DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

ANNA UNIVERSITY, CHENNAI – 25

VISION OF THE DEPARTMENT

The vision of Anna University is to be a world class institution by producing professionals with high technical knowledge, professional skills and ethical values, and remain as a preferred partner to the industry and community for their economic and social development through excellence in teaching, research and consultancy. Anna University shall be recognized as a point of reference, a catalyst, a facilitator, a trend setter and a leader in technical education.

MISSION OF THE DEPARTMENT

To produce full fledged Electrical and Electronics Engineers to cater to the needs of the modern industries and be useful for building the nation.

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
CHOICE BASED CREDIT SYSTEM
M.E. EMBEDDED SYSTEM TECHNOLOGIES

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To prepare students, for having career in industries/entrepreneurship through startups/ teaching in Institutions/research in organizations that meet, the needs of national and international interest
II. To develop among students, the ability to develop embedded solutions using processor based computation and communication to build smart solutions for purpose of system automation.
III. To encourage students, to work in interdisciplinary groups.
IV. To provide students good foundation in mathematical, scientific, engineering fundamentals and hardware-software programming intelligence.
V. To provide the students with knowledge to be involved with the technology advancements and future developments for system automation of societal value.
VI. To promote student awareness, for life-long learning and introduce them to professional ethics and code of practice.

2. PROGRAMME OUTCOME (POs):

On successful completion of the P.G Programme,

PO	Graduate Attribute	Programme Outcome
1.	Engineering knowledge	To disseminate knowledge of the principles and practices of the electrical and electronics based industries regarding intelligent automation using dedicated processors supported with computation and communication technology.
2.	Problem analysis	Capability to analyze regular operations and critical event operations of systems so as design fault tolerant smart solutions through fast switching.
3.	Development of solutions	Be able to design and develop Embedded system automation based on dedicated ICs that have computation, networking and control capacity.
4.	Technical development	Able to incorporate software programming skills and interfacing onto complex computation and communication dependant Hardcore processors.
5.	Modern tool usage	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.
6.	Conduct investigations of complex problems	Be able to identify problems in electrical and electronic systems, analyze the problems, and solve them with creativity, supporting consumer applications.
7.	Project management and finance	Competency to indigenously develop newer solutions in embedded automation by observing scientific strategies in smart

		processes to Implement cost effective and improved system.
8.	Product development	To involve in research on an industrial problem or develop an innovative smart system with automation as a consumer product of societal interest.
9.	Entrepreneurship outlook	Ability to establish small or medium scale startup on embedded application for proposing smart solutions of socio-economic value.
10.	The Engineer In team work with Ethics	Function in an ethical manner with Interaction in a multi-disciplinary team in an industry, institute and society by preserving professional conduct.
11.	Communication Skills	Ability to review, prepare and present technical developments with Proficiency in oral and written Communications.
12.	Environment and sustainability	Contribute to self and to system growth with environment consciousness and sustainable development of technology and the nation.

PEO / PO Mapping:

Program Educational Objective	**Program Outcome**											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1.	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
2.	✓	✓	✓	✓	✓	✓	✓		✓	✓		
3.	✓	✓	✓	✓								
4.				✓	✓		✓					
5			✓			✓			✓	✓		
6.			✓			✓		✓	✓	✓	✓	✓

MAPPING OF COURSE
OUTCOME AND PROGRAMME OUTCOME

		Course Name	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
	SEM 1	Design of Embedded Systems	✓	✓	✓	✓	✓			✓	✓			
		Microcontroller and RISC Processor Architecture		✓	✓	✓	✓		✓					
		Software for Embedded Systems		✓		✓	✓	✓	✓		✓	✓		
		Program Elective I		✓	✓	✓	✓		✓		✓			✓
		Research Methodology and IPR		✓	✓	✓	✓	✓			✓		✓	✓
		Audit Course I (one from list of Audit courses)									✓	✓	✓	
		Embedded System Lab – I		✓	✓	✓	✓	✓				✓		
		Embedded Programming Lab - I		✓	✓	✓	✓	✓				✓		
	SEM 2	Embedded Linux			✓	✓	✓		✓	✓				
		Real Time Operating System		✓	✓	✓		✓		✓				
		VLSI Design and Architecture		✓	✓	✓		✓		✓				
		Program Elective II	✓			✓	✓	✓						
		Program Elective III	✓			✓	✓	✓						
		Audit Course II (one from list of Audit courses)									✓	✓	✓	
		Embedded System Lab – II		✓	✓	✓	✓	✓			✓			
		Embedded Programming Lab - II		✓	✓	✓	✓	✓			✓			
		Mini Project with Seminar	✓	✓	✓		✓				✓	✓	✓	✓
	SEM 3	Program Elective IV	✓			✓	✓	✓						
		Program Elective V	✓			✓	✓	✓						

		Open Elective (one from listed courses)	✓			✓	✓	✓			✓			
		Project Phase I				✓	✓	✓	✓	✓	✓		✓	✓
	SEM 4	Project Phase II				✓	✓	✓	✓	✓	✓		✓	✓

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
CHOICE BASED CREDIT SYSTEM
M.E. EMBEDDED SYSTEM TECHNOLOGIES (FULL TIME)

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.	ET5101	Design of Embedded Systems	PCC	3	0	0	3	3
2.	ET5102	Microcontroller and RISC Processor Architecture	PCC	3	0	0	3	3
3.	ET5103	Software for Embedded Systems	PCC	4	0	0	4	4
4.		Program Elective I	PEC	3	0	0	3	3
5.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Audit Course I (one from list of Audit courses)	AC	2	0	0	2	0
PRACTICALS								
7.	ET5111	Embedded System Lab - I	PCC	0	0	4	4	2
8.	ET5112	Embedded Programming Lab -I	PCC	0	0	4	4	2
		TOTAL		**17**	**0**	**8**	**25**	**19**

*Audit Course is optional

SEMESTER II

S.NO	COURSEC ODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ET5201	Embedded Linux	PCC	3	1	0	4	4
2.	ET5202	Real Time Operating System	PCC	3	0	0	3	3
3.	ET5251	VLSI Design and Architecture	PCC	4	0	0	4	4
4.		Program Elective II	PEC	3	0	0	3	3
5.		Program Elective III	PEC	3	0	0	3	3
6.		Audit Course II (one from list of Audit courses)	AC	2	0	0	2	0
PRACTICALS								
7.	ET5211	Embedded System Lab - II	PCC	0	0	4	4	2
8.	ET5212	Embedded Programming Lab - II	PCC	0	0	4	4	2
9.	ET5213	Mini Project with Seminar	EEC	0	0	6	6	3
		TOTAL		**18**	**1**	**14**	**33**	**24**

*Audit Course is optional

SEMESTER III

S.NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective IV	PEC	3	0	0	3	3
2.		Program Elective V	PEC	3	0	0	3	3
3.		Open Elective (one from list of 6 courses)	OEC	3	0	0	3	3
PRACTICALS								
4.	ET5311	Project Phase 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.	ET5411	Project Phase II	EEC	0	0	24	24	12
		TOTAL		**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 70

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
CHOICE BASED CREDIT SYSTEM
M.E. EMBEDDED SYSTEM TECHNOLOGIES (PART TIME)

CURRICULUM AND SYLLABUS I TO VI SEMESTERS

SEMESTER I

S.NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ET5101	Design of Embedded Systems	PCC	3	0	0	3	3
2.	ET5102	Microcontroller and RISC Processor Architecture	PCC	3	0	0	3	3
3.	ET5103	Software for Embedded Systems	PCC	4	0	0	4	4
4		Audit Course I (one from list of Audit courses)	AC	2	0	0	2	0
PRACTICALS								
5	ET5111	Embedded System Lab - I	PCC	0	0	4	4	2
		TOTAL		**12**	**0**	**4**	**16**	**12**

*Audit Course is optional

SEMESTER II

S.NO	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	ET5201	Embedded Linux	PCC	3	1	0	4	4
2.	ET5202	Real Time Operating System	PCC	3	0	0	3	3
3.	ET5251	VLSI Design and Architecture	PCC	4	0	0	4	4
4		Audit Course II (one from list of Audit courses)	AC	2	0	0	2	0
PRACTICALS								
5.	ET5112	Embedded Programming Lab - I	PCC	0	0	4	4	2
		TOTAL		**12**	**1**	**4**	**17**	**13**

*Audit Course is optional

SEMESTER III

S.NO	COURSE CODE	COURSE TITLE	CATEG ORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective I	PEC	3	0	0	3	3
2.		Program Elective II	PEC	3	0	0	3	3
3.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
PRACTICALS								
4.	ET5211	Embedded System Lab - II	PCC	0	0	4	4	2
		TOTAL		**8**	**0**	**4**	**12**	**10**

SEMESTER IV

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective III	PEC	3	0	0	3	3
2.		Program Elective IV	PEC	3	0	0	3	3
PRACTICALS								
3.	ET5212	Embedded Programming Lab - II	PCC	0	0	4	4	2
4	ET5213	Mini Project with Seminar	EEC	0	0	6	6	3
		TOTAL		**6**	**0**	**10**	**16**	**11**

SEMESTER V

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective V	PEC	3	0	0	3	3
2.		Open Elective (one from list of 6 courses)	OEC	3	0	0	3	3
PRACTICALS								
3.	ET5311	Project Phase I	EEC	0	0	12	12	6
		TOTAL		**6**	**0**	**12**	**18**	**12**

SEMESTER VI

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	ET5411	Project Phase II	EEC	0	0	24	24	12
		TOTAL		**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 70

RESEARCH METHODOLOGY AND IPR [RMC]

S.NO	CODE NO.	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	RM5151	Research Methodology and IPR	2	0	0	2	1
					TOTAL CREDITS	2	

OPEN ELECTIVE COURSES [OEC]

*(Out of 6 Courses one Course must be selected)

S.NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OE5091	Business Data Analytics	3	0	0	3	3
2.	OE5092	Industrial Safety	3	0	0	3	3
3.	OE5093	Operations Research	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	3	0	0	3	3
5.	OE5095	Composite Materials	3	0	0	3	3
6.	OE5096	Waste to Energy	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AX5091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX5092	Disaster Management	2	0	0	0	
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0	
4.	AX5094	Value Education	2	0	0	0	
5.	AX5095	Constitution of India	2	0	0	0	
6.	AX5096	Pedagogy Studies	2	0	0	0	
7.	AX5097	Stress Management by Yoga	2	0	0	0	
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0	
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0	
Total Credits						**0**	

EMPLOYABILITY ENHANCEMENT COURSES [EEC]

S.NO	CODE NO.	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1.	ET5213	Mini Project with Seminar	0	0	6	3	2

2.	ET5311	Project Phase I	0	0	12	6	3
3.	ET5411	Project Phase II	0	0	24	12	4
					TOTAL CREDITS	**21**	

PROGRAM CORE COURSES (PCC) LIST

S.No	CODE NO.	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	ET5101	Design of Embedded Systems	PCC	3	0	0	3	3
2.	ET5102	Microcontroller and RISC Processor Architecture	PCC	3	0	0	3	3
3.	ET5103	Software for Embedded Systems	PCC	4	0	0	4	4
4.	ET5201	Embedded Linux	PCC	3	1	0	4	4
5.	ET5202	Real Time Operating System	PCC	3	0	0	3	3
6.	ET5251	VLSI Design and Architecture	PCC	4	0	0	4	4
7.	ET5111	Embedded System Lab – I	PCC	0	0	4	4	2
8.	ET5112	Embedded Programming Lab – I	PCC	0	0	4	4	2
9.	ET5211	Embedded System Lab – II	PCC	0	0	4	4	2
10.	ET5212	Embedded Programming Lab - II	PCC	0	0	4	4	2

PROGRAM ELECTIVE COURSE (PEC) LIST

S.No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	C
1.	ET5001	Wireless and Mobile Communication	PE	3	0	0	3	3
2.	ET5002	Ad Hoc Networks	PE	3	0	0	3	3
3.	ET5073	Cryptography and Network Security	PE	3	0	0	3	3
4.	ET5003	Embedded Computing	PE	3	0	0	3	3
5.	ET5072	Automotive Embedded System	PE	3	0	0	3	3
6.	ET5076	MEMS Technology	PE	3	0	0	3	3
7.	ET5077	Nano Electronics	PE	3	0	0	3	3
8.	ET5004	Reconfigurable Processor and SoC Design	PE	3	0	0	3	3
9.	ET5078	Robotics and Automation	PE	3	0	0	3	3
10.	ET5005	Smart System Design	PE	3	0	0	3	3
11.	ET5006	Digital Image Processing System	PE	3	0	0	3	3

12.	ET5007	Advanced Digital Systems Design	PE	3	0	0	3	3
13.	ET5008	Computer Architecture and Parallel Processing	PE	3	0	0	3	3
14.	ET5009	Network Embedded Processors	PE	3	0	0	3	3
15.	ET5071	Advanced Digital Signal Processing	PE	3	0	0	3	3
16.	ET5010	Embedded Product Development	PE	3	0	0	3	3
17.	ET5075	Embedded Networking and Automation of Electrical System	PE	3	0	0	3	3
18.	ET5074	Digital Instrumentation	PE	3	0	0	3	3
19.	ET5011	Web Technologies and Trends	PE	3	0	0	3	3
20.	ET5012	Open Source Software	PE	3	0	0	3	3
21.	CO5152	Intelligent Controllers	PE	3	0	0	3	3
22.	CO5251	Machine Learning	PE	3	1	0	4	4
23.	HV5072	Design of Substations	PE	3	0	0	3	3
24.	PW5078	SCADA System and Applications Management	PE	3	0	0	3	3
25.	PW5071	Electric Vehicles and Power Management	PE	3	0	0	3	3
26.	PW5251	Energy Management and Audit	PE	3	1	0	4	4
27.	PW5072	Energy Efficient Buildings	PE	3	0	0	3	3
28.	PS5076	Wind Energy Conversion System	PE	3	0	0	3	3
29.	PS5075	Smart Grid	PE	3	0	0	3	3
30.	PS5072	Application of DSP to Power System Protection	PE	3	0	0	3	3
31.	MA5001	Applied Mathematics for Electrical Engineers	PE	3	1	0	4	4
32.	ET5013	IoT for Smart Systems	PE	3	0	0	3	3
33.	ET5014	Unmanned Aerial Vehicle	PE	3	0	0	3	3

SUMMARY

Name of the Programme : **M.E in Embedded System Technologies**							
S.NO	**SUBJECT AREA**	**CREDITS PER SEMESTER**				**TOTAL CREDITS**	**%**
		I	**II**	**III**	**IV**		
1.	PCC	14	15	0	0	**29**	**41**
2.	PEC	3	6	6	0	**15**	**21**
3.	RMC	2	0	0	0	**2**	**3**
4.	OEC	0	0	3	0	**3**	**4**
5.	EEC	0	3	6	12	**21**	**30**
6.	Non Credit / Audit Course	✓	✓	0	0	**0**	
	TOTAL CREDITS	**19**	**24**	**15**	**12**	**70**	

ET5101 **DESIGN OF EMBEDDED SYSTEMS** **LT P C**
3 0 0 3

COURSE OBJECTIVES:

- To provide knowledge on the basics, building blocks of Embedded System.
- To discuss Input/output Interfacing & Bus Communication with processors.
- To teach automation using scheduling algorithms and Real time operating system.
- To discuss on different Phases & Modeling of a new embedded product.
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS 9

Introduction to Embedded Systems –built in features for embedded Target Architecture - selection of Embedded processor – DMA- memory devices – Memory management methods-memory mapping, cache replacement policies- Timer and Counting devices, Watchdog Timer, Real Time Clock- Software Development tools-IDE, assembler, compiler, linker, simulator, debugger, In circuit 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 (I^2C)- CAN Bus –Wireless protocol based on Wifi , Bluetooth, Zigbee – Introduction to Device Drivers.

UNIT III RTOS BASED EMBEDDED SYSTEM DESIGN 9

Introduction to basic concepts of RTOS- Need, Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, 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, uC/OS-II, RT Linux.

UNIT IV MODELLING WITH HARDWARE/SOFTWARE DESIGN APPROACHES 9

Modelling embedded systems- embedded software development approach --Overview of UML modeling with UML, UML Diagrams-- Hardware/Software Partitioning , Co-Design Approaches for System Specification and modeling- CoSynthesis- features comparing Single-processor Architectures & Multi-Processor Architectures--design approach on parallelism in uniprocessors & Multiprocessors.

UNIT V EMBEDDED SYSTEM APPLICATION DEVELOPMENT 9

Objective, Need, different Phases & Modelling of the EDLC.choice of Target Architectures for Embedded Application Development-for Control Dominated-Data Dominated Systems-Case studies on Digital Camera, Adaptive Cruise control in a Car, Mobile Phone software for key inputs.

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

TOTAL: 45 PERIODS

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 Embedded consumer product design based on phases of product development.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2			✓		✓							
CO3		✓			✓							
CO4			✓	✓	✓							
CO5								✓	✓			

REFERENCES:

1. Rajkamal, 'Embedded system-Architecture, Programming, Design', TMH,2011.
2. Peckol, "Embedded system Design",JohnWiley&Sons,2010
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. Giovanni De Micheli, Mariagiovanna Sami , Hardware / Software Co- Design, Kluwer Academic Publishers , 2002

ET5102 MICROCONTROLLER AND RISC PROCESSOR ARCHITECTURE LT P C
3 0 0 3

COURSE OBJECTIVES:

- To teach the architecture of PIC Microcontroller and RISC processor.
- To compare the architecture and programming of 8,16,32 bit (NUVOTON, ARM Cortex M Series) RISC processor.
- To teach the implementation of DSP in ARM processor.
- To discuss on memory management, application development in RISC processor.
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills.

UNIT I PIC MICROCONTROLLER 9

Architecture – memory organization – addressing modes – instruction set – PIC programming in Assembly & C –I/O port, Data Conversion, RAM & ROM Allocation, Timer programming, practice in MP-LAB.

UNIT II ARM ARCHITECTURE 9

Architecture – memory organization – addressing modes – The ARM Programmer's model - Registers – Pipeline - Interrupts – Coprocessors – Interrupt Structure

UNIT III PERIPHERALS OF PIC AND ARM MICROCONTROLLER 9

PIC: ADC, DAC and Sensor Interfacing –Flash and EEPROM memories. ARM: I/O Memory – EEPROM – I/O Ports – SRAM –Timer –UART - Serial Communication with PC – ADC/DAC Interfacing.

UNIT IV ARM MICROCONTROLLER PROGRAMMING 9

ARM general Instruction set – Thumb instruction set –Introduction to DSP on ARM – Implementation example of Filters

UNIT V DESIGN WITH PIC AND ARM MICROCONTROLLERS 9

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

TOTAL: 45 PERIODS

NOTE:

Discussions/Exercice/Practice on Workbench: on Programming practices on the KEIL Work Bench for Simple ASM/C / Input & output interfacing programs with ARM 7/ARM 9/Nuvoton Processors

COURSE OUTCOMES:

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

CO1: To understand the basics and requirement of processor functional blocks.
CO2: Observe the specialty of RISC processor Architecture.
CO3: Incorporate I/O hardware interface of a processor based automation for consumer application with peripherals.
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 commercial embedded processors

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2												
CO3			✓	✓	✓							
CO4			✓		✓							
CO5		✓	✓	✓	✓		✓					

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. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ' PIC Microcontroller and Embedded Systems using Assembly and C for PIC18', Pearson Education 2008
4. John Iovine, 'PIC Microcontroller Project Book ', McGraw Hill 2000
5.William Hohl, ' ARM Assebly Language' Fundamentals and Techniques,2009.
6. Rajkamal,"Microcontrollers Architecture, Programming, Interfacing,& System Design,Pearson,2012
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8. www.Nuvoton .com/websites on Advanced ARM Cortex Processors

ET5103 SOFTWARE FOR EMBEDDED SYSTEMS L T P C
4 0 0 4

COURSE OBJECTIVES:

- To expose the students to the fundamentals of embedded Programming
- To Introduce the GNU C Programming Tool Chain in Linux.
- To study the basic concepts of embedded C.
- To teach the basics of Python Programming
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills.

UNIT I BASIC C PROGRAMMING 12

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 12

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 **12**

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.

UNIT IV PYTHON PROGRAMMING **12**

Introduction - Parts of Python Programming Language - Control Flow Statements - Functions - Strings - Lists - Dictionaries - Tuples and Sets.

UNIT V MODULES, PACKAGES AND LIBRARIES IN PYTHON **12**

Python Modules and Packages - Creating Modules and Packages - Practical Example - Libraries for Python - Library for Mathematical functionalities and Tools - Numerical Plotting Library - GUI Libraries for Python - Imaging Libraries for Python - Netoworking Libraries.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Understanding of C programming and its salient features for embedded systems
CO2: The learning process delivers insight into various programming languages/software compatible to embedded process development with improved design & programming skills.
CO3: Developing knowledge on C programming in Linux environment.
CO4: Able to write python programming for Embedded applications.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded programming skills.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓	✓							
CO2	✓			✓	✓							
CO3	✓			✓	✓							
CO4			✓	✓	✓							
CO5	✓		✓		✓			✓	✓			

TEXTBOOKS:

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.

REFERENCES:

1. Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015.
2. Steve Oualline, "Practical C programming", O’Reilly Media, 1997.
3. Fabrizio Romano, “Learn Python Programming”, Second Edition, Packt Publishing, 2018.
4. John Paul Mueller, "Beginning Programming with Python for Dummies", 2nd Edition, John Wiley & Sons Inc., 2018.
5. Mark Lutz, "Programming Python", 4th Edition, O’Reilly Media Inc., 2010.

RM5151 **RESEARCH METHODOLOGY AND IPR** **LT P C**
2 0 0 2

COURSE OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.

Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

COURCE OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

REFERENCES:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” 2010

ET5111 EMBEDDED SYSTEM LAB – I L T P C
0 0 4 2

COURSE OBJECTIVES:

- To involve the students to Practice on Workbench /Software Tools/ Hardware Processor Boards with the supporting Peripherals.
- To teach the concepts of algorithm development & programming on software tools and Digital processors with peripheral interfaces.
- To encourage students to practice in opensource software / packages /tools
- To train though hands-on practices in commercial and licensed Hardware-software suites
- Practicing through the subdivisions covered within experiments listed below to expose the students into the revising the concepts acquired from theory subjects.

Domain	EXPERIMENT DETAIL	EQUIPMENT/ SUPPORTS REQUIRED	TRAINING OUTCOMES
1.	Programming with 8 bit Microcontrollers # Assembly programming Study on In-circuit Emulators, cross compilers, debuggers	8051/ other 8 bit Microcontrollers with peripherals; ;IDE, Board Support Software Tools /C Compiler/others	The students will learn design with simulators/experiments, in programming processor boards, processor interfacing/ designing digital controllers
2.	Programming with 8 bit Microcontrollers # C programming Study on in-circuit Emulators, cross compilers, debuggers	8051 Microcontrollers with peripherals; ;IDE, Board Support Software Tools /C Compiler/others	
3.	I/O Programming with 8 bit Microcontrollers I/O Interfacing : Timers/ Interrupts/ Serial port	8051 Microcontrollers with peripherals; Board Support Software Tools, peripherals	

	programming/PWM Generation/ Motor Control/ADC/DAC/ LCD/ RTC Interfacing/ Sensor Interfacing	with interface	
4.	Programming with AVR/ PIC Microcontrollers : ✓ Assembly ✓ C programming ✓ programming ✓ Interfacing peripherals Study on in-circuit Emulators, cross compilers, debuggers	AVR/ PIC Microcontrollers with peripherals; ;IDE, Board Support Software Tools /C Compiler/others	The students will learn design with simulators/experiments, in programming processor boards, processor interfacing/ designing digital controllers
5.	I/O Programming with AVR/ PIC Microcontrollers I/O Interfacing : Timers/ Interrupts/ Serial port programming/PWM Generation/ Motor Control/ADC/DAC/ LCD/ RTC Interfacing/ Sensor Interfacing	AVR/ PIC Microcontrollers with peripherals; Board Support Software Tools, peripherals with interface	

P = 60 TOTAL= 60

NOTE: Note:Laboratory training, discussions can include the given guidelines for improved teaching /learning process :Hands on experiences can be with Case specific experiments in domains on range of processors, programmes, simulators, circuits that support theory subjects.

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

CO1: The Laboratory experiments exposes insight into various embedded processors of CISC and RISC architecture / computational processors with peripheral interface.
CO2: Understanding the fundamental concepts of how process can be controlled with uC.
CO3: working 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2												✓
CO3			✓	✓	✓							✓
CO4			✓		✓							✓
CO5		✓	✓	✓	✓		✓		✓	✓	✓	✓

REFERENCES:

1. Mohamammad Ali Mazidi & Mazidi ' 8051 Microcontroller and Embedded Systems', Pearson Education
2. Mohammad Ali Mazidi, Rolind Mckinley 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. Jovitha Jerome,"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

ET5112 **EMBEDDED PROGRAMMING LAB - I** **LT P C**
0 0 4 2

COURSE OBJECTIVES:

- To involve the students to Practice on Workbench /Software Tools/ Hardware Processor Boards with the supporting Peripherals.
- To teach the concepts of algorithm development & programming on software tools and Digital processors with peripheral interfaces.
- To encourage students to practice in opensource softwares / packages /tools
- To train though hands-on practices in commercial and licensed Hardware-software suites
- Practicing through the subdivisions covered within experiments listed below to expose the students into the revising the concepts acquired from theory subjects.

Domain	EXPERIMENT DETAIL	EQUIPMENT/ SUPPORTS REQUIRED	TRAINING OUTCOMES
1.	Programming in Higher Level Languages/ Platforms	C/C++/Java/Embedded C/Embedded Java/ Compilers &Platforms/cloud/APP development/Big data analytics	The students will learn design with simulators/ programming environments
2.	Programming with Arduino Microcontroller Board : Study on Incircuit Emulators, cross compilers, debuggers	Arduino Boards with peripherals ;IDE, Board Support Software Tools /Compiler/others	
3.	VHDL Programming in FPGA processors	Processor Boards with Board Support Tools & Interfaces	The students will learn design ,modeling & simulation of Combinational, Sequential, Synchronous, Asynchronous circuits with simulators/experiments ,in programming processor boards, processor interfacing/designing reprogrammable system
4.	Programming & Simulation in Simulators /Tools/others	Simulation Tools as Proteus/ ORCAD	The students will learn design with experiments, in programming suites/ simulators/EV /Signal processing/Tool Bench.
5.	Programming & Simulation in Simulators /Tools/others	Simulation Tools as MATLAB /others	

P = 60 TOTAL= 60

NOTE: Note:Laboratory training, discussions can include the given guidelines for improved teaching /learning process :Hands on experiences can be with Case specific experiments in domains on range of processors, programmes, simulators, circuits that support theory subjects.

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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2												✓
CO3			✓	✓	✓							✓
CO4			✓		✓							✓
CO5		✓	✓	✓	✓		✓		✓	✓	✓	✓

ET5201 EMBEDDED LINUX LT P C
3 1 0 4

COURSE OBJECTIVES:

- To impart knowledge about Linux Operating System
- To expose the students to the fundamentals of Linux Operating system and its basic commands.
- To Teach about the various Linux distributions and running them on a typical Embedded Board.
- To demystify the details of various Embedded Boards and programming them.
- To give an introduction to Linux Device Drivers.

UNIT I LINUX FUNDAMENTALS 12

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 12

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 12

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 BUSSES 12

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 12

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: 60 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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓			✓	✓							
CO2		✓		✓	✓							
CO3	✓		✓	✓	✓	✓		✓				
CO4				✓	✓							
CO5	✓		✓		✓	✓		✓	✓			

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.

ET5202 **REAL TIME OPERATING SYSTEM** **LT P C**
3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the fundamentals of interaction of OS with a computer and User computation.
- To teach the fundamental concepts of how process are created and controlled with OS.
- To study on programming logic of modeling Process based on range of OS features
- To compare types and Functionalities in commercial OS, application development using RTOS
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I REVIEW OF OPERATING SYSTEMS 9

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 9

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 9

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 9

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

UNIT V APPLICATION DEVELOPMENT 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understanding Operating System structures and types.
CO2: Insight into scheduling, disciplining of various processes execution.
CO3: Provide knowledge on various RTOS support modelling
CO4: Understanding 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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				✓				✓				
CO2	✓	✓	✓									
CO3			✓		✓			✓				
CO4		✓	✓	✓								

CO5	✓	✓						✓	✓			

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

ET5251 VLSI DESIGN AND ARCHITECTURE LT P C
4 0 0 4

COURSE OBJECTIVES:

- To understand the basic concepts of VLSI and CMOS design.
- To introduce the IC fabrication methods
- To study the architectures of various RPLDs.
- To introduce the basics of analog VLSI design and its importance.
- To learn about the programming of Programmable device using Hardware description Language.

UNIT I CMOS DESIGN 12

Review of switching devices and logics- MOSFET Scaling- MOS Transistor Model-CMOS inverter-determination of pull up / pull down ratios, Nano MOSFET- CMOS based combinational logic & sequential design- Dynamic CMOS & clocking –Transmission Gates- BiCMOS- Low power VLSI.

UNIT II IC FABRICATION 12

Overview of IC Fabrication -NMOS, PMOS, CMOS, SOI ,BiCMOS fabrication- Stick Diagrams, Design Rules and Layout - recent trends in IC fabrication.

UNIT III PROGRAMMABLE LOGIC DEVICES AND ASIC DESIGN 12

Programming techniques- Architecture of CPLD and FPGA – advanced FPGA devices- ASIC physical design– Logic Implementation with PLDs.

UNIT IV ANALOG VLSI DESIGN 12

Introduction to analog VLSI- Design of CMOS 2stage-3 stage Op-Amp –High Speed and High frequency op-amps-Super MOS- Analog primitive cells-realization of neural networks- Introduction to FPAA**.**

UNIT V HDL PROGRAMMING 12

Overview of digital design with HDL, structural, data flow and behavioural modeling- logic synthesis-simulation-Combinational and Sequential logic design examples, Ripple carry Adders, Carry Look ahead adders, Multiplier, ALU, Test Bench.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: The learning process delivers insight into developing CMOS design techniques and development of low power VLSI logic circuits.
CO2: Insight into IC fabrication methods.
CO3: Improved skill set in RPLD/SOC usage for real time applications.

CO4: Design and development of reprogrammable analog devices and its usage for embedded
applications.
CO5: Understating and usage of HDL computational processes with improved design strategies.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓						
CO2	✓			✓	✓							
CO3	✓		✓	✓				✓	✓			
CO4	✓	✓	✓		✓			✓	✓			
CO5			✓	✓	✓	✓		✓				

TEXTBOOKS:

1. M.J.S Smith, “Application Specific integrated circuits”,Addition Wesley Longman Inc.1997.
2. Kamran Eshraghian,Douglas A.pucknell and Sholeh Eshraghian,”Essentials of VLSI circuits and system”, Prentice Hall India,2005.
3. Wayne Wolf, “ Modern VLSI design “ Prentice Hall India,2006.
4. Mohamed Ismail ,Terri Fiez, “Analog VLSI Signal and information Processing”, McGraw Hill International Editions,1994.
5. Samir Palnitkar, “Veri Log HDL, A Design guide to Digital and Synthesis” 2nd Ed,Pearson,2005.
6. Debprasad Das, VLSI Design, Oxford University Press, 2010.
7. Zainalatsedin Navabi, ‘VHDL Analysis and Modelling of Digital Systems’, 2n Edition, Tata McGraw Hill, 1998.

ET5211 **EMBEDDED SYSTEM LAB - II** **LT P C**
0 0 4 2

COURSE OBJECTIVES:

- To involve the students to Practice on Workbench /Software Tools/ Hardware Processor Boards with the supporting Peripherals.
- To teach the concepts of algorithm development & programming on software tools and Digital processors with peripheral interfaces.
- To encourage students to practice in opensource softwares / packages /tools
- To train though hands-on practices in commercial and licensed Hardware-software suites
- Practicing through the subdivisions covered within experiments listed below to expose the students into the revising the concepts acquired from theory subjects.

SL.	EXPERIMENT DETAIL	EQUIPMENT/ SUPPORTS REQUIRED	TRAINING OUTCOMES
	Programming ARM processor :		

1.	ARM7 / ARM9/ARM Cortex Study on Incircuit Emulators, crosscompilers, debuggers	Microcontrollers with peripherals; ;IDE, Board Support Software Tools /Keil/uCOS Compiler/others	
2	I/O Programming with ARM processor : ARM7 / ARM9/ARM Cortex Microcontrollers I/O Interfacing : Timers/ Interrupts/ Serial port programming/PWM Generation/ Motor Control/ADC/DAC/ LCD/ RTC Interfacing/ Sensor Interfacing	ARM processor : ARM7 / ARM9/ARM Cortex Microcontrollers with peripherals; Board Support Software Tools, peripherals with interface	The students will learn design with simulators/ experiments, in programming processor boards, processor interfacing/ designing digital controllers
3.	Programming with Rasberry Pi Microcontroller Board : Study on incircuit Emulators, crosscompilers, debuggers	Rasberry Pi Boards with peripherals ;IDE, Board Support Software Tools /Compiler/others	
4.	I/O Programming with Arduino ,Rasberry 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,Rasberry Pi Microcontroller Boards with peripherals;Board Support Software Tools, peripherals with interface	
5.	Programming with DSP processors	Processor Boards with Board Support Tools & Interfaces	The students will learn design & simulation of Arithmetic ,Logic programs, Filters, Signal anaysis with simulators/experiments ,in programming processor boards, processor interfacing/ Tools
6	Study of one type of Real Time Operating Systems (RTOS)	Compilers & Platforms with VXWorks/ Keil/ Android/ Tiny OS/ Linux Support/any RTOS/Java Semaphore implementations	The students will learn programming, compiling in various tools & software domains

7	Smart System Design using Embedded HW/SW modules	AMI/EV and hybrid vehicles	The students will learn indigenous designing of Automation that will help them to become entrepreneurs

P = 60 TOTAL= 60

NOTE: Laboratory training, discussions can include the given guidelines for improved teaching /learning process :Hands on experiences with Case specific experiments in domains on range of work Benches,programmable Test suites,simulators,circuit boards that support the practical skill training supportive to theory subjects **.**

COURSE OUTCOMES:
At the end of this course

CO1: students will learn design with simulators/ experiments, in programming processor boards, processor interfacing/ designing digital controllers
CO2: design & simulation of Arithmetic ,Logic programs, Filters, Signal analysis with simulators/experiments ,in programming processor boards, processor interfacing/ Tools
CO3: Understand and able to develop real time solution for embedded applications
CO4: The students will learn programming, compiling 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2												✓
CO3			✓	✓	✓							✓
CO4			✓		✓							✓
CO5		✓	✓	✓	✓		✓		✓	✓	✓	✓

ET5212 **EMBEDDED PROGRAMMING LAB - II** **LT P C**
0 0 4 2

COURSE OBJECTIVES:

- To involve the students to Practice on Workbench /Software Tools/ Hardware Processor Boards with the supporting Peripherals.
- To teach the concepts of algorithm development & programming on software tools and Digital processors with peripheral interfaces.
- To encourage students to practice in opensource softwares / packages /tools
- To train though hands-on practices in commercial and licenced Hardware-software suites
- Practicing through the subdivisions covered within experiments listed below to expose the students into the revising the concepts acquired from theory subjects.

SL.	EXPERIMENT DETAIL	EQUIPMENT/ SUPPORTS REQUIRED	TRAINING OUTCOMES
1.	Programming in Freeware softwares/ Platforms	Programming Compilers&Platforms on freeware	The students will learn programming, compiling in various tools & software domains
2.	Software & Modelling tools ✓ Study on MEMS Tools ✓ Study on process Controller modeling ✓ PLC/SCADA/PCB ✓ one type CAD Tool	Personal Computers, Licensed 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	The students will learn programming, compiling in various tools & software domains
5	Programming with wired/wireless communication protocol/Network Simulators	Learning Communication Protocols & Support Software Tools for BUS & network communication	Learning Communication Protocols & Experimenting with Support

			Software Tools for communication interfaces
6	Linux programming Tool chain	PC with Linux OS	Learning the various components of Linux Development tool chain

P = 60 TOTAL= 60

NOTE: Laboratory training, discussions can include the given guidelines for improved teaching /learning process :Hands on experiences with Case specific experiments in domains on range of work Benches,programmable Test suites,simulators,circuit boards that support the practical skill training supportive to theory subjects **.**

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: Understanding the concepts of how process can be realized using Software Modules
CO3: 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2												✓
CO3			✓	✓	✓							✓
CO4			✓		✓							✓
CO5		✓	✓	✓	✓		✓		✓	✓	✓	✓

ET 5213 **MINI PROJECT WITH SEMINAR** **LT P C**
0 0 6 3

COURSE OBJECTIVES

- To provide a hands on training on embedded systems technologies
- To improve the understanding ability and the presentation skills of the students
- To provide an insight of developing optimized embedded solution for supplications
- To emphasize the need of Hardware/Software co-design and its usage for real time applications.
- To provide guidance for entrepreneurships.

Note 1: (Mini project work can encourage seminar presentations and hands-on training of concepts learnt through theory subjects and also make preliminary exposure to domain topics in synchronism with PROJECT WORK PHASE)

MINI PROJECT WORK : COURSE OBJECTIVES AND OUTCOMES

	COURSE OBJECTIVES	**TRAINING OUTCOMES**
1.0	<u>Programming in</u> ✓ C/ Embedded C / C++ / JAVA/Python/others ✓ Network Simulators ✓ Multicore Processors suites ✓ Programming on Pervasive Computing ✓ Java for Wireless Devices	Skill development in software programming/working in simulators, emulators, learn using the commercial packages for wired, wireless communications
2.0	<u>Programming Embedded Processors</u> ✓ uC,ARM processor family ✓ DSP / pSoC/Image / Video Processors ✓ VHDL Programming in FPGA processors ✓ Multicore Processors	The students will learn design with simulators/experiments,in programming processor boards, processor interfacing/designing reprogrammable system
3.0	<u>Programming Embedded OS</u> ✓ Android / LINUX OS Internals/VxWorks/ Keil Os/ TinyOS/Device-driver programming/ ApplicationDevelopment/others	The students will skill through OS programming through API, libraries

4.0	Modelling/Simulation Suites ✓ Communication Protocols ✓ IED Standards ✓ Virtual Instrumentation programming ✓ Simulink/Mathlab Tools ✓ Study on MEMS Tools ✓ process Controller modeling ✓ PLC/SCADA/PCB/ORCAD ✓ CAD Tools ✓ UML/Modelling Tools	The students will apply programming logic for modeling/simulating embedded application development
5.0	✓ Entrepreneurship Skill development	The students will know to pickup skills for product development/establish consultancy services with an outlook into selecting commercially viable market for technical demands

TOTAL: 90 PERIODS

COURSE OUTCOMES

CO1 :Skill development in software programming/working in simulators, emulators, learn using the commercial packages for wired, wireless communications

CO2 :The students will learn design with simulators/emulator for experiments,in programming processor boards, processor interfacing/designing reprogrammable system

CO3: The students will skill through OS programming through API, libraries

CO4 : Apply programming logic for modeling/simulating embedded application development

CO5 : The students will know to pickup skills for product development/establish consultancy services with an outlook into selecting commercially viable technical demands in the industry

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2												✓
CO3			✓	✓	✓							✓
CO4			✓		✓							✓
CO5		✓	✓	✓	✓		✓		✓	✓	✓	✓

ET5311 **PROJECT PHASE I** **L T P C**
0 0 12 6

ET5411 **PROJECT PHASE II** **L T P C**
0 0 24 12

COURSE OBJECTIVES

- To provide a hands on skills by training on domains of embedded systems technologies
- To improve the design ability and the oral,written presentation skills of the students
- To provide an insight of developing optimized embedded solution for system automation
- To emphasize the need of Hardware &Software design tools usage for real time applications.
- To enhance capacity to compete for placement and developing ability for entrepreneurships.

DOMAIN	COURSE OBJECTIVES THROUGH DOMAINS		TRAINING OUTCOMES
1.0	✓ Programming in C/ Embedded C / C++ / JAVA ✓ Network Simulators ✓ Network simulation ✓ Programming on Pervasive Computing ✓ Java for Wireless Devices	1.1	Skill development in software programming/working in simulators, emulators, learn using the commercial packages for wired, wireless communications
2.0	Embedded Processors ✓ uc,ARM processors ✓ DSP / Image / Video Processors ✓ VHDL Programming in processors	2.1	The students will learn design with simulators/experiments,in programming processor boards, processor interfacing/designing reprogrammable system
3.0	✓ Android / LINUX OS Internals/VxWorks/Keil Os	3.1	The students will skill through OS programming through API, libraries
4.0	✓ Virtual Instrumentation programming ✓ Simulink/Mathlab Tools ✓ Study on MEMS Tools ✓ Study on process Controller modeling ✓ PLC/SCADA/PCB/ORCAD ✓ one CAD Tool	4.1	The students will apply programming logic for modeling/simulating embedded application development
5.0	✓ Entrepreneurship Skill development	5.1	The students will know to pickup skills for product development/establish consultancy services with an outlook into selecting commercially viable technical demands of the country

PRE-REQUISITES: choice of project title from the listed broad domain of research topics for Project work:

Design / development through simulation/ experimental analysis with report submission (relevant to the candidates project area) by individuals for getting skilled up through learning & practicing chosen domains of interest.
Project work domain is to be chosen to enhance student's capacity to work in Research Areas of interest. The domains of work will add value to the Department's research activity or by working in domains of Industrial importance.

1. **Network Simulators-**Design and Implement a GUI or text based network monitoring tool to record network statistics like packets sent and received, percentage errors, desktop grabbing, remote monitoring etc.

2. **Embedded Processors-** Implement an IO peripheral interface ARM/ PIC / MSP 430 / any advanced embedded Processor through Study of CAN / I2C / Ethernet/any serial bus communication protocol for IO interface

3. **Smart system design** for smart grid , smart metering ,smart cities , smart buildings, Vehicles and vehicle autonomy , AI based applications, Automation , E-health.

4. **Virtual Instrumentation programming to design smart metering** Design and Implement though GUI suite /tool to record Sensor data recording with signal analysis to discuss on system performance and controller scheme.

5. **Study on process Controller modeling -**with math lab suite with modeling, analysis for Embedded control of Machines

6. **VHDL Programming on Programmable Logic Devices -**Design and Implementation with using Xilinx/Altera FPGA / CPLD on Design ,verification of simple Combinational/Sequential Circuits

7. **Study on CAD Tool-** device modeling, codesign ,verification, analysis

8. **DSP / Image / Video Processing -** Simulation / Implementation of any one its algorithm

9. **Programming in C/ Embedded C / C++ / JAVA-** Embedded Application development

10. **Android / LINUX OS Internals/VxWorks/Keil -**Study on programming of the OS through one API for Driver interfaces, Disk driver and Terminal drivers

11. **Programming on Pervasive Computing** on mobile device application Platform through any one Operating System **/**Palm OS / Windows CE/ Embedded Linux -J2ME / Symbian /Android

12. **Network simulation-** using NS2/ Programming of TCP/IP protocol stack /any network simulator tools -Network Deployment, security concepts.- Java for Wireless Devices to Set up the development environment with Basic Data types, Libraries ,Wireless Messaging, Architecture for messaging application, Messaging API, Making a device connection using HTTP

13. **Study on MEMS –**device, structural modeling & analysis using CAD lab SUITE

14. **PLC/SCADA/PCB study-**develop one Case Study as application with suitable platform.

15. **Entrepreneurship Skill development through Product Design with Cost Estimation –** Learn through survey on on : project/product identification, development plan and execution, the Activity planning, schedule development ,Integration Management

configuration management, Time management-,Cost estimation, Quality Management planning , Human Resource Management- Organizational planning , staff acquisition, Communication Management-Information distribution , reporting, Risk Management-Procurement Management- contract, Legal & Government rules on administration.

COURSE OUTCOMES

CO1: At the end of this course, the students will demonstrate the ability in any of the listed Domains their Design, Development capability in Building Automation for a process through Hardware & Software Tools .

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

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

CO4: The Viva-Voce Examination will demonstrate this skill through Oral and Written Communication as presented in the Thesis Book .

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2												✓
CO3			✓	✓	✓							✓
CO4			✓		✓							✓
CO5		✓	✓	✓	✓		✓		✓	✓	✓	✓

ET5001 WIRELESS AND MOBILE COMMUNICATION LT P C
3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the fundamentals of wireless communication technologies.
- To teach the fundamentals of wireless mobile network protocols
- To study on wireless network topologies, network routing protocols
- To introduce the basis for classification of commercial family of wireless communication technologies
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

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 Standard-Architecture – Services – Hiper LAN, Bluetooth

UNIT IV ROUTING **9**

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

UNIT V TRANSPORT AND APPLICATION LAYERS **9**

TCP over Adhoc Networks – WAP – Architecture – WWW Programming Model –WDP – WTLS – WTP – WSP – WAE – WTA Architecture – WML – WML scripts.

NOTE: Discussions/Practice on Workbench : Sessions in NS2 / Glomosim / Open Source packages

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- CO1: The learning process delivers insight categorizing various embedded & communication protocols for networking
- CO2: Configuration strategies of distributed static & mobile secured systems.
- CO3: Deployment of distributed Wireless & mobile networks
- CO2: Establishment routing of distributed static & mobile systems
- CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded Communication Technologies.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓							✓

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3. C. Siva Ram Murthy and B.S. Manoj, AdHoc Wireless Networks: Architectures and protocols, Prentice Hall PTR, 2004

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5. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, " Principles of Mobile computing", Springer, New york, 2003.
6. C.K.Toh, " AdHoc mobile wireless networks", Prentice Hall, Inc, 2002.
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8. William Stallings, "Wireless communications and Networks", PHI/Pearson Education, 2002.

ET5002 AD HOC NETWORKS LT P C
3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the fundamentals of wireless communication technologies.
- To teach the fundamentals of wireless mobile network routing protocols
- To study on network OSI Layers
- To introduce on concepts for network deployment, Network performance& Analysis
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I WIRELESS LAN,PAN, WAN AND MAN 9

Characteristics of wireless channel, Fundamentals of WLANs, IEEE 802.11 standard, HIPERLAN Standard, First-, Second-, and third- generation cellular systems, WLL, Wireless ATM, IEEE 802.16 standard, HIPERACCESS, AdHoc Wireless Internet.

UNIT II MAC, ROUTING AND MULTICAST ROUTING PROTOCOLS 9

MAC Protocols: Design issues, goals and classification, Contention –based protocols with reservation and scheduling mechanisms, Protocols using directional antennas. Routing protocols: Design issues and classification, Table-driven, On-demand and Hybrid routing protocols, Routing protocols with efficient flooding mechanisms, Hierarchical and power-aware routing protocols. Multicast Routing Protocols: Design issues and operation, Architecture reference model, classification, Tree-based and Mesh-based protocols, Energy-efficient multicasting.

UNIT III TRANSPORT LAYER AND SECURITY PROTOCOLS 9

Transport layer Protocol: Design issues, goals and classification, TCP over AdHoc wireless Networks, Security, Security requirements, Issues and challenges in security provisioning, Network security attacks, Security routing. Quality of Service: Issues and challenges in providing QoS, Classification of QoS solutions, MAC layer solutions, Network layer solutions, QoS frameworks.

UNIT IV ENERGY MANAGEMENT 9

Need, classification of battery management schemes, Transmission power management schemes, System power management schemes. Wireless Sensor Networks: Architecture, Data dissemination, Date gathering, MAC protocols, location discovery, Quality of a sensor network.

UNIT V PERFORMANCE ANALYSIS 9

ABR beaconing, Performance parameters, Route-discovery time, End-to-end delay performance, Communication throughput performance, Packet loss performance, Route reconfiguration/repair time, TCP/IP based applications.

NOTE: Discussions/Practice on Workbench : on Zigbee/other Protocols with respect to understanding the importance of network components, Networking Layers

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1: The learning delivers insight categorizing various generations of wireless communication protocols for networking

CO2: Establishment routing of distributed static & mobile systems.

CO3: Deployment of distributed Wireless & mobile secured networks

CO4: Deployment of energy aware distributed Wireless sensor networks

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓							✓

REFERENCES:

1. C. Siva Ram Murthy and B.S. Manoj, AdHoc Wireless Networks: Architectures and protocols, Prentice Hall PTR, 2004
2. Jaganathan Sarangapani, Wireless AdHoc and Sensor Networks-Protocols, Performance and Control,CRC,2007
3. C.-K.Toh, AdHoc Mobile Wireless Networks: Protocols and Systems, Prentice Hall PTR, 2001
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6. Carlos De Morais Cordeiro,"Ad HOC & Sensor Networks, Theory & Application, World Sceintific,2010.
7. Mohammad Ilyas, The Handbook of AdHoc Wireless Networks, CRC press, 2002

ET 5073 CRYPTOGRAPHY AND NETWORK SECURITY LT P C
3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the fundamentals of data security.
- To teach the fundamentals of mathematical aspects in creating Encryption keys
- To teach the fundamentals of Security in data& wireless communication.
- To teach the fundamentals of Secured system operation.

- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I SYMMETRIC CIPHERS 9

Overview – classical Encryption Techniques – Block Ciphers and the Data Encryption standard – Introduction to Finite Fields–Advanced Encryption standard–Contemporary, Symmetric Ciphers – Confidentiality using Symmetric Encryption.

UNIT II PUBLIC-KEY ENCRYPTION AND HASH FUNCTIONS 9

Introduction to Number Theory – Public-Key Cryptography and RSA – Key Management – Diffie-Hellman Key Exchange – Elliptic Curve Cryptography – Message Authentication and Hash Functions – Hash Algorithms – Digital Signatures and Authentication Protocols.

UNIT III NETWORK SECURITY PRACTICE 9

Authentication Applications – Kerberos – X.509 Authentication Service – Electronic mail Security – Pretty Good Privacy – S/MIME – IP Security architecture – Authentication Header – Encapsulating Security Payload – Key Management.

UNIT IV SYSTEM SECURITY 9

Intruders – Intrusion Detection – Password Management – Malicious Software – Firewalls – Firewall Design Principles – Trusted Systems.

UNIT V WIRELESS SECURITY 9

Introduction to Wireless LAN Security Standards – Wireless LAN Security Factors and Issues.

NOTE: Discussions/Exercice/Practice on Workbench : on the basics /numerical design aspects of encryption, decryption keys/password creation etc

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understanding the significance of security for communication
Co2: Delivers Insight of security mechanism and architecture.
CO3: Applying the security algorithms for real time applications.
CO4: The learning process delivers insight onto role of security aspects during data transfer and communication systems like electrical grid
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems and secured system design.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓		✓						
CO2				✓	✓							
CO3			✓	✓				✓	✓			
CO4		✓	✓		✓			✓	✓			
CO5			✓	✓	✓	✓		✓				

REFERENCES:

1. William Stallings, “Cryptography And Network Security – Principles And Practices”, Pearson Education, 3rd Edition, 2003.
2. Atul Kahate, “Cryptography and Network Security”, Tata McGraw Hill, 2003.
3. Bruce Schneier, “Applied Cryptography”, John Wiley and Sons Inc, 2001.
4. Stewart S. Miller, “Wi-Fi Security”, McGraw Hill, 2003.
5. Charles B. Pfleeger, Shari Lawrence Pfleeger, “Security In Computing”, 3rd Edition, Pearson Education, 2003.
6. Mai, “Modern Cryptography: Theory and Practice”, First Edition, Pearson Education, 2003.

ET5003 EMBEDDED COMPUTING LT P C
3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the fundamentals of Network communication technologies.
- To teach the fundamentals of Java , Internet and Java card
- To develop distributed embedded system with Java
- To teach the smart card and Apps development
- To involve Discussions/ Practice in familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

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 SMART CARD TECHNIQUES 9

Smart Card basics – Java card technology overview – Java card Types - Card components SMART CARD MICROCONTROLLERS - Contactless Cards - Smart Card Operating Systems– smart card Security Techniques

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:

CO1: The learning process delivers insight into involving JAVA concepts& internet based Communication to establish decentralized control mechanism of system
CO2: Understanding the software and hardware architecture for distributed computing
CO3: Able to develop solution for smart card

CO4: Able to 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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓		✓						
CO2				✓	✓							
CO3			✓	✓	✓			✓	✓			
CO4			✓		✓			✓	✓			
CO5			✓	✓	✓	✓		✓				

REFERENCES:

1. Amitava Gupta , 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.
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ET5072 AUTOMOTIVE EMBEDDED SYSTEM LT P C
3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the fundamentals and building of Electronic Engine Control systems**.**
- To teach on functional components and circuits for vehicles
- To discuss on programmable controllers for vehicles management systems
- To teach logics of automation & commercial techniques for vehicle communication
- To introduce the embedded systems concepts for E-vehicle system development.

UNIT I BASIC OF ELECTRONIC ENGINE CONTROL SYSTEMS 9

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

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- Charging station – Aggregators- Fuel cells/Solar powered vehicles- Autonomous vehicles.

NOTE: Miniproject/Discussions/Practice on Workbench/AUTOSAR/ Vehicle simulators / modeling packages on the basics of interfacing sensors, actuators specific to automobile-microcontrollers/ special automobile-microcontrollers for i/o port communication applicable to vehicles

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: The learning process delivers insight into the significance of the role of embedded system for automotive applications.
CO2: Understanding the need, selection of sensors and actuators and interfacing with ECU
CO3: Applying the Embedded concepts for vehicle management and control systems.
CO4: Understanding 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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓							
CO2	✓	✓		✓	✓							
CO3	✓	✓	✓	✓	✓							
CO4		✓	✓									
CO5	✓	✓	✓			✓		✓	✓			

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ET5076 MEMS TECHNOLOGY LT P C
3 0 0 3

COURSE OBJECTIVES:

- To introduce the diverse technological and functional approaches of MEMS and applications.
- To understand the microstructures and fabrication methods.
- To provide an insight of micro sensors, actuators.
- To emphasis the need and role of MEMS process techniques.
- To update the ongoing trends and real time applications of MEMS technology.

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UNIT I INTRODUCTION TO MEMS 9

Overview of Micro electro mechanical systems (MEMS), devices and technologies, Laws of scaling- multi disciplinary nature of MEMS- Survey of materials- Smart Sensors-Applications of MEMS.

UNIT II MICRO-MACHINING AND MICROFABRICATION TECHNIQUES 9

Photolithography- 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 MEMS PROCESS TECHNIQUES 9

Simulation and modeling of MEMS components - Computer- aided design for MEMS layout, SOI, Metal and Poly MUMPs- Microsystem Design and Packaging -Rapid product development.

UNIT V MEMS APPLICATION AND RECENT TRENDS 9

Introduction to Micro/Nano Fluids- Micro pump- Bio MEMS- Optical MEMS- Micro motor- Accelerator- Applications of SMA- Recent trends in MEMS- Introduction to NEMS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Understanding the material properties and the significance of MEMS for industrial automation.

CO2: Knowledge delivery on micromachining and micro fabrication.
CO3: Applying the fabrication mechanism for MEMS sensor and actuators.
CO4: Applying the concepts of MEMS to models ,simulate and process the sensors and actuators.
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS technology.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓					✓						✓
CO2	✓			✓	✓			✓				
CO3	✓		✓	✓	✓							
CO4	✓		✓									
CO5	✓	✓	✓			✓		✓	✓			

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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. Sabrie solomon “Sensors Handbook”, Mc Graw Hill 1998.
6. MEMS and Microsystems: design , manufacture, and Nanoscale ... 2nd Edition, by Tai-.Ran Hsu, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008

ET5077 **NANO ELECTRONICS** **LT P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce the properties of electron and its implication for electronics
- To teach the importance and the issues of Nanoscale CMOS technology.
- To introduce the characteristics and applications of Nano electronic devices, methods and techniques.
- To teach the circuits and architectural features of nano memory devices.
- To introduce the various fabrication techniques for nano electronic devices.

UNIT I INTRODUCTION **9**

Overview of nanotechnology – Implication on science, engineering and technology- Particles-, waves, Wave mechanics, schrodinger equation- Electron transport in semiconductors and nanostructures, Nano materials and its properties- Electrical and Electronics Applications of Nanotechnology.

UNIT II NANOSCALE CMOS 9

Survey of modern electronics and trends towards nano electronics CMOS scaling, challenges and limits, static power, device variability, interconnect - CNT-FET, FinFET, FerroFET - Surround gate FET nanoscale CMOS circuit design and analysis

UNIT III NANOELECTRONIC DEVICES 9

Resonant-tunneling diodes- Resonant Tunneling Transistor-Single-electron transfer devices-Potential effect transistors- Nano Photonic Devices-Molecular electronic devices -Nano-electromechanical system devices-Recent development.

UNIT IV NANOELECTRONIC COMPUTATION AND MEMORIES 9

Quantum-dot cellular automata –Spintronics- Memristor- Nano tube for memories- Nano RAM-Nanoscale DRAM, SRAM, Tunnel magnetoresistance-Giant magnetoresistance- design and applications.

UNIT V FABRICATION TECHNIQUES 9

Clean room standards- Microfabrication –Synthesis of nao materials-nanofabrication- E-beam lithography- X-ray and ion-beam lithography- nanoimprint lithography- Scanning probe lithography-Nano-characterization techniques.

NOTE: Class room discussions and tutorials can include the following guidelines for improved teaching /learning process :Discussions/Practice on Workbench : on modelling of nano/micro analog &digital devices.

TOTAL : 45 PERIODS

COURSE OUTCOMES: After the completion of this course the student will be able to:

CO1: Understand the properties of electron and the significance of of nanotechnology.
CO2: Concept of nanoscale CMOS devices and its various issues.
CO3: Apply the concept of nanotechnology and understand the significance of nano electronic devices.
CO4: Understand the nano configurations of computational processors and memories with improved design strategies.
CO5: Learn and understand the nano fabrication techniques.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓			✓						✓
CO2	✓	✓	✓		✓	✓						
CO3	✓		✓	✓	✓							
CO4	✓		✓	✓	✓							
CO5	✓		✓			✓		✓				

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2. Rainer Waser, “Nanoelectronics and Information Technology”, Wiley 2005
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Cambridge University Press, 2000.
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5. Kiyoo Itoh Masashi Horiguchi ,Hitoshi Tanaka, Ultra Low voltage nano scale memories. Spl Indian Edition, Springer.
6. George W. Hanson, Fundamental of nano electronics, Pearson education.

ET5004 RECONFIGURABLE PROCESSOR AND SoC DESIGN LT P C
3 0 0 3

COURSE OBJECTIVES:

- To familiarize the need and role of Reconfigurable Processor for embedded system applications.
- To introduce the Reconfigurable Processor technologies
- To teach the salient features and architecture of FPGA.
- To provide an insight and architecture significance of SOC.
- To impart the knowledge of Reconfigurable embedded Processor for real time applications.

UNIT I INTRODUCTION 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

FPGA architecture overview- Challenges of FPGA processor design-Opportunities of FPGA processor design- Designing SoftCore Processors – Designing Hardcore Processors – hardware/software 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.

NOTE: Class Room Discussions and Tutorials can include the following Guidelines for improved Teaching /Learning Process: Practice through any of Case studies through Exercise/Discussions on Design , Development of embedded solutions using reconfigurable processor support

TOTAL: 45 PERIODS

COURSE OUTCOMES : After the completion of this course the student will be able to:

CO1: Understand the need of reconfigurable computing and hardware-software co design

CO2: Understand the significance of FPGA technology
CO3: Apply the concept of FPGA technology and understand FPGA architectures.
CO4: Understand the operation of SoC processor.
CO5: Apply and improve Employability and entrepreneurship capacity due to knowledge up- gradation on reconfigurable computing and SoC design

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓							
CO2		✓	✓		✓							
CO3	✓		✓	✓	✓							
CO4	✓		✓	✓	✓							
CO5	✓		✓		✓	✓		✓	✓			

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
3. Joao Cardoso, Michael Hübner, "Reconfigurable Computing: From FPGAs to Hardware/Software Codesign" Springer, 2011.
4. Ron Sass and Anderew G.Schmidt, “ Embedded System design with platform FPGAs: Principles and Practices”, Elsevier, 2010.
5. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007
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ET5078 ROBOTICS AND AUTOMATION LT P C
3 0 0 3

COURSE OBJECTIVES:

- To teach the need of embedded system technology for robot building
- To Study The Various Parts Of Robots And Fields Of Robotics.
- To Study The Various Kinematics And Inverse Kinematics Of Robots.
- To Study The Trajectory Planning For Robot.
- To Study The Control Of Robots For Some Specific Applications.

UNIT I INTRODUCTION TO ROBOTICS 9

Overview of Robotics & Automation – Different Types of Robotics – Various Generations of Robots- Asimov’s Laws Of Robotics –Selection of Robots-Role and design of embedded system for robotics and automation –Recent trends.

UNIT II POWER SOURCES AND SENSORS 9

Hydraulic, Pneumatic And Electric Drives – Determination Of HP Of Motor And Gearing Ratio –

Variable Speed Arrangements – Path Determination – Micro Machines In Robotics – Machine Vision – Ranging – Laser – Acoustic – Magnetic, Fiber Optic And Tactile Sensors-smart sensors.

UNIT III MANIPULATORS, ACTUATORS AND GRIPPERS 9

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

Solution Of Inverse Kinematics Problem – Multiple Solution Jacobian Work Envelop – Hill Climbing Techniques –path planning algorithms- Robot Programming Languages- Simulation and modeling of simple

UNIT V CASE STUDIES 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Selection of suitable embedded boards for robots

CO2: Understanding the concepts of robotics & automation and Working Of Robot

CO3: Analyze the Function of Sensors and actuators In the Robot

CO4: Write Program to Use a Robot For a Typical Application

CO5: Apply and improve Employability and entrepreneurship capacity due to knowledge up- gradation on Embedded system based robot development

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓							
CO2	✓		✓		✓							
CO3	✓		✓	✓	✓							
CO4	✓		✓	✓	✓							
CO5	✓		✓		✓	✓		✓	✓			

REFERENCES:

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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. Mikell P.Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, “Industrial Robotics Technology, Programming And Applications “, McGraw Hill Book Company 1986.

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ET5005 SMART SYSTEM DESIGN LT P C
3 0 0 3

COURSE OBJECTIVES:

- To understand about the smart system technologies and its role in real time applications
- To expose students to different open source platforms and Attributes.
- To teach the architecture and requirements of Home Automation.
- To provide an insight into smart appliances and energy management concepts.
- To familiarize the design and development of embedded system based system design.

UNIT I INTRODUCTION 9

Overview of smart system design and requirements- Hardware and software selection & co-design-Communications-smart sensors and actuators-Open-source resources for embedded system- android for embedded system - Embedded system for Ecommerce- Embedded system for Smart card design and development –Recent trends.

UNIT II MOBILE EMBEDDED SYSTEM 9

Design requirements-Hardware platform- OS and Software development platform- Mobile Apps development- Applications: heart beat monitoring, blood pressure monitoring, mobile banking and appliances control.

UNIT III HOME AUTOMATION: **9**

Home Automation System Architecture-Essential Components- Linux and Raspberry Pi – design and real time implementation.

UNIT IV SMART APPLIANCES AND ENERGY MANAGEMENT 9

Overview- functional requirements-Embedded and Integrated Platforms for Energy Management- Energy Measurement Techniques for Smart Metering-Smart Embedded Appliances Networks – Security Considerations.

UNIT V EMBEDDED SYSTEMS AND ROBOTICS 9

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

TOTAL: 45 PERIODS

NOTE: Class room discussions and tutorials can include the following guidelines for improved teaching /learning process :Discussions on integration of H/W & S/W technology in automation of system/process.

COURSE OUTCOMES:

CO1: Students will develop more understanding on the concepts of smart system design and its present developments.

CO2: Students will study about different embedded open source and cost effective techniques for developing solution for real time applications.

CO3: Students will acquire knowledge on different platforms and Infrastructure for Smart system design.
CO4: Students will learn about smart appliances and energy management concepts.
CO5: Apply and improve Employability and entrepreneurship capacity due to knowledge up gradation on embedded system technologies.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓							
CO2			✓	✓	✓							
CO3	✓		✓	✓	✓							
CO4	✓		✓	✓	✓							
CO5	✓		✓		✓	✓		✓	✓			

REFERENCES:

1. Thomas Bräunl, Embedded Robotics ,Springer, 2003.
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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.
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10. Robert Faludi,"Wireless Sensor Networks",O'Reilly,2011.

ET5006 **DIGITAL IMAGE PROCESSING SYSTEM** **LT P C**
3 0 0 3

COURSE OBJECTIVES:

The objectives of this course to impart knowledge in

- the fundamentals of image processing
- the techniques involved in image enhancement
- the low and high-level features for image analysis
- the fundamentals and significance of image compression
- the hardware for image processing applications

UNIT I FUNDAMENTALS OF IMAGE PROCESSING **9**

Introduction to image processing systems, sampling and quantization, color fundamentals and models, image operations – arithmetic, geometric and morphological. Multi-resolution analysis – image pyramids

UNIT II IMAGE ENHANCEMENT 9

Spatial domain; Gray-level transformations – histogram processing – spatial filtering, smoothing and sharpening. Frequency domain: filtering in frequency domain – DFT, FFT, DCT – smoothing and sharpening filters – Homomorphic filtering. Image enhancement for remote sensing images and medical images.

UNIT III IMAGE SEGMENTATION AND FEATURE ANALYSIS 9

Detection of discontinuities – edge operators – edge linking and boundary detection, thresholding – feature analysis and extraction – region based segmentation – morphological watersheds – shape skeletonization, phase congruency. Number plate detection using segmentation algorithm.

UNIT IV IMAGE COMPRESSION 9

Image compression: fundamentals – models – elements of information theory – error free compression – lossy compression – compression standards. Applications of image compression techniques in video and image transmission.

UNIT IV EMBEDDED 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

TOTAL: 45 PERIODS

COURSE OUTCOMES: At the end of the course students will comprehend

CO1: Able to understand the fundamentals of image processing.
CO2: Able to understand the techniques involved in image enhancement, segmentation and compression.
CO3: Able to analyze their real-time applications
CO4: Able to implement image processing applications using software and hardware.
CO5: Develop real time solutions for applications

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓	✓										
CO3		✓	✓					✓				
CO4		✓		✓	✓			✓				
CO5		✓		✓	✓			✓				

NOTE: Discussions / Exercise / practice on Image enhancement, segmentation and compression with simulation tools such as Matlab/ Raspberry pi (python programming) will help the student understand image processing concepts and hardware implementation using relevant processors

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1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image processing”, 2nd edition, Pearson education, 2003
2. Anil K. Jain, “Fundamentals of digital image processing”, Pearson education, 2003

3. Milan Sonka, ValclavHalavac and Roger Boyle, “Image processing, analysis and machine vision”, 2nd Edition, Thomson learning, 2001
4. Mark Nixon and Alberto Aguado,“Feature extraction & Image processing for computer vision”,3rd Edition, Academic press, 2012
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ET5007 ADVANCED DIGITAL SYSTEMS DESIGN LT P C
3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the fundamentals of sequential system design, Asynchronous circuits, switching errors.
- To study on Fault identification in digital switching circuits
- To introduce logics for design of Programmable Devices
- To teach the fundamentals of modeling through comparative study on the classification of commercial family of Programmable Device
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I SEQUENTIAL CIRCUIT DESIGN 9

Analysis of Clocked Synchronous Sequential Networks (CSSN) Modelling of CSSN – State Stable Assignment and Reduction – Design of CSSN – ASM Chart – ASM Realization.

UNIT II ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN 9

Analysis of Asynchronous Sequential Circuit (ASC) – Flow Table Reduction – Races in ASC – State – Design of ASC – Static and Dynamic Hazards – Essential Hazards – Designing Vending Machine Controller

UNIT III FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS 9

Fault Table Method – Path Sensitization Method – Boolean Difference Method – Kohavi Algorithm – Tolerance Techniques-Built-in Self Test.

UNIT IV SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES 9

Architecture of EPLD, Programmable Electrically Erasable Logic - Realize combinational, Arithmetic, Sequential Circuit with Programmable Array Logic; Architecture and application of Field Programmable Logic Sequence**.**

UNIT V ARCHITECTURES AND PROGRAMMING PROGRAMMABLE LOGIC DEVICES 9

FPGA Fundamentals– SRAM based FPGA architecture – Advanced FPGA features – FPGA selection and Design decisions - Xilinx Spartan and Virtex family.

NOTE:

Miniproject/Discussions/Practice on Workbench : Logic Synthesis And Simulation for digital design with VHDL, hierarchical modeling concepts, modules and port definitions, gate level modeling, data flowmodeling, behavioral modeling task & functions, logic synthesis-simulation-Design examples, Ripple carry Adders, Carry Look ahead adders, Design of Arithmetic circuits for Fast adder, Array Multiplier,ALU, Shift Registers, Multiplexer, Comparator/other examples on Test Bench.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: incorporating synchronous switching logics, with clocked circuits design

CO2: incorporating asynchronous switching logics, with clocked circuits design

CO3: applying the testing algorithms and fault diagnostic techniques for digital systems

CO3: Observe the detection of Error and correction for error free circuitry

CO4: Design of computation logics of processors using IEEE standard Software Emulator on reconfigurable device like FPGAs

CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on digital circuits design, testing and programming of reconfigurable digital logic processors.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2		✓	✓									✓
CO3		✓	✓									✓
CO4		✓	✓									✓
CO5		✓			✓							✓

REFERENCES:

1. Donald G. Givone, “Digital principles and Design”, Tata McGraw Hill 2002.
2. By R. C. Cofer, Benjamin F. Harding, “Rapid System Prototyping with FPGAs: Accelerating the Design Process” , Elsevier, 2006.
3. Charles H. Roth Jr., “Digital Systems design using VHDL”, Cengage Learning, 2010.
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5. Parag K Lala, “Digital System design using PLD”, BS Publications, 2003
6. John M Yarbrough, “Digital Logic applications and Design”, Thomson Learning,2001
7. Nripendra N Biswas, “Logic Design Theory”, Prentice Hall of India, 2001
8. Charles H. Roth Jr., “Fundamentals of Logic design”, Thomson Learning, 2004.
9. John V.Oldfeild,Richard C.Dorf,”Field Programmable Gate Arrays”,Wiley India Edition,2008

ET5008 COMPUTER ARCHITECTURE AND PARALLEL PROCESSING LT P C
3 0 0 3

COURSE OBJECTIVES:

- To educate the students about the fundamentals of parallel processing uC
- To teach the fundamentals of network topologies for multiprocessors
- To discuss on different pipeline designs, memory technologies
- To introduce features of parallel processors , OS for multiprogramming.
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I THEORY OF PARALLELISM IN PROCESSOR 9

Parallel Computer models – the state of computing-introduction to parallel processing- parallelism in uniprocessors& Multiprocessors,-parallel architectural classification schemes-speedup performance laws-issues in H/W-S/W parallelism

UNIT II SYSTEM INTERCONNECT ARCHITECTURES 9

System interconnect Architectures-Network Properties and routing-Static Interconnection Networks-Dynamic Interconnection Networks-Multiprocessor System Interconnects-interprocessor communication network-Structure of Parallel Computers-Hierarchical bus systems-Crossbar switch and multiport memory-multistage and combining network

UNIT III PIPELINING AND MULTITHREADED ARCHITECTURE TECHNOLOGIES 6

Pipeline principle and implementation-classification of pipeline processor-introduction of arithmetic, instruction, processor pipelining-pipeline mechanisms-hazards-Introduction to multithreaded Architecture-Cluster computing

UNIT IV HARDWARE TECHNOLGIES 12

Basic Comparative study features of advanced embedded processors: of Architectures - addressing modes -instruction types-performance of- Parallel and scalable architectures, Multiprocessors -SIMD ,MIMD computers, Superscalar, Array & vector processors, Systolic processors of their unique features - Memory Management- performance and issues.

UNIT V OS ISSUES FOR MULTI PROCESSOR 9

Introduction-Need for Pre emptive OS – Synchronising and Scheduling in Multiprocessor OS-, Usual OS scheduling Techniques, threads – Classification of multi processor OS – Software requirements of multiprocessor OS, Distributed scheduler in shared memory systems

NOTE: Discussions/Practice on Workbench : modelling of Computing Algorithms /ALU Functional Blocks

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To understand the basics and requirement of parallelism in processor functionals.
CO2: Observe the specialty of Interconnection Networks within processor through Comparative study on parallel architectures within multicore processors.
CO3: Understand on instruction and processor pipelining mechanisms
CO4: Design aspects and Software requirements of multiprocessor OS
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded processors.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2		✓	✓									
CO3		✓	✓									
CO4		✓	✓									
CO5		✓			✓							

REFERENCES:

1. John L. Hennessy, David A. Petterson, “Computer Architecture: A Quantitative Approach”, 4th Edition, Elsevier, 2007
2. Advanced Computer architecture , By Rajiv Chopra, S Chand , 2010
3. Kai Hwang “Advanced Computer Architecture”.Tata McGraw Hill 2000
4. Dezso Sima, Terence Fountain, Peter Kacsuk, “Advanced computer Architecture – A design Space Approach”. Pearson Education,2003.
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7. David E. Culler, Jaswinder Pal Singh with Anoop Gupta “Parallel Computer Architecture” ,Elsevier, 2004.
8. John P. Shen. “Modern processor design Fundamentals of super scalar processors”, Tata McGraw Hill 2003.
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10. Richard Y. Kain, “Advanced computer architecture – A system Design Approach”, PHI, 2003.

ET5009 NETWORK EMBEDDED PROCESSORS LT P C
3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the concepts of HARDWARE/SOFTWARE Modelling partitioning, co-simulation.
- To expose the students to the fundamentals of the internals of a router and hardware architecture for protocol processing,
- To study on Fundamentals on design attributes of functional units of Network processors their architecture, through the classification of commercial Network in processors
- To introduce aspects in Protocols: Design issues, goals in Network processors
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills.

UNIT I HARDWARE/SOFTWARE PARTITIONING IN EMBEDDED PROCESSOR 9

Embedded systems- Hardware/Software Co-Design, Co-Design for System Specification and modeling of Single-processor Architectures & Multi-Processor Architectures, Co-Design Approaches, Models of Computation, Hardware/Software Partitioning -Cost Estimation, Generation of Partitioning by Graphical modeling, Formulation of the HW/SW scheduling, CO-Synthesis.

UNIT II EMBEDDED PROCESSOR FOR NETWORK PROTOCOL PROCESSING 9

Introduction and overview, basic terminology and example systems, review of protocols and packet format, Conventional computer hardware architecture, basic packet processing, packet processing functions, protocol software on a conventional processor, hardware architecture for

protocol processing, classification and forwarding, switching fabrics, Hardware/Software Traffic management implementation

UNIT III ARCHITECTURE OF NETWORK PROCESSORS 9

Network processors, the complexity of network processor design, network processor architectural Overview and comparison of commercial network processors-Case study on the Intel network processor, RISC processor, packet processor hardware.

UNIT IV SCALING IN NETWORK PROCESSORS 9

Scalability With Parallelism And Pipelining-issues in scaling a network processor-Complexity Of Network Processor Design (packet processing, ingress & egress processing, Macroscopic Data Pipelining And Heterogeneity etc) - Network Processor fun : Packet Flow, Clock Rates, software architecture, Assigning Functionality To The Processor Hierarchy.

UNIT V CLASSIFICATION OF NETWORK PROCESSORS 9

Basis in Classification of network processors- Multichip pipeline, configurable instruction set processors, packet processor-Issues In Scaling A Network Processor (processing hierarchy and scaling)–functional configurations in commercial Network Processors : Multi-Chip Pipeline, Augmented RISC Processor, Embedded Processor Plus Coprocessors- Design Tradeoffs and consequences (Programmability Vs. Processing Speed , speed vs functionality. etc).

NOTE : Discussions/Exercise/: on commercial processor technology through comparisons on to the design strategies used in multicore processors

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: To understand the basics and requirement of Hardware/Software Partitioning in processor functional.
CO2: Observe the speciality of Interconnection Networks based on packets within multicore processors.
CO3: Understand on instruction and processor pipelining for packets processing mechanisms
CO4: Study the Design configurations in commercial Network Processors
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in parallel computation embedded processors.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2		✓	✓									
CO3		✓	✓									
CO4		✓	✓									
CO5		✓			✓							

REFERENCES:

1. Douglas E. Comer ”Network System Design using Network Processors” Prentice Hall, 2006.
2. Jorgen Staunstrup, Wayne Wolf, “Harware/Software Co-Design:Principles and Practice”, Kluwer Academic Pub, 1997.

3. Patrick Crowley, M A Franklin, H Hadimioglu, PZ Onufryk, "NetworkProcessor Design, Issues and Practices Vol – I, 2, Morgan Kauffman, Elsevier2011
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5. UYLESS black,'computer NETWORKS-Protocols,STANDARDS INTERFACES',2nd ED,PHI,2007
6. Ralf Niemann, "Hardware/Software Co-Design for Data Flow Dominated Embedded Systems", Kluwer Academic Pub, 1998.
7. Jorgen Staunstrup, Wayne Wolf, "Harware/Software Co-Design:Principles and Practice", Kluwer Academic Pub, 1997.
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ET5071 ADVANCED DIGITAL SIGNAL PROCESSING LT P C
3 0 0 3

COURSE OBJECTIVES:

- To expose the fundamentals of digital signal processing in frequency domain& its application
- To teach the fundamentals of digital signal processing in time-frequency domain& its application
- To teach the fundamentals of audio signal processing & its application
- To discuss on Application development with commercial family of DS Processors
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I INTRODUCTION TO DIGITAL SIGNAL PROCESSING 6

Introduction to Digital Signal Processing System- Discrete Time Sequences- Time-Invariant & Time-variant Systems, Decimation and Interpolation- The Sampling Process - Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)- Basics of Digital Filters- FIR Filters, IIR Filters -adaptive filter based on LMS.

UNIT II WAVELET TRANSFORM 9

Introduction to continuous wavelet transform- discrete wavelet transform -orthogonal wavelet decomposition- Multiresolution Analysis-Wavelet function-DWT,bases,orthogonal Basis-Scaling function, Wavelet coefficients- Multirate signal processing and their relationship to filter banks-Digital filtering interpolation(i) Decomposition filters, (ii) reconstruction, the signal- Example MRA-Haar & Daubechies wavelet.

UNIT III AUDIO SIGNAL PROCESSING 12

Introduction to Speech and Audio Processing - Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters- convolution - autoregressive model, autocorrelation estimation, General structure of speech coders; Requirements of speech codecs –quality, LPC model of speech production- LPC encoders and decoders-Power spectral density, periodogram ,Spectral measures of audio signal.

UNIT IV ARCHITECTURES OF COMMERCIAL DIGITAL SIGNAL PROCESSORS 12

Introduction, catogorisation of DSP Processors-one case example Architecture Processor for Fixed Point (Blackfin),Floating Point & Speech Processor- Basics of Architecture – study of functional variations of Computational building blocks(with comparison onto their MAC, Bus Architecture ,I/O interface, application).

UNIT V IMPLEMENTATION OF DSP BASED SYSTEMS 6

Introduction- Interfacing processor- Memory Interface-I/O Interface-Mapping of DSP algorithm onto hardware -Design of Filter-FFT Algorithm- Application with DSP based Interfacing- Power Meter; DSP as motor control

NOTE: Discussions/Miniproject/Practice on Workbench : Signal analysis transforms, Filter design concepts with simulation tools as Matlab /Labview/ VLSI/CCS/other suites to understand the commercial DSP processor technology and practice in programming.

. **TOTAL: 45 PERIODS**

COURSE OUTCOMES:

CO1: The concepts of Time and frequency analysis of Signal Transforms based on signal types.
CO2: The fundamentals of Time-Frequency Transforms are introduced
CO3: Analyze the quality and properties of speech based on DSP
CO4: Study features through comparison on commercial available DSProcessors
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in signal processing for embedded systems design.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2		✓	✓									
CO3		✓	✓									
CO4		✓	✓									
CO5		✓			✓							

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ET5010 EMBEDDED PRODUCT DEVELOPMENT LT P C
3 0 0 3

COURSE OBJECTIVES:

- Aims at providing the basic concepts of product design, product features & its architecture
- Creative thinking in developing automation into consumer products of market value
- To know the techniques & procedures that are practiced in Industry for Product manufacture
- Developing an embedded product with hardware-software components.
- Need for knowing role of IDE Tools, reverse engineering .

UNIT I CONCEPTS OF PRODUCT DEVELOPMENT 9

Need for PD- Generic product Development Phases- Product Development Process Flows- Product Planning –Product Specifications-Understanding customer and behavior analysis. Basics of Concept Generation-Five Step Method- Concept selection- Creative thinking methods and problem solving- design concepts-systematic methods for designing –functional decomposition – physical decomposition –Product Architecture--changes - variety – component standardization – Bill of materials**-**example case study on Conceptual Design of Digital Printer as a product.

UNIT II INTERFACES FOR PRODUCT DEVELOPMENT 9

Product development management - establishing the architecture - clustering -geometric layout development - Fundamental and incidental interactions - architecture of the chunks - creating detailed interface specifications-Portfolio Architecture- Producibility-quality assurance-value addition- advertisement-Benchmarking - competitive benchmarking- product performance analysis ..

UNIT III APPROACHES FOR NEW PRODUCT DEVELOPMENT 9

Idea Generation -Brainstorming Methods - Osborne's Checklist-Conjoint Analysis -Delphi Technique- Six Thinking Hats -TRIZ - Idea generation ,TRIZ Process Methodology -Failure Modes and Effects Analysis- SWOT Analysis- Concept Development & Testing**-** Risk Management Process- Force Field Analysis- Decision Tree Analysis- KANO Model Methodology- Quality Functional Deployment- Product Life Cycle-v- KANO Model- Gantt Charts- Critical Path Analysis & PERT- Reverse Engineering Methodology- Reverse Engineering of Electronic Components- Finding reusable software components- reverse engineering for consumer product development - ethical aspects in reverse engineering.

UNIT IV INDUSTRIAL DESIGN 9

Integrate process design - Industrial Design - Managing costs- need for Involving CAE, CAD, CAM tools -Prototype basics - Rapid Prototyping - Prototyping Techniques ,- Planning for prototypes- Economic & Cost Analysis - Understanding and representing tasks-baseline project planning - accelerating the project-project execution -Testing-Product Development Testing -Exploratory , Assessment , Validation Tests- Design for X- Industrial Design Management - -Lean Manufacturing- Just In Time (JIT) –Kaizen-Kanban-Re-engineering -

UNIT V DEVELOPING EMBEDDED PRODUCT 9

Creating Embedded System Architecture(with atleast one Case study example: Mobile Phone /Adaptive Cruise Controller/ Robonoid about) -Architectural Structures- Criteria in selection of Hardware & Software Components, product design by modeling, Performance , Testing.

NOTE: Miniproject/ Discussions/Assignment with a prototype design of a new product élucidating its design and development.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- CO1: Improved knowledge upgradation on recent trends in embedded systems design with understand the integration of customer requirements in product design
- CO2:Apply structural approach to concept generation, creativity, selection and testing so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in developing it as an commercial grade product.
- CO3: Understand various aspects of design such as industrial design, design of Consumer specific product , its Reverse Engineering manufacture ,economic analysis through product architecture
- CO4:Observe the success strategies practiced by Industries in New Product Development
- CO5: To involve Miniproject/Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability& entrepreneurship skills

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2		✓	✓									
CO3		✓	✓									
CO4		✓	✓									
CO5		✓			✓							

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2. George E.Dieter, Linda C.Schmidt, “Engineering Design”, McGraw-Hill International Edition,4th Edition, 2009, ISBN 978-007-127189-9
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ET5075 EMBEDDED NETWORKING AND AUTOMATION OF ELECTRICAL SYSTEM **L T P C 3 0 0 3**

COURSE OBJECTIVES:

- To discuss the fundamentals building blocks of a digital instrument.
- Introduce wired, WSN for configuring metering network
- Discuss requirements for grid automation using meters.
- To discuss networking configuration to develop PAN.
- To discuss the functions of digital instrument Power quality monitoring.

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 .

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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 Netmetering 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

NOTE : Mini project/ Discussions/Exercise on Workbench /simulators: on the basics interface of sensors,actuators to microcontrollers,role of virtual Instrumentation software packages simulators/ special microcontrollers for i/o port communication etc

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: The criteria of choice of sensors, components to build meters.
CO2: The demand for BUS communication protocols are introduced
CO3: Analyze 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2		✓	✓									
CO3		✓	✓									
CO4		✓	✓									
CO5		✓			✓							

REFERRENCES:

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2. Krzysztof Iniewski,"Smart Grid ,Infrastructure & Networking",TMcGH,2012
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8. Bhaskar Krishnamachari, 'Networking wireless sensors', Cambridge press 2005

ET5074 **DIGITAL INSTRUMENTATION** **LT P C**
3 0 0 3

COURSE OBJECTIVES:

- To expose the students to the fundamentals of wired embedded networking techniques.
- To expose the students to the fundamentals of wireless embedded networking
- To study on design of automation tools to model instrumentation
- To introduce design wireless networking for monitoring grid
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I DIGITAL METER INFRASTRUCTURE 9

Building blocks of automated instruments -Calibration, Overview of A/D converter- Data acquisition – Sampling , Errors–-Signal conditioners -–Counters – Modes of operation- Frequency, Period, Time interval measurements, autorange setting, Prescaler- Heterodyne converter for frequency measurement- Single and Multi channel Data Acquisition systems- Digital Modulation -serial wired Instrument bus protocols- RS 232C, RS 485 and USB standards –digital display.

UNIT II DIGITAL METERING OF PROCESS 9

Introduction – sensors and Digital Meters for vibration, temperature, pressure measurement of system- Multichannel DSO -Data loggers -meter data analytics -PC based process measurements - Digital Signal Sources- automating meter with Data analysis & display control.

UNIT III METERING WITH VIRTUAL INSTRUMENTATION 9

VI-Introduction, Block diagram and Architecture –VI for testing Real time process– Graphical programming using GUI – ADC/DAC – Digital I/O – Counter , Timer-I/O GUI-VI for Intelligent metering and control – Software and hardware of I/O communication blocks-peripheral interface

UNIT IV METERING BASED ON WIRELESS NETWORK 9

Wireless sensor networks-Introduction– performance of Zigbee sensor network for metering – challenges in wireless Meters- IoT in metering-Design challenges in IoT, - overview on ANSI ,IEC smart metering standards as case study.

UNIT V AUTOMATED METERING OF ELECTRICAL SYSTEMS 9

Digital meters and Instrumentation for electrical measurements- metering to test electrical components - meters for Smart grid management-AMI needs in smart grid- Meter data management -communication enabled metering.

NOTE : Miniproject / Discussions/ Practice on Workbench : on Digital meter ,Control of Relays/ Solenoids, DC/ STEPPER motor, Battery,Display Interface; modeling process metering and control /designing of Digital meter with wired /wireless communication interface suites / Virtual Laboratory tools.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: The concepts of Time and frequency analysis of Signal Transforms based on signal types.
CO2: The fundamentals of Time-Frequency Transforms are introduced
CO3: Analyze the quality and properties of speech based on DSP
CO4: Study through comparison on commercial available DSProcessors
CO5: Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2		✓	✓									✓

CO3		✓	✓									✓
CO4		✓	✓									✓
CO5		✓			✓							✓

REFERENCES:

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ET5011 WEB TECHNOLOGIES AND TRENDS LT P C
3 0 0 3

COURSE OBJECTIVES:

- To teach the fundamentals of Internet Technology.
- To teach on functional components Web services, data management
- To discuss on significance of SOA in embedded networking
- To teach the need of Cloud Computing, its services for embedded applications
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I WEB ESSENTIALS 9

Web Essentials: Clients, Servers, and Communication. The Internet-Basic Internet Protocols -The World Wide Web-HTTP request message-response message-Web Clients Web Servers-Case Study. Markup Languages: XHTML. An Introduction to HTML History-Versions-Basic XHTML Syntax and Semantics-Some Fundamental HTML Elements-Relative URLs-Lists-tables-Frames-Forms-XML Creating HTML Documents Case Study.

UNIT II WEB DATA 9

Representing Web Data: XML-Documents and Vocabularies- Versions and Declaration-Namespaces JavaScript and XML: Ajax-DOM based XML processing Event-oriented Parsing: SAX-Transforming XML Documents-Selecting XML Data: XPATH-Template based Transformations: XSLT-Displaying XML Documents in Browsers.

UNIT III SERVICE ORIENTED ARCHITECTURE 9

Roots of SOA – Characteristics of SOA - Comparing SOA to client-server and distributed internet architectures – Anatomy of SOA- How components in an SOA interrelate - Principles of service orientation

UNIT IV INTRODUCTION TO CLOUD COMPUTING 9

Basics of Cloud Computing – History of Cloud Computing – Cloud Architecture – Cloud Storage – Why Cloud Computing Matters – Advantages of Cloud Computing – Disadvantages of Cloud Computing – Companies in the Cloud Today – Cloud Services

UNIT V USING CLOUD SERVICES 9

Collaborating on Calendars, Schedules and Task Management – Exploring Online Scheduling Applications – Exploring Online Planning and Task Management – Collaborating on Event Management – Collaborating on Contact Management – Collaborating on Project Management – Collaborating on Word Processing - Collaborating on Databases – Storing and Sharing Files

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to get a strong insight onto role of Web enabled communication systems.
CO2: Able to understand the use of networking for large scale systems
CO3: Able to use Web based technologies for product development
CO4: Able to use cloud computing for simple applications.
CO5: Able to gain improved employability and entrepreneurship capacity

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓	✓		✓								
CO3		✓	✓	✓	✓							
CO4								✓	✓			
CO5								✓	✓			

REFERENCES:

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ET5012 **OPEN SOURCE SOFTWARE** **LT P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce and define open source software
- To identify and discuss various software licensing models
- Understand the motivation, theory, strengths and weaknesses of open source software.
- Become familiar with Linux, MySQL, PHP, Python, Apache and other Tools and technologies
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

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 - 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓		✓		✓							

CO3	✓								✓			
CO4		✓	✓		✓							
CO5				✓				✓				

REFERENCES:

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CO5152 INTELLIGENT CONTROLLERS LT P C
3 0 0 3

COURSE OBJECTIVES

To educate the students on

- Design of ANN and fuzzy set theory.
- Analysis and implementation of ANN and Fuzzy logic for modeling and control of Non-linear system and to get familiarized with the Matlab toolbox.
- Impart the knowledge of various optimization techniques and hybrid schemes with the ANFIS tool box.

UNIT I OVERVIEW OF ARTIFICIAL NEURAL NETWORK (ANN) & FUZZY LOGIC 9

Review of fundamentals - Biological neuron, Artificial neuron, Activation function, Single Layer Perceptron – Limitations – Multi Layer Perceptron – Back propagation algorithm (BPA); Fuzzy set theory – Fuzzy sets – Operation on Fuzzy sets - Scalar cardinality, fuzzy cardinality, union and intersection, complement (yager and sugeno), equilibrium points, aggregation, projection, composition, fuzzy relation – Fuzzy membership functions.

UNIT II NEURAL NETWORKS FOR MODELLING AND CONTROL 9

Generation of training data - optimal architecture – Model validation- Control of non linear system using ANN- Direct and Indirect neuro control schemes- Adaptive neuro controller – Case study - Familiarization of Neural Network Control Tool Box.

UNIT III FUZZY LOGIC FOR MODELLING AND CONTROL 9

Modeling of nonlinear systems using fuzzy models(Mamdani and Sugeno) –TSK model - Fuzzy Logic controller – Fuzzification – Knowledge base – Decision making logic – Defuzzification- Adaptive fuzz y systems-Case study-Familiarization of Fuzzy Logic Tool Box.

UNIT IV GENETIC ALGORITHM 9

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

UNIT V 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 - Case study– Familiarization of ANFIS Tool Box.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Ability to

CO1: Understand the basic architectures of NN and Fuzzy sets
CO2: Design and implement ANN architectures, algorithms and know their limitations.
CO3: Identify and work with different operations on the fuzzy sets.
CO4: Develop ANN and fuzzy logic based models and control schemes for non-linear systems.
CO5: Understand and explore hybrid control schemes and PSO

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓			✓						✓
CO2	✓	✓	✓			✓						
CO3	✓	✓	✓			✓						✓
CO4	✓	✓	✓			✓						✓
CO5	✓	✓	✓			✓						✓

REFERENCES:

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2. Timothy J.Ross, “Fuzzy Logic with Engineering Applications”, Wiley, Third Edition, 2010.
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CO5251 **MACHINE LEARNING** **LT P C**
3 1 0 4

COURSE OBJECTIVES

To educate the students

- On several fundamental concepts and methods for machine learning.
- And get acquaint with basic learning algorithms and techniques and their applications.
- Acquire knowledge in processing, analyzing and handling data sets.
- Demonstrate typical applications of various clustering based learning algorithms

UNIT 1 INTRODUCTION TO MACHINE LEARNING 12

Objectives of machine learning – Human learning/ Machine learning – Types of Machine learning:- Supervised Learning – Unsupervised learning – Reinforcement Learning – Evolutionary Learning - Regression – Classification – The Machine Learning Process:- Data Collection and Preparation – Feature Selection – Algorithm Choice – Parameter and Model Selection – Training – Evaluation.

UNIT II DATA PREPROCESSING 12

Data quality – Data preprocessing: - Data Cleaning:– Handling missing data and noisy data – ata integration:- Redundancy and correlation analysis – Data Reduction:- Dimensionality reduction (Linear Discriminant Analysis – Principal Components Analysis – Factor Analysis –Independent Components Analysis) – Numerosity Reduction - Data Compression - Data Normalization and Data Discretization.

UNIT III SUPERVISED LEARNING 12

Linearly separable and nonlinearly separable populations – Multi Layer Perceptron – Back propagation Learning Algorithm – Radial Basis Function Network – Support Vector Machines: - Kernels – Risk and Loss Functions - Support Vector Machine Algorithm – Multi Class Classification – Support Vector Regression.

UNIT IV CLUSTERING AND UNSUPERVISED LEARNING 12

Introduction – Clustering:- Partitioning Methods:- K-means algorithm - Hierarchical clustering – Fuzzy Clustering – Clustering High-Dimensional Data:- Problems – Challenges – Subspace Clustering – Biclustering - Self Organizing Map (SOM) - SOM algorithm.

UNIT V BAYESIAN LEARNING 12

Probability based clustering – The Expectation Maximization Algorithm – Bayesian Classification – Bayesian Networks – Learning Bayesian Networks – Hidden Markov Models.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: To understand the basic theory underlying machine learning.
CO2: A range of machine learning algorithms along with their strengths and weaknesses.
CO3: To formulate machine learning problems corresponding to different applications.
CO4: To apply machine learning algorithms to solve problems of moderate complexity.
CO5: To read current research papers and understand the issues raised by current research.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓		✓		✓						
CO2	✓	✓										
CO3	✓	✓			✓							✓
CO4	✓	✓				✓						✓
CO5	✓	✓		✓								✓

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2. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Elsevier, 2011
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4. Ferdinand van der Heijden, Robert Duin, Dick de Ridder, David M. J. Tax, Classification,Parameter Estimation and State Estimation: An Engineering Approach Using MATLAB, John Wiley & Sons, 2005.

HV5072 DESIGN OF SUBSTATIONS LT P C
3 0 0 3

COURSE OBJECTIVES:

- To provide in-depth knowledge on design criteria of Air Insulated Substation (AIS) and Gas Insulated Substation (GIS).
- To obtain the knowledge about layout of AIS and GIS with proper Right of Way.
- To study the substation insulation co-ordination and protection scheme.
- To study the source and effect of fast transients in AIS and GIS.

UNIT I INTRODUCTION TO AIS AND GIS 9

Introduction – characteristics – comparison of Air Insulated Substation (AIS) and Gas Insulated Substation (GIS) – main features of substations, Environmental considerations, Planning and installation- GIB / GIL

UNIT II MAJOR EQUIPMENT AND LAYOUT OF AIS AND GIS 9

Major equipment – design features – equipment specification, types of electrical stresses, mechanical aspects of substation design- substation switching schemes- single feeder circuits; single or main bus and sectionalized single bus- double main bus-main and transfer bus- main, reserve and transfer bus- breaker-and-a- half scheme-ring bus

UNIT III INSULATION COORDINATION OF AIS AND GIS 9

Introduction – stress at the equipment – insulation strength and its selection – standard BILs – Application of simplified method – Comparison with IEEE and IEC standards.

UNIT IV GROUNDING AND SHIELDING 9

Definitions – soil resistivity measurement – ground fault currents – ground conductor – design of substation grounding system – shielding of substations – Shielding by wires and masts.

UNIT V FAST TRANSIENTS PHENOMENON IN AIS AND GIS 9

Introduction – Disconnector switching in relation to very fast transients – origin of VFTO – propagation and mechanism of VFTO – VFTO characteristics – Effects of VFTO.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

CO1 Ability to understand the fundamental components of **AIS AND GIS**.
CO2 Ability to understand the role of **major equipment and layout of AIS AND GIS**.
CO3 Ability to understand the **insulation coordination of AIS and GIS.**
CO4 Ability to understand the significance of **grounding and shielding.**
CO5 Ability to know about the effects of **fast transients in Substation equipment.**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2		✓										
CO3		✓	✓		✓	✓						
CO4				✓	✓	✓						
CO5			✓		✓	✓						

REFERENCES

1. Andrew R. Hileman, “Insulation coordination for power systems”, Taylor and Francis, 1999.
2. M.S. Naidu, “Gas Insulation Substations”, I.K. International Publishing House Private Limited, 2008.
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6. “Design guide for rural substation”, United States Department of Agriculture, RUS Bulletin, 1724E-300, June 2001.
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PW5078 SCADA SYSTEM AND APPLICATIONS MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVES:

- To understand the basic concepts and components of SCADA
- To introduce the SCADA communication protocols
- To apply the SCADA technology to power systems for automation
- To provide knowledge about SCADA based energy management centre.
- To emphasis the role of SCADA monitoring and control concepts.

UNIT I INTRODUCTION TO SCADA 9

SCADA overview, general features, SCADA architecture, SCADA Applications, Benefits, Remote Terminal Unit (RTU), Human- Machine Interface Units (HMI), Display Monitors/Data Logger Systems, Intelligent Electronic Devices (IED), Communication Network, SCADA Server, SCADA Control systems and Control panels

UNIT II SCADA COMMUNICATION 9

SCADA Communication requirements, Communication protocols: Past, Present and Future, Structure of a SCADA Communications Protocol, Comparison of various communication protocols, IEC61850 based communication architecture, Communication media like Fiber optic, PLCC etc. Interface provisions and communication extensions, synchronization with NCC, DCC, IOT, Cyber cell, Redundancy of Network.

UNIT III SCADA IN POWER SYSTEM AUTOMATION 9

Applications in Generation, Transmission and Distribution sector, Substation SCADA system Functional description, System specification, System selection such as Substation

configuration, IEC61850 ring configuration, SAS cubicle concepts, gateway interoperability list, signal naming concept. System Installation, Testing and Commissioning,

CASE STUDIES:SCADA Design for 66/11KV and 132/66/11KV or 132/66 KV any utility Substation and IEC 61850 based SCADA Implementation issues in utility Substations

UNIT IV ENERGY MANAGEMENT CENTRE **9**

Functions, production control and load management, economic despatch, distributed centres and power pool management, energy management system and its role.

UNIT V SCADA MONITORING AND CONTROL **9**

Online monitoring the event and alarm system, trends and reports, Blocking list, Event disturbance recording. Control function: Station control, bay control, breaker control and disconnector control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Students will learn the SCADA system components and its significance.
CO2: Students will understand the need and advantages of communication protocols for SCADA
CO3: Students will get implementation knowledge about the application of SCADA to Power System.
CO4: Students will get exposure to the best operating mechanism for Energy centre based on SCADA concepts
CO5: Students will understand the need and importance of monitoring and control logic for SCADA based power systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓							✓
CO2			✓		✓							
CO3		✓	✓		✓				✓			✓
CO4		✓	✓		✓				✓			✓
CO5	✓		✓									

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PW5071 ELECTRIC VEHICLES AND POWER MANAGEMENT LT P C
3 0 0 3

COURSE OBJECTIVES:

- To provide knowledge about electric vehicle architecture and power train components.
- To know the concepts of dynamics of electrical vehicles
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)
- To understand the concept of energy storage systems.
- To provide knowledge about different energy sources and energy management in HEVs.

UNIT I HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS 9

History of evolution of Electric Vehicles - 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 and 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, models, 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:

CO1: Learned the electric vehicle architecture and power train components.
CO2: Acquired the concepts of dynamics of electrical vehicles
CO3: Able to understand the vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs).
CO4: Ability to design and select energy storage systems.
CO5: Acquired the knowledge of different energy sources and energy management in HEVs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓							
CO2	✓	✓	✓						✓			
CO3	✓			✓		✓	✓					
CO4	✓	✓	✓		✓							
CO5	✓		✓								✓	

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1. Iqbal Husain, 'Electric and Hybrid Electric Vehicles', CRC Press, 2011.
2. Wei Liu, 'Hybrid Electric Vehicle System Modeling and Control', Second Edition, WILEY, 2017.
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PW5251 ENERGY MANAGEMENT AND AUDIT LT P C
3 1 0 4

COURSE OBJECTIVES:

- To study the concepts behind economic analysis and Load management.
- To understand the basics of materials and energy balance.
- To analyze the energy efficiency in thermal utilities.
- To know the concept of compressed air system.
- To illustrate the concept of lighting systems and cogeneration.

UNIT I GENERAL ASPECTS OF ENERGY MANAGEMENT AND ENERGY AUDIT 12

Commercial and Non-commercial energy - final energy consumption - energy needs of growing economy - energy pricing - energy conservation and its importance - Re-structuring of the energy supply sector - Energy Conservation Act 2001, Energy Conservation (Amendment) Act, 2010, and its features - electricity tariff - Thermal Basics - need and types of energy audit - Energy management/audit approach- understanding energy costs - maximizing system efficiencies - optimizing the input energy requirements - energy audit instruments - Case study.

UNIT II MATERIAL AND ENERGY BALANCE 12

Methods for preparing process flow - material and energy balance diagrams - Energy policy purpose - location of energy management - roles and responsibilities of energy manager – employees training and planning- Financial Management:financial analysis techniques, simple payback period, return on investment, net present value, internal rate of return – Case Study.

UNIT III ENERGY EFFICIENCY IN THERMAL UTILITIES 12

Introduction to fuels - properties of fuel oil, coal and gas - principles of combustion - combustion of oil, coal and gas - Boilers: Types, combustion in boilers, performances evaluation, analysis of losses - energy conservation opportunities - FBC boilers - Steam System: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings - Furnaces: Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery – Refractory : types, selection and application of refractories, heat loss - Cogeneration: classification and saving potentials - Case Study.

UNIT IV ENERGY EFFICIENCY IN COMPRESSED AIR SYSTEM 12

Compressed Air System: Types of air compressors - efficient compressor operation - Compressed air system components - leakage test - savings opportunities - Refrigeration System: Vapour compression refrigeration cycle – refrigerants - coefficient of performance - factors affecting Refrigeration and Air conditioning system - savings opportunities - Vapour absorption refrigeration system: working principle - types and comparison with vapour compression system - saving potential - Cooling Tower: Types and performance evaluation, efficient system operation - flow

control strategies and energy saving - Diesel Generating system: Factors affecting selection - energy performance assessment of diesel conservation avenues - Case Study.

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UNIT V ENERGY EFFICIENCY IN ELECTRICAL UTILITIES 12

Electrical load management and maximum demand control - power factor improvement and its benefit - selection and location of capacitors - performance assessment of PF capacitors - automatic power factor controllers - transformer losses - Electric motors: Types - losses in induction motors - motor efficiency - factors affecting motor performance - rewinding and motor replacement issues - energy saving opportunities with energy efficient motors - soft starters with energy saver - variable speed drives – Fans and blowers: Types - efficient system operation - flow control strategies -Pumps and Pumping System: Types - system operation - flow control methods - Lighting System: Light source, choice of lighting, luminance requirements – ballast - occupancy sensors - energy efficient lighting controls - energy conservation avenues - Case Study.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

CO1: Students able to acquire knowledge in the field of energy management and auditing process.
CO2: Learned the about basic concepts of economic analysis and load management.
CO3: Able to design the effective thermal utility system.
CO4: Able to improve the efficiency in compressed air system.
CO5: Acquired the design concepts in the field of lighting systems, light sources and various forms of cogeneration.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓								
CO2	✓						✓		✓		✓	
CO3	✓		✓	✓	✓							
CO4	✓	✓							✓			
CO5	✓		✓	✓							✓	

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2. Sonal Desai, 'Handbook of Energy Audit', McGraw Hill Education (India) Private Limited, 2015.
3. Michael P.Deru, Jim Kelsey, 'Procedures for Commercial Building Energy Audits', American Society of Heating, Refrigerating and Air conditioning Engineers, 2011.
4. Thomas D.Eastop, 'Energy Efficiency: For Engineers and Technologists', Longman Scientific & Technical, 1990.
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6. Larry C. Witte, Philip S.Schmidt, David R.Brown, 'Industrial Energy Management and Utilization', Springer Berlin Heidelberg, 1988.

PW5072 ENERGY EFFICIENT BUILDINGS LT P C
3 0 0 3

COURSE OBJECTIVES:

- To understand the different climate zones and modelling methods
- To understand about the principle of energy conscious building design.

- To understand about the concept of passive solar heating and efficient technologies in electrical system.
- To provide knowledge about the energy conservation techniques in buildings.
- To provide knowledge about energy efficient technologies.

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 equipments – 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 controllers, automatic power factor controllers, energy efficient motors, and soft starters – Energy efficient Lighting and Transformers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to understand the different climate zones and modelling methods
CO2: Able to design energy conscious building design.
CO3: Able to understand about the concept of passive solar heating and efficient technologies in electrical system.
CO4: Able to gain knowledge about the energy conservation techniques in buildings.
CO5: Know about different energy efficient technologies.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2			✓									
CO3			✓	✓								
CO4			✓									
CO5			✓	✓								

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.
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PS5076 WIND ENERGYCONVERSION SYSTEM LT P C
3 0 0 3

COURSE OBJECTIVES

- To learn about the basic concepts of wind energy conversion system
- To learn the design and control principles of Wind turbine.
- To understand the concepts of fixed speed wind energy conversion systems.
- To understand the concepts of Variable speed wind energy conversion systems.
- To analyze the grid integration issues.

UNITI INTRODUCTION 9

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine

UNIT II WINDTURBINES 9

HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-No. Of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.

UNIT III FIXEDSPEEDSYSTEMS 9

Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model- Generator model for Steady state and Transient stability analysis.

UNIT IV VARIABLESPEED SYSTEMS 9

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modelling - Variable speed variable frequency schemes.

UNIT V GRIDCONNECTED SYSTEMS 9

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Students will be able to:

CO1: Attain knowledge on the basic concepts of Wind energy conversion system.
CO2: Attain the knowledge of the mathematical modelling and control of the Wind turbine
CO3: Develop more understanding on the design of Fixed speed system
CO4: Study about the need of Variable speed system and its modelling.
CO5: Learn about Grid integration issues and current practices of wind interconnections with power system.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓		✓		✓							
CO3	✓		✓									
CO4	✓		✓		✓							
CO5	✓	✓	✓	✓								

REFERENCES

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2. S.N.Bhadra, D.Kastha,S.Banerjee,"Wind Electrical Sytems",Oxford University Press,2010.
3. Ion Boldea, "Variable speed generators", Taylor & Francis group,2006.
4. E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge,1976.
5. N. Jenkins," Wind Energy Technology" John Wiley &Sons,1997
6. S.Heir "Grid Integration of WECS", Wiley1998.

PS5075 **SMART GRID**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

Students will be able to:

- Understand concept of smart grid and its advantages over conventional grid
- Know smart metering techniques
- Learn wide area measurement techniques
- Understanding the problems associated with integration of distributed generation & its solution through smart grid.
- To familiarize the high performance computing for Smart Grid applications

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 HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing algorithms for Smart grid, IOT, Cyber Security for Smart Grid.

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 advancedmetering infrastructure.

CO5:Develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓	✓	✓					
CO2	✓				✓	✓	✓					
CO3	✓				✓	✓	✓					
CO4	✓				✓	✓	✓					
CO5	✓				✓	✓	✓			✓		

REFERENCES

1. Stuart Borlase “Smart Grid :Infrastructure, Technology and Solutions”,CRC Press 2016.
2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”,Wiley.
3. Vehbi C. Gungor, DilanSahin, TaskinKocak, Salih Ergut, Concettina Buccella, Carlo Cecati ,and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies andStandards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.
4. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang “Smart Grid – The New and Improved Power Grid: A Survey” , IEEE Transaction on Smart Grid

PS5072 APPLICATION OF DSP TO POWER SYSTEM PROTECTION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- To expose the students to learn about DFT and Wavelet transforms.
- To provide an in-depth knowledgeon the components used for the implementation of digital protection.
- To impart knowledge on different algorithms for digital protection of power system components.
- To implement digital protection for transformer.
- To understand different decision making methodologies in protective relays.

UNIT I DIGITAL SIGNAL PROCESSING TECHNIQUES 9

Sampling-Principle of scaling-aliasing-Decimation, Interpolation. Fourier and discrete Fourier transforms - Fast Fourier Transforms.-Wavelet transform -Numerical Algorithms

UNIT II DIGITAL PROTECTION 9

Digital Protection -performance and operational characteristics of digital protection. Basic components of digital relays -Signal conditioning sub systems -Conversion subsystem -digital relay subsystem-Digital relay as a unit.

UNIT III ALGORITHMIC TECHNIQUES 9

Finite difference techniques- Interpolation-Numerical differentiation-curve fitting and smoothing. Sinusoidal wave based algorithms -First and second derivative method -two and three sample technique .Walsh function analysis- least squares based methods-differential equation based techniques -Travelling wave protective schemes.FIR based algorithms-Least square curve fitting algorithm.

UNIT IV DIGITAL PROTECTION TECHNIQUES 9

Transformer protection- -Fourier based algorithm-basic hardware of microprocessor based transformer protection .Digital line differential scheme. Measurement algorithms for digital protection -power-voltage -current -Impedance -phase shift.

UNIT V DIGITAL PROTECTIVE RELAYS 9

Decision making in protective relays- Deterministic Decision Making - Statistical Hypotheses Testing -Decision Making with Multiple Criteria - Adaptive Decision Schemes .Elements of Fuzzy Logic in Protective Relays -Fuzzy Sets and Fuzzy Numbers -Boolean Versus Fuzzy Logic -Fuzzy Reasoning - Fuzzy Logic Applications for Protection and Control.

TOTAL: 45 PERIODS

COURSE OUTCOMES

CO1: The students will be able to apply DSP techniques for digital protection.
CO2: The students will be capable of decision making algorithm suitable for digital relaying applications.
CO3: The students will be able to employ FIR based algorithms for digital relaying.
CO4: The students will be able to do transformer protection using digital techniques.
CO5: The students will be able to perform coordinated operation of relays for specific purposes.

MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2	✓	✓	✓	✓	✓							
CO3	✓	✓	✓	✓	✓			✓				
CO4	✓	✓	✓	✓	✓							
CO5	✓	✓	✓	✓	✓	✓						✓

REFERENCES

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2. A.G. Phadke and J.S. Thorp, Computer Relaying for Power Systems, John Wiley & Sons, New York, 1988.

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MA5001 APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS LT P C
3 1 0 4

OBJECTIVES:

- To develop the ability to apply the concepts of Matrix theory in Electrical Engineering problems.
- To familiarize the students in the concept of calculus of variations.
- To achieve an understanding of the basic concepts of one dimensional random variables and apply in electrical engineering problems.
- To formulate and solve linear programming problems.
- To solve engineering problems using Fourier series.

UNIT I MATRIX THEORY 12

The Cholesky decomposition - Generalized Eigen vectors, Canonical basis - QR factorization - Least squares method - Singular value decomposition

UNIT II CALCULUS OF VARIATIONS 12

Concept of variation and its properties – Euler's equation – Functionals dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries - Direct methods: Ritz and Kantorovich methods

UNIT III ONE DIMENSIONAL RANDOM VARIABLES 12

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable

UNIT IV LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method – Two phase method - Transportation and Assignment Models

UNIT V FOURIER SERIES 12

Fourier Trigonometric series: Periodic function as power signals – Convergence of series – Even and odd function: cosine and sine series – Non-periodic function: Extension to other intervals - Power signals: Exponential Fourier series – Parseval's theorem and power spectrum

TOTAL: 60 PERIODS

OUTCOMES:

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

CO1: Apply the concepts of Matrix theory in Electrical Engineering problems.
CO2: Use calculus of variation techniques to solve various engineering problems.
CO3: Solve electrical engineering problems involving one-dimensional random variables.
CO4: Formulate and solve linear programming problems in electrical engineering.
CO5: To solve engineering problems using Fourier series techniques.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓								
CO2	✓	✓		✓								
CO3	✓		✓	✓								
CO4		✓	✓	✓	✓							
CO5		✓	✓	✓	✓			✓				

REFERENCES:

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ET5013 IoT FOR SMART SYSTEMS LT P C
3 0 0 3

COURSE OBJECTIVES:

- To Study about **Internet of Things** technologies and its role in real time applications.
- To introduce the Infrastructure required for IoT
- To provide insight about the embedded processor and sensors required for IoT
- To familiarize the accessories and communication techniques for IoT.
- To familiarize the different platforms and Attributes for IoT

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Overview, Hardware and software requirements for IOT, Sensor and actuators ,Technology drivers , Business drivers, 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 **9**

PROTOCOLS : 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), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV **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**

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Students will have a clear understanding on the concepts of IoT and its present developments.
CO2: Able to analyze different IoT technologies
CO3: Able to use different platforms and infrastructures available for IoT
CO4: Able to understand the big data analytic and its importance
CO5: Able to implement IoT solutions for smart applications

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓								
CO2	✓	✓		✓								
CO3	✓		✓	✓								
CO4		✓	✓	✓	✓							
CO5		✓	✓	✓	✓			✓				

NOTE: Class Room Discussions and Tutorials can include the following Guidelines for improved Teaching /Learning Process: Practice through any of Case studies through Exercise/Discussions on Design , Development of embedded solutions using wireless communication by processor support

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ET5014 UNMANNED AERIAL VEHICLE LT P C
3 0 0 3

COURSE OBJECTIVES:

- To make the students to understand the basic concepts and components of UAV systems.
- To teach the UAV design concepts
- To provide an insight about the hardware structure for UAVs
- To emphasis the communication protocol requirements and control strategy for UAVs.
- To highlight the need and the role of UAVs for real time applications and development of real time UAVs

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:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓	✓							
CO2		✓	✓									
CO3	✓	✓	✓									
CO4		✓	✓	✓								
CO5		✓			✓			✓	✓			

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OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS LT P C
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.

- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop– RDBMS versus Hadoop–Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop– Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

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	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

OE5092 INDUSTRIAL SAFETY LT P C
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types

of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

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OE5093 OPERATIONS RESEARCH LT P C
3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method,Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

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3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
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OE5094 COST MANAGEMENTOF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING *CONCEPTS* 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES

CO1 – Understand the costing concepts and their role in decision making
CO2–Understand the project management concepts and their various aspects in selection
CO3–Interpret costing concepts with project execution
CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

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OE5095 **COMPOSITE MATERIALS** **L T P C**
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓					
CO4			✓	✓	✓		✓					
CO5				✓	✓		✓					

REFERENCES:
1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, WestGermany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 WASTE TO ENERGY L T P C
3 0 0 3

OBJECTIVES:
- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9
Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS 9
Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9
Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION 9
Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY 9
Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:
CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy

CO5 – Understand the principles of bio-energy systems and their features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

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AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports:

Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explaina critical understanding of key concepts in disaster riskreduction and humanitarian response.
CO3: Ability to illustratedisaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describean understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6
Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6
Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES
- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX5094 VALUE EDUCATION L T P C
2 0 0 0

OBJECTIVES
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I
Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III
Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.
Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for

truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

Suggested reading

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

AX5095	**CONSTITUTION OF INDIA**	**L T P C**
		2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

Suggested reading

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX5096 PEDAGOGY STUDIES L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT III THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT IV EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses-71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

Suggested reading

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.