RAJALAKSHMI ENGINEERING COLLEGE

(AN AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

DEPARTMENT VISION AND MISSION

VISION

To be an international centre in education, research and the application of knowledge, to benefit the society globally in the field of Electrical and Electronics Engineering

MISSION

- To impart high quality technical education and develop Electrical and Electronics Engineers with a sound theoretical combined with practical skills in all the areas concerning the discipline.
- To inculcate innovative research capabilities and exemplary professional conduct to lead and to use technology for the progress of our country.

M.E. EMBEDDED SYSTEM TECHNOLOGIES

Program Outcomes (POs)

PO1 : An ability to independently carry out research / investigation and development work to solve practical problems

PO2 : An ability to write and present a substantial technical report/ document

PO3 : Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4 : Be able to design and develop Embedded system automation based on dedicated ICs that have computation, networking and control capacity

PO5 : Skill to work on professional software languages, standard modeling and analysis tools & commercial packages with communication protocols and computation platforms for analysis and design of system automation.

PO6 : To involve in research on an industrial problem or develop an innovative smart system with automation as a consumer product through project management and finance with due concerned for socio economic values.

RAJALAKSHMI ENGINEERING COLLEGE
(AN AUTONOMOUS INSTITUTION AFFILIATED TO ANNA UNIVERSITY)

M.E. EMBEDDED SYSTEM TECHNOLOGIES
REGULATION – 2023

CURRICULUM AND SYLLABUS

CHOICE BASED CREDIT SYSTEM

SEMESTER I

SL.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	MH23115	Applied Mathematics for Electrical Engineers	3	1	0	4	4	FC
2	ET23111	Design of Embedded Systems	3	1	0	4	4	PC
3	ET23112	Software for Embedded Systems	3	0	0	3	3	PC
4	ET23113	Design of Microcontroller Based Systems	3	0	0	3	3	PC
5	ET23114	Real Time Operating Systems	3	0	0	3	3	PC
6	PG23111	Research Methodology and IPR	3	0	0	3	3	MC
7	AC23111	English for Research Paper Writing	3	0	0	3	0	AC
8	ET23121	Embedded System Laboratory I	0	0	4	4	2	PC
		TOTAL	**21**	**2**	**4**	**27**	**22**	

SEMESTER II

SL.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	ET23211	VLSI Architecture and Design Methodologies	3	0	0	3	3	PC
2	ET23212	Embedded Networking	3	0	0	3	3	PC
3	ET23213	Programming with VHDL	3	0	0	3	3	PC
4	ET23AXX	Professional Elective- I	3	0	0	3	3	PE
5	ET23BXX	Professional Elective- II	3	0	0	3	3	PE
6	ET23CXX	Professional Elective–III	3	0	0	3	3	PE
7	AC23211	Constitution of India	3	0	0	3	0	MC
8	ET23221	Embedded System Laboratory II	0	0	4	4	2	PC
		TOTAL	**21**	**0**	**4**	**25**	**20**	

SEMESTER III

SL.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	ET23311	Introduction to Machine Learning	3	0	0	3	3	PC
2	ET23DXX	Professional Elective–IV	3	0	0	3	3	PE
3	******	Open Elective	3	0	0	3	3	OE
4	ET23322	IoT for Embedded Applications Laboratory	0	0	4	4	2	PC
5	ET23321	Project Work (Phase I)	0	0	12	12	6	EEC
		TOTAL	**9**	**0**	**16**	**25**	**17**	

SEMESTER IV

SL.NO	COURSE CODE	COURSE TITLE	PERIODS / WEEK					CATEGORY
			L	T	P	TOTAL	CREDITS	
1	ET23421	Project Work (Phase II)	0	0	24	24	12	EEC
		TOTAL	**0**	**0**	**24**	**24**	**12**	

TOTAL NUMBER OF CREDITS = 71

PROFESSIONAL ELECTIVES

Professional Electives						
Elective 1	Wireless and Mobile Communication	Adhoc Networks	MEMS and NEMS Technology	IoT for Smart Systems	Unmanned Aerial Vehicle	Cyber Physical Systems
Elective 2	Automotive Embedded Systems	Open Source Software	Digital Instrumentation	RISC Processor Architecture and Programming	Embedded Computing	Industrial Automation
Elective 3	DSP Based System Design	Soft Computing Techniques	Deep Learning Techniques	Digital Image Processing System	Computer Vision	Embedded Systems for Biomedical Applications
Elective 4	Embedded System Development	Embedded Systems Security	Reconfigurable Processor and SoC Design	Robotics and Machine Vision	Embedded Linux	Cyber Security

SEMESTER II

PROFESSIONAL ELECTIVE I

S.No	CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1	ET23A11	Wireless and Mobile Communication	3	3	0	0	3
2	ET23A12	Adhoc Networks	3	3	0	0	3

3	ET23A13	MEMS and NEMS Technology	3	3	0	0	3
4	ET23A14	IoT for Smart Systems	3	3	0	0	3
5	ET23A15	Unmanned Aerial Vehicle	3	3	0	0	3
6	ET23A16	Cyber Physical Systems	3	3	0	0	3

PROFESSIONAL ELECTIVE II

S.No	CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1	ET23B11	Automotive Embedded Systems	3	3	0	0	3
2	ET23B12	Open-Source Software	3	3	0	0	3
3	ET23B13	Digital Instrumentation	3	3	0	0	3
4	ET23B14	RISC Processor Architecture and Programming	3	3	0	0	3
5	ET23B15	Embedded Computing	3	3	0	0	3
6	ET23B16	Industrial Automation	3	3	0	0	3

PROFESSIONAL ELECTIVE III

S.No	CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1	ET23C11	DSP Based System Design	3	3	0	0	3
2	ET23C12	Soft Computing Techniques	3	3	0	0	3
3	ET23C13	Deep Learning Techniques	3	3	0	0	3
4	ET23C14	Digital Image Processing System	3	3	0	0	3
5	ET23C15	Computer Vision	3	3	0	0	3
6	ET23C16	Embedded Systems for Biomedical Applications	3	3	0	0	3

SEMESTER III

PROFESSIONAL ELECTIVE IV

S.No	CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C
1	ET23D11	Embedded System Development	3	3	0	0	3
2	ET23D12	Embedded Systems Security	3	3	0	0	3
3	ET23D13	Reconfigurable Processor and SoC Design	3	3	0	0	3
4	ET23D14	Robotics and Machine Vision	3	3	0	0	3
5	ET23D15	Embedded Linux	3	3	0	0	3
6	ET23D16	Cyber Security	3	3	0	0	3

AUDIT COURSES - I & II

SEMESTER I							
S.No	**CODE**	**COURSE TITLE**	**CONTACT**	L	T	P	C

			PERIODS				
THEORY							
1	AC23111	English for Research Writing	3	3	0	0	0
SEMESTER II							
S.No	**CODE**	**COURSE TITLE**	**CONTACT PERIODS**	L	T	P	C
1	AC23211	Constitution of India	3	3	0	0	0

CREDIT DISTRIBUTION

CATEGORY	I	II	III	IV	Total
FC	4				**4**
PC	15	11	5		**31**
PE		9	3		**12**
EEC			6	12	**18**
MC	3				**3**
OE			3		**3**
Semester Credit	**22**	**20**	**17**	**12**	**71**

SYLLABUS
SEMESTER I

Subject Code	Subject Name	Category	L	T	P	C
MH23115	APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS	FC	3	1	0	4

I sem. – M.E. Embedded System Technology

Objectives:

- To develop the ability to apply the concepts of decomposition in Matrix theory.
- To provide an introduction to the ideas and techniques of the calculus of variations.
- To exhibit the ability to design, use, and interpret control charts.
- To formulate a given simplified description of a suitable real-world problem as a linear programming model.
- To familiarize the students to solve problems using Fourier series associated with engineering applications.

UNIT-I MATRIX THEORY **12**

LU Factorization-The Cholesky Decomposition – generalized eigenvectors – Canonical forms – pseudo inverse – least square approximations - Toeplitz matrices and some applications- Stochastic matrices and Markov Chains-Tridiagonal matrices.

UNIT-II CALCULUS OF VARIATIONS **12**

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

UNIT-III STATISTICAL QUALITY CONTROL **12**

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling

UNIT-IV LINEAR PROGRAMMING **12**

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

UNIT-V FOURIER ANALYSIS **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– Eigen value problems and orthogonal functions – Regular Sturm-Liouville systems –Generalized Fourier series.

Total Contact Hours:60

Course Outcomes:

On completion of the course the students will be able to

- Demonstrate various techniques of matrix decomposition in solving complex engineering problems.
- Illustrate techniques of the calculus of variations to solve variation problems arising in engineering applications.
- Analyse quality related data using the traditional statistical quality control methods and develop charting techniques.
- Formulate mathematical model for management and technical problems using LPP concepts and to solve transportation and assignment problems with its physical significance.
- In-depth knowledge of Fourier analysis and its applications to problems in physics and electrical engineering.

SUGGESTED ACTIVITIES

- Problem solving sessions
- Activity Based Learning

SUGGESTED EVALUATION METHODS

- Tutorial problems
- Assignment problems
- Class Presentation/Discussion

Text Book(s):	
1.	Grewal, B.S., Higher Engineering Mathematics, 42nd edition, Khanna Publishers, 2012.
2.	Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India, 2007.
3	Taha, H.A., "Operations Research, An introduction", 10th edition, Pearson education, New Delhi, 2010.
4.	Gupta. R.C, "Statistical Quality control", Khanna Publishers, 1997
Reference Books(s) / Web links:	
1.	Richard Bronson, "Matrix Operation", Schaum's outline series, 2nd Edition, McGraw Hill,2011.
2.	Gupta, A.S., Calculus of Variations with Applications, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
3.	Andrews L.C. and Phillips R.L., Mathematical Techniques for Engineers and Scientists, Prentice Hall of India Pvt.Ltd., New Delhi, 2005.
4.	Elsgolts, L., Differential Equations and the Calculus of Variations, MIR Publishers, Moscow, 1973.
5.	O'Neil, P.V., Advanced Engineering Mathematics, Thomson Asia Pvt. Ltd., Singapore,2003.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	1	2	1	2
CO2	3	-	1	1	2	2
CO3	3	-	1	2	2	1
CO4	3	-	1	1	1	1
CO5	3	-	2	2	2	2
AVG	**3**	**-**	**1.2**	**1.6**	**1.6**	**1.6**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23111	**DESIGN OF EMBEDDED SYSTEMS**	**PC**	**3**	**1**	**0**	**4**

Objectives:

- To introduce embedded system design, specifications, and modelling
- To provide knowledge on embedded system hardware and software design
- To make the students understand the evaluation and validation techniques
- To teach various scheduling methods in different conditions
- To educate with various optimization techniques and the attest procedures.

UNIT-I	**INTRODUCTION TO EMBEDDED SYSTEMS, SPECIFICATIONS, AND MODELING**	12

Opportunities – Challenges - design flows – requirements - models of computation - Early design phases- communicating finite state machines - timed automata - data flow - levels of hardware modelling – comparison of models of computation - unified modelling language (UML)

UNIT-II	**EMBEDDED SYSTEM HARDWARE AND SOFTWARE DESIGN**	12

Input - processing units – memories – communication – output - electrical energy - secure hardware, embedded software - embedded operating system, resource access protocols - hardware abstraction layer.

UNIT-III	**EVALUATION AND VALIDATION**	12

Performance evaluation - quality metrics-energy and power models - dependability and risk analysis - simulation-rapid prototyping - formal verification.

UNIT-IV	**APPLICATION MAPPING**	12

Definition of scheduling problems - scheduling for uniprocessors - Scheduling for Independent Jobs on Identical Multiprocessors - Scheduling for Independent Jobs on Identical processors.

UNIT-V	**OPTIMIZATION AND TEST**	12

High level optimizations - simple loop transformations - loop tiling/blocking - loop splitting - array folding - floating point to fixed point conversion, test- scope - test procedures - evaluation of test pattern sets - design for testability.

Total Contact Hours: 60

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

● describe various modelling techniques for embedded system design
● discuss the hardware and software used for embedded system design
● perform performance evaluation and rapid prototyping
● schedule different jobs in different conditions
● improve employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system computing environment
SUGGESTED ACTIVITIES ● Activity Based Learning
Text Book(s):
1. Marwedel, Peter. Embedded System Design, 3rd ed., Springer, 2018.
2. Noergaard, Tammy. Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers, 2nd ed., Newnes, 2013.
3. Elicia White," Making Embedded Systems", O'Reilly Series, SPD,2011
4. Arkin, R.C., Behaviour-based Robotics, The MIT Press, 1998.
5. Lyla B Das," Embedded Systems-An Integrated Approach", Pearson 2013
6. James K.Peckol, "Embedded system Design", JohnWiley&Sons, 2010

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	3	3
CO2	3	1	2	-	3	-
CO3	2	1	1	-	1	-
CO4	2	1	2	-	1	-
CO5	2	1	2	2	3	3
AVG	**2.2**	**1**	**2**	**2**	**2.2**	**3**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23112	**SOFTWARE FOR EMBEDDED SYSTEMS**	**PC**	**3**	**0**	**0**	**3**

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		
UNIT-I	**BASIC C PROGRAMMING**	9
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**	9
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**	9
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**	9
Introduction - Parts of Python Programming Language - Control Flow Statements - Functions – Strings - Lists - Dictionaries - Tuples and Sets.		
UNIT-V	**MODULES, PACKAGES AND LIBRARIES IN PYTHON**	9

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 - Networking Libraries.
Total Contact Hours: 45
Course Outcomes: At the end of this course, the students will be able to
● demonstrate C programming and its salient features for embedded systems
● deliver insight into various programming languages/software compatible to embedded process development with improved design & programming skills.
● develop knowledge on C programming in Linux environment.
● write python programming for Embedded applications.
● improve employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded programming skills.
SUGGESTED ACTIVITIES ● Activity Based Learning ● Implementation of small module
Text Book(s):
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, 2007.
3. William von Hagen, "The Definitive Guide to GCC", 2nd Edition, Apress Inc., 2006.
Reference Books(s) / Web links:
1. Gowrishankar S and Veena A, "Introduction to Python Programming", CRC Press, Taylor & Francis Group, 2019.
2. Noel Kalicharan, "Learn to Program with C", Apress Inc., 2015.
3. Steve Oualline, ‘Practical C Programming 3rd Edition’, O’Reilly Media, Inc, 2006.
4. Fabrizio Romano, “Learn Python Programming”, Second Edition, Packt Publishing, 2018.
5. John Paul Mueller, "Beginning Programming with Python for Dummies", 2nd Edition, John Wiley & Sons Inc., 2018.
6. Mark Lutz, "Programming Python", 4th Edition, O’Reilly Media Inc., 2010.

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

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23113	**DESIGN OF MICROCONTROLLER BASED SYSTEMS**	**PC**	**3**	**0**	**0**	**3**
Objectives:						
● To teach the students to the fundamentals of microcontroller-based system design.						
● To teach I/O and RTOS role in microcontroller.						
● To impart knowledge on PIC Microcontroller based system design.						
● To understand the Microchip PIC 8bit peripheral system design.						
● To study the basic applications of microcontroller.						
UNIT-I	**8051 ARCHITECTURE**					9
Architecture – memory organization – addressing modes – instruction set –Timers – Interrupts – I/O ports, Interfacing I/O Devices – Serial Communication.						

UNIT-II	8051 PROGRAMMING	9
Assembly language programming – Arithmetic Instructions – Logical Instructions –Single bit Instructions – Timer Counter Programming – Serial Communication Programming Interrupt Programming – RTOS for 8051 – RTOS Lite – Full RTOS – Task creation and run – LCD digital clock/thermometer using Full RTOS		
UNIT-III	**PIC MICROCONTROLLER**	9
Architecture of PIC 16F877A– memory organization – addressing modes – instruction set – PIC programming in Assembly & C –I/O port, Data Conversion, RAM & ROM Allocation, Timer programming, MP-LAB, MICRO C Pro.		
UNIT-IV	**PERIPHERAL OF PIC MICROCONTROLLER**	9
Timers – Interrupts, I/O ports- I2C bus-A/D converter-UART- CCP modules -ADC, DAC and Sensor Interfacing – Flash and EEPROM memories.		
UNIT-V	**SYSTEM DESIGN – CASE STUDY**	9
Interfacing LCD Display – Keypad Interfacing – sensor Interfacing- Generation of Gate signals for converters and Inverters – Motor Control – Controlling DC/ AC appliances – Measurement of frequency – Standalone Data Acquisition System.		
Total Contact Hours: 45		

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

- analyze the process delivers insight into involving the capacities of a programmable microcontroller for system interface.
- design the automation of processes with improved design strategies.
- design on memory management, application development in PIC processor.
- design, develop and program micro controllers with peripheral interfaces using software tools
- improve employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

SUGGESTED ACTIVITIES

- Activity Based Learning
- Implementation of small module

Text Book(s):

1. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ‘ PIC Microcontroller and Embedded Systems using Assembly and C for PIC18’, Pearson Education 2008
2. John Iovine, ‘PIC Microcontroller Project Book’, McGraw Hill 2000
3. I Scott Mackenzie and Raphael C.W. Phan, “The Micro controller”, Pearson, Fourth edition 2012
4. Myke Predko, “Programming and customizing the 8051 microcontrollers”, Tata McGraw Hill 2001.
5. Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, ‘The 8051 Microcontroller and Embedded Systems’ Prentice Hall, 2005.
6. Rajkamal,”. Microcontrollers-Architecture, Programming, Interfacing & System Design”, 2nd Edition, Pearson, 2012.
7. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ‘ PIC Microcontroller and Embedded Systems using Assembly and C for PIC18’, Pearson Education 2008

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

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23114	REAL TIME OPERATING SYSTEMS	PC	3	0	0	3

Objectives:

- To expose the students to the fundamentals of interaction of OS with a computer and user
- To teach the fundamental concepts of how processes are created and controlled with OS.
- To provide knowledge on programming models of process based on range of OS feature
- To highlight the features of commercial OS and teach 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	SCHEDULING ALGORITHMS	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 – µC OS - C Executive for development of RTOS Application – Case study

Total Contact Hours: 45

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

- present an Outline Operating System structures and types.
- insight into scheduling, disciplining of various processes execution.
- illustrate knowledge on various RTOS support modelling
- demonstrate commercial RTOS Suite features to work on real time processes design.
- exhibit Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in RTOS and embedded automation design

SUGGESTED ACTIVITIES

- individual assignment

SUGGESTED EVALUATION METHODS (if Any)

- grading based on the presentation of the assignment to the class

Text Book(s):

1. Silberschatz, Galvin, Gagne" Operating System Concepts,6th ed, John Wiley,2003
2. Li, Qing and Caroline Yao. Real-time Concepts for Embedded Systems, CRC Press, 2018.

Reference Books(s) / Web links:

1. Charles Crowley, "Operating Systems-A Design Oriented approach" McGraw Hill,1997
2. Karim Yaghmour, Building Embedded Linux System",O'reilly Pub,2003
3. Raj Kamal, "Embedded Systems- Architecture, Programming and Design" Tata McGrawHill,2006.
4. Mukesh Sighal and N G Shi "Advanced Concepts in Operating System", McGraw Hill,2000

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	2	1	1
CO2	--	-	2	2	1	1
CO3	-	-	2	2	1	1
CO4	1	-	3	2	1	1
CO5	2	-	3	2	1	1
AVG	1.5	-	2.5	2	1	1

Course Code	Course Title (Theory course)	Category	L	T	P	C
PG23111	RESEARCH METHODOLOGY AND IPR	MC	3	0	0	3

Objectives:

- Understand the research problem formulation and analyse the research related information by following research ethics.
- Inculcating the understanding of today's computer, information technology and also understand tomorrow's world of ideas and creativity.
- Emphasizing the role of IPR in individual and nations growth

UNIT-I	INTRODUCTION TO RESEARCH METHODOLOGY	9

Objectives and Motivation of Research - Types of Research - Defining and Formulating the Research Problem - Errors in selecting a research problem - Features of research design, Different Research Designs- Criteria of good research - Problems encountered by researchers in India - Benefits to the society in general.

UNIT-II	DATA ANALYSIS AND HYPOTHESIS TESTING	9

Data collection: Primary data - Secondary data - Data organization - Sample design - Estimation of population - Parametric vs. non parametric methods - Measures of central tendency and dispersion.

ANOVA; Principles of least squares-Regression and correlation; Normal Distribution Properties of Normal Distribution; Testing of Hypothesis – Hypothesis Testing Procedure, Types of errors, t-Distribution - Chi-Square Test as a Test of Goodness of Fit - Use of statistical softwares.

UNIT-III	LITERATURE REVIEW AND RESEARCH REPORT WRITING	9

Effective literature studies approaches- Importance of literature survey - Sources of information– analysis – Plagiarism - Research ethics.

Interpretation and Report Writing - Techniques and Precautions; Report Writing – Significance - Different Steps – Layout - Types of reports, Mechanics of Writing a Research Report - Precautions in Writing Reports; Format of the research report

UNIT-IV	INTRODUCTION TO INTELLECTUAL PROPERTY , TRADE MARKS ,GRAPHICAL INDICATION AND INDUSTRIAL DESIGN	9

Importance of intellectual property rights; types of intellectual property-international organizations; Purpose and function of trademarks - acquisition of trade mark rights - protectable matter - selecting and evaluating trade mark - trade mark registration processes.

Industrial designs and IC Layout design - Registrations of designs-Semiconductor Integrated circuits and layout design Act - Geographical indications-potential benefits of Geographical Indications.

UNIT-V	LAW OF COPYRIGHTS & PATENTS	9

Fundamental of copy right law - originality of material - rights of reproduction - rights to perform the work publicly - copy right ownership issues - copy right registration -notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process - ownership rights and transfer New Developments in IPR: Administration of Patent System.

Total Contact Hours	:	45

Course Outcomes:

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

- Understand the research problem and research process
- To formulate the hypothesis, data collection and processing, analyzing the data using statistical methods

•	Interpret the observations and communicating the novel findings through a research report.
•	Apply the conceptual knowledge of intellectual property rights for filing patents and trade mark registration process.
•	Understand the adequate knowledge on copyright and patent law and rights.
Reference Books(s):	
1	C.R. Kothari, Research Methodology: Methods and Techniques, 2nd revised edition, New Age International Publishers, New Delhi, 2004.
2	Deborah, E. Bouchoux, Intellectual property right, 5th edition, Cengage learning, 2017.
3	R. Panneerselvam, Research Methodology, PHI learning Pvt. Ltd., 2009.
4	Prabuddha Ganguli, Intellectual property right - Unleashing the knowledge economy, Tata McGraw Hill Publishing Company Ltd, 2001.
5	Donald R. Cooper and Ramela S. Schindler, Business Research Methods, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000
6	Uma Sekaran, Research Methods for Business, John Wiley and Sons Inc., New York, 2000.
7	Ranjit Kumar, Research Methodology, Sage Publications, London, New Delhi, 1999.
8	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	2	1	1	2
CO2	1	3	2	-	2	1
CO3	2	3	2	1	2	2
CO4	2	3	2	1	3	1
CO5	1	2	1	1	2	1
AVG	**1.6**	**2.6**	**1.8**	**1**	**2**	**1.4**

Course Code	**Course Title**	**Category**	**L**	**T**	**P**	**C**
AC23111	**ENGLISH FOR RESEARCH PAPER WRITING**	**AC**	**3**	**0**	**0**	**0**

Common to all branches of I semester M.E. / M.Tech. Programmes

Objectives:

- To facilitate the students to express technical ideas in writing
- To train the students in using language structures appropriately
- To enable students to plan and organize the research paper
- To assist the students in understanding the structure and familiarize the mechanics of organized writing
- To equip the students to improvise academic English and acquire research writing skills

UNIT-I	**INTRODUCTION TO RESEARCH WRITING**	**9**

Research – Types of Research - Selecting the Primary resources - Categorizing secondary sources - Discovering a researchable area and topic – Need Analysis - Research Question- Focusing on the Research Problem- Developing Research Design – Framing the Hypothesis – Identifying the Scope of the Research - Writing – General and Academic Writing

UNIT-II	**LANGUAGE OF WRITING**	**9**

Active reading – text mining – use of academic words – jargons – ambiguities – use of expression – use of tense - proper voices – third person narration – phraseology – use of foreign words – use of quotes – interpreting quotes.

UNIT-III	**THE FORMAT OF WRITING**	**9**

Types of Journals - different formats and styles - IEEE format - Structure – Margins - Text Formatting - Heading and Title - Running Head with Page Numbers - Tables and illustrations - Paper and Printing - Paragraphs - Highlighting – Quotation – Footnotes

UNIT-IV	**ORGANISING A RESEARCH PAPER**	**9**

Title- Abstract – Introduction – Literature review - Methodology - Results –Discussion

–Conclusion - Appendices - Summarising - Citation and Bibliography		
UNIT-V	**PUBLISHING PAPER**	**9**
Finding the Prospective publication or Journal - analysing the credits - Reviewing - Revising – Plagiarism Check - Proofreading - Preparing the Manuscript- Submitting - Resubmitting – Follow up - Publishing		
		Total Contact Hours: 45

Course Outcomes:

On completion of the course, students will be able to

- Understand the basic structure of research work
- Apply proper use of language in writing paper
- Comprehend different formats of journal paper
- Follow the process of writing a research paper and write one
- Emulate the process of publishing journal paper and publish papers

SUGGESTED ACTIVITIES

- Group Discussions
- Writing review of literature
- Presentations
- Case study
- Writing a paper

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Reference Books(s) / Web links:

1. Adrian Wallwork: "English for Writing Research Papers", Springer Science Business Media, Second Edition, LLC 2011
2. Stephen Howe and Kristina Henrikssion: "Phrasebook for Writing Papers and Research in English", The Whole World Company Press, Cambridge, Fourth edition 2007
3. The Modern Language Association of America: "MLA Handbook for Writers of Research Papers" 8th Edition, The Modern Language Association of America, 2016
4. Rowena Murray: The Handbook of Academic Writing: A Fresh Approach, Sarah Moore Open University Press, 2006
5. Stephen Bailey: Academic Writing: A Practical Guide for Students Routledge Falmer: 2003
6. Joseph M. Moxley: Publish, Don't Perish: The Scholar's Guide to Academic Writing and Publishing, Praeger Publishers, 1992.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	2
CO2	1	3	2	-	2	1
CO3	2	3	2	1	2	2
CO4	2	3	2	1	3	1
CO5	1	2	1	1	2	1
AVG	**1.6**	**2.6**	**1.8**	**1**	**2**	**1.4**

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
ET23121	**EMBEDDED SYSTEM LABORATORY I**	PC	0	0	4	2

Objectives:

- To provide knowledge on programming with PIC Microcontrollers for assembly language
- To provide knowledge on programming with PIC Microcontrollers for C programming
- To provide knowledge on programming with DSPIC Microcontrollers

● To impart knowledge on I/O programming
● To inculcate knowledge on CAD tools for the implementation of Combinational, Sequential Circuits
Description of the Experiments
1. Programming of PIC Microcontrollers (PIC 16F877A) using Assembly language
2. Programming of PIC Microcontrollers (PIC 16F877A) using C language
3. Interfacing of LED/ Switch/buzzer with PIC Microcontrollers (PIC 16F877A)
4. Interfacing of Relay/LCD/UART with PIC Microcontrollers (PIC 16F877A)
5. Arithmetic operations like addition, subtraction, multiplication, division, factorial using python programming language
6. Programming with Raspberry Pi with Python programming
7. Interfacing of input devices like Switch sensor with Raspberry Pi processor
8. Interfacing output devices like LED, buzzer with Raspberry Pi processor
9. Design with ORCAD tool- Design and Implementation of Combinational Circuits in ORCAD simulators
10. Design with ORCAD tool- Design and Implementation of Sequential Circuits in ORCAD simulators
11. Simulation & Programming of sensor interface & measurement with using programming environments (MATLAB/LabVIEW/Simulation Tools)
12. Design of Filters using MATLAB
Total Contact Hours:60
Course Outcomes: At the end of the course the student will be able to:
● understand the programming with PIC Microcontrollers for assembly language
● understand the programming with PIC Microcontrollers for C programming
● understand python programming and packages
● understand the programming with Raspberry Pi processor and comprehend the I/O programming
● synthesize combinational, Sequential Circuits using CAD tools
SUGGESTED EVALUATION METHODS ● Experiment based viva
Web links for virtual lab
http://vlabs.iitkgp.ernet.in/rtes/index.html

Lab equipment required:

S. No	Name of the Equipment	Quantity Required
1	PC system	20
2	PIC microcontroller board	10
3	Raspberry Pi	10
4	CAD simulation tool	10 user
5	C2000 microcontroller boards	5
6	MATLAB simulation software	5

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	3	2	2
CO2	3	3	-	3	2	2
CO3	3	3	-	-	-	-
CO4	3	3	-	3	-	3
CO5	3	-	3	-	-	-
AVG	**3**	**3**	**3**	**3**	**2**	**2.33**

SEMESTER II

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23211	VLSI ARCHITECTURE AND DESIGN METHODOLOGIES	PC	3	0	0	3

Objectives:

- To give an insight to the students about the significance of CMOS technology
- To teach the importance and architectural features of programmable logic devices.
- To introduce the ASIC construction and design algorithms
- To teach the basic analog VLSI design techniques.
- To study the Logic synthesis and simulation of digital system with Verilog HDL.

UNIT-I	**CMOS DESIGN**	9

Overview of digital VLSI design Methodologies- Logic design with CMOS-transmission gate circuits-Clocked CMOS-dynamic CMOS circuits, Bi-CMOS circuits- Layout diagram, Stick diagram-IC fabrications – Logical effort and electrical effort- propagation delay

UNIT-II	**PROGRAMMABLE LOGIC DEVICES**	12

Programming Techniques-Anti fuse-SRAM-EPROM and EEPROM technology – Re-Programmable Devices Architecture- Function blocks, I/O blocks, Interconnects, Xilinx-XC9500– XC-4000, XC5200, Virtex

UNIT-III	**BASIC CONSTRUCTION, FLOOR PLANNING, PLACEMENT AND ROUTING**	6

System partition – FPGA partitioning – Partitioning methods -KL algorithm, Stiener tree- Floor planning – Placement- Physical design flow – Global routing – Detailed routing – Special routing- Circuit extraction – DRC.

UNIT-IV	**ANALOG VLSI DESIGN**	6

Introduction to analog VLSI- Concept of Gilbert's Cell-Design of CMOS 2 stage-3 stage Op-Amp –High Speed and High frequency op-amps- Super MOS- Analog primitive cells- Realization of neural networks.

UNIT-V	**LOGIC SYNTHESIS AND SIMULATION**	12

Overview of digital design with Verilog HDL, hierarchical modelling concepts, modules and port definitions, gate level modelling, data flow modelling, behavioral modelling, task & functions, Verilog and logic synthesis-simulation-Design examples, Ripple carry Adders, Carry Look ahead adders, Multiplier, ALU, Shift Registers, Multiplexer, Comparator, Test Bench

Total Contact Hours: 45

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

- analyze the process delivers insight into developing design logic/arithmetic functionalities of various embedded design strategies.
- analyze the computational arithmetic/logic functionalities evolvable in processors.
- determine the ASIC construction and design algorithms specific process.
- write the program for logic separation and simulation of digital system with Verilog HDL
- improve employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

Reference Books(s) / Web links:

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, "VeriLog HDL, A Design guide to Digital and Synthesis" 2nd Ed, Pearson,2005
6. John P. Uyemera "Chip design for submicron VLSI CMOS layout and simulation ", Cengage Learning India Edition", 2011.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	3	2	2
CO2	-	3	3	3	2	2
CO3	3	3	-	-	-	-
CO4	3	3	3	3	-	3
CO5	-	-	3	-	3	3
AVG	3	3	3	3	2.33	2.5

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23212	EMBEDDED NETWORKING	PC	3	0	0	3

Objectives:

- To give an insight to the students about the Serial communication protocols.
- To impart knowledge on parallel communication protocols.
- To learn the basics of Ethernet and its controllers.
- To provide exposure on application Development using Ethernet.
- To explore Application development using Embedded Ethernet for Wireless Sensor Network communication protocols.

UNIT-I EMBEDDED COMMUNICATION PROTOCOLS 9

Introduction: Serial/Parallel Communication – Serial communication protocols: RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I^2C) – PC Parallel port programming -ISA/PCI Bus protocols

UNIT-II USB AND CAN BUS 9

USB bus: Introduction – Speed Identification on the bus – USB States – USB bus communication: Packets –Data flow types –Enumeration –Descriptors –CAN Bus: Introduction – Frames –Bit stuffing –Types of errors – Nominal Bit Timing – PIC microcontroller CAN Interface.

UNIT-III ETHERNET BASICS 9

Elements of a network – Inside Ethernet – Building a Network: Hardware options – Cables, Connections and network speed – Design choices: Selecting components –Ethernet Controllers – Using the internet in local and internet communications – Inside the Internet protocol

UNIT-IV EMBEDDED ETHERNET 9

Exchanging messages using UDP and TCP – Serving web pages with Dynamic Data – Serving web pages that respond to user Input – Email for Embedded Systems – Using FTP – Keeping Devices and Network secure.

UNIT-V WIRELESS EMBEDDED NETWORKING 9

Wireless sensor networks: Introduction –Network Topology – Localization – Time Synchronization – Energy efficient MAC protocols –Energy efficient and robust routing – Data Centric routing

Total Contact Hours: 45

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

- design functional units of network processes for sensor network using serial communication protocols.
- apply the instrument-based internet protocol for CAN and USB bus systems.
- describe the importance of Ethernet in embedded system.
- develop data transfer and communication system in large industrial processes
- build automation communication systems through wired, wireless technology for monitoring and control of grid.

SUGGESTED ACTIVITIES (if any)

- To develop any application as a mini project

SUGGESTED EVALUATION METHODS

- Assignment and class Presentation/Discussion

Text Book(s):

1. Frank Vahid, Givargis ‘Embedded Systems Design: A Unified Hardware/Software Introduction’, Wiley

Publications
2. Jan Axelson, 'Parallel Port Complete', Penram publications
3. Dogan Ibrahim, 'Advanced PIC microcontroller projects in C', Elsevier 2008
Reference Books(s) / Web links:
1. Jan Axelson 'Embedded Ethernet and Internet Complete', Penram publications
2. Bhaskar Krishnamachari, 'Networking wireless sensors', Cambridge press 2005

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	2	1
CO2	1	-	2	2	3	1
CO3	3	1	2	-	-	-
CO4	2	-	2	3	3	2
CO5	2	1	2	-	-	3
AVG	2.2	1	2	2	2.67	1.75

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23213	PROGRAMMING WITH VHDL	PC	3	0	0	3

Objectives:

- To give an insight to the students about the significance of VHDL Programming
- To teach the importance and architectural modelling of programmable logic devices
- To introduce the construction and design programming
- To teach the basic VLSI design configurations
- To study the Logic synthesis and simulation of digital system with PLD

UNIT-I	VHDL FUNDAMENTALS	9

Fundamental concepts- Modeling digital system-Domain and levels of modeling- modeling languages-VHDL modeling concepts-Scalar Data types and operations- constants and Variable-Scalar Types- Type Classification-Attributes and scalar types-expression and operators-Sequential statements.

UNIT-II	DATA TYPES AND BASIC MODELING CONSTRUCTS	9

Arrays - unconstrained array types - array operations and referencing - records – Access Types - Abstract Date types- - basic modeling constructs - entity declarations - Architecture bodies - behavioral description - structural descriptions-design Processing, case study: A pipelined Multiplier accumulator. Vending Machine

UNIT-III	SUBPROGRAMS, PACKAGES AND FILES	9

Procedures - Procedure parameters - Concurrent procedure call statements – Functions – Overloading – visibility of Declarations - packages and use clauses - Package declarations-package bodies - use clauses - Predefined Aliases - Aliases for Data objects - Aliases for Non-Data items - Files- I/O-Files. Case study: A bit vector arithmetic Package. VHDL-AMS

UNIT-IV	SIGNALS, COMPONENTS, CONFIGURATIONS	9

Basic Resolved Signals - IEEE std_Logic_1164 resolved subtypes- resolved Signal Parameters – Generic Constants-Parameterizing behavior - Parameterizing structure - components and configurations - Generate Statements-Generating Iterative Structure-Conditionally generating structure-Configuration of generate statements, case study: Sequential Multiplier

UNIT-V	DESIGN WITH PROGRAMMABLE LOGIC DEVICES	9

Realization of -Micro controller CPU. – Memories- I/O Devices, Design of an I^2C Interface for an EEPROM Memory -Vending Machine design, synthesis, simulation, and testing

Total Contact Hours	:	45

Course Outcomes:

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

- model complex digital systems at several level of abstractions; behavioral and structural, synthesis and rapid system prototyping

•	develop and simulate register-level models of hierarchical digital systems
•	develop a formal test bench from informal system requirements
•	design and model complex digital system independently or in a team
•	analyze and simulate digital system with PLD
Reference Books(s):	
1	Peter J.Ashenden, "The Designer's guide to VHDL", Morgan Kaufmann publishers, San Francisco, Second Edition, May 2001
2	Zainalabedin navabi, "VHDL Analysis and modeling of Digital Systems", McGraw Hill international Editions, Second Editions, 1998
3	Charles H Roth, Jr. "Digital system Design using VHDL", Thomson ,2006
4	Douglas Perry, "VHDL Programming by Example", Tata McGraw Hill,4th Edition 2002
5	Navabi.Z., "VHDL Analysis and Modeling of Digital Systems", McGraw International, 1998
6	Peter J Ashenden, "The Designers Guide to VHDL", Harcourt India Pvt Ltd, 2002
7	Skahill. K, "VHDL for Programmable Logic", Pearson education, 1996
8	Mark Zwolinski, "Digital System Design with VHDL", Pearson Education, 2004

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	3	2	3
CO2	3	-	-	-	2	3
CO3	1	-	-	3	3	3
CO4	2	-	-	-	-	3
CO5	3	-	-	3	3	2
AVG	**2.4**	**-**	**-**	**3**	**2.5**	**2.8**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23P1X	**PROFESSIONAL ELECTIVE- I**	**PE**	**3**	**0**	**0**	**3**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23P2X	**PROFESSIONAL ELECTIVE- II**	**PE**	**3**	**0**	**0**	**3**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23P3X	**PROFESSIONAL ELECTIVE- III**	**PE**	**3**	**0**	**0**	**3**

Course Code	Course Title	Category	L	T	P	C
AC23211	**CONSTITUTION OF INDIA**	MC	**3**	**0**	**0**	**0**

Objectives:	
•	To inculcate the values enshrined in the Indian constitution.
•	To create a sense of responsible and active citizenship.
•	To make the students aware of the Constitutional and the Non- Constitutional bodies
•	To help the students understand the relationships exist between union and states
•	To make the students understand the sacrifices made by the freedom fighters.

UNIT-I	**INTRODUCTION**	**9**
Historical Background - Constituent Assembly of India - Philosophical foundations of the Indian Constitution - Features - Basic Structure – Preamble.		
UNIT-II	**UNION GOVERNMENT - EXECUTIVE, LEGISLATURE AND JUDICIARY**	**9**

Union and its territory - Citizenship - Fundamental Rights - Directive Principles of State Policy (DPSP) - Fundamental Duties. President - Vice President - Prime Minister - Central Council of Ministers - Cabinet Committees - Parliament: Committees, Forums and Groups - Supreme Court.		
UNIT-III	**STATE GOVERNMENT & UNION TERRITORIES: STATE GOVERNMENT EXECUTIVE, LEGISLATURE AND JUDICIARY**	**9**
Governor - Chief Minister - State Council of Ministers - State Legislature - High Court - Subordinate Courts - Panchayati Raj – Municipalities-Union Territories - Scheduled and Tribal Areas.		
UNIT-IV	**RELATIONS BETWEEN UNION AND STATES**	**9**
Relations between Union and States - Services under Union and States. Cooperative Societies - Scheduled and Tribal Areas - Finance, Property, Contracts and Suits - Trade and Commerce within Indian Territory – Tribunals.		
UNIT-V	**CONSTITUTIONAL BODIES AND AMENDMENTS**	**9**
Introduction to Constitutional & Non-Constitutional Bodies-Elections - Special Provisions relating to certain classes - Languages - Emergency Provisions - Miscellaneous - Amendment of the Constitution - Temporary, Transitional and Special Provisions - Short title, date of commencement, Authoritative text in Hindi and Repeals. Schedules of the Constitution of India - Appendices in the Constitution of India.		
	Contact Hours : 45	

Course Outcomes:

On completion of the course students will be able to

- Appreciate the philosophical foundations of the Indian Constitution.
- Understand the functions of the Indian government.
- Apprehend and abide by the rules of the Indian constitution.
- Comprehend the functions of state Government and Local bodies.
- Gain Knowledge on constitution functions and role of constitutional bodies and amendments of constitution..

SUGGESTED ACTIVITIES

- Online Quizzes
- Poster presentations
- Presentations
- Group Discussions
- Case study

SUGGESTED EVALUATION METHODS

- Assignment topics
- Quizzes
- Class Presentation/Discussion
- Continuous Assessment Tests

Text Books:

1	M Lakshmikanth “Indian Polity”, McGraw Hill Education, 5th edition 2017.
2	Durga Das Basu, “Introduction to the Constitution of India “, Lexis Nexis, New Delhi., 21st edition, 2013.

Reference Books / Web links:

1	Sharma, Brij Kishore, “Introduction to the Constitution of India”, Prentice Hall of India, New Delhi, 7th edition, 2015.
2	Subhash Kashyap, “Our Constitution: An Introduction to India’s Constitution and Constitutional Law”, National Book Trust India, 1994.
3	Mahendra Prasad Singh and Himanshu Roy, “Indian Political System”, Pearson India, 4th edition, 2017.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	-	-	-
CO2	1	1	-	-	-	-
CO3	1	1	-	-	-	-
CO4	1	1	-	-	-	-
CO5	1	1	-	-	-	-
AVG	**1**	**1**	**-**	**-**	**-**	**-**

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
ET23221	EMBEDDED SYSTEM LABORATORY II	PC	0	0	4	2

Objectives:

- To provide knowledge on programming with ARM Processors for assembly language
- To provide knowledge on programming with ARM Processors for C programming
- To provide knowledge on programming with DSP Processors
- To impart knowledge on I/O programming with FPGA
- To inculcate knowledge on Network Topology

Description of the Experiments

1. Programming of ARM Processors using Assembly language
2. Programming of ARM Processors using C language
3. Interfacing of LED/ Switch/LCD with ARM Processors
4. Interfacing of Motor/UART/ADC/Seven Segment Display with ARM Processors
5. Programming with DSP processors for Auto Correlation/Linear Convolution/Circular Convolution
6. Programming with DSP processors for Waveform Generation/LED
7. Design of FIR Filter using DSP Processors
8. Design of IIR Filter using DSP Processors
9. Design using Xilinx/Altera FPGA Design and Implementation of simple Combinational/Sequential Circuits
10. Interfacing of LED/ Switch with FPGA
11. Study on in-circuit Emulators, Cross compilers, debugger
12. Network Simulators Communication Topology of network using NS2

Total Contact Hours: 60

Course Outcomes:

- understand the programming with ARM Processors for assembly language
- understand the programming with ARM Processors for C programming
- understand the programming with DSP Processors
- comprehend the I/O programming with FPGA
- synthesize of Network Topology using NS2

SUGGESTED EVALUATION METHODS (if Any) (UNIT/ Module Wise) – could suggest topic

- Experiment based viva

Web links for virtual lab (if any)

http://vlabs.iitkgp.ernet.in/rtes/index.html

Lab equipment required:

S. No	Name of the Equipment	Quantity Required
1	PC	20
2	ARM Processor boards	10
3	DSP boards	10
4	FPGA boards	10
5	NS2 Simulator	5 User

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	3
CO2	3	-	3	3	-	3
CO3	2	-	3	3	-	3
CO4	2	-	3	3	-	2
CO5	2	-	3	3	-	2
AVG	**2.4**	-	**3**	**3**	-	**2.6**

SEMESTER III

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23311	INTRODUCTION TO MACHINE LEARNING	PC	3	0	0	3

Objectives:

- To educate on several fundamental concepts and methods for machine learning.
- To get acquaint with basic learning algorithms and techniques and their applications.
- To acquire knowledge in processing, analyzing and handling data sets.
- To teach typical applications of various clustering-based learning algorithms
- To familiarize the different platforms and Attributes for machine learning

UNIT-I	INTRODUCTION TO MACHINE LEARNING	9

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	9

Data quality – Data preprocessing: - Data Cleaning: – Handling missing data and noisy data – data 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	9

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	9

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	9

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

Total Contact Hours: 45

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

- explain the basic theory underlying machine learning.
- use different types of machine learning algorithms along with their strengths and weaknesses.
- formulate machine learning problems corresponding to different applications.
- apply machine learning algorithms to solve problems of moderate complexity.
- read current research publications related to machine learning and understand the issues raised by current research.

SUGGESTED ACTIVITIES

- Problem solving sessions
- Flipped classroom _
- Survey on various machine learning algorithms
- Activity Based Learning
- Implementation of small module

SUGGESTED EVALUATION METHODS

- Tutorial problems
- Assignment problems
- Quizzes

● Class Presentation/Discussion
Text Book(s):
1. Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press, 2011.
2. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Elsevier, 2011
3. Jiawei Han, MichelineKamber, Jian Pei, Data Mining: Concepts and Techniques: Concepts and Techniques, Elsevier, 2011.
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.
5. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
Reference Books(s) / Web links:
1. https://www.youtube.com/watch?v=T3PsRW6wZSY&list=PLIg1dOXc_acbdJo-AE5RXpIM_rvwrerwR

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	3	-	3	-	2
CO2	3	3	-	-	-	-
CO3	3	3	-	-	2	-
CO4	3	3	-	-	-	2
CO5	3	3	-	3	-	-
AVG	**3**	**3**	**-**	**3**	**2**	**2**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23P4X	**PROFESSIONAL ELECTIVE- IV**	**PE**	**3**	**0**	**0**	**3**

Course Code	Course Title (Theory course)	Category	L	T	P	C
*******	**OPEN ELECTIVE**	**OE**	**3**	**0**	**0**	**3**

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
ET23322	**IoT FOR EMBEDDED APPLICATIONS LABORATORY**	**PC**	**0**	**0**	**4**	**2**
Objectives:						
● To implement the basic concepts of ARDUINO.						
● To develop applications using ARDUINO						
● To understand fundamentals of programming such as variables, conditional and iterative Execution, methods						
● To develop applications using IoT concepts						
● To implement features of IoT to solve real world problems.						
Description of the Experiments						
1. Interfacing and configuration of LED using digital pin of ARDUINO						
2. Interfacing and configuration of Buzzer using digital pin of ARDUINO						
3. Interfacing and configuration of switches using digital pin of ARDUINO						
4. Interfacing of potentiometers using analog pin of ARDUINO						
5. Interfacing of moisture, light, flame, temperature & humidity, IR, Gas, Ultrasonic and Sound sensor with ARDUINO						
6. Interfacing of Actuators with ARDUINO						
7. Interfacing of GSM with ARDUINO						

8. Control an LED from Web server using ESP8266
9. Smart Irrigation System using IoT
10. Smart Street Lighting System using IoT
11. Interfacing of camera with Raspberry Pi
12. Basic image processing applications using Raspberry Pi
Total Contact Hours: 60
Course Outcomes:
● apply the concepts of data acquisition system
● discuss different programming structures to represent real world problems.
● acquire the concepts of Graphical User Interfaces.
● design various ways of algorithms to solve the problems
● Explain the principles of the internet of things.
SUGGESTED EVALUATION METHODS ● Experiment based viva ● Quizzes
Web links for virtual lab (if any)
http://internetofthinking.blogspot.com/2015/12/control-led-from-webserver-using.html

Lab equipment required:

S. No	Name of the Equipment	Quantity Required
1	Arduino boards	20
2	ESP8266	10
3	LEDs, Sensors(variety)	30
4	Raspberry Pi board	10

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

Course Code	Course Title (Laboratory Course)	Category	L	T	P	C
ET23321	**PROJECT WORK (PHASE I)**	**EEC**	**0**	**0**	**12**	**6**
ET23421	**PROJECT WORK (PHASE II)**	**EEC**	**0**	**0**	**24**	**12**

Objectives:
● To provide a hands-on skill 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.
Course Outcomes: At the end of this course, the students will have the ability in
● Any of the listed Domains their Design, Development capability in Building Automation for a process through Hardware & Software Tools.
● Interpreting Pre-Requisites insists choice of project title from the enlisted broad domain of research topics for

Project work
● Demonstrate project work to enhance students' capacity to work in Research Areas of the Department interests or of Industrial importance.
● Demonstrate the skill in Oral and Written Communication as presented in the Thesis Book via Viva-Voce Examination
● 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.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3	-	-	-	-	-
CO3	3	-	-	-	-	3
CO4	3	3	3	3	3	3
CO5	3	3	3	3	3	3
AVG	**3**	**3**	**3**	**3**	**3**	**3**

PROFESSIONAL ELECTIVES

SEMESTER II
PROFESSIONAL ELECTIVE I

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23A11	**WIRELESS AND MOBILE COMMUNICATION**	**PE**	**3**	**0**	**0**	**3**

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
- To introduce network routing protocols
- To study the basis for classification of commercial family of wireless communication technologies

UNIT-I	**INTRODUCTION**	9

Wireless Transmission – signal propagation – spread spectrum – Satellite Networks – Capacity Allocation – FAMA – DAMA – MAC

UNIT-II	**MOBILE NETWORKS**	9

Cellular Wireless Networks – GSM – Architecture – Protocols – Connection Establishment – Frequency Allocation – Routing – Handover – Security – GPRS

UNIT-III	**WIRELESS NETWORKS**	9

Wireless LAN – IEEE 802.11 Standard-Architecture – Services – AdHoc Network – Hiper Lan – Blue Tooth, Zigbee, 6LowPAN,LoRa

UNIT-IV	**ROUTING**	9

Mobile IP – DHCP – AdHoc Networks – Proactive Routing Protocols – DSDV-WRP-CGSR-STAR - Reactive Routing Protocols – DSR –AODV-TORA-LAR-ABR

UNIT-V	**TRANSPORT AND APPLICATION LAYERS**	9

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

Total Contact Hours: 45

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

- deliver insight into categorizing various embedded & communication protocols for networking of distributed

static & mobile systems.
● evaluate the wireless network routing protocols
● analyze the current and future cellular mobile communication systems
● determine the appropriate wireless standard for mobile routing
● provide improved employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design
Text Book(s):
1. Jochen Schiller, " Mobile communications", PHI/Pearson Education, Second Edition, 2003
2. William Stallings, " Wireless communications and Networks", PHI/Pearson Education, 2002.
3. C. Siva Ram Murthy and B.S. Manoj, AdHoc Wireless Networks: Architectures and protocols, Prentice Hall PTR, 2004
Reference Books(s) / Web links:
1. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile computing", Springer, Newyork, 2003
2. C.K.Toh, " AdHoc mobile wireless networks", Prentice Hall, Inc, 2002.
3. Charles E. Perkins, " Adhoc Networking", Addison-Wesley, 2001.

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

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23A12	**ADHOC NETWORKS**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To expose the students to the fundamentals of wireless communication technologies.
- To teach the fundamentals of wireless network routing protocols
- To study on wireless issues in network layers topologies
- To introduce energy management in network routing protocols
- To study the basis of performance metrics for N/W communication technologies

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		
	Total Contact Hours : 45	

Course Outcomes:

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

•	analyze the fundamentals of wireless communication technologies.
•	analyze the fundamentals of wireless network routing protocols
•	determine the wireless issues in network layers topologies
•	apply energy management concepts in network routing protocols
•	evaluate the performance metrics for N/W communication technologies

Reference Books(s):

1	C. Siva Ram Murthy and B.S. Manoj, AdHoc Wireless Networks: Architectures and protocols, Prentice Hall PTR, 2004
2	C.-K.Toh, AdHoc Mobile Wireless Networks: Protocols and Systems, Prentice Hall PTR, 2001
3	Mohammad Ilyas, The Handbook of AdHoc Wireless Networks, CRC press, 2002

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	2
CO2	1	3	2	-	2	1
CO3	2	3	2	1	2	2
CO4	2	3	2	1	3	1
CO5	1	2	1	1	2	1
AVG	**1.6**	**2.6**	**1.8**	**1**	**2**	**1.4**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23A13	**MEMS and NEMS TECHNOLOGY**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To introduce the diverse technological and functional approaches of MEMS/NEMS and applications.
- To understand the microstructures and fabrication methods.
- To provide an insight of micro and nano sensors, actuators.
- To emphasise the need for NEMS technology.
- To update the ongoing trends and real time applications of MEMS and NEMS technology.

UNIT-I	INTRODUCTION TO MEMS and NEMS	9
Overview of Micro electro mechanical systems and Nano Electro mechanical systems, devices and technologies, Laws of scaling- Survey of materials- Smart Sensors-Applications of MEMS and NEMS.		
UNIT-II	**MICRO-MACHINING AND MICROFABRICATION TECHNIQUES**	9
Photolithography- 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	**NEMS TECHNOLOGY**	9

Atomic scale precision engineering- Nano Fabrication techniques - NEMS in measurement, sensing, actuation and systems design.		
UNIT-V	**MEMS and NEMS APPLICATION**	9
Introduction to Micro/Nano Fluids and applications- Bio MEMS- Optical NEMS- Micro and Nano motors- Recent trends in MEMS and NEMS.		
	Total Contact Hours: 45	

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

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

SUGGESTED ACTIVITIES

- Activity Based Learning

Text Book(s):

1. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.
2. Marc F madou" Fundamentals of micro fabrication" CRC Press 2002 2nd Edition Marc Madou.
3. M.H.Bao "Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 2000.

Reference Books(s) / Web links:

1. Maluf, Nadim "An introduction to Micro Electro-mechanical Systems Engineering "AR Tech house, Boston 2000.
2. Mohamed Gad – el – Hak "MEMS Handbook" Edited CRC Press 2002 2. Sabriesolomon "Sensors Handbook", Mc Graw Hill 1998.
3. Tai-.Ran Hsu, "MEMS and Microsystems: design , manufacture, and Nanoscale"- 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008

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

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23A14	**IoT FOR SMART SYSTEMS**	**PE**	**3**	**0**	**0**	**3**

Objectives:

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

UNIT-I	**INTRODUCTION TO INTERNET OF THINGS**	9
Introduction to IoT-, Hardware, and software requirements for IOT, Sensor and actuators, Basics of IoT Networking, Connectivity Technologies, 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. 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-III	**PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT PROTOCOLS:**	**9**
AMQP, CoAP, MQTT, M2M, NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.		
UNIT-IV	**IOT PROCESSORS**	9
Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability. Embedded processors for IOT : Introduction to Python programming - Introduction to Raspberry Pi -Building IOT with RASPERRY PI and Arduino- Integration of Sensors and Actuators with STM boards.		
UNIT-V	**APPLICATIONS**	9
Industry 4.0, Home Automation, smart cities, Smart Grid, electric vehicle charging, Environment, Agriculture		
		Total Contact Hours: 45

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

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

SUGGESTED ACTIVITIES

- Activity Based Learning
- Implementation of small module

Text Book(s):

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach “Internet of Things”,Universities Press 2015.
2. Oliver Hersent , David Boswarthick and Omar Elloumi “ The Internet of Things”, Wiley,2016.
3. Samuel Greengard, “ The Internet of Things”, The MIT press, 2015.
4. Adrian McEwen and Hakim Cassimally“Designing the Internet of Things “Wiley,2014.
5. Jean- Philippe Vasseur, Adam Dunkels, “Interconnecting Smart Objects with IP: The Next Internet” Morgan Kuffmann Publishers, 2010.
6. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley and sons, 2014.
7. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain,” Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8. OvidiuVermesan and Peter Friess (Editors), “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers Series in Communication,2013
9. UpenaDalal,”Wireless Communications & Networks,Oxford,2015.

Reference Books(s) / Web links:

1. Vijay Madisetti , ArshdeepBahga, “Internet of Things (A Hands on-Approach)”, 2014.
2. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and sons, 2009.
3. Lars T.Berger and Krzysztof Iniewski, “Smart Grid applications, communications and security”, Wiley, 2015.
4. JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, Smart Grid Technology and Applications”, Wiley, 2015.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	-
CO2	3	3	-	3	-	-

CO3	3	-	3	3	-	-
CO4	-	3	3	3	3	-
CO5	-	3	3	3	3	2
AVG	**3**	**3**	**3**	**3**	**3**	**2**

Course Code	**Course Title (Theory course)**	**Category**	**L**	**T**	**P**	**C**
ET23A15	**UNMANNED AERIAL VEHICLE**	**PE**	**3**	**0**	**0**	**3**

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	**DESIGN OF UAV SYSTEMS**	9

Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations- Characteristics of Aircraft Types- Design Standards-Regulatory 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	**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 Contact Hours: 45

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

- Identify different hardware for UAV.
- Determine preliminary design requirements for an unmanned aerial vehicle.
- Design UAV system.
- Identify and integrate various systems of unmanned aerial vehicle.
- Design micro aerial vehicle systems by considering practical limitations.

Text Book(s):

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

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	3	2	-	-	2
CO2	3	3	3	-	-	2

CO3	3	3	3	3	3	3
CO4	-	-	2	3	3	2
CO5	3	-	3	3	3	3
AVG	**2.5**	**3**	**2.6**	**3**	**3**	**2.4**

Course Code	**Course Title (Theory course)**	**Category**	**L**	**T**	**P**	**C**
ET23A16	**CYBER PHYSICAL SYSTEMS**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To provide knowledge on empirical findings and historical trends in Cyber-Physical Systems.
- :To get familiarized with dynamic system, stability and controller design techniques.
- To acquire knowledge on the challenges in HiTL and able to explain the future of HiTL CPS.
- To impart the main concepts, key technologies, strengths and limitations of Human Centered Cyber Physical Systems
- :To inculcate knowledge on basic feedback and control research methods, including both theory-driven and applied research design.

UNIT-I **CYBER-PHYSICAL SYSTEMS** 9

Cyber-Physical Systems (CPS) in the real world - Characteristics of CPS - Architecture of CPS - Distinctive features of CPS systems - CPS for Industry 4.0 - IIOT implications - Logical Foundations of Cyber-Physical Systems - CPS HW platforms : Processors, Sensors, Actuators - CPS Network - Scheduling Real Time CPS tasks.

UNIT-II **CPS - FEEDBACK SYSTEMS** 9

Modeling of system : Continuous Dynamics, Discrete Dynamic, Hybrid Systems, Composition of State Machine, Concurrent Models of Computation - CPU Dynamics - Relation between physical and software models - Principles of Dynamical Systems : Dynamical Systems and Stability - Controller Design Techniques - Meta Model of CPS - Control systems: Human-in or on the loop - Economics in the loop - Environment in the loop.

UNIT-III **CPS - HITL** 9

Taxonomies for HiTL CPS - Data Acquisition : Humans as Sets of Sensors, Humans as Communication Nodes - State Inference: Humans as Processing Nodes - Actuation - HiTL Technologies and Applications - Requirements and Challenges for HiTL Applications - Future of Human-In-the-Loop Cyber-Physical Systems - Human-in-the-Loop Constraints

UNIT-IV **HUMAN CENTRIC COMPUTING** 9

Aim of Human Centric Computing - Context-aware service technology - Multi-device Collaboration technology - Human Interaction technology - Human Centric Computing in a Data-Driven Society.

UNIT-V **CPS IMPLEMENTATION ISSUES** 9

From features to automotive software components - Mapping software components to ECUs - CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion - Building real-time networks for CPS.

Total Contact Hours: 45

Course Outcomes: At the end of this course, the students will be able to

- elucidate empirical findings, and historical trends in Cyber-Physical Systems.
- realize dynamic system, stability and controller design techniques.
- describe challenges in HiTL and able to explain the future of HiTL CPS. Systems.
- illustrate main concepts, key technologies, strengths and limitations of Human Centered Cyber Physical
- Be proficient with basic feedback and control research methods, including both theory-driven and applied research design.

SUGGESTED ACTIVITIES

- Activity Based Learning

Text Book(s):

1.E. A. Lee and S. A. Seshia, “Introduction to Embedded Systems: A Cyber-Physical Systems Approach”, 2011.

2.Platzer, Andre, " Logical Foundation of Cyber-Physical Systems", Theorectical Computer Science, Springer-

2018.
3.Constance Heitmeyer and Dino Mandrioli, “Formal methods for real-time computing”, Wiley publisher, 1996.
Reference Books(s) / Web links:
1.R. Alur, “Principles of Cyber-Physical Systems,” MIT Press, 2015.
2.T. D. Lewis “Network Science: Theory and Applications”, Wiley, 2009
3.P. Tabuada, “Verification and control of hybrid systems: a symbolic approach”, SpringerVerlag 2009.
4. C. Cassandras, S. Lafortune, “Introduction to Discrete Event Systems”, Springer 2007.
5.Rajkamal, " Enbedded Systems, Architecture, Programming and Design", Second Edition, Tata McGraw-Hill Publisher, 2008.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	3
CO2	3	1	2	3	3	3
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	2	3	3	3
AVG	**3**	**1.8**	**2.6**	**3**	**3**	**3**

PROFESSIONAL ELECTIVE II

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23B11	**AUTOMOTIVE EMBEDDED SYSTEMS**	**PE**	**3**	**0**	**0**	**3**

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	**CONTROL, COMFORT AND SAFETY MECHANISM IN AUTOMOTIVES**	9

Control: 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- Air Bag and Anti-pitch suspension mechanism – electronic steering, Automatic wiper control- body control system; Vehicle system schematic for interfacing with EMS, ECU.

Safety: 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 DIAGNOSTICS 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 AND EMBEDDED PROTOCOLS	9

Electric vehicles –Components- Plug in Electrical vehicle- Charging station – Aggregators- Fuel cells/Solar powered vehicles- Autonomous vehicles- BMS and Controller. Embedded communication Protocols- standards IEC 61851, ISO 15118, DIN 70121 and VDV 261- Power Line Communication- Signal Level Attenuation Characterization- Controller Area Network

Total Contact Hours: 45

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

- deliver insight into the significance of the role of embedded system for automotive applications.
- understand the need, selection of sensors and actuators and interfacing with ECU
- apply the Embedded concepts for vehicle management and control systems.
- understand the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs
- improve Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.

SUGGESTED ACTIVITIES

- Assignments

Text Book(s):

1. William B. Ribbens ,"Understanding Automotive Electronics", Elseiver,2012
2. Ali Emedi, Mehrded ehsani, John M Miller , "Vehicular Electric power system- land, Sea, Air and Space Vehicles" Marcel Decker, 2004.
3. L.Vlacic,M.Parent,F.Harahima,"Intelligent Vehicle Technologies", SAE International,2001.

Reference Books(s) / Web links:

1. Jack Erjavec, Jeff Arias," Alternate Fuel Technology-Electric , Hybrid& Fuel Cell Vehicles", Cengage ,2012
2. Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection – Ford
3. Automotive Electricals / Electronics System and Components, Tom Denton, 3 rd Edition, 2004.
4. Uwe Kiencke, Lars Nielsen, "Automotive Control Systems: For Engine, Driveline, and Vehicle", Springer; 1 edition, March 30, 2000 .
5. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 4 th Edition, 2004.
6. Automotive Hand Book, Robert Bosch, Bently Publishers, 1997.
7. https://www.vector.com/in/en/know-how/smart-charging/communication-protocols/

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	3	-
CO2	3	3	-	2	3	-
CO3	3	3	3	2	3	-
CO4	-	3	3	-	-	-
CO5	3	3	3	-	-	3
AVG	**3**	**3**	**3**	**2**	**3**	**3**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23B12	**OPEN-SOURCE SOFTWARE**	**PE**	**3**	**0**	**0**	**3**

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 - Modelling Tools - Mozilla Firefox - Wikipedia - Eclipse		
	Total Contact Hours : 45	
Course Outcomes: At the end of this course, the students will demonstrate the ability to		
•	clear understanding about the terms, tools used for Open-source software	
•	Able to use programming Languages in the open-source category for application development.	
•	Able to gain improved employability and entrepreneurship capacity	
•	Able to develop solutions to problems using open-source tools available	
•	Able to get an insight into the recent trends in embedded system design	
Reference Books(s):		
1	Remy Card, Eric Dumas and Frank Mevel, “The Linux Kernel Book”, Wiley Publications, 2003	
2	Richard Blum "PHP, MySQL & JavaScript All - in - One for Dummies", Wiley, 2018	
3	Kevin Tatroe, Peter MacIntyre and Rasmus Lerdorf, “Programming PHP: Creating Dynamic Web Pages”, 3rd edition, O’Reilly, 2013	
4	Wesley J. Chun, “Core Phython Programming”, Prentice Hall, 2001	
5	Martin C. Brown, “Perl: The Complete Reference”, 2nd Edition, Tata McGraw- Hill Publishing Company Limited, Indian Reprint 2009.	
6	Steven Holzner, “PHP: The Complete Reference”, 2nd Edition, Tata McGraw- Hill Publishing Company Limited, Indian Reprint 2009.	
7	Vikram Vaswani, “MYSQL: The Complete Reference”, 2nd Edition, Tata McGraw-Hill Publishing Company Limited, Indian Reprint 2009	

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	-	-	-
CO2	3	-	2	-	2	-
CO3	3	-	-	-	-	-
CO4	-	3	2	-	2	-
CO5	-	-	-	2	-	-
AVG	**3**	**3**	**2**	**2**	**2**	-

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23B13	DIGITAL INSTRUMENTATION	PE	3	0	0	3

Objectives:

- To impart knowledge on the fundamentals building blocks of a digital instrument
- To teach the digital data communication techniques
- To provide knowledge on bus communication standards and its working principles
- To teach Graphical programming using VI for instrument building
- To discuss the case studies on industrial process measurements.

UNIT-I **DATA ACQUISITION SYSTEMS** 9

Overview of A/D converter, types and characteristics – Sampling, Errors. Objective – Building blocks of Automation systems –Counters – Modes of operation- Frequency, Period, Time interval measurements, Prescaler, Heterodyne converter for frequency measurement, Single and Multi-channel Data Acquisition systems.

UNIT-II **INTERFACING AND DATA TRANSMISSION** 9

Data transmission systems – Peripheral Interfaces– Time Division Multiplexing (TDM) – Digital Modulation – Pulse Modulation – Pulse Code Format – Interface systems and standards – Communications.

UNIT-III **INSTRUMENTATION BUS** 9

Introduction, Modem standards, Basic requirements of Instrument Bus standards, Bus communication, interrupt and data handshaking, Interoperability, interchangeability for RS- 232, USB, RS-422, RS-485- CAN bus

UNIT-IV **VIRTUAL INSTRUMENTATION** 9

Fundamental Concepts of Virtual Instrumentation (VI) - Block diagram and Architecture – Virtual instruments- and Traditional instruments, Hardware and Software in Virtual instrumentation, Data Flow Programming - Graphical programming using GUI - Data Types – Customization of VI Properties - VI Documentation.

UNIT-V **APPLICATIONS** 9

PC based Data Acquisition system, Data Loggers, PC based industrial process measurements like flow, temperature, pressure, flow and level development system.

Total Contact Hours : 45

Course Outcomes:

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

- comprehend the fundamentals building blocks of a digital instrument.
- analyse the different methods of Data Transmission Systems.
- acquire the concept of various instrumentation Bus.
- build VIs for simple industrial applications
- acquire detail knowledge on industrial process measurements.

SUGGESTED ACTIVITIES

- Quiz
- Guest Lectures

SUGGESTED EVALUATION METHODS

Assignments

Text Books:

1. A.J. Bouwens, “Digital Instrumentation” , TATA McGraw-Hill Edition, 1998.
2. H S Kalsi, “Electronic Instrumentation” Fourth Edition, Tata McGraw-Hill,2017.
3. Joseph J. Carr, “Elements of Electronic Instrumentation and Measurement” Third Edition, Pearson Education, 2003.

Reference Books / Web links:

1. Buchanan, “Computer busses”, Arnold, London,2000.
2. Doebelin, E.O., Measurement systems, McGraw Hill, Fourth edition, Singapore, 1990.
3. Jonathan W Valvano, “Embedded Microcomputer systems”, Asia Pvt. Ltd., Brooks/Cole, Thomson, 2001.
4. Albert D.Helstrick and William D.Cooper, “Electronics Instrumentation & Measurement Techniques”, Pearson Education, January 1985.

5	Website Link : https://www.ni.com/en-in/innovations/white-papers/06/virtual-instrumentation.html

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	3	3	3
CO2	3	1	1	3	3	3
CO3	2	1	1	3	3	3
CO4	3	2	2	2	2	3
CO5	3	3	3	3	3	3
AVG	2.8	1.6	1.6	2.8	2.8	3

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23B14	RISC PROCESSOR ARCHITECTURE AND PROGRAMMING	PE	3	0	0	3

Objectives:

- To understand the embedded system based on ARM processor and its hardware
- To impart knowledge on programming skill.
- To understand the techniques and rules for writing efficient C code and optimizing ARM assembly code.
- To discuss various Cache technologies and Architecture that surrounds the ARM cores and MMU.
- To Understand the architecture of ARM CORTEX-M3

UNIT-I	**ARM ARCHITECTURE**	9

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

UNIT-II	**PERIPHERALS OF ARM MICROCONTROLLER**	9

I/O Memory –EEPROM – I/O Ports – SRAM –Timer –UART - Serial Communication with PC – ADC/DAC Interfacing.

UNIT-III	**ARM MICROCONTROLLER PROGRAMMING**	9

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

UNIT-IV	**DESIGN WITH ARM MICROCONTROLLERS**	9

ARM Implementation- Simple ASM/C programs- Loops –Look up table- Block copy- subroutines-Hamming Code.

UNIT-V	**ARM Cortex-M3**	9

ARM Cortex-M3 Processor –Architecture- Instruction Set Development-Thumb-2 Technology and Instruction Set Architecture-CORTEX-M3 Applications.

Total Contact Hours	**:**	**45**

Course Outcomes:

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

- design an embedded system using ARM processor
- write source code that will compile more efficiently in terms of increased speed and reduced code size.
- develop an embedded system with optimized key subroutines to reduce system power consumption and clock
- realize the optimized memory allocation
- describe the basics of ARM Cortex-M3 and its application.

Reference Books(s):

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	William Hohl, ' Arm Assembly Language' Fundamentals and Techniques,2009.
4	ARM Architecture Reference Manual, LPC213x User Manual
5	www.Nuvoton .com/websites on Advanced ARM Cortex Processors

6	ARM Architecture Reference Manual

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	2	3
CO2	3	3	3	3	2	3
CO3	3	3	3	3	-	-
CO4	3	3	-	-	-	-
CO5	3	3	-	3	-	3
AVG	**3**	**3**	**3**	**3**	**2**	**3**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23B15	**EMBEDDED COMPUTING**	PE	**3**	**0**	**0**	**3**

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

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 Smartcard 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 Contact Hours	**:**	**45**

Course Outcomes:

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

- deliver insight into involving JAVA concepts& internet-based Communication to establish decentralized control mechanism of system
- interpret the software and hardware architecture for distributed computing
- develop solution for smart card
- develop Apps based on android SDK.
- improved Employability and entrepreneurship capacity due to knowledge up gradation

Reference Books(s):

1. AmitavaGupta , Anil Kumar Chandra and Peter Luksch " Real-Time and Distributed Real-Time Systems Theory and Applications " CRC Press 2016 International Standard Book Number-13: 978-1-4665-9849-2
2. Wolfgang Rankl and Wolfgang Effing "Smart Card Handbook" John Wiley & Sons Ltd , Third Edition, 2003
3. Reto Meier "Professional Android application development" Wiley Publishing , Inc , 2009.
4. Joshua " Android hacker's Handbook" John Wiley & sons , 2014

5	Dietel & Dietel, "JAVA how to program", Prentice Hall 1999.
6	Sape Mullender, "Distributed Systems", Addison-Wesley, 1993

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	-	2	2
CO2	2	3	2	-	-	-
CO3	3	1	2	3	2	3
CO4	3	1	2	3	2	3
CO5	2	1	2	-	-	3
AVG	**2.4**	**1.5**	**1.8**	**3**	**2**	**2.75**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23B16	**INDUSTRIAL AUTOMATION**	**PC**	**3**	**0**	**0**	**3**

Objectives:

- To provide knowledge on industrial automation principles and strategies
- To gain knowledge on the material handling system used in the automated industries.
- To inculcate knowledge on the working of industrial robots and its sensors.
- To provide knowledge on the kinematics of robotic manipulators.
- To acquire knowledge on the dynamics of robotic manipulators.

UNIT-I **INTRODUCTION** 9

Definition, automation principles and strategies - scope of automation - socioeconomic consideration, low cost automation - Production concepts and automation strategies - Fixed Automation: Automated Flow lines, Methods of Work part Transport. Transfer Mechanism - Continuous transfer, intermittent transfer - Indexing mechanism Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis.

UNIT-II **MATERIAL HANDLING SYSTEM** 9

Concepts of material handling, principles and considerations in material handling systems design, conventional material handling systems - industrial trucks, rail guided vehicles, conveyor systems - advanced material handling systems - automated guided vehicle systems - automated storage and retrieval systems(ASRS), Work-in-process Storage - Interfacing Handling and Storage with Manufacturing.

UNIT-III **ROBOTS AND SENSORS** 9

Introduction - Definition, Classification, Robot Components, Degree of Freedom, Mobile robots, Robot Characteristics, Robot Workspace, Robot programming - Application of Robots - Various Sensors and their Classification - Use of Sensors and Sensor Based System in Robotics - Machine Vision System - Description, Sensing – Digitizing - Image Processing and Analysis and Application of Machine Vision System - Robotic Assembly Sensors and Intelligent Sensors.

UNIT-IV **KINEMATICS OF ROBOTIC MANIPULATORS** 9

General Mathematical Preliminaries on Vectors & Matrices - Direct Kinematics problem - Geometry Based Direct kinematics problem - Co-ordinate and vector transformation using matrices, Rotation matrix, Inverse Transformations, Problems - Composite Rotation matrix - Homogenous Transformations - Robotic Manipulator Joint Co-Ordinate System - Euler Angle & Euler Transformations - Roll-Pitch-Yaw (RPY) Transformation - DH Representation & Displacement - Matrices for Standard Configurations - Jacobian Transformation in Robotic Manipulation - Trajectory Interpolators.

UNIT-V **DYNAMICS OF ROBOTIC MANIPULATORS** 9

Definitions - Generalized Robotic Coordinates - Jacobian for a two link Manipulator - Euler Equations and The Lagrangian Equations of motion - Application of Lagrange – Euler (LE) - Dynamic Modeling of Robotic Manipulators - Velocity of Joints, Kinetic Energy (T) of Arm, Potential Energy (V) of Robotic Arm, The Lagrange L, Two Link Robotic Dynamics with Distributed Mass.

	Total Contact Hours: 45
Course Outcomes: At the end of this course, the students will be able to	
● Describe the industrial automation principles and strategies.	
● Evaluate the material handling system for automation.	
● Distinguish between different sensors for different applications.	
● Demonstrate the Kinematics of Robotic Manipulators.	
● Demonstrate the Dynamics of Robotic Manipulators.	
SUGGESTED ACTIVITIES ● Activity Based Learning	
Text Book(s):	
1.Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.	
2.Richaerd D Klafter, Thomas Achmielewski and MickaelNegin, "Robotic Engineering – An integrated Approach" Prentice Hall India, New Delhi, 2001.	
Reference Books(s) / Web links:	
1.Deb S R and Deb S, Robotics Technology and Flexible Automation, Tata McGraw Hill Education Pvt. Ltd, 2010.	
2.Mikell P Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, 2015.	

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	2	1	1
CO2	1	-	-	2	-	3
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	3	3	3	3
AVG	**2.6**	**1.4**	**2**	**2.6**	**2**	**2.6**

PROFESSIONAL ELECTIVE III

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23C11	**DSP BASED SYSTEM DESIGN**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To understand various representation methods of DSP system
- To provide insight about different DSP algorithms
- To familiarize the various architectures of DSP system
- To perform analysis of DSP architectures and to learn the implementation of DSP system in programmable hardware
- To learn the details of DSP system interfacing with other peripherals

UNIT-I	**REPRESENTATION OF DSP SYSTEM**	9

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

UNIT-II	**DSP ALGORITHMS**	9

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

UNIT-III	SYSTEM ARCHITECTURE	9
Introduction, Basic Architectural Features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Features for External Interfacing. VLIW architecture. Basic performance issue in pipelining, Simple implementation of MIPS, Instruction Level Parallelism, Dynamic Scheduling, Dynamic Hardware Prediction, Memory hierarchy. Study of Fixed point and floating-point DSP architectures		
UNIT-IV	**ARCHITECTURE ANALYSIS ON PROGRAMMABLE HARDWARE**	9
Analysis of basic DSP Architectures with C6713 and C6416 DSK on programmable hardware. Algorithms for FIR, IIR, Lattice filter structures, architectures for real and complex fast Fourier transforms, 1D/2D Convolutions, Winograd minimal filtering algorithm. FPGA: Architecture, different sub-systems, design flow for DSP system design, mapping of DSP algorithms onto FPGA.		
UNIT-V	**SYSTEM INTERFACING**	9
Examples of digital signal processing algorithms suitable for parallel architectures such as GPUs and multiGPUs. Interfacing: Introduction, Synchronous Serial Interface CODE, A CODEC Interface Circuit, ADC interface.		
Total Contact Hours: 45		

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

- Evaluate the DSP system using various methods.
- Design algorithm suitable for different DSP applications.
- Explain various architectures of DSP system.
- Implement DSP system in programmable hardware.
- Build interfacing of DSP system with various peripherals

SUGGESTED ACTIVITIES

- Activity Based Learning
- Implementation of small module

Text Book(s):

1. Sen M Kuo, Woon Seng S Gan, Digital Signal Processors
2. RulphChassaing, Digital signal processing and applications with C6713 and C6416 DSK, Wiley,2005
3. Architectures for Digital Signal Processing, Peter Pirsch John Weily, 2007

Reference Books(s) / Web links:

1. DSP Processor and Fundamentals: Architecture and Features. Phil Lapsley, JBier, AmitSohan, Edward A Lee; Wiley IEEE Press
2. Nasser Kehtarnavaz, Digital Signal Processing System Design: LabVIEW-Based Hybrid Programming, Academic Press, 2008
3. Keshab K Parhi, VLSI Digital Signal Processing Systems: Design and Implementation, student Edition, Wiley, 1999.
4. K. K. Parhi - VLSI Digital Signal Processing Systems - Wiley – 1999.
5. DSP Processor and Fundamentals: Architecture and Features. Phil Lapsley, JBier, AmitSohan, Edward A Lee; Wiley IEEE Press

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	2	2	-
CO2	-	3	3	-	-	-
CO3	-	3	3	-	-	1
CO4	-	3	3	-	-	-
CO5	2	3	-	-	2	-
AVG	**0.4**	**3**	**3**	**2**	**2**	**1**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23C12	SOFT COMPUTING TECHNIQUES	PE	3	0	0	3

Objectives:

- To provide exposure on the concepts of feed forward neural networks.
- To provide knowledge on feedback neural networks.
- To get familiarized with the concept of fuzziness involved in various systems.
- To explore the ideas about genetic algorithm.
- To inculcate knowledge on FLC and NN toolbox.

UNIT-I **INTRODUCTION AND ARTIFICIAL NEURAL NETWORKS** 9

Introduction of soft computing –various types of soft computing techniques- applications of soft computing-Neuron-Nerve structure and synapse-Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCulloch Pitts neuron model- perceptron model- Adaline and Madeline- multilayer perception model- Back propagation learning methods- effect of learning rule coefficient -back propagation algorithm- factors affecting back propagation training.

UNIT-II **ARTIFICIAL NEURAL NETWORKS** 9

Counter propagation network- architecture- functioning & characteristics of counter Propagation network - Hopfield / Recurrent network – configuration - stability constraints - associative memory – characteristics - limitations and applications - Hopfield v/s Boltzman machine - Adaptive Resonance Theory – Architecture – classifications - Implementation and training.

UNIT-III **FUZZY LOGIC SYSTEM** 9

Introduction to crisp sets and fuzzy sets - basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control – Fuzzification and defuzzification - Fuzzy knowledge and rule bases - Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control - Fuzzy logic control for nonlinear time delay system.

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 and ant colony search techniques for solving optimization problems.

UNIT-V **APPLICATIONS** 9

GA application to power system optimization problem - Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab - Neural Network toolbox. Stability analysis of Neural Network interconnection systems - Implementation of fuzzy logic controller using Matlab fuzzy logic toolbox - Stability analysis of fuzzy control systems.

Total Contact Hours: 45

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

- To describe the basic ANN architectures, algorithms and their limitations.
- To elucidate the different operations on the fuzzy sets.
- To develop the ANN based models and control schemes for non-linear system.
- To illustrate the use of different ANN structures and online training algorithm.
- To develop the fuzzy logic control of non-linear systems

SUGGESTED ACTIVITIES : Assignments

Text Book(s):

1. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson Education, 1993
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” 3rd Edition, Wiley India, 2011

Reference Books(s) / Web links:

1. Zimmermann H.J. “Fuzzy set theory and its applications” Springer international edition, 2011
2. David E.Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning”, Pearson Education, 2009

3. W.T.Miller, R.S.Sutton and P.J.Webrose, "Neural Networks for Control", MIT Press, 1996

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	2	-	2	1
CO2	3	-	2	3	2	-
CO3	2	2	2	3	2	3
CO4	2	-	2	3	2	3
CO5	3	-	2	-	2	3
AVG	2.8	2	2	3	2	2.5

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23C13	DEEP LEARNING TECHNIQUES	PE	3	0	0	3

Objectives:

- To acquire knowledge on the basics of neural networks.
- To implement neural networks using computational tools for variety of problems.
- To explore various deep learning algorithms.
- To implement Neural Networks using Tensor flow.
- To know the various applications of Deep Learning.

UNIT-I **CONVOLUTIONAL NEURAL NETWORKS** 9

Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT-II **MEMORY AUGMENTED NEURAL NETWORKS** 9

Neural Turing Machines-Attention-Based Memory Access-NTM Memory Addressing Mechanisms Differentiable Neural Computers-Interference-Free Writing in DNCs-DNC Memory Reuse-Temporal Linking of DNC Writes-Understanding the DNC Read Head-The DNC Controller Network Visualizing the DNC in Action-Implementing the DNC in TensorFlow-Teaching a DNC to Read and Comprehend.

UNIT-III **DEEP REINFORCEMENT LEARNING** 9

Deep Reinforcement Learning Masters Atari Games - Reinforcement Learning -Markov Decision Processes (MDP)-Explore Versus Exploit-Policy versus Value Learning-Pole-Cart with Policy Gradients-Q-Learning and Deep Q-Networks-Improving and Moving Beyond DQN.

UNIT-IV **IMPLEMENTING NEURAL NETWORKS IN TENSORFLOW** 9

Introduction to TensorFlow – Comparitive analysis of Tenforflow - Installing TensorFlow-Creating and Manipulating TensorFlow Variables-TensorFlow Operations-Placeholder Tensors-Sessions in TensorFlow-Navigating Variable Scopes and Sharing Variables-Managing Models over the CPU and GPU-Specifying the Logistic Regression Model in TensorFlow-Logging and Training the Logistic Regression Model-Leveraging TensorBoard to Visualize Computation Graphs and Learning-Building a Multilayer Model for MNIST in TensorFlow.

UNIT-V **APPLICATIONS OF DEEP LEARNING** 9

Deep learning for computer vision – Data Augmentation - Neural Language Models - High-Dimensional Outputs – Health care applications.

Total Contact Hours: 45

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

- Develop algorithms simulating human brain.
- Implement Neural Networks in Tensor Flow for solving problems.
- Explore the essentials of Deep Learning and Deep Network architectures.
- Apply reinforcement
- Define, train and use a Deep Neural Network for solving real world problems that require artificial

SUGGESTED ACTIVITIES

● Activity Based Learning
Text Book(s):
1. Nikhil Buduma, Nicholas Locascio, Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, O'Reilly Media, 2017.
2. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning (Adaptive Computation and Machine Learning series, MIT Press, 2017.
Reference Books(s) / Web links:
1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools and Techniques to Build Intelligent Systems 1st Edition, O'Reilly Media, 2017
2. Indra den Bakker, Python Deep Learning Cookbook: Over 75 practical recipes on neural network modeling, reinforcement learning, and transfer learning using Python, Packt Publishing, 2017

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	1	-	-	-
CO2	2	3	2	-	-	-
CO3	3	-	3	-	3	-
CO4	2	3	2	-	-	-
CO5	3	3	3	-	3	-
AVG	**2.2**	**3**	**2.2**	**-**	**3**	**-**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23C14	**DIGITAL IMAGE PROCESSING SYSTEM**	**PE**	**3**	**0**	**0**	**3**

Objectives:

- To learn the fundamentals of image processing
- To acquire techniques involved in image enhancement
- To enhance low and high-level features for image analysis
- To learn the fundamentals and significance of image compression
- To acquire the skills needed to implement 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-V	**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 Contact Hours: 45

Course Outcomes: At the end of this course, the students will demonstrate the ability to
● understand the fundamentals of image processing.
● understand the techniques involved in image enhancement, segmentation and compression.
● analyze their real-time applications
● implement image processing applications using software and hardware.
● develop real time solutions for applications
Text Book(s):
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
5. Donald G. Bailey, "Design for Embedded Image processing on FPGAs" John Wiley and Sons, 2011.

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	-	-	-
CO2	3	3	-	-	-	-
CO3	-	3	2	-	-	2
CO4	-	3	-	3	3	2
CO5	-	3	-	3	3	2
AVG	**3**	**3**	**2**	**3**	**3**	**2**

Course Code	**Course Title (Theory course)**	**Category**	**L**	**T**	**P**	**C**
ET23C15	**COMPUTER VISION**	**PE**	**3**	**0**	**0**	**3**

Objectives:		
● To introduce the fundamentals of Human and Computer Vision.		
● To introduce the major ideas, concepts, methods and techniques in Computer Vision.		
● To impart Computer Vision knowledge by way of learning related algorithms.		
● To make them familiar with both the Theoretical and Practical aspects of Computing with Images.		
● To provide the student with programming experience for implementing Computer Vision and algorithms.		
UNIT-I	**INTRODUCTION TO COMPUTER VISION**	9
Digital Image Processing – Various Fields that use Image Processing – Fundamentals Steps in Digital Image Processing – Components of an Image Processing System. Applications of Computer Vision – Recent Research in Computer Vision. Introduction to Computer Vision and Basic Concepts of Image Formation: Introduction and Goals – Image Formation and Radiometry – Geometric Transformation – Geometric Camera Models – Image Reconstruction from a Series of Projections.		
UNIT-II	**IMAGE PROCESSING CONCEPTS AND IMAGE FEATURES**	9
Image Processing Concepts: Fundamentals – Image Transforms – Image Filtering – Colour Image Processing – Mathematical Morphology – Image Segmentation. Image Descriptors and Features: Texture Descriptors – Colour Features – Edge Detection – Object Boundary and Shape Representation – Interest or Cornet Point Detectors – Histogram Oriented Gradients – Scale Invariant Feature Transform.		
UNIT-III	**IMAGE PROCESSING WITH OPENCV**	9
Introduction to OpenCV and Python: Setting up OpenCV – Image Basics in OpenCV – Handling Files and Images –		

Constructing Basic Shapes in OpenCV. Image Processing in OpenCV: Image Processing Techniques – Constructing and Building Histograms – Thresholding Techniques.		
UNIT-IV	**OBJECT DETECTION**	9
Models and types – Importance of Object Detection. The Working: Inputs and outputs – Basic Structure – Model Architecture Overview – Object Detection on the Edge. Use Cases and Applications: Video Surveillance – Self-driving Cars. Embedded Boards: Connecting Cameras to Embedded Boards – Simple algorithms for processing Images and Videos.		
UNIT-V	**APPLICATIONS AND CASE STUDIES**	9
Applications: Machine Learning algorithms and their Applications in Medical Image Segmentation – Motion Estimation and Object Tracking – Face and Facial Expression Recognition – Image Fusion. Case Studies: Face Detection – Object Tracing – Eye Tracking – Handwriting Recognition with HoG.		
Total Contact Hours: 45		
Course Outcomes: At the end of this course, the students will demonstrate the ability to		
● Understand the major concepts and techniques in computer vision and image processing		
● Infer known principles of human visual system		
● Demonstrate a thorough knowledge of Open CV		
● Develop real-life Computer Visions Applications.		
● Build design of a Computer Vision System for a specific problem.		
Text Book(s):		
1. "Digital Image Processing", 4th Edition (Global Edition), Rafael C Gonzalez and Richard E Woods, Pearson Education Limited, 2018.		
2. "Computer Vision and Image Processing - Fundamentals and Applications", Manas Kamal Bhuyan, CRC Press, 2020.		
3. "Mastering OpenCV 4 with Python", Alberto Fernández Villán, Packt Publishing, 2019.		
4. "Practical Python and Open CV: Case Studies", 3rd Edition, Adrian Rosebrock, PyImageSearch, 2016.		

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

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23C16	**EMBEDDED SYSTEMS FOR BIOMEDICAL APPLICATIONS**	**PE**	**3**	**0**	**0**	**3**

Objectives:		
● To provide Knowledge on the fundamental art of biomedical engineering.		
● To explore wearable health devices and its importance.		
● To gain Knowledge on image processing applications using software and hardware		
● To inculcate knowledge on embedded diagnostic applications.		
● To impart knowledge on of some biomedical equipment.		
UNIT-I	**INTRODUCTION TO BIOMEDICAL ENGINEERING**	9
Origin of bio potential and its propagation - Resting and Action Potential - Bio signals characteristics -Types of electrodes - Types of transducers and applications - Bio-amplifiers - Types of recorders - components of a biomedical system.		

UNIT-II	**WEARABLE HEALTH DEVICES**	9
Concepts of wearable technology in health care - Components of wearable devices – Biosensors - Blood glucose sensors - Head worn - Hand worn - Body worn -pulse oximeter- Cardiac pacemakers - Hearing aids and its recent advancements - wearable artificial kidney.		
UNIT-III	**EMBEDDED SYSTEM FOR MEDICAL IMAGE PROCESSING**	9
Introduction to embedded image processing - ASIC vs FPGA - memory requirement - power consumption - parallelism - Design issues in VLSI implementation of Image processing algorithms - interfacing. Hardware implementation of image processing algorithms: Segmentation and compression		
UNIT-IV	**EMBEDDED SYSTEM FOR DIAGNOSTIC APPLICATIONS**	9
ICCU patient monitoring system - ECG-EEG-EMG acquisition system - MRI scanner - CT scanner - Sonography.		
UNIT-V	**CASE STUDY**	9
Respiratory measurement using spirometer - IPPB unit for monitoring respiratory parameters – ventilators - Defibrillator – Glucometer – Heart - Lung machine.		
Total Contact Hours: 45		

Course Outcomes: At the end of this course, the students will be able to

- apply the fundamental art of biomedical engineering.
- elucidate wearable health devices and its importance.
- Implement image processing applications using software and hardware
- describe various embedded diagnostic applications.
- Build and analyze of some biomedical equipment.

SUGGESTED ACTIVITIES

- Activity Based Learning

Text Book(s):

1.Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.

2.John G.Webster, “Medical Instrumentation Application and Design”, 3rd Edition, Wiley India Edition, 2007

Reference Books(s) / Web links:

1.Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Prentice Hall of India, New Delhi, 2007.

2.L.A Geddes and L.E.Baker, Principles of Applied Biomedical Instrumentation, 3rd Edition, John Wiley and Sons, Reprint 2008.

3.Richard S.Cobbold, Transducers for Biomedical Measurements; Principle and applicationsJohn Wiley and sons, 1992.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	2	-	2	-
CO2	2	-	1	1	-	2
CO3	3	2	2	3	2	3
CO4	1	1	1	1	1	-
CO5	2	2	1	2	1	2
AVG	**1.6**	**1**	**1.4**	**1.4**	**1.2**	**1.4**

PROFESSIONAL ELECTIVE IV

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23D11	EMBEDDED SYSTEM DEVELOPMENT	PE	3	0	0	3

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.

Total Contact Hours: 45

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

- Identify the recent trends in embedded systems design with understand the integration of customer requirements in product design
- 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.
- Understand various aspects of design such as industrial design, design of Consumer specific product, its Reverse Engineering manufacture, economic analysis through product architecture
- Observe the success strategies practiced by Industries in New Product Development

● familiarizing the concepts acquired over the 5 Units of the subject for improved employability& entrepreneurship skills
SUGGESTED ACTIVITIES ● Activity Based Learning ● Miniproject
Text Book(s):
1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition,2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9
2. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition,4th Edition, 2009, ISBN 978-007-127189-9
3. I.Komninos, D. Milossis, N. Komninos, Product Life Cycle Management A Guide to New Product Development, 1991
4. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education, ISBN 9788177588217
5. Katheryn, A. Ingle, Reverse Engineering, McGraw-Hill, 1994

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

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23D12	**EMBEDDED SYSTEMS SECURITY**	**PE**	**3**	**0**	**0**	**3**

Objectives:		
● To introduce the fundamentals related to Cryptography and Data Security		
● To teach the mathematical foundations for Cryptography.		
● To impart knowledge about Embedded Cryptography and Data Protection Protocols		
● To make them understand the practical aspects of Embedded System Security.		
● To provide basic concepts about system security and attacks.		
UNIT-I	**BACKGROUND AND INTRODUCTION**	
Computer and Network Security Concepts: Computer Security Concepts – The OSI Security Architecture – Security Attacks – Security Services – Security Mechanisms – Fundamentals of Security Design Principles – Attack Surfaces and Attack Trees – A Model for Network Security. Introduction to Number Theory: Divisibility and the Division Algorithm – The Euclidean Algorithm – Modular Arithmetic – Prime Numbers – Fermet's and Euler's Theorems – Testing for Primality – The Chinese Remainder Theorem – Discrete Logarithms.		
UNIT-II	**SYMMETRIC CIPHERS**	9
Classical Encryption Techniques: Symmetric Cipher Model – Substitution Techniques – Transposition Techniques. Block Ciphers and the Data Encryption Standard (DES): Traditional Block Cipher Structure – The Data Encryption Standard – A DES Example – Strength of DES. Advanced Encryption Standard: Finite Field Arithmetic – AES Structure – AES Transformation Functions – AES Key Expansion – An AES Example – AES Implementation.		
UNIT-III	**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-IV	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-V	**PRACTICAL EMBEDDED SYSTEM SECURITY**	9
Network Communications Protocols and Built-in Security – Security Protocols and Algorithms – The Secured Socket Layer – Embedded Security – Wireless – Application-Layer and Client/Server Protocols – Choosing and Optimizing Cryptographic Algorithms for Resource-Constrained Systems – Hardware Based Security.		
Total Contact Hours: 45		
Course Outcomes: At the end of this course, the students will demonstrate the ability to		
● Explain the significance of Security.		
● Understand the major concepts and techniques related to Cryptography.		
● Demonstrate thorough knowledge about the aspects of Embedded System Security.		
● Delivers insight onto role of Security Aspects during Data Transfer and Communication.		
● Applying the Security Algorithms for Real-time Applications.		
Text Book(s):		
1. "Cryptography and Network Security Principles and Practice", 7th Edition – Global Edition, William Stallings, Pearson Education Limited, 2017.		
2. "Embedded Systems Security - Practical Methods for Safe and Secure Software and Systems Development", David Kleidermacher and Mike Kleidermacher, Newnes (an imprint of Elsevier),2012.		
3. "Practical Embedded Security - Building Secure Resource-Constrained Systems", Timothy Stapko, Newnes (an imprint of Elsevier), 2008.		
4. W. Mao, "Modern Cryptography – Theory and Practice", Pearson Education, Second Edition, 2007.		
5. Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing Third Edition – Prentice Hall of India 2006.		
6. Forouzan, "Cryptography And Network Security", McGraw Hill Education, 3th edition, 2015.		

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	1	3	1
CO2	3	3	2	-	-	-
CO3	1	1	-	1	3	3
CO4	3	3	2	-	3	2
CO5	3	3	3	2	3	3
AVG	**2.2**	**2.2**	**2.33**	**1.33**	**3**	**2.25**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23D13	**RECONFIGURABLE PROCESSOR AND SoC DESIGN**	**PE**	**3**	**0**	**0**	**3**

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.		
Total Contact Hours: 45		
Course Outcomes: At the end of this course, the students will demonstrate the ability to		
● Illustrate the need of reconfigurable computing and hardware-software co design		
● Demonstrate the significance of FPGA technology		
● Apply the concept of FPGA technology and understand FPGA architectures		
● Interpret the operation of SoC processor		
● Relate and improve Employability and entrepreneurship capacity due to knowledge up-gradation on reconfigurable computing and SoC design		
SUGGESTED ACTIVITIES To develop any application as a mini project		
SUGGESTED EVALUATION METHODS Assignment and class Presentation/Discussion		
Text Book(s):		
1. Nurmi, Jari (Ed.) "Processor Design System-On-Chip Computing for ASICs and FPGAs" Springer, 2007.		
2. Ian Grout , “Digital system design with FPGAs and CPLDs” Elsevier, 2008 Joao Cardoso, Michael Hübner, "Reconfigurable Computing: From FPGAs to Hardware/Software Codesign" Springer, 2011.		
3. Ron Sass and AnderewG.Schmidt, “ Embedded System design with platform FPGAs: Principles and Practices”, Elsevier, 2010.		
Reference Books(s) / Web links:		
1. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007		
2. Pierre-Emmanuel Gaillardon, Reconfigurable Logic: Architecture, Tools, and Applications, 1st Edition, CRC Press , 2015		

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	-	-	-	-	-
CO2	-	2	3	-	-	-
CO3	-	-	2	1	2	-
CO4	-	1	3	-	-	-
CO5	-	-	-	-	-	3
AVG	-	**1.5**	**2.7**	**1**	**2**	**3**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23D14	**ROBOTICS AND MACHINE VISION**	**PE**	**3**	**0**	**0**	**3**
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	**BASICS OF ROBOTICS**	9
Introduction- Basic components of robot-Laws of robotics- classification of robot-work space- accuracy-resolution– repeatability of robot. Power transmission system: Rotary to rotary motion, Rotary to linear motion, Harmonics drives		
UNIT-II	**ROBOT END EFFECTORS**	9
Robot End effectors: Introduction-types of End effectors-Mechanical gripper-types of gripper mechanism-gripper force analysis-other types of gripper-special purpose grippers.		
UNIT-III	**ROBOT MECHANICS**	9
Robot kinematics: Introduction-Matrix representation- rigid motion &homogeneous transformation- forward & inverse kinematics trajectory planning. Robot Dynamics: Introduction-Manipulator dynamics		
UNIT-IV	**MACHINE VISION FUNDAMENTALS**	9
Machine vision: image acquisition, digital images-sampling and quantization-levels of computation, Feature extraction- windowing technique-segmentation-Thresholding- edge detection-binary morphology-gray morphology		
UNIT-V	**PROGRAMMING ROBOTIC FUNCTIONS**	9
Robot programming: Robot Languages-Classification of robot language-Computer control and robot software-Val system and Languages- Application of AI in robots.		
Total Contact Hours: 45		
Course Outcomes: At the end of this course, the students will demonstrate the ability to		
● Choose suitable embedded boards for robots		
● Demonstrate the concepts of robotics & automation and Working of Robot		
● Analyze the Function of Sensors and actuators In the Robot		
● Develop Program to Use a Robot for a Typical Application		
● Apply and improve Employability and entrepreneurship capacity due to knowledge upgradation on Embedded system-based robot development		
Text Book(s):		
1. Groover MP, M.Weiss ,R.N. Nagal, N.G.Odrey, "Industrial Robotics - Technology, programming and Applications" Second Edition, Tata McGraw-Hill Education Pvt. Limited, 2012		
2. John.J.Craig, " Introduction to Robotics: Mechanics & control" Pearson Publication, Fourth edition, 2018.		
3. Ralph Gonzale, C.S.G. Lee K. S. Fu, "Robotics: Sensing, Vision &Intelligence", Tata McGraw- Hill Publication, 2008.		
4. Sathya Ranjan Deb, "Robotics Technology & flexible Automation" Second edition, Tata McGraw-Hill Publication, 2009.		
5. Jazar, "Theory of Applied Robotics :Kinematics, Dynamics and Control", Springer, Indian Reprint, 2010		
Reference Books(s) / Web links:		
1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., “Industrial Robotics”, Mc Graw-Hill Singapore, 1996.		
2. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.		
3. Deb. S.R.,“Robotics Technology And Flexible Automation”, John Wiley, USA 1992.		

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

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23D15	EMBEDDED LINUX	PE	3	0	0	3

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	9

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

UNIT-II	CROSS-DEVELOPMENT TOOLCHAIN	9

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

UNIT-III	RUNNING LINUX ON EMBEDDED BOARDS	9

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

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

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

UNIT-V	INTRODUCTION TO LINUX DEVICE DRIVERS	9

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

Total Contact Hours: 45

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

- Thorough understanding of Linux and its commands
- Differentiate Embedded Linux from its Desktop counterpart and its internals
- Successfully run Linux on an Embedded Board, Use Eclipse IDE for Cross- compilation
- Able to write a simple device driver in Linux
- Improved Employability and entrepreneurship capacity due to knowledge up gradation

Text Book(s):

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.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	-	3	3	-
CO2	-	2	-	3	3	-
CO3	3	-	3	3	3	3
CO4	-	-	-	3	3	-
CO5	3	-	3	-	3	3
AVG	**3**	**2**	**3**	**3**	**3**	**3**

Course Code	Course Title (Theory course)	Category	L	T	P	C
ET23D16	CYBER SECURITY	PE	3	0	0	3

Objectives:

- To provide knowledge on the cyber security and cyber security standards
- To impart knowledge on security issues in networks and computer systems to secure an infrastructure.
- To explore design operational cyber security strategies and policies
- To inculcate knowledge on critical thinking and problem-solving skills to detect current and future attacks on an organization's computer systems and networks
- To explore the functionality of cyber security tools.

UNIT-I	**INTRODUCTION**	9

Need for Cyber security - History of Cyber security - Defining Cyberspace and Cyber security Standards - CIA Triad – Cyber security Framework

UNIT-II	**ATTACKS AND COUNTERMEASURES**	9

Malicious Attacks, Threats, and Vulnerabilities – Scope of cyber-attacks – Tools used to attack computer systems – security breach – Risks, vulnerabilities and threats. Malware – malicious software attack – social engineering attack – wireless network attack – web application attack Access control - Audit – Authentication - Biometrics - Denial of Service Filters - Ethical Hacking – Firewalls - Scanning, Security policy, Threat Management - Applying software update and patches - Intrusion Detection Systems -Virtual Private Networks –Cryptographic Techniques

UNIT-III	**SECURING THE INFRASTRUCTURE**	9

Infrastructure Security in the Real World - Understanding Access-Control and Monitoring Systems - Understanding Video Surveillance Systems - Understanding Intrusion-Detection and Reporting Systems

UNIT-IV	**SECURING LOCAL HOSTS AND NETWORKS**	9

Local Host Security in the Real World - Securing Devices - Protecting the Inner Perimeter - Protecting Remote Access Local Network Security in the Real World - Networking Basics - Understanding Networking Protocols - Understanding Network Servers - Understanding Network Connectivity Devices - Understanding Network Transmission Media Security

UNIT-V	**TOOLS**	9

Zenmap – Hydra –Kismet – John the Ripper – Airgeddon – Deauther Board – Aircrack-ng – EvilOSX

Total Contact Hours: 45

Course Outcomes: At the end of this course, the students will be able to

- Analyze and evaluate the cyber security needs of an organization.
- Analyze the security issues in networks and computer systems to secure an infrastructure.
- Design operational cyber security strategies and policies
- Apply critical thinking and problem-solving skills to detect current and future attacks on an organization's computer systems and networks
- Understand the functionality of cyber security tools.

SUGGESTED ACTIVITIES

● Activity Based Learning
Text Book(s):
1.William Stallings, Effective Cybersecurity: A Guide to Using Best Practices and Standards, 1st edition, 2019.
2.Charles J. Brooks, Christopher Grow, Philip A. Craig, Donald Short, Cybersecurity Essentials, Wiley Publisher, 2018.
3. Anand Shinde, "Introduction to Cyber Security Guide to the World of Cyber Security", Notion Press, 2021
Reference Books(s) / Web links:
1.Yuri Diogenes, ErdalOzkaya, Cyber security - Attack and Defense Strategies, Packt Publishers, 2018.
2.Carol C. Woody, Nancy R. Mead, Cyber Security Engineering: A Practical Approach for Systems and Software Assurance, Addison-Wesley, 2016.
3.Thomas A. Johnson Cyber Security- Protecting Critical Infrastructures from Cyber Attack and Cyber Warfare, CRC Press, 2015.
4. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley Publishers, 2011
5. David Kim, Michael G. Solomon, "Fundamentals of Information Systems Security", Jones & Bartlett Learning Publishers, 2013

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	3
CO2	3	2	2	3	3	3
CO3	3	2	3	3	3	3
CO4	3	2	3	3	3	3
CO5	2	2	2	3	3	2
AVG	**2.8**	**2**	**2.6**	**3**	**3**	**2.8**