KSR College of Engineering

NAAC ACCREDITED A++ | NBA ACCREDITED PROGRAMMES

AN AUTONOMOUS INSTITUTION

M.E. - EMBEDDED SYSTEMS TECHNOLOGY

Curriculum &
Syllabus for Semester I and II

REGULATIONS 2024

(Academic Year 2024-25 Onwards)

K.S.R. COLLEGE OF ENGINEERING: TIRUCHENGODE - 637 215

(Autonomous)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

(REGULATIONS 2024)

Vision of the Institution

IV	We envision to achieve status as an excellent Educational Institution in the global knowledge hub, making self-learners, experts, ethical and responsible engineers, technologists, scientists, managers, administrators and entrepreneurs who will significantly contribute to research and environment friendly sustainable growth of the nation and the world.

Mission of the Institution

IM 1	To inculcate in the students self-learning abilities that enable them to become competitive and considerate engineers, technologists, scientists, managers, administrators and entrepreneurs by diligently imparting the best of education, nurturing environmental and social needs.
IM 2	To foster and maintain mutually beneficial partnership with global industries and Institutions through knowledge sharing, collaborative research and innovation.

Vision of the Department

DV	We envision a department that leads in the field of Electrical and Electronics Engineering through education, training and research committed to influence the direction of the field and make a constructive contribution to society wherein the Department can thrive and grow.

Mission of the Department

DM 1	To create professionally competent and resourceful Electrical and Electronics Engineers.
DM 2	To promote excellence in teaching, pioneering research and innovation for a sustainable growth of the nation and enrichment of humanity.

Programme Educational Objectives (PEOs): M.E. - Embedded System Technologies

The graduates of the programme will be able to

PEO 1	Design and develop Embedded system automation based on dedicated ICs that have computation, networking and control capacity.
PEO 2	Conduct research and apply innovative problem-solving techniques, leading to the creation of cutting-edge embedded systems that address complex challenges in industry and academia, thereby contributing to technological progress.
PEO 3	Exhibit leadership qualities and ethical practices, positioning themselves as experts in the field of embedded systems while continuously pursuing professional development opportunities to stay abreast of technological advancements.

Programme Outcomes (POs) of 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.

Programme Specific Outcomes (PSOs) of M.E. - Embedded System Technologies

Program Specific Outcomes (PSOs)	
PSO1	Design and develop Embedded system automation based on dedicated ICs that have computation, networking and control capacity.
PSO2	Skill to work on professional software languages, standard modeling and analysis tools and commercial packages with communication protocols and computation platforms for analysis and design of system automation.

KSR College of Engineering	**K.S.R. COLLEGE OF ENGINEERING (Autonomous)** **Approved by AICTE and Affiliated to Anna University, Chennai** **Accredited by NAAC ('A++' Grade)** **K.S.R. Kalvi Nagar, Tiruchengode - 637 215**	**Curriculum** **PG** **R - 2024**
Department	**Department of Electrical and Electronics Engineering**	
Programme	**M.E. - Embedded System Technologies**	

SEMESTER – I

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
THEORY COURSES											
1	MA24T17	Applied Mathematics (Common to PE, ET & CU)	FC	3	1	0	4	4	40	60	100
2	RM24T19	Research Methodology and IPR	RMC	3	0	0	3	3	40	60	100
3	ET24T11	Design of Embedded Systems	PCC	3	0	0	3	3	40	60	100
4	ET24T12	Software for Embedded Systems	PCC	3	0	0	3	3	40	60	100
5	-	Professional Elective – I	PEC	3	0	0	3	3	40	60	100
6	-	Professional Elective – II	PEC	3	0	0	3	3	40	60	100
LABORATORY COURSES											
7	ET24P11	Embedded System Laboratory – I	PCC	0	0	4	4	2	60	40	100
8	ET24P12	Embedded Programming Laboratory	PCC	0	0	4	4	2	60	40	100
			TOTAL	**18**	**1**	**8**	**27**	**23**	**800**		

SEMESTER – II

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
THEORY COURSES											
1	ET24T21	Real Time Operating System	PCC	3	0	0	3	3	40	60	100
2	ET24T22	Embedded System Networking	PCC	3	0	0	3	3	40	60	100
3	ET24T23	Embedded Control for Electric Drives	PCC	3	0	0	3	3	40	60	100
4	ET24T24	IoT for Smart Systems	PCC	3	0	0	3	3	40	60	100
5	--	Professional Elective – III	PEC	3	0	0	3	3	40	60	100
6	--	Professional Elective – IV	PEC	3	0	0	3	3	40	60	100
LABORATORY COURSES											
7	ET24P21	Embedded System Laboratory – II	PCC	0	0	4	4	2	60	40	100
EMPLOYABILITY ENHANCEMENT COURSES											
8	ET24P22	Technical Presentation	EEC	0	0	2	2	1	60	40	100
		TOTAL		**18**	**0**	**6**	**24**	**21**	**800**		

SEMESTER – III											
S. No.	**Course Code**	**Course Title**	**Category**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot.**		**CA**	**ES**	**Tot.**
THEORY COURSES											
1	ET24T31	RISC Processor Architecture and Programming	PCC	3	0	0	3	3	40	60	100
2	ET24T32	Embedded Product Development	PCC	3	0	0	3	3	40	60	100
3	--	Professional Elective – V	PEC	3	0	0	3	3	40	60	100
4	--	Open Elective	OEC	3	0	0	3	3	40	60	100
EMPLOYABILITY ENHANCEMENT COURSES											
5	ET24P31	Project Work Phase – I	EEC	0	0	12	12	6	60	40	100
AUDIT COURSES											
6	--	Audit Course	AC	2	0	0	2	0	100	--	100
TOTAL				**14**	**0**	**12**	**26**	**18**	**500**		

SEMESTER – IV											
S. No.	**Course Code**	**Course Title**	**Category**	**Periods / Week**				**Credit**	**Max. Marks**		
				L	**T**	**P**	**Tot.**		**CA**	**ES**	**Tot.**
EMPLOYABILITY ENHANCEMENT COURSES											
1	ET24P41	Project Work Phase – II	EEC	0	0	24	24	12	60	40	100
TOTAL				0	0	24	24	**12**	**100**		
TOTAL NO. OF CREDITS: 74											
TOTAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE = 74											

Note: PCC-Professional Core Courses, PEC-Professional Elective Courses, OEC- Open Elective Courses, EEC-Employability Enhancement Courses, AC- Mandatory Courses, FC-Foundation Courses, RMC - Research Methodology and IPR Courses

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Department	**Department of Electrical and Electronics Engineering**	
Programme	**M.E. - Embedded System Technologies**	

FOUNDATION COURSES (FC)

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
1.	MA24T17	Applied Mathematics	FC	3	1	0	4	4	40	60	100
			TOTAL	**3**	**1**	**0**	**4**	**4**	**100**		

PROFESSIONAL CORE COURSES (PCC)

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
1.	ET24T11	Design of Embedded Systems	PCC	3	0	0	3	3	40	60	100
2.	ET24T12	Software for Embedded Systems	PCC	3	0	0	3	3	40	60	100
3.	ET24P11	Embedded System Laboratory – I	PCC	0	0	4	4	2	60	40	100
4.	ET24P12	Embedded Programming Laboratory	PCC	0	0	4	4	2	60	40	100
5.	ET24T21	Real Time Operating System	PCC	3	0	0	3	3	40	60	100
6.	ET24T22	Embedded System Networking	PCC	3	0	0	3	3	40	60	100
7.	ET24T23	Embedded Control for Electric Drives	PCC	3	0	0	3	3	40	60	100
8.	ET24T24	IoT for Smart Systems	PCC	3	0	0	3	3	40	60	100
9.	ET24P21	Embedded System Laboratory – II	PCC	0	0	4	4	2	60	40	100
10.	ET24T31	RISC Processor Architecture and Programming	PCC	3	0	0	3	3	40	60	100
11.	ET24T32	Embedded Product Development	PCC	3	0	0	3	3	40	60	100
			TOTAL	**24**	**0**	**12**	**36**	**30**	**1100**		

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
1.	RM24T19	Research Methodology and IPR	RMC	3	0	0	3	3	40	60	100
			TOTAL	**3**	**0**	**0**	**3**	**3**	**100**		

EMPLOYABILITY ENHANCEMENT COURSES (EEC)											
S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
1.	ET24P22	Technical Presentation	EEC	0	0	2	2	1	60	40	100
2.	ET24P31	Project Work Phase – I	EEC	0	0	12	12	6	60	40	100
3.	ET24P41	Project Work Phase – II	EEC	0	0	24	24	12	60	40	100
			TOTAL	**0**	**0**	**38**	**38**	**19**	**300**		

PROFESSIONAL ELECTIVE – I & II (SEMESTER I)											
S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
1.	ET24E01	Wireless and Mobile Communication	PEC	3	0	0	3	3	40	60	100
2.	ET24E02	Robotics and Automation	PEC	3	0	0	3	3	40	60	100
3.	ET24E03	Embedded Processor Development	PEC	3	0	0	3	3	40	60	100
4.	ET24E04	System Design using Microcontroller (Common to PE & ET)	PEC	3	0	0	3	3	40	60	100
5.	ET24E05	Intelligent Control and Automation	PEC	3	0	0	3	3	40	60	100
6.	ET24E06	Renewable Energy and Grid Integration	PEC	3	0	0	3	3	40	60	100
7.	ET24E07	Electric Vehicles and Power Management	PEC	3	0	0	3	3	40	60	100
8.	ET24E08	Unmanned Aerial Vehicle	PEC	3	0	0	3	3	40	60	100
9.	ET24E09	DSP Based System Design	PEC	3	0	0	3	3	40	60	100
			TOTAL	**27**	**0**	**0**	**27**	**27**	**900**		

PROFESSIONAL ELECTIVE – III & IV (SEMESTER II)											
S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
1.	ET24E10	Automotive Embedded System	PEC	3	0	0	3	3	40	60	100
2.	ET24E11	Computer Vision	PEC	3	0	0	3	3	40	60	100
3.	ET24E12	Multimedia Communication	PEC	3	0	0	3	3	40	60	100
4.	ET24E13	Embedded Networking and Automation of Electrical System	PEC	3	0	0	3	3	40	60	100
5.	ET24E14	Smart System Design	PEC	3	0	0	3	3	40	60	100
6.	ET24E15	Embedded Computing	PEC	3	0	0	3	3	40	60	100
7.	ET24E16	Embedded Systems Security	PEC	3	0	0	3	3	40	60	100
8.	ET24E17	Machine Learning and Deep Learning	PEC	3	0	0	3	3	40	60	100
			TOTAL	**24**	**0**	**0**	**24**	**24**	**800**		

PROFESSIONAL ELECTIVE – V (SEMESTER III)											
S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
1.	ET24E18	Reconfigurable Processor and SoC Design	PEC	3	0	0	3	3	40	60	100
2.	ET24E19	MEMS and NEMS Technology	PEC	3	0	0	3	3	40	60	100
3.	ET24E20	Entrepreneurship Development	PEC	3	0	0	3	3	40	60	100
4.	ET24E21	Embedded System for Biomedical Applications	PEC	3	0	0	3	3	40	60	100
5.	ET24E22	Python Programming for Machine Learning	PEC	3	0	0	3	3	40	60	100
6.	ET24E23	VLSI Design and Reconfigurable Architecture	PEC	3	0	0	3	3	40	60	100
7.	PE24E16	Smart Grid (Common to PE & ET)	PEC	3	0	0	3	3	40	60	100
8.	PE24E22	Virtual Instrumentation System (Common to PE & ET)	PEC	3	0	0	3	3	40	60	100
			TOTAL	24	0	0	24	24			800

OPEN ELECTIVES OFFERED BY OTHER PG PROGRAMMES											
S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
1.	CS24O01	Machine learning and Deep Learning	OEC	3	0	0	3	3	40	60	100
2.	CS24O02	Blockchain and Crypto Currency	OEC	3	0	0	3	3	40	60	100
3.	CS24O03	Multimedia Technologies	OEC	3	0	0	3	3	40	60	100
4.	BD24O01	Big Data Analytics	OEC	3	0	0	3	3	40	60	100
5.	BD24O02	Internet of Things and Cloud	OEC	3	0	0	3	3	40	60	100
6.	BD24O03	Big Data Visualization	OEC	3	0	0	3	3	40	60	100
7.	PE24O01	Switching Concepts and Power Semiconductor Devices	OEC	3	0	0	3	3	40	60	100
8.	PE24O02	Smart Grid Technology	OEC	3	0	0	3	3	40	60	100
9.	PE24O03	Renewable Energy Technology	OEC	3	0	0	3	3	40	60	100
10.	PE24O04	Energy Management and Conservation	OEC	3	0	0	3	3	40	60	100
11.	IT24O01	IoT for Smart System	OEC	3	0	0	3	3	40	60	100
12.	IT24O02	Machine Learning for Intelligent Multimedia Analytics	OEC	3	0	0	3	3	40	60	100
13.	IT24O03	DevOps and Microservices	OEC	3	0	0	3	3	40	60	100

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
14.	IT24O04	Cyber security and Digital Awareness	OEC	3	0	0	3	3	40	60	100
15.	CN24O01	Energy Efficient Building	OEC	3	0	0	3	3	40	60	100
16.	CN24O02	Economics and Finance Management in Construction	OEC	3	0	0	3	3	40	60	100
17.	CN24O03	Stress management	OEC	3	0	0	3	3	40	60	100
18.	ST24O01	Principles of Sustainable Development	OEC	3	0	0	3	3	40	60	100
19.	ST24O02	Failure Analysis of Structures	OEC	3	0	0	3	3	40	60	100
20.	ST24O03	Smart materials and Smart Structures	OEC	3	0	0	3	3	40	60	100
21.	CU24O01	Principles of Multimedia	OEC	3	0	0	3	3	40	60	100
22.	CU24O02	Software Defined Radio	OEC	3	0	0	3	3	40	60	100
23.	CU24O03	MEMS and NEMS	OEC	3	0	0	3	3	40	60	100
24.	CU24O04	Introduction to Cognitive Radio Network	OEC	3	0	0	3	3	40	60	100
25.	CC24O01	Digital Manufacturing	OEC	3	0	0	3	3	40	60	100
26.	CC24O02	Design for Manufacturing and Assembly	OEC	3	0	0	3	3	40	60	100
27.	CC24O03	Smart Materials and Structures	OEC	3	0	0	3	3	40	60	100
28.	IS24O01	Industrial Safety Engineering	OEC	3	0	0	3	3	40	60	100
29.	IS24O02	Fire Engineering and Protection	OEC	3	0	0	3	3	40	60	100
30.	IS24O03	Food and Bio-safety	OEC	3	0	0	3	3	40	60	100

OPEN ELECTIVES OFFERED TO OTHER PG PROGRAMMES

S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
1.	ET24O01	Embedded Systems	OEC	3	0	0	3	3	40	60	100
2.	ET24O02	Embedded Control	OEC	3	0	0	3	3	40	60	100
3.	ET24O03	Embedded Automation	OEC	3	0	0	3	3	40	60	100

AUDIT COURSES (SEMESTER III)											
S. No.	Course Code	Course Title	Category	Periods / Week				Credit	Max. Marks		
				L	T	P	Tot.		CA	ES	Tot.
1.	AX24A01	Disaster Management	AC	2	0	0	2	0	100	--	100
2.	AX24A02	Value Education	AC	2	0	0	2	0	100	--	100
3.	AX24A03	Constitution of India	AC	2	0	0	2	0	100	--	100
4.	AX24A04	Indian Knowledge System	AC	2	0	0	2	0	100	--	100
			TOTAL	**8**	**0**	**0**	**8**	**0**	**---**		

SUMMARY

Name of the Programme: M.E. & Embedded System Technologies							
S. No	**Subject area**	**Credits Per Semester**				**Credits Total**	**Percentage Credits**
		I	**II**	**III**	**IV**		
1	**FC**	**4**	**-**	**-**	**-**	**4**	**5.41**
2	**PCC**	**10**	**14**	**6**	**-**	**30**	**40.54**
3	**PEC**	**6**	**6**	**3**	**-**	**15**	**20.27**
4	**RMC**	**3**	**-**	**-**	**-**	**3**	**4.05**
5	**OEC**	**-**	**-**	**3**	**-**	**3**	**4.05**
6	**EEC**	**-**	**1**	**6**	**12**	**19**	**25.68**
7	**Audit Course**	**-**	**-**	**√**	**-**	**-**	**-**
	Total Credit	**23**	**21**	**18**	**12**	**74**	**100**

MA24T17	APPLIED MATHEMATICS	Category	L	T	P	C
		FC	3	1	0	4

(Common to CU, ES and PE)

PREREQUISITE:

Students should have the strong foundation in mathematical concepts including Linear Algebra, Probability theory and Statistics, familiarity with Mathematical modeling and Numerical methods techniques.

OBJECTIVES:

- To equip students to apply matrix decomposition methods.
- To enable students to translate real-world problems into linear programming problems and implement solutions effectively.
- To provide insights into methods to analyze discrete and continuous random variables.
- To develop the ability to analyze the basic components and behavior of queuing systems.
- To acquire the skills to apply and formulate to solve boundary value problems in ordinary differential equations.

UNIT - I	MATRIX THEORY	(9 + 3)

Matrix factorizations – The Cholesky decomposition – QR factorization – Least squares method – Singular value decomposition – Toeplitz matrices and some applications.

UNIT - II	LINEAR PROGRAMMING PROBLEMS	(9 + 3)

Formulation of LPP – Graphical Method – Simplex Method – Big M Method – Two Phase Simples Method – Dual Simplex method.

UNIT - III	ONE-DIMENSIONAL RANDOM VARIABLE	(9 + 3)

One dimensional Random Variable – Discrete and continuous random Variables – Probability mass function and probability density function – Expectations – Moments – Moment generating functions and their properties – Binomial, Poisson, Uniform, Exponential and Normal distributions.

UNIT - IV	QUEUING MODELS	(9 + 3)

Characteristics of Queuing Models – Kendall’s notations – Little’s formula – (M/M/1): $(\infty/FIFO)$ Single Server with infinite capacity – (M/M/C): $(\infty/FIFO)$ Multi Server with infinite capacity – (M/M/1): $(N/FIFO)$ Single Server with finite capacity – (M/M/C): $(N/FIFO)$ Multi server with finite capacity.

UNIT - V	COMPUTATIONAL METHODS IN ENGINEERING	(9 + 3)

Boundary value problems for ODE – Classification of PDE – Solution of Laplace and Poisson Equations – Liebmann's Iteration Process – Solution of Heat Conduction Equation by Bender Schmidt Explicit Formula and Crank Nicolson Implicit Scheme – Solution of Wave Equation.

LECTURE: 45, TUTORIAL: 15, TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Apply and decompose matrices effectively.	Apply
CO2	Create models and formulate linear programming problems.	Analyze
CO3	Analyze and work with a single random variable.	Analyze
CO4	Analyze and interpret the key features of various queuing systems.	Analyze
CO5	Set up and solve boundary value problems for ODEs.	Apply

TEXT BOOKS

1. Johnson R. A. and Gupta C. B., ‘Miller & Freund’s Probability and Statistics for Engineers’, Pearson Education, Eighth Edition, 2015.
2. Grewal, B.S., ‘Higher Engineering Mathematics’, Khanna Publishers, Forty-Fourth Edition, 2017.

REFERENCES:

1. Bronson, R., ‘Schaum’s Outline Series of Matrix Operations’, McGraw-Hill Education, Second Edition, 2011.
2. Hamdy A Taha., ‘Operations research. An introduction’, Pearson Edition, Tenth Edition, 2017.
3. Donald Gross and Carl M. Harris, ‘Fundamentals of Queuing Theory’, John Wiley and Sons, Fourth Edition, 2013.
4. Kandasamy, P., Thilagavathy and Gunavathy, K., ‘Numerical Methods’, S. Chand & Company Ltd, Third Edition, 2003.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	-	-	3	-
CO2	3	-	-	3	-
CO3	3	-	-	3	-
CO4	3	-	-	3	-
CO5	3	-	-	3	-
Avg.	**3**	**-**	**-**	**3**	**-**

1 - Low, 2 - Medium, 3 - High

RM24T19	**RESEARCH METHODOLOGY AND IPR**	**Category**	**L**	**T**	**P**	**C**
		RMC	**3**	**0**	**0**	**3**

(Common to PED, EST, CSE, BDA, CAD CAM, ISE)

PREREQUISITE: A basic understanding of academic writing and critical thinking skills to analyze research literature, familiarity with fundamental statistical concepts for data analysis, and a strong grasp of core subject knowledge relevant to the student's field. Additionally, a general awareness of legal principles related to intellectual property, ethical research practices, and innovation trends will enhance the student’s ability to engage with both research methodologies and IPR concepts.

OBJECTIVES:

- To equip students with the ability to design and conduct rigorous research, employing appropriate methodologies, and critically analyzing results.
- To foster the ability to critically evaluate academic literature, identify research gaps, and formulate research questions.
- To enable students to effectively communicate research findings and legal arguments, both in written form and through presentations, to academic and professional audiences.
- To instill an understanding of ethical issues in research, including responsible conduct, data integrity, and the ethical use of intellectual property.
- To provide a comprehensive understanding of intellectual property rights, including patents, trademarks, copyrights, and their application in various industries.

UNIT - I	**RESEARCH DESIGN**	**(9)**

Overview of research process and design – Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies – Experiments and surveys.

UNIT - II	**DATA COLLECTION AND SOURCES**	**(9)**

Measurements: Measurement Scales – Questionnaires and Instruments – Sampling and Methods. Data - Preparing, Exploring, Examining and displaying.

UNIT - III	**DATA ANALYSIS AND REPORTING**	**(9)**

Overview of Multivariate analysis – Hypotheses testing and Measures of Association – Presenting Insights and findings using written reports and oral presentation.

UNIT - IV	**INTELLECTUAL PROPERTY RIGHTS**	**(9)**

Intellectual Property – The concept of IPR, Evolution and development of the concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Biodiversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT - V	**PATENTS**	**(9)**

Patents – objectives and benefits of patent – Concept, features of patent, Inventive step, Specification – Types of patent application, process E-filling – Examination of patent – Grant of patent, Revocation, Equitable Assignments. Licenses – Licensing of related patents – patent agents, – Registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
COs	**Course Outcome**	**Cognitive Level**
CO1	Develop a suitable research process to solve real-time problems.	Apply
CO2	Apply appropriate methods to collect qualitative and quantitative data for analysis.	Apply
CO3	Apply appropriate statistical tools to analyze data and solve research problems.	Apply
CO4	Describe the types and features of intellectual property and its role in IPR establishment.	Apply
CO5	Illustrate the patent procedures, E-filling, register of patents, and licensing of patents.	Apply

TEXT BOOKS:	
1	Cooper Donald, R., Schindler Pamela, S., and Sharma, J.K., “Business Research Methods”, Tata McGraw Hill Education, Eleventh Edition, 2012.
2	Catherine J. Holland, Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets, Entrepreneur Press, 2007.
REFERENCES:	
1	David Hunt, Long Nguyen, Matthew Rodgers, Patent Searching: Tools & Techniques, Wiley, 2007.
2	The Institute of Company Secretaries of India, Statutory body under an Act of Parliament, Professional Programme Intellectual Property Rights, Law and Practice, September 2013.

Mapping of COs with POs and PSOs

COs/ POs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	3	3	-	1	1
CO2	3	3	-	1	1
CO3	3	3	-	1	1
CO4	3	3	-	1	1
CO5	3	3	-	1	1
Avg.	**3**	**3**	**-**	**1**	**1**

1 - Low, 2 - Medium, 3 - High

ET24T11	DESIGN OF EMBEDDED SYSTEMS	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE:

A solid foundation in basic electronics and digital logic is essential, including a strong understanding of circuits, microprocessors, microcontrollers, and digital logic design. Proficiency in programming, particularly in languages like C/C++, is crucial, along with familiarity with embedded system programming. Additionally, familiarity with standard communication protocols such as I2C, SPI, UART, and CAN is required to design and implement embedded systems effectively.

OBJECTIVES:

- To equip students with the skills to design and develop efficient embedded systems, from concept to implementation, using appropriate hardware and software tools.
- To enable students to write, optimize, and debug embedded software using industry-standard programming languages and development environments.
- To design and implement real-time embedded systems, focusing on scheduling, synchronization, and time-sensitive operations.
- To provide students with the ability to seamlessly integrate hardware components, including sensors, actuators, and communication modules, with embedded software.
- To foster critical thinking and innovation in solving complex design challenges in embedded systems, preparing students for advanced roles in industry or research.

UNIT – I	INTRODUCTION TO EMBEDDED SYSTEMS	(9)

Introduction to Embedded Systems – Built-in features for embedded Target Architecture – Selection of Embedded processor – DMA – memory devices – Memory management methods – Memory mapping, cache replacement policies – Timer and Counting devices, Watchdog Timer, Real Time Clock – Software Development tools – IDE, assembler, compiler, linker, simulator, debugger, In-circuit emulator, Target Hardware Debugging – Overview of functional safety standards for embedded systems.

UNIT – II	EMBEDDED NETWORKING BY PROCESSORS	(9)

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

UNIT – III	RTOS BASED EMBEDDED SYSTEM DESIGN	(9)

Introduction to basic concepts of RTOS – Need, Task, Process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, preemptive and non-preemptive scheduling, Task communication – context switching, interrupt latency and deadline shared memory, message passing – Interprocess communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance, comparison of Real-time Operating systems: VxWorks, uC/OS-II, RT Linux.

UNIT – IV	MODELLING WITH HARDWARE/SOFTWARE DESIGN APPROACHES	(9)

Modeling embedded systems – Embedded software development approach – Overview of UML modeling with UML, UML diagrams – Hardware/Software Partitioning, Co-Design Approaches for System Specification and modeling – CoSynthesis – Features Comparing Single-processor Architectures and Multi-Processor Architectures – Design approach on parallelism in Uniprocessors and Multiprocessors.

UNIT – V	EMBEDDED SYSTEM APPLICATION DEVELOPMENT	(9)

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Demonstrate the functionalities of processor internal blocks, with their requirement.	Apply
CO2	Recognize the Bus standards chosen based on interface overheads without sacrificing processor performance.	Apply
CO3	Describe the role and features of the RT operating system, that makes multitask execution possible by processors.	Apply
CO4	Illustrate that using multiple CPUs based on either hardcore or softcore helps data overhead management with processing speed reduction for uC execution.	Apply
CO5	Recommend Embedded consumer product design based on phases of product development.	Apply

TEXT BOOKS:

1	Rajkamal, “Embedded System: Architecture, Programming, Design”, TMH, 2011.
2	Peckol, “Embedded system Design”, John Wiley & Sons, 2010.

REFERENCES:

1	Rajiv Chopra, “Advanced Computer Architecture”, S. Chand, 2010.
2	Elicia White, “Making Embedded Systems”, O’Reilly Series, SPD, 2011.
3	Bruce Powel Douglass, Real-Time UML Workshop for Embedded Systems, Elsevier, 2011.
4	Lyla B.Das, “Embedded Systems: An Integrated Approach”, Pearson, 2013.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	3	-	2
CO2	2	-	1	-	2
CO3	-	2	2	-	2
CO4	2	-	3	-	2
CO5	2	-	1	-	2
Avg.	**2**	**2**	**2**	**-**	**2**

1 - Low, 2 - Medium, 3 - High

ET24T12	SOFTWARE FOR EMBEDDED SYSTEMS	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE:

Students should have a strong background in programming, particularly in languages such as C/C++ and Python, with a focus on low-level programming and embedded software development. A solid understanding of microcontrollers and microprocessors is essential, including familiarity with their architectures and interfacing techniques. Knowledge of operating systems, especially Real-Time Operating Systems (RTOS), and their application in embedded environments is crucial.

OBJECTIVES:

- To equip students with the ability to design, develop, and optimize software specifically for embedded systems, focusing on efficiency and reliability.
- To understand and implement real-time operating systems in embedded applications, including task scheduling, synchronization, and resource management.
- To seamlessly integrate embedded software with hardware components, ensuring smooth communication and functionality within embedded systems.
- To provide students with the tools and techniques to effectively debug, test, and validate embedded software, ensuring it meets performance and safety requirements.
- To encourage critical thinking and innovation in solving complex challenges related to embedded software, preparing students for leadership roles in technology development and research.

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: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Demonstrate C programming and its salient features for embedded systems.	Understand
CO2	Deliver insight into various programming languages/software compatible with embedded process development with improved design & programming skills.	Apply
CO3	Develop knowledge of C programming in a Linux environment.	Apply
CO4	Possess the ability to write Python programming for Embedded applications.	Apply
CO5	Have improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills.	Apply

TEXT BOOKS:

1	Paul Deitel and Harvey Deitel, ‘C How to Program’, Eighth Edition, Pearson Education Limited, 2016.
2	Michael J.Pont, ‘Embedded C’, Addison-Wesley, An imprint of Pearson Education, 2002.

REFERENCES:

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’, O'Reilly Media, 1997.
4	William Von Hagen, ‘The Definitive Guide to GCC’, Second Edition, Apress Inc., 2006.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	2	-	2
CO2	1	-	1	-	2
CO3	-	2	-	-	2
CO4	1	-	1	-	2
CO5	-	-	2	-	2
Avg.	**1**	**2**	**1.5**	**-**	**2**

1 - Low, 2 - Medium, 3 - High

ET24P11	EMBEDDED SYSTEM LABORATORY – I	Category	L	T	P	C
		PCC	0	0	4	2

PREREQUISITE:

Proficiency in C/C++ is essential since most embedded systems are programmed in these languages. Familiarity with microprocessor and microcontroller architectures, including memory hierarchy, registers, and I/O interfaces. Basic knowledge of RTOS concepts, task scheduling, and multitasking in embedded systems. Familiarity with IDEs like Keil, MPLAB, or Atmel Studio for embedded system development.

OBJECTIVES:

- To involve the students in Practice on Workbench / Software Tools / Hardware Processor Boards with supporting Peripherals.
- To impart the concepts of algorithm development & programming on software tools and Digital processors with peripheral interfaces.
- To encourage students to practice in open-source software/packages/tools.
- To train through hands-on practices in commercial and licensed Hardware-software suites.
- To expose the students into the revising the concepts acquired from theory subjects.

LIST OF EXPERIMENTS:

1.	Programming with 8-bit Microcontrollers # Assembly programming.
2.	Programming with 8-bit Microcontrollers # C programming.
3.	I/O Programming with 8-bit Microcontrollers.
4.	I/O Interfacing: Serial port programming/ LCD/Sensor Interfacing.
5.	Programming with PIC Microcontrollers - Assembly and C programming.
6.	I/O Programming with PIC Microcontrollers.
7.	I/O Interfacing: PWM Generation/ Motor Control/ADC/DAC/ LCD/Sensor Interfacing.
8.	8051/other 8-bit Microcontrollers with peripherals; IDE, Board Support Software Tools / Compiler/others.
9.	8051 Microcontrollers with peripherals; IDE, Board Support Software Tools/C Compiler/others.
10.	8051 Microcontrollers with peripherals; Board Support Software Tools, peripherals with interface.
11.	PIC Microcontrollers with peripherals; IDE, Board Support Software Tools/C Compiler/others.
12.	PIC Microcontrollers with peripherals; Board Support Software Tools, peripherals with interface.

TOTAL: 60 PERIODS

COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
COs	**Course Outcome**	**Cognitive Level**
CO1	Experiment with insight into various embedded processors of CISC and RISC architecture / computational processors with peripheral interfaces.	Apply
CO2	Understand the fundamental concepts of how process can be controlled with C.	Apply
CO3	Experimenting on programming logic of Processor based on software suites (simulators, emulators).	Apply
CO4	Incorporate the I/O software interface of a processor with peripherals.	Apply
CO5	Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in interfacing and use of commercial embedded processors.	Apply

REFERENCES:

1. Mohamammad Ali Mazidi and Mazidi ‘8051 Microcontroller and Embedded Systems’, Pearson Education, Second Edition, 2007.
2. Mohammad Ali Mazidi, Rolind Mckinley and Danny Causey, ‘PIC Microcontroller and Embedded Systems’ Pearson Education, Second Edition, 2009.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	1	2
CO2	-	-	1	1	2
CO3	2	3	1	1	2
CO4	2	-	2	1	2
CO5	-	-	1	1	2
Avg.	**2**	**2**	**1.4**	**1**	**2**

1- Low, 2- Medium, 3- High

ET24P12	EMBEDDED PROGRAMMING LABORATORY	Category	L	T	P	C
		PCC	0	0	4	2

PREREQUISITE:

A basic knowledge of microcontrollers and microprocessors, including their architecture and interfacing is needed. Proficiency in programming languages like C/C++ is essential, particularly for low-level coding. Basic knowledge of digital electronics and communication protocols such as I2C, SPI, and UART is also required.

OBJECTIVES:

- To develop knowledge in writing and debugging embedded software using languages like C/C++ for various microcontroller platforms.
- To gain practical skills in interfacing embedded software with hardware components, including sensors, actuators, and communication modules.
- To understand and apply real-time operating system concepts by developing and testing software that manages time-sensitive tasks.
- To learn to use debugging tools and techniques to identify, analyze, and resolve issues in embedded systems.
- To integrate software and hardware effectively, and optimize code for performance and resource efficiency in embedded applications.

LIST OF EXPERIMENTS:

1.	Programming in Higher Level Languages/Open Source Platforms.
2.	Programming with Arduino Microcontroller Board.
3.	HDL Programming in FPGA processors.
4.	Programming and Simulation in Simulators/Tools/others using Proteus/ORCAD.
5.	Programming and Simulation in Simulators /Tools/others using MATLAB/Others.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Apply programming concepts and syntax to develop applications in higher-level languages.	Apply
CO2	Design and develop embedded system applications using Arduino IDE.	Apply
CO3	Simulate HDL code for implementing digital logic designs in FPGA processors.	Apply
CO4	Develop and simulate electronic circuits using Proteus/ORCAD software.	Apply
CO5	Develop programs to simulate dynamic systems and control mechanisms using MATLAB.	Apply

REFERENCES:

1. Jonathan W. Valvano ‘Embedded Systems: Introduction to the MSP432 Microcontroller’, Createspace Independent Publication, First Edition, 2015.
2. Richard H. Barnett, Sarah Cox, Larry O'Cull ‘Embedded C Programming and the ATMEL AVR’, Cengage Learning, Second Edition, 2012.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	1	-	2
CO2	2	-	2	-	2
CO3	2	1	3	-	2
CO4	2	1	2	-	2
CO5	-	-	2	-	2
Avg.	**2**	**1**	**2**	**-**	**2**

1 - Low, 2 - Medium, 3 - High

ET24T21	REAL TIME OPERATING SYSTEM	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE:

Knowledge of how general-purpose operating systems (like Windows, Linux) work, including processes, threads, scheduling, and memory management. Understanding of multithreading, mutual exclusion (mutexes), semaphores, and inter-process communication. Proficiency in C or C++ is crucial, as RTOS development often involves low-level programming close to the hardware. Knowledge of what constitutes a real-time system, including the difference between soft and hard real-time systems. Experience with IDEs commonly used in embedded systems development, like Keil, IAR, or Eclipse.

OBJECTIVES:

- To expose the students to the fundamentals of the interaction of OS with a computer and user computation.
- To impart the fundamental concepts of how processes are created and controlled with OS.
- To study the programming logic of modeling Processes based on the range of OS features.
- To compare types and Functionalities in commercial OS, application development using RTOS.
- To involve Discussions/ Practice/Exercises on revising and familiarizing the concepts acquired over the 5 units of the subject for improved employability skills.

UNIT - I	REVIEW OF OPERATING SYSTEMS	(9)

Basic principles – Operating system structures – System calls – Files – Processes – Design and implementation of processes – Communication between processes – Introduction to Distributed operating system – Embedded operating systems.

UNIT - II	OVERVIEW OF RTOS	(9)

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

UNIT - III	REALTIME MODELS AND LANGUAGES	(9)

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

UNIT - IV	REALTIME KERNEL	(9)

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

UNIT - V	APPLICATION DEVELOPMENT	(9)

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Recognize operating system structures and types.	Understand
CO2	Insight into scheduling, and disciplining of various processes execution.	Apply
CO3	Exemplify knowledge of various RTOS support modeling.	Understand
CO4	Demonstrate commercial RTOS Suite features to work on real-time process design.	Understand
CO5	Improved employability and entrepreneurship capacity due to knowledge upgradation on recent trends in RTOS and embedded automation design.	Apply

TEXT BOOKS:

1. Silberschatz, Galvin, Gagne, 'Operating System Concepts', Sixth Edition, John Wiley, 2003.
2. Charles Crowley, 'Operating Systems: A Design Oriented approach', McGraw Hill,1997.

REFERENCES:

1. Raj Kamal, 'Embedded Systems- Architecture, Programming and Design', Tata McGraw Hill, 2006.
2. Karim Yaghmour, 'Building Embedded Linux System', O'reilly Publication, 2003.
3. Mukesh Sighal and Shi, N.G., 'Advanced Concepts in Operating System', McGraw Hill, 2000.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	-	1	2	2
CO2	-	-	2	2	2
CO3	2	-	2	2	2
CO4	2	2	3	2	2
CO5	-	-	1	2	2
Avg.	**2**	**2**	**1.8**	**2**	**2**

1- Low, 2- Medium, 3- High

ET24T22	EMBEDDED SYSTEM NETWORKING	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE:

A knowledge on the architecture, instruction sets, and interfacing of microcontrollers and microprocessors is needed. It also needs the knowledge on CAN bus protocol, widely used in automotive and serial communication protocols like RS-232, RS-485, and USB. Familiarity with implementing embedded web servers for remote monitoring and control.

OBJECTIVES:

- To expose the students to the fundamentals of wired embedded networking techniques.
- To introduce the concepts of embedded ethernet.
- To expose the students to the fundamentals of wireless embedded networking.
- To discuss the fundamental building blocks of digital instrumentation.
- To introduce the design of programmable measurement and control of electrical devices.

UNIT - I	EMBEDDED PROCESS COMMUNICATION WITH INSTRUMENT BUS	(9)

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

UNIT - II	EMBEDDED ETHERNET	(9)

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

UNIT - III	WIRELESS EMBEDDED NETWORKING	(9)

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

UNIT - IV	BUILDING SYSTEM AUTOMATION	(9)

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

UNIT - V	COMMUNICATION FOR LARGE ELECTRICAL SYSTEM AUTOMATION	(9)

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Recognize the different bus communication protocols used for embedded networking.	Understand
CO2	Explain the basic concepts of embedded networking.	Understand
CO3	Apply the embedded networking concepts in wireless networks.	Apply
CO4	Relate different data acquisition concepts.	Apply
CO5	Build system automation for different applications.	Apply

TEXT BOOKS:

1. Mohammad Ilyas, Imad Mahgoub, 'Handbook of sensor Networks: Compact wireless and wired sensing systems', CRC Press, 2004.
2. Peter W. Gofton, 'Understanding Serial Communication', Sybes International, 2000.

REFERENCES:

1. Jan Axelson, 'Embedded Ethernet and Internet Complete', Penram Publications, 2003.
2. Krzysztof Iniewski, 'Smart Grid, Infrastructure and Networking', TMcGH, 2012.
3. James Northcote-Green, 'Robert Wilson, Control and Automation of Electrical Power Distribution Systems', CRC, Taylor and Francis, 2006.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	-	2	2
CO2	-	2	-	2	2
CO3	3	2	2	2	2
CO4	2	-	3	2	2
CO5	3	-	3	2	2
Avg.	**2.25**	**2**	**2.7**	**2**	**2**

1- Low, 2- Medium, 3- High

ET24T23	EMBEDDED CONTROL FOR ELECTRIC DRIVES	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE:

A knowledge of architecture, instruction sets, and peripherals of microcontrollers and microprocessors used in embedded systems is needed. Proficiency in C or C++ for programming microcontrollers, as these are the primary languages used in embedded system development. Basic knowledge of control principles, such as PID control, transfer functions, feedback loops, power semiconductor devices (e.g., MOSFETs, IGBTs), power converters (DC-DC, AC-DC, DC-AC), and their operation.

OBJECTIVES:

- To provide the control concept for electrical drives.
- To emphasize the need for an embedded system for controlling the electrical drives.
- To provide knowledge about various embedded system-based control strategies for electrical drives.
- To enable students to grasp and articulate the basic principles underlying the operation of switch-mode converters and machine learning techniques used for electrical drives.
- To familiarize the high-performance computing for electrical drives.

UNIT - I	INTRODUCTION ELECTRICAL DRIVES	(9)

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

UNIT - II	OVERVIEW OF EMBEDDED PROCESSOR	(9)

Embedded Processor architecture – RTOS – Hardware/software co-design – Programming with SoC processors.

UNIT - III	INDUCTION MOTOR CONTROL	(9)

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

UNIT - IV	BLDC MOTOR CONTROL	(9)

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

UNIT - V	SRM MOTOR CONTROL	(9)

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Interpret the significance of embedded control of electrical drives	Understand
CO2	Deliver insight into various control strategies for electrical drives.	Understand
CO3	Develop knowledge of Machine learning and optimization techniques for motor control.	Apply
CO4	Develop embedded system solutions for real-time applications such as Electric vehicles and UAVs.	Apply
CO5	Improved Employability and entrepreneurship capacity due to knowledge gradation on recent trends in embedded system skills required for motor control strategy.	Apply

TEXT BOOKS:

1. Krishnan, R., 'Electric Motor Drives: Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New Delhi, 2010.
2. Vedam Subramanyam, 'Electric Drives: Concepts and Applications', Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2002.

REFERENCES:

1. Venkataratnam, K., 'Special Electrical Machines', Universities Press, 2014.
2. Steve Furber, 'ARM System on Chip Architecture', Addision Wesley,2010.
3. Ron Sass, Anderew G.Schmidt, 'Embedded System design with platform FPGAs: Principles and Practices', Elsevier, 2010.
4. Steve Kilts, 'Advanced FPGA Design: Architecture, Implementation, and Optimization', Willey, 2007.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	-	2	2	2
CO2	1	1	3	2	2
CO3	2	-	-	2	2
CO4	1	2	3	2	2
CO5	-	-	-	2	2
Avg.	**1.25**	**1.5**	**2.7**	**2**	**2**

1- Low, 2- Medium, 3- High

ET24T24	IoT FOR SMART SYSTEMS	Category	L	T	P	C
		PCC	3	0	0	3

PREREQUISITE:

Knowledge of basic electrical components like resistors, capacitors, transistors, and how they form circuits. Understanding how to store and retrieve data from databases (SQL, NoSQL). Basic knowledge of cloud services (AWS, Azure, Google Cloud) as IoT systems often integrate with cloud platforms for data processing and storage. Depending on the smart system's application (e.g., smart home, smart agriculture, healthcare), domain-specific knowledge will be beneficial. Understanding the security challenges in IoT, including encryption, secure communication protocols, and device authentication.

OBJECTIVES:

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

UNIT - I	**INTRODUCTION TO INTERNET OF THINGS**	**(9)**

Overview, Hardware and software requirements for IOT – Sensor and actuators – Technology drivers, Business drivers, Typical IoT applications – Trends and implications.

UNIT - II	**IOT ARCHITECTURE**	**(9)**

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

UNIT - III	**PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT, PROTOCOLS**	**(9)**

NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe, GSM, CDMA, LTE, GPRS, small cell. Wireless technologies for IoT: WiFi (IEEE 802.11) – Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems – Recent trends.

UNIT - IV	**IoT PROCESSORS**	**(9)**

Services/Attributes: Big-Data Analytics for IoT – Dependability – Interoperability –Security, Maintainability. Embedded processors for IoT: Introduction to Python programming – Building IoT with RASPERRY PI and Arduino.

UNIT - V	**CASE STUDIES**	**(9)**

Industrial IoT – Home Automation – Smart Cities, Smart Grid connected vehicles – Electric vehicle charging, Environment, Agriculture – Productivity Applications – IoT Defense.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Deliberate the concepts of IoT and its present developments.	Understand
CO2	Compare and contrast different platforms and infrastructures available for IoT.	Understand
CO3	Elucidate different protocols and communication technologies used in IoT.	Understand
CO4	Apply the big data analytics and programming of IoT.	Apply
CO5	Implement IoT solutions for smart applications.	Apply

TEXT BOOKS:

1. Arshdeep Bahga, Vijai Madisetti, 'A Hands-on Approach: Internet of Things', Universities Press, 2015.
2. Oliver Hersent, David Boswarthick, 'Omar Elloumi', The Internet of Things, Wiley, 2016.

REFERENCES:

1. Samuel Greengard, 'The Internet of Things', The MIT Press, 2015.
2. Adrian McEwen, Hakim Cassimally, 'Designing the Internet of Things', Wiley, 2014.
3. Jean-Philippe Vasseur, Adam Dunkels, 'Interconnecting Smart Objects with IP: The Next Internet', Morgan Kuffmann Publishers, 2010.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	1	2	2	2
CO2	-	2	-	2	2
CO3	1	2	-	2	2
CO4	2	-	3	2	2
CO5	3	2	3	2	2
Avg.	**1.75**	**1.75**	**2.6**	**2**	**2**

1- Low, 2- Medium, 3- High

ET24P21	EMBEDDED SYSTEM LABORATORY – II	Category	L	T	P	C
		PCC	0	0	4	2

PREREQUISITE:

The students should have a foundational understanding of embedded systems design and programming, particularly in C/C++. Proficiency in hardware interfacing techniques and familiarity with real-time operating systems (RTOS) are also essential. Basic knowledge of digital electronics and communication protocols is required.

OBJECTIVES:

- To enhance skills in designing and developing complex embedded systems, integrating both hardware and software components.
- To gain experience with advanced interfacing techniques, including communication protocols such as CAN, Ethernet, and wireless technologies.
- To apply real-time operating system (RTOS) concepts to develop and test applications that require precise timing and task management.
- To focus on optimizing embedded software for performance, efficiency, and resource management, including memory and power consumption.
- To improve debugging skills and troubleshoot complex issues in embedded systems using advanced tools and techniques.

LIST OF EXPERIMENTS:

1.	Programming ARM processor: ARM7/ARM9/ARM Cortex – Study on In-circuit emulators, cross compilers and debuggers.
2.	I/O Programming with ARM processor: ARM7/ARM9/ARM Cortex Microcontrollers. I/O Interfacing: Timers / Interrupts / Serial portprogramming / PWM Generation / Motor Control / ADC / DAC / LCD / RTC Interfacing / Sensor Interfacing.
3.	Programming with Raspberry Pi Microcontroller Board: Study on in-circuit emulators, cross compilers and debuggers.
4.	I/O Programming with Arduino, Raspberry Pi Microcontroller Boards I/O Interfacing: Timers / Interrupts / Serial port programming / PWM Generation / Motor Control / ADC / DAC / LCD / RTC Interfacing / Sensor Interfacing / IoT Applications.
5.	Programming with DSP processors.
6.	Study of one type of Real-Time Operating Systems (RTOS).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Develop and implement programs for ARM7/ARM9/ARM Cortex processors using in-circuit emulators, cross-compilers, and debuggers to optimize embedded system performance.	Apply
CO2	Develop and troubleshoot I/O programming applications on ARM7/ARM9/ARM Cortex microcontrollers, interfacing peripherals such as timers, interrupts, serial ports, PWM generation, motor control, ADC/DAC, LCD, RTC, and various sensors.	Apply
CO3	Design and implement I/O interfacing applications on Raspberry Pi and Arduino microcontroller boards, utilizing in-circuit emulators, cross-compilers, and debuggers for real-time IoT applications, including sensor integration, PWM control, and motor control.	Apply
CO4	Apply advanced programming techniques on DSP processors to process real-time data, ensuring high performance and precision in embedded systems applications.	Apply
CO5	Evaluate the architecture and functionalities of Real-Time Operating Systems (RTOS) and implement embedded applications that require real-time processing and multitasking capabilities.	Apply

REFERENCES:

1. Amos Gilat, ‘MATLAB: An Introduction with Applications’, Wiley, Fourth Edition, 2012.
2. Farzin Asadi, ‘Simulation of Power Electronics Circuits with MATLAB®/Simulink®, Design, Analyze, and Prototype Power Electronics’, Apress Berkeley, CA, First Edition, 2022.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	1	2	-	2
CO2	-	-	2	-	2
CO3	2	3	2	-	2
CO4	2	-	2	-	2
CO5	-	-	2	-	2
Avg.	**2**	**2**	**2**	**-**	**2**

1 - Low, 2 - Medium, 3 - High

ET24P22	TECHNICAL PRESENTATION	Category	L	T	P	C
		EEC	0	0	2	1

PREREQUISITE:

Students should have a core grasp of the subject matter connected to their area of study to efficiently prepare and deliver technical presentations. This understanding should include a fundamental comprehension of research methodologies, the ability to write reports, and familiarity with key technical ideas.

OBJECTIVES:

- To enable students to critically review and recognize key challenges in their field of interest, enabling distinct study and the development of new solutions.
- To facilitate students to explore particular topics or areas of interest via complete literature evaluation, including journals, conference proceedings, and other academic sources.
- To bridge the gap between theoretical knowledge and practical application by enhancing students' ability to apply learned concepts to solve real-time problems effectively and collaboratively.
- To enhance their understanding of a topic by having them present and receive feedback on their findings.
- To equip students with the skills needed to effectively communicate their research and ideas through structured report writing and professional presentations related to their area of study.

The students should adhere to the following Guidelines:

1. The students have to refer to the journals and conference proceedings and collect the published literature.
2. By mutual discussions with the faculty in-charge the student can decide on a topic related to the area/topic.
3. The student is expected to collect at least 20 such research papers published in the last 5 years.
4. Using OHP / PowerPoint, the student has to make a presentation for 20 minutes followed by 10 minutes discussion.
5. The student has to make five presentations in the semester.
6. The student has to write a technical report for about 30 - 50 pages (Title page, One-page Abstract, Review of Research paper under various sub-headings, concluding remarks, and list of references). The technical report has to be submitted to the course coordinator one week before the final presentation, after the approval of the faculty in-charge.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

Course Outcome	Description	Bloom's Taxonomy Level
CO1	Familiarize the problems in general areas of interest to the student.	Understand
CO2	Identify the area/problem by referring to journals, conference proceedings, etc.	Understand
CO3	Develop the collective skills between theoretical knowledge and real-time problems.	Understand
CO4	Gain knowledge on the problem by presentation and review.	Understand
CO5	Acquire ideas on report writing and presentation.	Understand

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	3	3	3	2
CO2	2	3	3	3	2
CO3	2	3	3	3	2
CO4	2	3	3	3	2
CO5	2	3	3	3	2
Avg.	**2**	**3**	**3**	**3**	**2**

ET24E01	WIRELESS AND MOBILE COMMUNICATION	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

A solid foundation in basic communication principles, including analog and digital communication, is essential. Familiarity with electromagnetic theory, signal processing, and network fundamentals will help in understanding complex topics. Knowledge of electronics, particularly in RF and microwave engineering, provides an advantage. Additionally, programming skills and experience with simulation tools like MATLAB will enhance practical understanding and application.

OBJECTIVES:

- To realize the fundamental cellular principles.
- To explore wireless technologies and standards.
- To investigate network performance and optimization.
- To design and implement mobile communication solutions.
- To evaluate emerging trends and innovations.

UNIT - I	THE CELLULAR CONCEPT	(9)

System Design Fundamentals: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies – Prioritizing Handoffs, Practical Handoff Considerations, Interference and system capacity –Co-channel Interference and system capacity, Channel planning for Wireless Systems, Adjacent Channel interference, Power Control for Reducing interference, Trunking and Grade of Service, Improving Coverage & Capacity in Cellular Systems-Cell Splitting, Sectoring.

UNIT - II	MOBILE RADIO PROPAGATION: LARGE-SCALE PATH LOSS	(9)

Introduction to Radio Wave Propagation, Free Space Propagation Model, Relating Power to Electric Field, Diffraction-Fresnel Zone Geometry, Knife edge Diffraction Model, Multiple knife-edge Diffraction, Scattering, Outdoor Propagation Models-Longley-Ryce Model, Okumura Model, Hata Model, Indoor Propagation Models-Partition losses, Partition losses between Floors, Log-distance path loss model, Ericsson Multiple Breakpoint Model, Attenuation Factor Model, Signal penetration into buildings, Ray Tracing and Site Specific Modelling.

UNIT - III	MOBILE RADIO PROPAGATION	(9)

Small-Scale Fading and Multipath: Small Scale Multipath propagation – Factors influencing small-scale fading, Doppler shift, Impulse Response Model of a multipath channel – Relationship between Bandwidth and Received power, Small-Scale Frequency Domain Channels Sounding, Parameters of Mobile Multipath Channels – Time Dispersion Parameters, Coherence Bandwidth, Doppler Spread and Coherence Time, Types of Small-Scale Fading-Fading effects Due to Multipath Time Delay Spread, Flat fading, Frequency selective fading, Fading effects Due to Doppler Spread – Fast fading, slow fading, Fundamentals of Equalization, Training A Generic Adaptive Equalizer, Equalizers in a communication Receiver, Linear Equalizers, Nonlinear Equalization.

UNIT - IV	WIDEBAND CODE DIVISION MULTIPLE ACCESS	(9)

CDMA system overview – air interface – physical and logical channel – speech coding, multiplexing and channel coding – spreading and modulation: frame structure, spreading codes – uplink – downlink – physical layer procedures: cell search and synchronization – establishing a connection-power control- handover – overload control.

UNIT - V	**IP MOBILITY FRAMEWORK**	**(9)**

Challenges of IP Mobility – Address Management – Dynamic Host Configuration Protocol and Domain Name Server Interfaces – Security – Mobility – Based AAA Protocol – IP Mobility Architecture Framework – x Access Network – IPv6 Challenges for IP Mobility.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Describe the principles of cellular communication.	Understand
CO2	Exemplify the concepts of mobile radio propagation.	Understand
CO3	Perceive the wireless network's different types of MAC protocols.	Apply
CO4	Discuss Equalization and Diversity.	Understand
CO5	Build the Wireless multiple access and IP.	Apply

TEXT BOOKS:

1. Theodore S. Rappaport, ‘Wireless Communications, Principles’, Practice, Second Edition, PHI, 2002.
2. Andrea Goldsmith, ‘Wireless Communications’, Cambridge University Press, 2005.

REFERENCES:

1. Kaveh Pah Laven and P. Krishna Murthy, ‘Principles of Wireless Networks’, Pearson Education, 2002.
2. Gottapu Sasibhushana Rao, ‘Mobile Cellular Communication’, Pearson Education, 2012.
3. Kamilo Feher, ‘Wireless Digital Communications’, PHI, 1999
4. Sanjeev Kumar, ‘Wireless and Mobile Communication’, New Age International, 2008.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	3	2	-	2
CO2	3	3	2	-	2
CO3	3	3	2	-	2
CO4	-	-	-	-	2
CO5	-	-	-	-	2
Avg.	**3**	**3**	**2**	**-**	**2**

1- Low, 2- Medium, 3- High

ET24E02	ROBOTICS AND AUTOMATION	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

A strong foundation in mathematics, including linear algebra, calculus, and differential equations, is essential. Knowledge of physics, particularly in mechanics and dynamics, is crucial for understanding robotic motion and control. Familiarity with programming languages like Python or C++ and experience with embedded systems are important for developing robotic algorithms. Additionally, a background in control systems, sensors, and actuators will enhance the understanding of robotic system design and automation.

OBJECTIVES:

- To impart the need for embedded system technology for robot building.
- To explore the various parts of robots and the fields of robotics.
- To study the various kinematics and inverse kinematics of robots.
- To explore the trajectory planning for the robot.
- To study the control of robots for some specific applications.

UNIT - I INTRODUCTION TO ROBOTICS & AUTOMATION (9)

Overview of Robotics and Automation – Principles and Strategies of Automation System – Hardware and Software for Automation – Embedded Processors for Automation – Different Types of Robots – Various Generations of Robots – Asimov's Laws of Robotics – Key Components of a Robot – Design Criteria for selection of a robot – Role of embedded system in Robotics and automation – Recent trends.

UNIT - II SENSORS AND DRIVE SYSTEMS (9)

Hydraulic, Pneumatic, and Electric Drive Systems – Understanding how motor power, current torque, friction coefficient affects the design of a robot – Determination of motor HP and gearing ratio – Variable Speed Arrangements. Sensors – Classification based on sensing type (including Optical, Acoustic, Magnetic) – Proximity Sensors – Ranging Sensors – Speed & Displacement Sensors – Tactile Sensors – Vision sensors – Smart Sensors – MEMS sensors.

UNIT - III MANIPULATORS AND GRIPPERS (9)

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

UNIT – IV KINEMATICS AND PATH PLANNING (9)

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

UNIT - V CASE STUDIES (9)

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Choose suitable embedded boards for robots.	Understand
CO2	Demonstrate the concepts of robotics and automation and the working of robots.	Apply
CO3	Describe the function of sensors and actuators in the robot.	Undersatnd
CO4	Develop a program to use a robot for a typical application.	Apply
CO5	Apply and improve employability and entrepreneurship capacity due to knowledge upgradation on Embedded system-based robot development.	Apply

TEXT BOOKS:

1. Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., ‘Industrial Robotics’, Mc Graw-Hill Singapore, 2017.
2. Ghosh, ‘Control in Robotics and Automation: Sensor Based Integration’, Allied Publishers, Chennai, 2009.

REFERENCES:

1. Deb. S.R., ‘Robotics Technology and Flexible Automation’, John Wiley, USA 1992.
2. Klafter R.D., Chimielewski T.A., Negin M., ‘Robotic Engineering - An Integrated Approach’, Prentice Hall of India, New Delhi, 1994.
3. Mc Kerrow P.J. ‘Introduction to Robotics’, Addison Wesley, USA, 1991.
4. Issac Asimov ‘Robot’, Ballantine Books, New York, 1986.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	-	-	2
CO2	-	3	-	-	2
CO3	-	-	-	-	2
CO4	-	-	-	-	2
CO5	-	-	2	-	2
Avg.	**1**	**2.5**	**2**	**-**	**2**

1- Low, 2- Medium, 3- High

ET24E03	EMBEDDED PROCESSOR DEVELOPMENT	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

A strong understanding of microcontroller architecture and digital electronics is crucial. Familiarity with C/C++ programming and assembly language is essential for coding and interfacing with hardware. Knowledge of computer organization, operating systems, and real-time systems provides a solid foundation. Additionally, hands-on experience with development boards and debugging tools will enhance practical skills in designing and optimizing embedded systems.

OBJECTIVES:

- To demonstrate a solid understanding of the fundamental concepts of embedded systems, including their design and application.
- To build a comprehensive knowledge of ARM architecture, including its structure, functionality, and use in embedded systems.
- To develop proficiency in C language and assembly programming, applying these skills to embedded system development.
- To build and compile object-oriented programming concepts using C++, with a focus on their application in embedded systems.
- To create effective software models for embedded systems, utilizing industry-standard tools and methodologies.

UNIT - I	EMBEDDED CONCEPTS	(9)

Introduction to embedded systems, Application Areas, Categories of embedded systems, Overview of embedded system architecture, Specialties of embedded systems, recent trends in embedded systems, Architecture of embedded systems, Hardware architecture, Software architecture, Application Software, Communication Software, Development and debugging Tools.

UNIT - II	ARM ARCHITECTURE AND OVERVIEW OF CORTEX	(9)

Background of ARM Architecture, Architecture Versions, Processor Naming, Instruction Set Development, Thumb-2 and Instruction Set Architecture. Overview of Cortex-M3. Cortex-M3 Basics: Registers, General Purpose Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector. Tables, Stack Memory Operations, Reset Sequence. Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions. Cortex-M3 Implementation Overview: Pipeline, Block Diagram, Bus Interfaces on Cortex-M3, I-Code Bus, D-Code Bus, System Bus, External PPB and DAP Bus.

UNIT - III	CORTEX-M3/M4 PROGRAMMING	(9)

Overview, Typical Development Flow, Using C, CMSIS (Cortex Microcontroller Software Interface Standard), Using Assembly Exception Programming: Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Vector Table Relocation. Memory Protection Unit and other Cortex-M3 features: MPU Registers, Setting Up the MPU, Power Management, Multiprocessor Communication.

UNIT – IV	UNIFIED MODELING LANGUAGE	(9)

Connecting the object model with the use case model – Key strategies for object identification – UML basics. Object state behaviour – UML state charts – Role of scenarios in the definition of behaviour – Timing diagrams – Sequence diagrams – Event hierarchies – types and strategies of operations – Architectural design in UML concurrency design – threads in UML.

UNIT - V	UNIFIED MODELING LANGUAGE	(9)
The compilation process – libraries – porting kernels – C extensions for embedded systems – emulation and debugging techniques – RTOS – System design using RTOS.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Demonstrate basic concepts of embedded systems.	Understand
CO2	Build ARM architecture.	Understand
CO3	Understand C language and assembly programming.	Apply
CO4	Build and compile Object orientation for programming and C++.	Apply
CO5	Create software modeling.	Apply

TEXT BOOKS:

1. David Seal ‘ARM Architecture Reference Manual’, Addison Wesley, England; Morgan Kaufmann Publisher, 2001.
2. Andrew N Sloss, Dominic Symes, Chris Wright, ‘ARM System Developer's Guide – Designing and Optimizing System Software’, Elsevier, 2006.

REFERENCES:

1. Cortex-M series-ARM Reference Manual.
2. Ajay Deshmukh, ‘Microcontroller -Theory & Applications’, Tata McGraw Hill.
3. Joseph Yiu, ‘The Definitive Guide to the ARM Cortex-M3’, Elsevier Inc., Second Edition, 2010.
4. Marwedel P, ‘Embedded System Design’, 2021.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	3	1	-	2
CO2	3	-	3	-	2
CO3	-	-	2	-	2
CO4	-	-	3	-	2
CO5	2	-	3	-	2
Avg.	**2.3**	**3**	**2.4**	**-**	**2**

1- Low, 2- Medium, 3- High

ET24E04	SYSTEM DESIGN USING MICROCONTROLLER	Category	L	T	P	C
		PEC	3	0	0	3

(Common to ET & PE)

PREREQUISITE:

Students should be familiar with memory structures, addressing modes, and instruction sets, with prior exposure to programming in Assembly and C for microcontrollers. A basic understanding of peripheral interfacing, such as ADC/DAC, Flash and EEPROM, along with experience in handling I/O ports, timers, and communication protocols like UART, is essential. Additionally, a grasp of signal generation, motor control techniques, and real-time data acquisition systems is necessary to facilitate the practical design and implementation of control systems using both PIC and ARM microcontrollers.

OBJECTIVES:

- To understand the architecture, memory organization, and addressing modes of PIC microcontrollers.
- To gain proficiency in programming PIC microcontrollers using Assembly and C languages for various embedded applications.
- To explore the utilization of I/O ports, data conversion techniques, and RAM & ROM allocation in PIC microcontroller-based systems.
- To master the implementation of timer programming for time-sensitive applications using PIC microcontrollers.
- To develop practical experience in embedded system design through hands-on practice using the MP-LAB development environment for PIC microcontrollers.

UNIT - I	**PIC MICROCONTROLLER**	**(9)**

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

UNIT - II	**ARM ARCHITECTURE**	**(9)**

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

UNIT - III	**PERIPHERALS OF PIC AND ARM MICROCONTROLLER**	**(9)**

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

UNIT – IV	**ARM MICROCONTROLLER PROGRAMMING**	**(9)**

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

UNIT - V	**DESIGN WITH PIC AND ARM MICROCONTROLLERS**	**(9)**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Describe the basics and requirements of processor functional blocks.	Understand
CO2	Observe the specialty of RISC processor Architecture.	Apply
CO3	Incorporate I/O hardware interface of processor-based automation for consumer applications with peripherals.	Apply
CO4	Incorporate the I/O software interface of a processor with peripherals.	Apply
CO5	Elaborate the recent trends in commercial embedded processors	Apply

TEXT BOOKS:

1. Steve Furber, 'ARM system on chip architecture', Addison Wesley, 2010.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield 'ARM System Developer's Guide Designing and Optimizing System Software', Elsevier, 2007.

REFERENCES:

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. ARM Architecture Reference Manual, LPC213x User Manual.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	-	2	-	2
CO2	1	-	3	-	2
CO3	-	-	1	--	2
CO4	1	-	-	-	2
CO5	-	-	2	-	2
Avg.	**1**	**-**	**2**	**-**	**2**

1- Low, 2- Medium, 3- High

ET24E05	INTELLIGENT CONTROL AND AUTOMATION	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

A solid background in control systems theory, including classical and modern control techniques, is essential. Understanding of linear algebra, differential equations, and system dynamics is crucial for analyzing and designing control algorithms. Familiarity with artificial intelligence concepts, such as neural networks and fuzzy logic, will aid in grasping advanced control strategies. Additionally, experience with simulation tools like MATLAB and programming languages such as Python is beneficial for practical implementation.

OBJECTIVES:

- To validate and understand the fundamental architectures, principles, and applications of neural networks and fuzzy logic systems.
- To apply and implement Genetic Algorithms (GA) while understanding their applications and limitations.
- To enlighten and critically evaluate hybrid control schemes, focusing on their design, integration, and effectiveness.
- To interpret and understand the significance of automation concepts in improving efficiency, accuracy, and productivity across various industries.
- To develop intelligent controllers tailored for automation applications, enhancing system adaptability and performance.

UNIT - I ARTIFICIAL NEURAL NETWORK AND FUZZY LOGIC (9)

Artificial Neural Network: Learning with ANNs, single-layer networks, multi-layer perceptrons, Back propagation algorithm (BPA) ANNs for identification, ANNs for control, and Adaptive neuro controller.

Fuzzy Logic Control: Introduction, fuzzy sets, fuzzy logic, fuzzy logic controller design, Fuzzy Modelling & identification, Adaptive Fuzzy Control Design.

UNIT - II GENETIC ALGORITHM (9)

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

UNIT - III HYBRID CONTROL SCHEMES (9)

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

UNIT – IV AUTOMATION (9)

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

UNIT - V INTELLIGENT CONTROLLER FOR AUTOMATION APPLICATION (9)

Applications of intelligent controllers in industrial monitoring, optimization and control – Smart appliances – Automation concept for electrical vehicles – Intelligent controller and automation for power systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Describe the basic architectures of NN and Fuzzy logic.	Understand
CO2	Design and implement GA algorithms and know their limitations.	Apply
CO3	Explain and evaluate hybrid control schemes.	Apply
CO4	Interpret the significance of Automation concepts.	Apply
CO5	Develop the intelligent controller for automation applications.	Apply

TEXT BOOKS:

1. Laurene V. Fausett, ‘Fundamentals of Neural Networks, Architecture, Algorithms, and Applications’, Pearson Education, 2008.
2. Timothy J.Ross, ‘Fuzzy Logic with Engineering Applications’, Wiley, Third Edition, 2010.

REFERENCES:

1. David E. Goldberg, ‘Genetic Algorithms in Search, Optimization, and Machine Learning’, Pearson Education, 2009.
2. Miller, W.T. Sutton, R.S. and Webrose, P.J., ‘Neural Networks for Control’, MIT Press, 1996.
3. Chanchal Dey and Sunit Kumar Sen, ‘Industrial Automation Technologies’, First Edition, CRC Press, 2022.
4. Jovan Pehcevski, ‘Intelligent Control and Automation’, Barnes and Noble, 2022.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	1	1	-	2
CO2	2	2	3	-	2
CO3	3	2	2	-	2
CO4	3	2	2	-	2
CO5	3	-	3	-	2
Avg.	**2.4**	**1.75**	**2.2**	**-**	**2**

1- Low, 2- Medium, 3- High

ET24E06	RENEWABLE ENERGY AND GRID INTEGRATION	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

A foundational knowledge of electrical engineering principles, including circuit theory and power systems, is essential. Understanding of renewable energy technologies, such as solar, wind, hydropower, and energy storage systems. Familiarity with grid operation, control systems, and power electronics will aid in comprehending integration challenges. Additionally, a grasp of environmental science and sustainability concepts will enhance the understanding of the broader impact of renewable energy systems.

OBJECTIVES:

- To provide knowledge about stand-alone and grid-connected renewable energy systems.
- To equip with the required skills to derive the criteria for designing power converters for renewable energy applications.
- To comprehend the various operating modes of wind electrical generators and solar energy systems.
- To design different power converters namely AC to DC, DC to DC, and AC to AC converters for renewable energy systems.
- To develop maximum power point tracking algorithms.

UNIT - I	INTRODUCTION	(9)

Introduction to renewable energy systems, environmental aspects of electric energy conversion, impacts of renewable energy penetration to grid. Grid Codes in India and other countries. Basic power electronic converters for renewable energy integration to grid – Qualitative analysis – Boost and buck-boost converters, three-phase AC voltage controllers – AC-DC-AC converters, PWM inverters, Grid Interactive Inverters – Matrix converters.

UNIT - II	PHOTO VOLTAIC ENERGY CONVERSION SYSTEMS	(9)

Introduction, Photo Voltaic (PV) effect, Solar Cell, Types, Equivalent circuit of PV cell, PV cell characteristics (I/V and P/V) for variation of insolation, temperature and shading effect, Stand-alone PV system, Grid connected PV system, Design of PV system-load calculation, array sizing, selection of converter/inverter, battery sizing.

UNIT - III	WIND ENERGY CONVERSION SYSTEMS	(9)

Introduction, Power contained in wind, Efficiency limit in wind, types of wind turbines, Wind control strategies, Power curve, and Operating area, Types of wind generators system based on electrical machines – Induction Generator and Permanent Magnet Synchronous Generator (PMSG), Grid connected Single and Double output system, Self-excited operation of Induction Generator and Variable Speed PMSG.

UNIT – IV	MPPT TECHNIQUES IN SOLAR AND WIND SYSTEMS	(9)

Case studies of PV – Maximum Power Point Tracking (MPPT) and Wind Energy system.

UNIT - V	**HYBRID STORAGE SYSTEMS AND GRID MANAGEMENT**	**(9)**
Energy Storage systems, Need for Hybrid Systems, Features of Hybrid Systems, Range and types of Hybrid systems (Wind-Diesel, PV-Diesel and Wind-PV).		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Relate the power generation of different renewable energy sources to grid impact and grid codes.	Understand
CO2	Elucidate the design principles of solar energy management systems.	Apply
CO3	Explicate the power conversion system of wind generators.	Apply
CO4	Describe the different Maximum Power Point Tracking Techniques.	Apply
CO5	Build a grid-connected and stand-alone renewable energy management system.	Apply

TEXT BOOKS:

1. Bhadra, S.N., Kastha, D., Banerjee S, ‘Wind Electrical Systems’, Oxford University Press, 2009.
2. Haitham Abu-Rub, Mariusz Malinowski and Kamal Al-Haddad, ‘Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications’, IEEE Press and John Wiley and Sons Ltd. Press, 2014.

REFERENCES:

1. Rashid. M.H., ‘Power Electronics Handbook’, Academic Press, 2001.
2. Rai. G.D, ‘Non-conventional Energy Sources’, Khanna Publishers, 1993.
3. Gray, L. Johnson, ‘Wind Energy System’, Prentice Hall Linc, 1995.
4. Khan, B.H., ‘Non-Conventional Energy sources’, Tata McGraw-Hill Publishing Company, New Delhi, 2018.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	2	1	-	2
CO2	1	1	2	-	2
CO3	2	-	1	-	2
CO4	1	2	1	-	2
CO5	3	3	2	-	2
Avg.	**1.6**	**2**	**1.4**	**-**	**2**

1- Low, 2- Medium, 3- High

ET24E07	ELECTRIC VEHICLES AND POWER MANAGEMENT	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

Knowledge of how electric drive trains, batteries, and charging systems work. Familiarity with grid integration, charging infrastructure, and smart grid technologies. Knowledge about battery types, charging cycles, and lifecycle management. Awareness of safety standards, regulations, and policies related to EVs and charging stations. Skills in analyzing usage data, energy consumption patterns, and predictive maintenance.

OBJECTIVES:

- To recognize the concept of electric vehicles and its operations.
- To realize an overview of Electric Vehicle (EV) and their architecture.
- To recognize an overview of Hybrid Electric vehicle (HEV) and their architecture.
- To recognize the need for energy storage in hybrid vehicles.
- To provide knowledge about various possible energy storage technologies that can be used in electric vehicles.

UNIT - I	**ELECTRIC VEHICLES AND VEHICLE MECHANICS**	**(9)**

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings – Comparisons of EV with internal combustion engine vehicles – Fundamentals of vehicle mechanics.

UNIT - II	**ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS**	**(9)**

Architecture of EVs and HEV_S – Plug-in hybrid electric vehicles (PHEV) – Power train components and sizing, gears, clutches, transmission and brakes.

UNIT - III	**POWER ELECTRONICS AND MOTOR DRIVES**	**(9)**

Electric drive components – Power electronic switches – Four quadrant operation of DC drives – Induction motor and Permanent Magnet Synchronous Motor-based vector control operation – Switched Reluctance Motor (SRM) drives – EV motor sizing.

UNIT - IV	**BATTERY ENERGY STORAGE SYSTEM**	**(9)**

Battery Basics – Different types – Battery Parameters – Battery life and safety impacts – Battery modeling – Design of battery for large vehicles.

UNIT - V	**ALTERNATIVE ENERGY STORAGE SYSTEMS**	**(9)**

Introduction to fuel cell – Types, operation, and characteristics – Proton Exchange Membrane (PEM) fuel cell for E-mobility – Hydrogen storage systems – Supercapacitors for transportation applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
COs	**Course Outcome**	**Cognitive Level**
CO1	Describe the concept of electric vehicles and energy storage systems.	Understand
CO2	Explore the workings and components of electric vehicles and hybrid electric vehicles.	Understand
CO3	Discuss the principles of power converters and electrical drives.	Understand
CO4	Describe the operation of storage systems such as batteries and supercapacitors.	Understand
CO5	Explore the various energy storage systems based on fuel cells and hydrogen storage.	Understand

TEXT BOOKS:

1.	Iqbal Hussain, 'Electric and Hybrid Vehicles: Design Fundamentals', CRC Press, Taylor & Francis Group, Second Edition, 2011.
2.	Ali Emadi, Mehrdad Ehsani, John M.Miller, 'Vehicular Electric Power Systems', Marcel dekker, Inc., Special 63 Indian Edition, 2010.

REFERENCES:

1.	Mehrdad Ehsani, Yimin Gao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
2.	C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001.
3.	Wie Liu, 'Hybrid Electric Vehicle System Modeling and Control', John Wiley & Sons, Second Edition, 2017.
4.	J. G. Cowan, 'Power Management of Electrical Vehicles,' McGraw-Hill, 1st Edition, 2020.

Mapping of COs with POs and PSOs

COs/ POs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	3	3	3	-	2
CO2	3	3	3	-	2
CO3	3	3	3	-	2
CO4	3	3	3	-	2
CO5	3	3	3	-	2
Avg.	**3**	**3**	**3**	**-**	**2**

1- Low, 2- Medium, 3- High

ET24E08	UNMANNED AERIAL VEHICLE	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

Knowledge of the UAV's components, including its flight system, GPS, communication links, payloads (cameras, sensors, etc.), UAV's intended use (e.g., hobbyist, commercial, or military) and the specific regulations of the operating country. Selection of a UAV suitable for the intended task, whether it's a consumer drone, a commercial-grade model, or a specialized UAV.

OBJECTIVES:

- To understand basic UAV concepts and components.
- To impart UAV design principles.
- To explore UAV hardware structure.
- To emphasize communication protocols and control strategies.
- To know the importance of UAVs in various real-time applications and the process of developing UAV systems.

UNIT - I	**INTRODUCTION TO UAV**	**(9)**
Overview and background – History of UAV – Classification – Societal impact and future outlook Unmanned Aerial System (UAS) components – Models and prototypes – System Composition – applications.		
UNIT - II	**THE DESIGN OF UAV SYSTEMS**	**(9)**
Introduction to design and selection of the system – Aerodynamics and airframe configurations – Characteristics of aircraft types – Design standards – Regulatories and regulations – Design for stealth – Control surfaces – Specifications.		
UNIT - III	**HARDWARE 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 – Troubleshooting.		
UNIT - V	**THE DEVELOPMENT OF UAV SYSTEMS**	**(9)**
Waypoints Navigation – Ground control software – System ground testing – System in-flight testing – Mini, Micro and Nano UAVS – Case study: Agriculture – health – surveying – Disaster management and defense.		

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Leve
CO1	Identify and describe various hardware components used in UAV systems.	Understand
CO2	Determine preliminary design requirements for unmanned aerial vehicles.	Apply
CO3	Design and develop a UAV system based on specified requirements.	Apply
CO4	Identify and integrate various subsystems of an unmanned aerial vehicle.	Apply
CO5	Design micro aerial vehicle systems, considering practical limitations.	Apply

TEXT BOOKS:

1.	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.

REFERENCES:

1.	Dr. Armand J. Chaput, 'Design of Unmanned Air Vehicle Systems', Lockheed Martin Aeronautics Company, 2001.
2.	Kimon P. Valavanis, 'Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy', Springer, 2007.
3.	Robert C. Nelson, 'Flight Stability and Automatic Control', McGraw-Hill, Inc, 1998.
4.	Correll, N., Hayes, B., Martin, R., & Khatib, O. 'Introduction to Autonomous Robots: Mechanics, Control, Decision Making, and Algorithms'. MIT Press, 2017.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	1	3	2	-	2
CO2	3	3	3	-	2
CO3	3	3	3	-	2
CO4	-	-	2	-	2
CO5	3	-	3	-	2
Avg.	**2.5**	**3**	**2.6**	-	**2**

1- Low, 2- Medium, 3- High

ET24E09	DSP BASED SYSTEM DESIGN	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

Understanding of signal processing concepts, including sampling, Fourier transforms, and filtering. Proficiency in linear algebra, calculus, and complex numbers. Knowledge of programming languages commonly used in DSP, such as C/C++ or MATLAB. Familiarity with DSP hardware architectures, microprocessors, and FPGA systems. Basics of analog and digital circuit design.

OBJECTIVES:

- To understand various representation methods of the DSP system.
- To explore and recognize various DSP algorithms for real-time systems.
- To familiarize the various architectures of DSP system.
- To familiarize DSP architectures for interfacing with DSP systems and programmable hardware.
- To expose students to the knowledge of interfacing DSP systems 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, and features for external interfacing. VLIW architecture. Basic performance issues in pipelining, simple implementation of MIPS, instruction level parallelism, dynamic scheduling, dynamic hardware prediction, and memory hierarchy. Study of fixed point and floating-point DSP architectures.

UNIT - IV	ARCHITECTURE ANALYSIS ON PROGRAMMABLE HARDWARE	(9)

Analysis of basic DSP Architectures on programmable 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 Multi GPUS. Interfacing: Introduction, synchronous serial interface code, a codec interface circuit, ADC interface.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Evaluate DSP systems using various methods.	Understand
CO2	Design algorithms suitable for different DSP applications.	Apply
CO3	Explain various architectures of DSP systems.	Understand
CO4	Implement DSP systems in programmable hardware.	Apply
CO5	Interface DSP systems with various peripherals.	Apply

TEXT BOOKS:

1. Chassaing, 'Digital Signal Processing and Application with C6713 and C6416 DSK', A Wiley Interscience Publication, 2017.
2. Peter Pirsch John, 'Architectures for Digital Signal Processing', Weily, 2007.

REFERENCES:

1. Sen M Kuo, Woon Seng S Gan, 'Digital Signal Processors', Upper Saddle River, Pearson /Prentice Hall, 2002.
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', Wiley, Student Edition, 1999.
4. Smith, S. W. 'Digital Signal Processing: A Practical Guide for Engineers and Scientists', First Edition, Elsevier, 2003.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	3	-	-	2
CO2	3	3	3	-	2
CO3	-	3	-	-	2
CO4	3	-	3	-	2
CO5	2		3	-	2
Avg.	**2.6**	**3**	**3**	**-**	**2**

1- Low, 2- Medium, 3- High

ET24E10	AUTOMOTIVE EMBEDDED SYSTEM	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

A basic understanding of electrical circuits and electronic components is crucial. Knowledge of programming and embedded systems principles is often required. Proficiency in C and C++ programming languages, as they are commonly used for embedded systems development. Experience with programming microcontrollers and working with embedded software.

OBJECTIVES:

- To expose the students to the fundamentals and building of Electronic Engine Control systems.
- To explore the functional components and circuits for vehicles.
- To understand the programmable controllers used in vehicle management systems.
- To impart the logic of automation and 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 and software selection and 37 requirements for Automotive applications – Open-source ECU – RTOS – Concept for Engine management; 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 – Sensor's interface to the ECU, Conventional sensors and actuators, Modern sensors and actuators – Lidar Sensor – Smart sensors – MEMs/NEMs sensors and actuators for automotive applications.

UNIT - III	**VEHICLE MANAGEMENT SYSTEMS**	**(9)**

Electronic engine control – Engine mapping, air/fuel ratio spark timing control strategy, fuel control, electronic ignition – Adaptive cruise control – Speed control – Anti-locking braking system – Electronic suspension – Electronic steering, Automatic wiper control – Body control system; vehicle system schematic for interfacing with EMS, ECU. Energy management system for electric vehicles – Battery management system, Power management system – Electrically assisted power steering system adaptive lighting system – Safety and collision avoidance.

UNIT - IV	**ONBOARD DIAGNOSTICS AND TELEMATICS**	**(9)**

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

UNIT - V	**ELECTRIC VEHICLES**	**(9)**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Insight into the significance of the role of embedded systems for automotive applications.	Understand
CO2	Illustrate the need, selection of sensors and actuators, and interfacing with ECU.	Apply
CO3	Develop the Embedded concepts for vehicle management and control systems.	Apply
CO4	Demonstrate the need for Electrical Vehicles and able to apply the embedded system technology for various aspects of EVs.	Apply
CO5	Describe the embedded systems design and its application in automotive systems.	Apply

TEXT BOOKS:

1. William B. Ribbens, 'Understanding Automotive Electronics', Elsevier Hand Book, 2012.
2. Ali Emedi, Mehrdedehsani, John M Miller, 'Vehicular Electric power system - land, Sea, Air and Space Vehicles', Marcel Decker, 2004.

REFERENCES:

1. Vlacic, L. Parent, M. Harahima, F. 'Intelligent Vehicle Technologies', SAE International, 2001.
2. Jack Erjavec, Jeff Arias, 'Alternate Fuel Technology-Electric, Hybrid, and Fuel Cell Vehicles', Cengage, 2012.
3. Ronald K.Jurgen Chiltons, 'Electronic Engine Control Technology Guide to Fuel Injection' SAE International, Second Edition, 2002.
4. Tom Denton, 'Automotive Electricals / Electronics System and Components', Third Edition, 2004.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	2	1	-	2
CO2	2	3	2	-	2
CO3	3	3	3	-	2
CO4	3	3	3	-	2
CO5	3	3	3	-	2
Avg.	**2.75**	**2.8**	**2.4**	**-**	**2**

1- Low, 2- Medium, 3- High

ET24E11	COMPUTER VISION	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

Proficiency in languages commonly used in computer vision, such as Python, C++, or MATLAB. Python is particularly popular due to its extensive libraries (e.g., OpenCV, scikit-image). Familiarity with libraries and frameworks related to computer vision and machine learning, such as OpenCV, TensorFlow, PyTorch, or scikit-learn. Basic understanding of data structures (e.g., arrays, lists, trees) and algorithms (e.g., sorting, searching).

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 – Fundamental 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 OPEN CV	(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 – The 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: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Discuss the major concepts and techniques in computer vision and image processing.	Understand
CO2	Infer known principles of the human visual system.	Apply
CO3	Establish a thorough knowledge of open CV.	Apply
CO4	Develop real-life Computer vision applications.	Apply
CO5	Build design of a Computer Vision System for a specific problem.	Apply

TEXT BOOKS:

1. Rafael C Gonzalez and Richard E Woods, 'Digital Image Processing', Pearson Education Limited, Fourth Edition (Global Edition), 2018.
2. Manas Kamal Bhuyan, 'Computer Vision and Image Processing - Fundamentals and Applications', CRC Press, 2020.

REFERENCES:

1. Alberto Fernandez Villan, 'Mastering OpenCV 4 with Python', Packet Publishing, 2019.
2. Adrian Rosebrock, 'Practical Python and Open CV: Case Studies', PyImageSearch, Third Edition, 2016.
3. David L. Poole and Alan K. Mackworth, 'Artificial Intelligence: Foundations of Computational Agents', Cambridge University Press, 2017.
4. Jan Erik Solem, 'Programming Computer Vision with Python: Tools and algorithms for analyzing images', O'Reilly Media, 2012.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	3	2	-	2
CO2	2	2	2	-	2
CO3	3	3	3	-	2
CO4	3	3	3	-	2
CO5	3	3	3	-	2
Avg.	**2.6**	**2.8**	**2.6**	**-**	**2**

1- Low, 2- Medium, 3- High

ET24E12	MULTIMEDIA COMMUNICATION	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

Basic knowledge of programming languages such as C, C++, or Python. Digital Signal Processing (DSP): Understanding of signals, systems, and basic concepts of digital signal processing. Networking Fundamentals: Basics of computer networks, including protocols, architectures, and network design. Electronics or Communication Systems: Understanding of basic electronics and communication systems might also be required, particularly for hardware-oriented courses.

OBJECTIVES:

- To enlighten multimedia communication models.
- To apply multimedia transport techniques in wireless networks.
- To address security issues in multimedia networks.
- To demonstrate real-time multimedia network applications.
- To explore different network layer-based applications.

UNIT - I	INTRODUCTION TO MULTIMEDIA COMMUNICATIONS	(9)

Introduction, multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology, network QoS and application QoS, Digitization principles, Text, images, audio and video.

UNIT - II	COMPRESSION TECHNIQUES FOR TEXT AND IMAGE	(9)

Text and image compression, compression principles, text compression – Runlength, Huffman, LZW, Document Image compression using T2 and T3 coding, image compression – GIF, TIFF and JPEG.

UNIT - III	COMPRESSION TECHNIQUES FOR AUDIO AND VIDEO	(9)

Audio and video compression, audio compression – Principles, DPCM, ADPCM, Adaptive and Linear predictive coding, code-excited LPC, Perceptual coding, MPEG and Dolby coders video compression, video compression principles.

UNIT - IV	STANDARDS AND FRAMEWORK	(9)

Video compression standards: H.261, H.263, MPEG, MPEG 1, MPEG 2, MPEG-4 and Reversible VLCs, MPEG 7 standardization process of multimedia content description, MPEG 21 multimedia framework.

UNIT - V	SYNCHRONIZATION AND MANAGEMENT	(9)

Notion of synchronization, presentation requirements, a reference model for synchronization, Introduction to SMIL, Multimedia operating systems, Resource management, and process management techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Deploy the right multimedia communication models.	Apply
CO2	Apply QoS to multimedia network applications with efficient routing techniques.	Apply
CO3	Solve the security threats in multimedia networks.	Apply
CO4	Develop real-time multimedia network applications.	Apply
CO5	Improve synchronization and manage the multimedia systems.	Understand

TEXT BOOKS:

1. Jerry D. Gibson, ‘Multimedia Communications’, Department of Electrical Engineering Southern Methodist University, Texas, 2019.
2. Mario Marques da Silva, ‘Multimedia Communications and Networking’, Taylor and Francis Group, 2012.

REFERENCES:

1. Fred Halsall, ‘Multimedia Communications’, Pearson Education, 2001.
2. Raif Steinmetz, Klara Nahrstedt, ‘Multimedia: Computing, Communications and Applications’, Pearson Education, 2002.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	2	-	1	1	2
CO2	2	-	1	1	2
CO3	3	-	-	1	2
CO4	-	-	-	1	2
CO5	2	-	-	1	2
Avg.	**2.25**	**-**	**1**	**1**	**2**

1- Low, 2- Medium, 3- High

ET24E13	EMBEDDED NETWORKING AND AUTOMATION OF ELECTRICAL SYSTEM	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

Basic Electronics: Understanding of electronic components, circuits, and basic electrical systems Microcontroller/Microprocessor Fundamentals: Knowledge of microcontrollers or microprocessors, including how to program and interface with them. Embedded Systems: Prior exposure to embedded systems, including familiarity with real-time operating systems (RTOS) and hardware-software interfacing. Computer Networks: Understanding of networking concepts, including protocols, data transmission, and network architectures.

OBJECTIVES:

- To investigate the fundamental building blocks of a digital instrument.
- To introduce wired, WSN for configuring metering network.
- To investigate grid automation.
- To deliberate networking configuration to develop PAN.
- To confer the functions of digital instrument power quality monitoring.

UNIT - I	BUILDING SYSTEM AUTOMATION	(9)

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

UNIT - II	EMBEDDED NETWORKING OF INSTRUMENT CLUSTER	(9)

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

UNIT - III	AUTOMATION OF SUBSTATION	(9)

Substation automation – Distribution SCADA system principles – Role of PMU, RTU, IEDs, BUS for smart Substation automation – Introduction to the role of IEC 61850, IEEEC37.118 std – Interoperability and IEC 61850 – Challenges of substations in smart grid – Challenges of energy storage and distribution systems monitoring – Communication challenges in monitoring electric utility asset.

UNIT - IV	METERING OF SMART GRID	(9)

Characteristics of smart grid – Generation by renewable energy sources based on solar grid – Challenges in smart grid and microgrids – Electrical measurements with AMI – Smart meters for EV plug-in electric vehicles power management – Home area net metering and Demand-side energy management applications.

UNIT - V	SMART METERS FOR PQ MONITORING	(9)
Power quality issues of grid-connected renewable energy sources – Smart meters for power quality monitoring and control – Power quality issues – Surges – Flicker – Interharmonics – Transients – Power Quality Benchmarking – Power Quality Meters – Meter data management in smart grid – Communication enabled Power Quality metering.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Validate criteria of choice of sensors, and components to build meters.	Apply
CO2	Deliberate the demand for BUS communication protocols is introduced.	Understand
CO3	Discuss the needs and standards in substation automation.	Understand
CO4	Deployment of PAN for metering networked commercial applications.	Apply
CO5	Realize the improved employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded networked communications.	Understand

TEXT BOOKS:

1. Krzysztof Iniewski, ‘Smart Grid, Infrastructure & Networking’, TMcGH, 2012.
2. Robert Faludi, ‘Building Wireless Sensor Networks’, O’Reilly, 2011.

REFERENCES:

1. Robert Wilson, ‘Control and automation of electrical power distribution systems’, James Northcote-Green, CRC, Taylor and Francis, 2006.
2. Mohammad Ilyas and Imad Mahgoub, ‘Handbook of sensor Networks: Compact wireless and wired sensing systems’, CRC Press, 2005.
3. Shih-Lin Wu, Yu-Chee Tseng, ‘Wireless Ad Hoc Networking, PAN, LAN, SAN’, Auerbach Publication, 2012.
4. Sanjay Gupta, ‘Virtual Instrumentation, LABVIEW’, TMH, New Delhi, 2003.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	1	2	3	1
CO2	1	-	2	3	1
CO3	3	1	2	3	1
CO4	2	-	2	3	1
CO5	2	1	2	3	1
Avg.	**2.2**	**1**	**2**	**3**	**1**

1 - Low, 2 - Medium, 3 - High

ET24E14	SMART SYSTEM DESIGN	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

Embedded Systems: Knowledge of embedded systems, including microcontrollers, sensors, actuators, and basic interfacing techniques. Programming Skills: Proficiency in programming languages like C, C++, Python, or Java, especially for writing code that interfaces with hardware components. Artificial Intelligence (AI) and Machine Learning (ML): For advanced smart systems, knowledge of AI/ML techniques may be required, particularly in applications involving automation, pattern recognition, or decision-making. Mathematics: Proficiency in mathematical concepts, particularly those related to algorithms, optimization, and linear algebra. Sensor Technologies: Understanding of various sensors and their applications in smart systems, including data acquisition and processing.

OBJECTIVES:

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

UNIT - I	INTRODUCTION	(9)

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

UNIT - II	HOME AUTOMATION	(9)

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

UNIT - III	SMART APPLIANCES AND ENERGY MANAGEMENT	(9)

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

UNIT - IV	SMART WEARABLE DEVICES	(9)

Application of smart wearables in healthcare and activity monitoring – Functional requirements – Selection of body sensors, Hardware platform, OS and Software platform – Selection of suitable communication protocol. Case Study: Design of a wearable, collecting heart-beat, temperature and monitoring health status using a smartphone application.

UNIT - V	EMBEDDED SYSTEMS AND ROBOTICS	(9)

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

COs	Course Outcome	Cognitive Level
CO1	Recognize the concepts of smart system design and its present developments.	Understand
CO2	Illustrate different embedded open-source and cost-effective techniques for developing solutions for real-time applications.	Understand
CO3	Acquire knowledge of different platforms and Infrastructure for Smart system design.	Apply
CO4	Infer about smart appliances and energy management concepts.	Understand
CO5	Apply and improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.	Apply

TEXT BOOKS:

1. Thomas Braunl, ‘Embedded Robotics’, Springer, 2003.
2. Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, ‘Embedded Systems for Smart Appliances and Energy Management’, Springer, 2013.

REFERENCES:

1. Raj Kamal, ‘Embedded Systems - Architecture, Programming and Design’, McGraw-Hill, 2008.
2. Nilanjan Dey, Amartya Mukherjee, ‘Embedded Systems and Robotics with Open-Source Tools’, CRC press, 2016.
3. Karim Yaghmour, ‘Embedded Android’, O'Reilly, 2013.
4. Steven Goodwin, ‘Smart Home Automation with Linux and Raspberry Pi’, Apress, 2013.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	-	3	2	2	2
CO2	2	-	-	2	2
CO3	-	-	-	2	2
CO4	-	-	-	2	2
CO5	-	-	-	2	2
Avg.	**2**	**3**	**2**	**2**	**2**

1- Low, 2- Medium, 3- High

ET24E15	**EMBEDDED COMPUTING**	**Category**	**L**	**T**	**P**	**C**
		PEC	**3**	**0**	**0**	**3**

PREREQUISITE:

Embedded Systems: Prior coursework or experience with embedded systems, including basic concepts of hardware-software interfacing and real-time operating systems (RTOS). Computer Architecture: Understanding of basic computer architecture, including memory hierarchy, data paths, and instruction sets. Operating Systems: Basic knowledge of operating systems, particularly real-time operating systems (RTOS), which are often used in embedded computing.

OBJECTIVES:

- To expose the students to the fundamentals of Network communication technologies.
- To impart the fundamentals of Java, Internet, and Java cards.
- To develop a distributed embedded system with Java.
- To impart the smart card and apps development.
- To involve discussions/practice in familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills.

UNIT - I	**NETWORK INFRASTRUCTURE**	**(9)**

Broad Band Transmission facilities – Open Interconnection standards – Networking devices Network diagram –Network management – Network Security – Cluster computers.

UNIT - II	**JAVA TECHNOLOGY FOR EMBEDDED SYSTEMS**	**(9)**

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

UNIT - III	**SMART CARD TECHNIQUES**	**(9)**

Smart Card basics – Java card technology overview – Java card Types – Card components Smart Card Microcontrollers – Contactless cards – Smart card operating systems – Smart card Security Techniques.

UNIT - IV	**ANDROID FRAMEWORK**	**(9)**

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

UNIT - V	**DEVELOPING DISTRIBUTED REAL-TIME SYSTEM APPLICATIONS**	**(9)**

Developing MATLAB Real-Time Targets – Using the xPC Target – Building various distributed Real-Time applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:		
At the end of the course, the students will be able to:		
COs	**Course Outcome**	**Cognitive Level**
CO1	Describe the JAVA concepts and internet-based communication to establish a decentralized control mechanism of the system.	Understand
CO2	Interpret the software and hardware architecture for distributed computing.	Understand
CO3	Develop a solution for smart cards.	Apply
CO4	Develop Apps based on Android SDK.	Apply
CO5	Deliberate recent trends in the embedded system computing environment.	Understand

TEXT BOOKS:

1.	Wolfgang Rankl and Wolfgang Effing, ‘Smart Card Handbook’, John Wiley & Sons Limited, Third Edition, 2003.
2.	Reto Meier, ‘Professional Android application development’, Wiley Publishing, Inc., 2009.

REFERENCES:

1.	Joshua, ‘Android hacker’s Handbook’, John Wiley & Sons, 2014.
2.	Dietel & Dietel, ‘JAVA how to program’, Prentice Hall, 1999.
3.	Sape Mullender, ‘Distributed Systems’, Addison-Wesley, 1993.
4.	Amitava Gupta, Anil Kumar Chandra and Peter Luksch, ‘Real-Time and Distributed Real-Time Systems Theory and Applications’, CRC Press, International Standard Book Number-13: 978-1-4665-9849-2 (eBook - PDF), 2016.

Mapping of COs with POs and PSOs

COs/ POs	**PO1**	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	2	-	1	2	2
CO2	2	3	2	2	2
CO3	3	1	2	2	2
CO4	3	1	2	2	2
CO5	2	1	2	2	2
Avg.	**2.4**	**1.5**	**1.8**	**2**	**2**

1- Low, 2- Medium, 3- High

ET24E16	EMBEDDED SYSTEMS SECURITY	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

A solid understanding of embedded systems security requires several prerequisites. Firstly, a strong foundation in embedded system design, including knowledge of microcontrollers, processors, and real-time operating systems (RTOS), is essential. Familiarity with programming languages commonly used in embedded systems, such as C and C++, is also crucial, as is an understanding of hardware-software interaction. Additionally, a grasp of basic cybersecurity principles.

OBJECTIVES:

- To introduce the fundamentals related to Cryptography and Data Security.
- To impart 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 involve the students in Discussions/Tutorials/Programming to familiarize the concepts.

UNIT - I **BACKGROUND AND INTRODUCTION** **(9)**

Computer and Network Security Concepts: Computer Security Concepts – The OSI Security Architecture – Security Attacks – Security Services – Security Mechanisms – Fundamentals of Security Design Principles – Attack Surfaces and Attack Trees – A Model for Network Security. Introduction to Number Theory: Divisibility and the Division Algorithm – The Euclidean Algorithm – Modular Arithmetic – Prime Numbers – 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 **EMBEDDED SYSTEMS SECURITY** **(9)**

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

UNIT - IV **EMBEDDED CRYPTOGRAPHY AND DATA PROTECTION PROTOCOLS** **(9)**

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

UNIT - V	PRACTICAL EMBEDDED SYSTEM SECURITY	(9)
Network Communications Protocols and Built-in Security – Security Protocols and Algorithms – The Secured Socket Layer – Embedded Security – Wireless – Application-Layer and Client/Server Protocols – Choosing and Optimizing Cryptographic Algorithms for Resource-Constrained Systems – Hardward based security.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Enlighten the significance of security.	Understand
CO2	Recognize the major concepts and techniques related to cryptography.	Understand
CO3	Demonstrate thorough knowledge of the aspects of embedded System Security.	Understand
CO4	Delivers insight into the role of security aspects during data transfer and communication.	Understand
CO5	Applying the security algorithms for real-time applications.	Apply

TEXT BOOKS:

1. William Stallings, 'Cryptography and Network Security Principles and Practice', Global Edition, Pearson Education Limited, Eighth Edition, 2023.
2. David Kleidermacher and Mike Kleidermacher, 'Newnes Embedded Systems Security-Practical Methods for Safe and Secure Software and Systems Development', 2012.

REFERENCES:

1. Timothy Stapko, Newnes (an imprint of Elsevier), 'Practical Embedded Security-Building Secure Resource-Constrained Systems', 2008.
2. David Kleidermacher and Mike Kleidermache, 'Embedded Systems Security: Building a Trustworthy Internet of Things', Elsevier Science and Technology Books, 2017.
3. David Kleidermacher and Mike Kleidermacher, 'Embedded Systems Security: Practical Methods for Safe and Secure Software and Systems Development', Second Edition, CRC Press, 2020.
4. Jonathan Katz and Yehuda Lindell, 'Introduction to Modern Cryptography: Principles and Protocols', Cambridge University Press, 2007.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	-	3	2	-
CO2	3	-	3	2	-
CO3	3	-	3	2	-
CO4	3	-	3	2	-
CO5	3	-	3	2	-
Avg.	**3**	**-**	**3**	**2**	**-**

1 - Low, 2 - Medium, 3 - High

ET24E17	MACHINE LEARNING AND DEEP LEARNING	Category	L	T	P	C
		PEC	3	0	0	3

PREREQUISITE:

To successfully engage with a course in Machine Learning and Deep Learning, students should possess a solid foundation in several key areas. Proficiency in mathematics is essential, including linear algebra (understanding vectors, matrices, and eigenvalues), calculus (differentiation and integration), and probability and statistics (probability distributions, Bayesian inference, and statistical metrics). Students should be skilled in programming, particularly in Python, and familiar with machine learning libraries.

OBJECTIVES:

- To make the students realize the learning problem and algorithms.
- To enable the students by providing insight into neural networks.
- To introduce the students to the machine learning fundamentals and significance.
- To acquire knowledge about pattern recognition.
- To apply deep learning algorithms for solving real-life problems.

UNIT - I	LEARNING PROBLEMS AND ALGORITHMS	(9)

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

UNIT - II	NEURAL NETWORKS	(9)

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

UNIT - III	MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS	(9)

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

UNIT - IV	DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS	(9)

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

UNIT - V	DEEP LEARNING: RNNS, AUTOENCODERS AND GANS	(9)

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the students will be able to:

COs	Course Outcome	Cognitive Level
CO1	Categorize various machine learning algorithms.	Understand
CO2	Compare and contrast the types of neural network architectures, and activation functions.	Apply
CO3	Apply pattern association techniques using neural networks.	Apply
CO4	Elaborate on various terminologies related to pattern recognition and architectures of convolutional neural networks.	Apply
CO5	Integrate classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.	Apply

TEXT BOOKS:

1. Jang, J. S. R., Sun, C. T., Mizutani, E. 'Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence', PHI Learning, 2012.
2. Deep Learning, Ian Good fellow, 'Yoshua Bengio and Aaron Courville', MIT Press, ISBN: 9780262035613, 2016.

REFERENCES:

1. Shai Shalev-Shwartz and Shai Ben-David 'Understanding Machine Learning', Cambridge University Press. 2017.
2. Jang, J.S.R, Sun, C.T, Mizutani, E., 'Neuro-Fuzzy and Soft Computing - A Computational', Upper Saddle River, NJ: Prentice Hall, 1997.
3. Vinod Chandra S.S, Anand Hareendran S. 'Approach to Learning and Machine Intelligence', PHI learning, First Edition, 2012.
4. Christopher Bishop, 'Pattern Recognition and Machine Learning', Springer, 2006.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PSO1	PSO2
CO1	3	-	3	2	2
CO2	3	-	3	2	2
CO3	3	-	3	2	2
CO4	3	-	3	2	2
CO5	3	-	3	2	2
Avg.	**3**	**-**	**3**	**2**	**2**

1 - Low, 2 - Medium, 3 - High