING 9

Examples of digital signal processing algorithms suitable for parallel architectures such as GPUs and multiGPUs. Interfacing: Introduction, Synchronous Serial Interface CODE, A CODEC Interface Circuit, ADC interface.

TOTAL : 45 PERIODS

COURSEOUTCOMES:

At the end of this course, the students will have the ability in

CO 1: Evaluate the DSP system using various methods.
CO 2: Design algorithm suitable for different DSP applications.
CO 3: Explain various architectures of DSP system.
CO 4: Implement DSP system in programmable hardware.
CO 5: Build interfacing of DSP system with various peripherals.

REFERENCES

1. Sen M Kuo, Woon Seng S Gan, Digital Signal Processors
2. Digital Signal Processing and Application with C6713 and C6416 DSK, Rulph Chassaing, Worcester Polytechnic Institute, A Wiley Interscience Publication
3. Architectures for Digital Signal Processing, Peter Pirsch John Weily, 2007
4. DSP Processor and Fundamentals: Architecture and Features. Phil Lapsley, JBier, AmitSohan, Edward A Lee; Wiley lEEE Press
5. K. K. Parhi - VLSI Digital Signal Processing Systems - Wiley – 1999.
6. RulphChassaing, Digital signal processing and applications with C6713 and C6416 DSK, Wiley, 2005
7. Keshab K Parhi, VLSI Digital Signal Processing Systems:Design and Implementation, student Edition, Wiley, 1999.

8. Nasser Kehtarnavaz, Digital Signal Processing System Design: LabVIEW-Based Hybrid Programming, Academic Press, 2008

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	3	-	-	-	-
CO2	3	3	3	2	3	2
CO3	-	3	-	-	-	-
CO4	3	-	3	3	3	3
CO5	2	-	3	2	3	3
Average	2.67	3	3	2.33	3	2.67

PW3053	ENERGY EFFICIENT BUILDINGS	LT P C 3 0 0 3

UNIT I CLIMATE AND SHELTER 9

Historic buildings – Modern architecture – Examples from different climate zones –Thermal comfort – Solar geometry and shading – Energy modeling techniques– Integrative Modeling methods and building simulation.

UNIT II PRINCIPLES OF ENERGY CONSCIOUS BUILDING DESIGN 9

Energy conservation in buildings – Day lighting – Solar based Water heating - Advances in thermal insulation – Heat gain/loss through building components - Solar architecture.

UNIT III PASSIVE SOLAR HEATING 9

Basics of Passive solar – Mechanical Systems – South Facing Glass – Thermal mass – Orientation – site planning for solar access - Direct gain – thermal storage wall – Sunspace – Passive cooling – Ventilation - Radiation – Evaporation and Dehumidification – Design guidelines and natural cooling guidelines.

UNIT IV ENERGY CONSERVATION IN BUILDING 9

Air conditioning – HVAC equipment's – Computer packages for thermal design of buildings and performance prediction – Monitoring and instrumentation of passive buildings – Control systems for energy efficient buildings – Illustrative passive buildings – Integration of emerging technologies – Intelligent building design principles – ECBC applicability – Building Envelope – Comfort system and controls – Lighting – Electrical Power and Renewable Energy.

UNIT V EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS 9

Maximum Demand Controller, Automatic Power Factor Controller, Energy Efficient Motor – Energy Efficient Lighting System and Energy Efficient Transformers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the different climate zones and modelling methods.
CO2: Design energy conscious building.
CO3: Understand the concepts of Passive Solar Heating (PSH) and design guidelines for PSH.
CO4: Gain knowledge about the energy conservation techniques in buildings.
CO5: Know about different energy efficient technologies for electrical system.

REFERENCES:

1. Joseph Clarke, "Energy Simulation in Building Design", II Edition, Butterworth, 2001
2. J. K. Nayak and J. A. Prajapati, "Handbook on Energy Conscious Buildings", Solar Energy Centre, MNES, May 2006
3. "Energy Conservation Building Codes Guide Book", 2017
4. "Passive Solar Building - Design Strategies", Guidelines for Home Passive Solar Industries Council, National Renewable Energy Laboratory, USA, 2001
5. J. Douglas Batcomb, "Passive Solar Building", The MIT Press, 1992
6. Thomas H.Kuehn, James W. Ramsey and J. L. Threlkeld, "Thermal Environmental Engineering", 3rd Edition, Prentice Hall, 1970
7. Zhiqiang John Zhai, "Energy Efficient Buildings: Fundamentals of Building Science and Thermal Systems", 1st Edition, Wiley, 2022
8. David S-K. Ting, Rupp Carriveau, "Energy Generation and Efficiency Technologies for Green Residential Buildings (Energy Engineering)",IET, 2019

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	-	3
CO2	2	1	3	2	-	3
CO3	2	1	3	2	-	3
CO4	2	1	3	2	-	3
CO5	2	1	3	2	-	3
Average	**2**	**1**	**3**	**2**	**-**	**3**

PS3252	SMART GRID	L T P C
		3 0 0 3

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, Functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.

UNIT II SMART GRID TECHNOLOGIES (TRANSMISSION) 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control

UNIT III SMART GRID TECHNOLOGIES (DISTRIBUTION) 9

DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High- Efficiency Distribution Transformers, Phase Shifting Transformers, and Plug in Hybrid Electric Vehicles (PHEV).

UNIT IV SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.

UNIT V COMMUNICATION PROTOCOLS FOR POWER SYSTEM AUTOMATION 9

Introduction to Communication Protocol, Comparison of Communication media and different communication network topologies Description of Different Communication Protocol - Physical based Protocol(RS-232,RS-485) - Layered Based Protocol(IEC-61850 - Substation Automation) (C37.118 - Wide Area Monitoring and Protection),(DNP3 - Distribution Automation),MODBUS.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to:

CO1:Understand on the concepts of Smart Grid and its present developments.
CO2:Analyze about different Smart Grid transmission technologies.
CO3:Analyze about different Smart Grid distribution technologies.
CO4:Acquire knowledge about different smart meters and advanced metering infrastructure.
CO5:Develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

REFERENCES

1. Stuart Borlase “Smart Grid :Infrastructure, Technology and Solutions”,CRC Press 2016.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”,Wiley.
3. Vehbi C. Gungor, DilanSahin, TaskinKocak, SalihErgut, ConcettinaBuccella, Carlo Cecati ,and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
4. Xi Fang, SatyajayantMisra, GuoliangXue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey” , IEEE Transaction on Smart Grid

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	-	-	1	-	-
CO2	1	2	-	1	1	1
CO3	1	2	-	1	2	-
CO4	1	-	-	1	1	2
CO5	1	2	2	1	-	2
Average	**1**	**2**	**2**	**1**	**1.33**	**1.67**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

PW3052 ELECTRIC VEHICLES AND POWER MANAGEMENT LT P C
3 0 0 3

UNIT I HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS 9

History of Evolution of Electric Vehicles (EV) - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in Hybrid Electric Vehicles (PHEV)- Power Train Components and Sizing, Gears, Clutches, Transmission and Brakes

UNIT II MECHANICS OF HYBRID ELECTRIC VEHICLES 9

Fundamentals of Vehicle Mechanics - Tractive Force, Power and Energy Requirements for Standard Drive Cycles of HEV's - Motor Torque - Power Rating and Battery Capacity

UNIT III CONTROL OF DC AND AC MOTOR DRIVES 9

Speed control for Constant Torque, Constant HP operation of all Electric Motors - DC/DC chopper based Four Quadrant Operation of DC Motor Drives, Inverter-based V/f Operation (motoring and braking) of Induction Motor Drives, Vector Control Operation of Induction Motor and PMSM, Brushless DC Motor Drives, Switched Reluctance Motor (SRM) Drives

UNIT IV ENERGY STORAGE SYSTEMS 9

Battery: Principle of operation, Types, Estimation Of Parameters, Battery Modeling, SOC of Battery, Traction Batteries and their capacity for Standard Drive Cycles, Vehicle to Grid operation of EV's -Alternate sources: Fuel cells, Ultra capacitors, Fly wheels

UNIT V HYBRID VEHICLE CONTROL STRATEGY AND ENERGY MANAGEMENT 9

HEV Supervisory Control - Selection of modes - Power Spilt Mode - Parallel Mode - Engine Brake Mode - Regeneration Mode - Series Parallel Mode - Energy Management of HEV's

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Learn the electric vehicle architecture and power train components.
CO2: Acquire the concepts of dynamics of Electrical Vehicles.
CO3: Understand the vehicle control for Standard Drive Cycles of Hybrid Electrical Vehicles (HEVs).
CO4: Ability to model and understand the Energy Storage Systems for EV.
CO5: Acquire the knowledge of different modes and Energy Management in HEVs.

REFERENCES:

1. Iqbal Husain, “Electric and Hybrid Electric Vehicles”, First Edition, CRC Press, 2011
2. Wei Liu, “Hybrid Electric Vehicle System Modeling and Control”, Second Edition, Wiley, 2017
3. James Larminie and John Lowry, “Electric Vehicle Technology Explained”, Second Edition, 2012
4. Mehredad Ehsani, Yimi Gao, Stefano Longo and Kambiz Ebrahimi,” Modern Electric, Hybrid Electric and Fuel cell Vehicles”, Third edition, CRC Press, 2019
5. Jingsheng Yu and Vladimir V. Vantsevich, “Control Application of Vehicle Dynamics”, First Edition, CRC Press, 2021

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	-	3
CO2	3	1	2	1	-	3
CO3	3	1	2	1	-	3
CO4	3	1	2	1	-	3
CO5	3	1	2	1	-	3
Average	**3**	**1**	**2**	**1**	**-**	**3**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

CO3251	MODERN AUTOMATION SYSTEMS	LT P C 3 0 0 3

UNIT I INTRODUCTION TO AUTOMATION 9

Sensing and actuation, Communication – Globalization and emerging issues – Cyber Physical systems - Cyber security - Challenges and prospective of AI and 5G enabled technologies – Effect of integrated IT systems on enterprise competitiveness - requirement for automation – Automation system controllers, Industry 4.0 and 5.0 standards and implementation – Robotics 4.0

UNIT II PLC 9

PLC –– Hardware – Internal architecture – Ladder and functional block programming – IL, SFC and ST programming methods - Communication Networks for PLC – Case study.

UNIT III DCS AND SCADA 9

Distributed Control System – Functional components- Diagnostics & IOS – Controllers – Work station – Features of Distributed Control System – Functional Safety – SCADA – RTU – Communication technologies – Operator Interface – Case study

UNIT IV VIRTUAL INSTRUMENTATION 9

Virtual Instrumentation (VI) – Architecture – Programming Techniques – Front Panel and Block diagram – Data flow programming – G programming concepts – Creating and saving VIs – Wiring, Editing and Debugging of Vis – Creating Sub Vis – Control structures – Nodes – Arrays – Cluster controls and indicators – Error handling – String controls – File I/O VIs and functions – Augmented Reality – Case Study

UNIT V INDUSTRIAL INTERNET OF THINGS 9

INDUSTRIAL INTERNET OF THINGS: Introduction – Architecture – Sensing, communication – Big data analytics – Security and Fog computing, cloud computing- Internet for energy – Case Study

TOTAL: 45 PERIODS

COURSE OUTCOMES:

In the end of the course the students will be:

CO1: able to gain the knowledge on fundamentals of automation.
CO2: able to understand the concepts of PLC, DCS and SCADA
CO3: able to understand Virtual Instrumentation for engineering processes.
CO4: able to gain the knowledge on Industrial Internet of Things
CO5: able to apply the concepts and develop automation for different systems.

REFERENCES:

1. Lamb, Frank, “Industrial Automation: Hands-On”, 1st Edition, New York: McGraw-Hill Education, 2013.
2. Mehta B.R and Reddy Y.J, “Industrial Process Automation Systems: Design and Implementation”, Waltham MA: Butterworth-Heinemann, 2015.
3. Giacomo Veneri , Antonio Capasso, “ Hands on Industrial Internet of things” , Packt, 2018
4. Labview based Advanced Instrumentation systems, S. Sumathi & P. Surekha, Springer Publications, 2018 Edition
5. Dag H. Hanssen, Programmable Logic Controllers, A Practical Approach to IEC 61131-3 using CODESYS, John Wiley & Sons Ltd., 2015
6. David Bailey & Edwin Wright,”Practical SCADA for Industry’’, Elsevier 2010.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

MAPPING OF COs WITH POs

CO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	3	3	3	3	3	3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
Average	**3**	**2.8**	**2.8**	**3**	**2.8**	**2.8**

Note: 1-low, 2-medium, 3-high, '-"- no correlation