KNOWLEDGE INSTITUTE OF TECHNOLOGY

(An Autonomous Institution)

Approved by AICTE, Affiliated to Anna University, Chennai.
Accredited by NBA (CSE, ECE, EEE & MECH), Accredited by NAAC with 'A' Grade
KIOT Campus, Kakapalayam – 637 504. Salem Dt., Tamil Nadu, India.

Beyond Knowledge

M.E. / M.Tech. Regulations 2023

M.E. – Embedded System Technologies

CURRICULUM and SYLLABI

(For the Students Admitted from the Academic Year 2023-24 Onwards)

Version: 1.0	Date: 06.07.2024

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CHAIRPERSON
Board of Studies
Faculty of Electrical & Electronics Engg
Knowledge Institute of Technology
KIOT Campus, Kakapalayam,
Salem-637 504

	KNOWLEDGE INSTITUTE OF TECHNOLOGY (AUTONOMOUS), SALEM
	Approved by AICTE, Affiliated to Anna University, Accredited by NAAC and NBA (B.E.: Mech., ECE, EEE & CSE)

M.E. / M.Tech. REGULATIONS 2023 (R 2023)
CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION

M.E. – Embedded System Technologies

VISION OF THE INSTITUTE
To be a world-class institution to impart value and need based professional education to the aspiring youth and carving them into disciplined world class professional who have the quest for excellence, achievement orientation and social responsibilities.

MISSION OF THE INSTITUTE	
A	To promote academic growth by offering state-of-art undergraduate, postgraduate and doctoral programs and to generate new knowledge by engaging in cutting – edge research
B	To nurture talent, Innovation, entrepreneurship, all-round personality and value system among the students and to foster competitiveness among students
C	To undertake collaborative projects which offer opportunities for long-term interaction with academia and industry
D	To pursue global standards of excellence in all our endeavors namely teaching, research, consultancy, continuing education and support functions

VISION OF THE DEPARTMENT
To produce technically competent Electrical and Electronics Engineers having exemplary skills with ethical and social values.

MISSION OF THE DEPARTMENT	
M1	To provide state-of-the art facilities in Electrical and Electronics Engineering for improving the learning environment and research activities
M2	To continuously enrich the knowledge and skill of students towards the employment and creation of innovative products for society
M3	To develop ethical, social-valued and entrepreneurship skilled Electrical and Electronics Engineers

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PROGRAM EDUCATIONAL OBJECTIVES (PEOs)	
PEO 1	To provide students good foundation in mathematical, scientific, engineering fundamentals and hardware-software programming intelligence.
PEO 2	To develop among students, the ability to develop embedded systems based smart solutions for purpose of system automation.
PEO 3	To promote student awareness, for life-long learning and introduce them to professional ethics and code of practice.

PROGRAM OUTCOMES (POs)	
PO 1	An ability to independently carry out research / investigation and development work to solve practical problems.
PO 2	An ability to write and present a substantial technical report / document.
PO 3	Student 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.
PO 4	Be able to design and develop Embedded system automation based on dedicated ICs that have computation, networking and control capacity.
PO 5	Skill to work on professional software languages, standard modeling and analysis tools & commercial packages with communication protocols and computation platforms for analysis and design of system automation.
PO 6	To involve in research on an industrial problem or develop an innovative smart system with automation as a consumer product through project management and finance with due concerned for socio economic values

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M.E. EMBEDDED SYSTEM TECHNOLOGIES											Version: 1.0	
Courses of Study and Scheme of Assessment (Regulations 2023)											Date: 06.07.24	
Sl. No.	Course Code	Course Title	Periods / Week						Maximum Marks			
			CAT	CP	L	T	P	C	IA	ESE	Total	
SEMESTER III												
THEORY												
1	ME23ET310	IoT for Smart Systems	PC	3	3	0	0	3	40	60	100	
2	ME23ET4XX	Professional Elective-III	PE	3	3	0	0	3	40	60	100	
3	ME23ET4XX	Professional Elective-IV	PE	3	3	0	0	3	40	60	100	
4	ME23XX5XX	Open Elective-II	OE	3	3	0	0	3	40	60	100	
PRACTICAL												
5	ME23ET601	Project Work - Phase I	PW	12	0	0	12	6	60	40	100	
Total				24	12	0	12	18	220	280	500	
SEMESTER IV												
PRACTICAL												
1	ME23ET602	Project Work - Phase II	PW	24	0	0	24	12	60	40	100	
Total				24	0	0	24	12	60	40	100	
Total Number of Credits: 75												

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M.E. EMBEDDED SYSTEM TECHNOLOGIES												Version: 1.0
Courses of Study and Scheme of Assessment (Regulations 2023)												Date: 06.07.24
Sl. No.	Course Code	Course Title	Periods / Week						Maximum Marks			
			CAT	CP	L	T	P	C	IA	ESE	Total	
PROFESSIONAL ELECTIVES												
SEMESTER III (Professional Electives - III & IV)												
1	ME23ET409	Computer Vision	PE	3	3	0	0	3	40	60	100	
2	ME23ET410	Multimedia Communications	PE	3	3	0	0	3	40	60	100	
3	ME23ET411	Embedded Networking and Automation of Electrical System	PE	3	3	0	0	3	40	60	100	
4	ME23ET412	Smart System Design	PE	3	3	0	0	3	40	60	100	
5	ME23ET413	Embedded Computing	PE	3	3	0	0	3	40	60	100	
6	ME23ET414	Embedded Systems Security	PE	3	3	0	0	3	40	60	100	
7	ME23ET415	Robotics and Automation	PE	3	3	0	0	3	40	60	100	
8	ME23ET416	Reconfigurable Processor and SoC Design	PE	3	3	0	0	3	40	60	100	
9	ME23ET417	MEMS and NEMS Technology	PE	3	3	0	0	3	40	60	100	
10	ME23ET418	Entrepreneurship and Embedded Product Development	PE	3	3	0	0	3	40	60	100	
11	ME23ET419	Embedded System for Biomedical Applications	PE	3	3	0	0	3	40	60	100	
12	ME23ET420	Python Programming for Machine Learning	PE	3	3	0	0	3	40	60	100	
13	ME23ET421	Renewable Energy and Grid Integration	PE	3	3	0	0	3	40	60	100	
14	ME23ET422	Electric Vehicles and Power Management	PE	3	3	0	0	3	40	60	100	
15	ME23ET423	Smart Grid	PE	3	3	0	0	3	40	60	100	

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ME23ET310 / ME23ET501	IoT FOR SMART SYSTEM	CP	L	T	P	C
		3	3	0	0	3
Programme &Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

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

UNIT–I	INTRODUCTION TO INTERNET OF THINGS	9

Overview(L2), Hardware and software requirements for IOT(L2), Sensor and actuators, Technology driver(L2)s, Business drivers(L2), Typical IoT applications(L3), Trends and implications(L3).

UNIT–II	IOT ARCHITECTURE	9

IoT reference model and architecture (L2)-Node Structure(L2) - Sensing, Processing, Communication, Powering, Networking(L2) - Topologies(L2), Layer/Stack architecture(L2), IoT standards(L2), Cloud computing for IoT(L2), Bluetooth(L2), Bluetooth Low Energy beacons(L2).

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(L2). **Wireless technologies for IoT:** WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends. (L3).

UNIT – IV	IOT PROCESSORS	9

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability (L2). **Embedded processors for IOT** :Introduction to Python programming(L2) - Building IOT with RASPERRY PI and Arduino (L3).

UNIT–V	CASE STUDIES	9

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense(L3).

Total : 45 Periods

Course Outcomes: At the end of this course, the students will have the ability to		BLOOM'S Taxonomy
CO1	Analyze the concepts of IoT and its present developments.	L3 - Apply
CO2	Compare and contrast different platforms and infrastructures available for IoT	L2 - Understand
CO3	Explain different protocols and communication technologies used in IoT	L2 - Understand
CO4	Analyze the big data analytic and programming of IoT	L3 - Apply
CO5	Implement IoT solutions for smart applications	L3 - Apply

REFERENCE BOOKS:

1.	ArshdeepBahga and VijaiMadisetti : A Hands-on Approach "Internet of Things",Universities Press 2015.
2.	Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things", Wiley,2016.
3.	Samuel Greengard, " The Internet of Things", The MIT press, 2015.
4.	Adrian McEwen and Hakim Cassimally"Designing the Internet of Things" Wiley,2014.
5.	Jean- Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet" Morgan Kuffmann Publishers, 2010.

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6.	Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
7.	Lingyang Song/DusitNiyato/ Zhu Han/Ekram Hossain,"Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
8.	OvidiuVermesan and Peter Friess (Editors), "Internet of Things: Converging Technologies for Smart Environments and I ntegrated Ecosystems", River Publishers Series in Communication, 2013.
9.	Vijay Madisetti , ArshdeepBahga, "Internet of Things (A Hands on-Approach)", 2014.
10.	Lars T.Berger and Krzysztof Iniewski, "Smart Grid applications, communications and security", Wiley, 2015.
11.	JanakaEkanayake, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, " Smart Grid Technology and Applications", Wiley, 2015.
12.	UpenaDalal,"Wireless Communications & Networks,Oxford,2015.

WEB REFERENCES:

1.	https://archive.nptel.ac.in/courses/106/105/106105166/
2.	https://www.geeksforgeeks.org/architecture-of-internet-of-things-iot/

ONLINE COURSES:

1.	https://onlinecourses.nptel.ac.in/noc22_cs53/
2.	https://www.udemy.com/course/internet-of-things-iot-fundamentals

VIDEO REFERENCES:

1.	https://www.youtube.com/watch?v=WUYAjxnwjU4&list=PLE7VH8RC_N3bpVn-e8QzOAHziEgmjQ2qE
2.	https://www.youtube.com/watch?v=urUBLmXFKI0&list=PLgMDNELGJ1CaBrefq-0eYatfOnoncW0y-
3.	https://www.youtube.com/watch?v=hdZzNOQV5vU

Mapping of COs with POs

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1			
CO2		2				
CO3	1	2		1	3	
CO4	2		3	3	3	
CO5	3	2	3	3	3	
Avg.	**1.75**	**2**	**2.33**	**2.33**	**3**	

1–Low, 2 –Medium, 3–High.

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ME23ET601	PROJECT WORK – PHASE I	CP	L	T	P	C
		12	0	0	12	6
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version: 1.0				

Course Objectives:

1	To identify relevant research problems by searching academic databases and literature.
2	To design and conduct preliminary studies to explore identified problems.
3	To compile and present research findings effectively.

COURSE CONTENT:

The Student will identify and select a problem based on comprehensive literature survey. The student should submit a proposal and get it approved by the Head of the department.
Three reviews will be conducted by Project review committee. Students will be evaluated by the committee during the review and suggestions will be offered by members.
The report for PHASE -I should be submitted by the students at the end of course

Course Outcomes: Upon completion of this course, the students will be able to:		BLOOM'S Taxonomy
CO1	Identify the research problem.	L3 - Apply
CO2	Collect, analyze the relevant literature and finalize the research problem.	L4 - Analyze
CO3	Design the experiment, conduct preliminary experiment, analyze the data and conclude.	L4 - Analyze
CO4	Prepare project report and present.	L5 - Evaluate

Mapping of COs with POs

COs	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	1		
CO2	3	3	3	2	2	
CO3	3	3	3	3	2	
CO4		3				1
Avg.	3	3	3	2	2	1

1–Low, 2 –Medium, 3–High.

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ME23ET602	PROJECT WORK – PHASE II	CP	L	T	P	C
		24	0	0	24	12
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version: 1.0				

Course Objectives:

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

COURSE CONTENT:

It is the continuation of Phase I project Three reviews will be conducted by Project review committee. Students will be evaluated by the committee during the review and suggestions will be offered by members.

At least one paper should be published by the student in an international / national conference. The report should be submitted by the students at the end of course.

Course Outcomes: Upon completion of this course, the students will be able to:		BLOOM'S Taxonomy
CO1	Any of the listed Domains their Design, Development capability in Building Automation for a process through Hardware & Software Tools	L4 - Analyze
CO2	Interpreting Pre-Requisites insists choice of project title from the enlisted broad domain of research topics for Project work:	L3 - Apply
CO3	Demonstrate project work to enhance students' capacity to work in Research Areas of the Department interests or of Industrial importance	L5 - Evaluate
CO4	Demonstrate the skill in Oral and Written Communication as presented in the Thesis Book via Viva-Voce Examination	L3 - Apply
CO5	Improved Employability and entrepreneurship capacity due to knowledge up gradation with getting skilled up through learning & practicing in Design / development through simulation/ experimental analysis with project report submission (relevant to the candidates project area) by individuals	L5 - Evaluate

Mapping of COs with POs

COs	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	3
CO2	3					
CO3	3					
CO4	3	3	3	3	3	3
CO5	2	3	3	3	3	3
Avg.	2.8	3	3	3	3	3
1–Low, 2 –Medium, 3–High.						

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ME23ET409	COMPUTER VISION	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

1	To introduce the fundamentals of Human and Computer Vision
2	To introduce the major ideas, concepts, methods and techniques in Computer Vision.
3	To impart Computer Vision knowledge by way of learning related algorithms.
4	To make them familiar with both the Theoretical and Practical aspects of Computing with Images.
5	To provide the student with programming experience for implementing Computer Vision and algorithms

UNIT–I	INTRODUCTION TO COMPUTER VISION	9

Digital Image Processing (L2) – Various Fields that use Image Processing (L2)– Fundamentals Steps in Digital Image Processing (L2)– Components of an Image Processing System. (L2) Applications of Computer Vision (L2)– Recent Research in Computer Vision(L2). Introduction to Computer Vision and Basic Concepts of Image Formation(L2): Introduction and Goals (L2)– Image Formation and Radiometry(L2) – Geometric Transformation (L2)– Geometric Camera Models(L3) – Image Reconstruction from a Series of Projections(L3).

UNIT–II	IMAGE PROCESSING CONCEPTS AND IMAGE FEATURES	9

Image Processing Concepts: Fundamentals(L2) – Image Transforms (L2)– Image Filtering(L2) – Colour Image Processing(L2) – Mathematical Morphology(L2)– Image Segmentation(L2). Image Descriptors and Features: Texture Descriptors(L2) – Colour Features (L2)– Edge Detection(L2) – Object Boundary and Shape Representation(L2) – Interest or Cornet Point Detectors(L3) – Histogram Oriented Gradients(L3) – Scale Invariant Feature Transform(L2)

UNIT– III	IMAGE PROCESSING WITH OPENCV	9

Introduction to OpenCV and Python: Setting up OpenCV(L2) – Image Basics in OpenCV(L2) – Handling Files and Images(L2) – Constructing Basic Shapes in OpenCV(L2). Image Processing in OpenCV(L2): Image Processing Techniques(L2) – Constructing and Building Histograms(L3) – Thresholding Techniques(L3).

UNIT – IV	OBJECT DETECTION	9

Models and types (L2)– Importance of Object Detection(L2). The Working: Inputs and outputs(L2) – Basic Structure(L2) – Model Architecture Overview (L2)– Object Detection on the Edge(L2). Use Cases and Applications: Video Surveillance(L3) – Self-driving Cars(L3). Embedded Boards: Connecting Cameras to Embedded Boards(L3) – Simple algorithms for processing Images and Videos(L3).

UNIT–V	APPLICATIONS AND CASE STUDIES	9

Applications: Machine Learning algorithms and their Applications in Medical Image Segmentation(L3) – Motion Estimation and Object Tracking(L3) – Face and Facial Expression Recognition(L3) – Image Fusion(L2). Case Studies: Face Detection(L3) – Object Tracing(L3) – Eye Tracking (L3)– Handwriting Recognition with HoG (L3).

Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Understand the major concepts and techniques in computer vision and image processing	L2 - Understand
CO2	Infer known principles of human visual system	L2 - Understand
CO3	Demonstrate a thorough knowledge of Open CV	L2 - Understand

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CO4	Develop real-life Computer Visions Applications	L2 - Understand
CO5	Build design of a Computer Vision System for a specific problem.	L3 - Apply

REFERENCE BOOKS:	
1.	"Digital Image Processing", 4th Edition (Global Edition), Rafael C Gonzalez and Richard E Woods, Pearson Education Limited, 2018.
2.	"Computer Vision and Image Processing - Fundamentals and Applications", Manas Kamal Bhuyan, CRC Press, 2020.
3.	"Mastering OpenCV 4 with Python", Alberto Fernández Villán, Packt Publishing, 2019.
4.	"Practical Python and Open CV: Case Studies", 3rd Edition, Adrian Rosebrock, PyImage Search, 2016.
WEB REFERENCES:	
1.	https://archive.nptel.ac.in/courses/106/105/106105216/
2.	https://www.researchgate.net/publication/358823508_Computer-Vision_Based_Object_Detection_and_Recognition_for_Service_Robot_in_Indoor_Environment
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc21_cs101
2.	https://onlinecourses.nptel.ac.in/noc23_ee39
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=3LaVxEX3F0o&list=PLwdnzlV3ogoVsma5GmBSsgJM6gHv1QoAo
2.	https://www.youtube.com/watch?v=a4yd0Au8QLg&list=PLyqSpQzTE6M8X3Veh5ijSQ2UGFFEZIpKf

Mapping of COs with POs

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	2			
CO2	2	2	2	2		
CO3	3	3	3	3	3	
CO4	3	3	3	3	3	
CO5	3	3	3	3	3	
Avg.	**2.6**	**2.8**	**2.6**	**2.75**	**3**	

1–Low, 2 –Medium, 3–High.

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ME23ET410	MULTIMEDIA COMMUNICATIONS	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

1	To define the Multimedia Communication Models
2	To explain Multimedia Transport in Wireless Networks
3	To Solve the Security issues in multimedia networks
4	To Illustrate real-time multimedia network applications.
5	To explain different network layer based application

UNIT–I	INTRODUCTION TO MULTIMEDIA COMMUNICATIONS	9

Introduction (L2), multimedia information representation(L2), multimedia networks(L2), multimedia applications(L2), Application and networking terminology(L2), network QoS and application QoS(L2), Digitization principles(L2), Text, images, audio and video(L3).

UNIT–II	COMPRESSION TECHNIQUES FOR TEXT AND IMAGE	9

Text and image compression(L2), compression principles(L2), text compression- Runlength, Huffman, LZW(L2), Document Image compression using T2 and T3coding(L3), image compression- GIF, TIFF and JPEG(L3)

UNIT– III	COMPRESSION TECHNIQUES FOR AUIDO AND VIDEO	9

Audio and video compression(L2), audio compression – principles(L2), DPCM, ADPCM, Adaptive and Linear predictive coding(L2), Code-Excited LPC, Perceptual coding(L2), MPEG and Dolby coders video compression, video compression principles(L3).

UNIT – IV	STANDARDS AND FRAMEWORK	9

Video compression standards (L2): H.261, H.263, MPEG, MPEG 1, MPEG 2, MPEG-4 (L2) and Reversible VLCs, MPEG 7 standardization process of multimedia content description, MPEG 21 multimedia framework(L3).

UNIT–V	SYNCHRONIZATION AND MANAGEMENT	9

Notion of synchronization, presentation requirements(L2), reference model for synchronization, Introduction to SMIL(L2), Multimedia operating systems, Resource management, process management techniques(L3).

Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Deploy the right multimedia communication models.	L2 – Understand
CO2	Apply QoS to multimedia network applications with efficient routing techniques.	L3 – Apply
CO3	Solve the security threats in the multimedia networks	L2 - Understand
CO4	Develop the real-time multimedia network applications	L3 - Apply
CO5	Improve to synchronize and manage the multimedia systems	L2 - Understand

REFERENCE BOOKS:

1.	Fred Halsall, "Multimedia Communications", Pearson education,2001.
2.	Raif Steinmetz, Klara Nahrstedt, "Multimedia: Computing, Communications and Applications",Pearsoneducation,2002.

WEB REFERENCES:

https://archive.nptel.ac.in/content/storage2/courses/117105083/pdf/ssg_m1l1.pdf

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https://archive.nptel.ac.in/courses/117/105/117105083/
ONLINE COURSES:
https://archive.nptel.ac.in/courses/105/107/105107160/
https://archive.nptel.ac.in/courses/117/105/117105083/
VIDEO REFERENCES:
https://www.youtube.com/watch?v=4-AsEtIpEWg
https://www.youtube.com/watch?v=Dz3Du5jod90

Mapping of COs with POs						
CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		1		3	
CO2	2		1	3	2	2
CO3	3					
CO4				2	3	2
CO5	2					
Avg.	**2.25**		**1**	**2.5**	**2.66**	**2**
1–Low, 2 –Medium, 3–High.						

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ME23ET411	EMBEDDED NETWORKING AND AUTOMATION OF ELECTRICAL SYSTEM	CP	L	T	P	C
		3	3	0	0	3
Programme &Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

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

UNIT–I	BUILDING SYSTEM AUTOMATION	9

Sensor Types & Characteristics: Sensing Voltage, Current, flux, Torque, Position, Proximity, Accelerometer(L2) - Data acquisition system(L2)- Signal conditioning circuit design (L2)- Uc Based & PC based data acquisition (L2)– uC for automation and protection of electrical appliances(L2)–processor based digital controllers for switching Actuators(I2): Stepper motors, Relays(L3) –System automation with multi-channel Instrumentation and interface(L3).

UNIT–II	EMBEDDED NETWORKING OF INSTRUMENT CLUSTER	9

Embedded Networking: Introduction – Cluster of Instruments in System- Comparison of bus protocols(L2) – RS 232C- embedded ethernet - MOD bus and CAN bus, LIN BUS(L2)- Introduction to WSN(L2) – Commercially available sensor nodes-Zigbee protocol(L2)-Network Topology Energy efficient MAC protocols(L2) – SMAC – Data Centric routing(L2)- Applications of sensor networks(L3)- Database perspective on sensor networks- IoT Applications(L3).

UNIT– III	AUTOMATION OF SUBSTATION	9

Substation automation- Distribution SCADA system principles(L2) -role of PMU,RTU, IEDs, BUS for smart Substation automation(L2)- Introduction to Role of IEC 61850,IEEEC37.118 std-Interoperability and IEC 61850(L2)-challenges of Substations in Smart Grid(L2) - challenges of Energy Storage and Distribution Systems monitoring(L2) - Communication Challenges in monitoring electric utility asset (L3).

UNIT – IV	METERING OF SMART GRID	9

Characteristics of Smart Grid(L2)- Generation by Renewable Energy Sources based on solar grid Challenges in Smart Grid and Microgrids(L2)- electrical measurements with AMI -Smart meters for EV plug in electric vehicles power management(L3) -Home Area Netmetering and Demand side Energy Management applications(L3).

UNIT–V	SMART METERS FOR PQ MONITORING	9

Power Quality issues of Grid connected Renewable Energy Sources(L2) - Smart meters for Power Quality monitoring and Control (L2)- Power Quality issues(L2) - Surges – Flicker - Interharmonics(L2) - Transients – Power Quality Benchmarking(L2) – Power Quality Meters(L2) - Meter data management In Smart Grid (L3) - communication enabled Power Quality metering(L3)

Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Demonstrate criteria of choice of sensors, components to build meters.	L2 - Understand
CO2	Illustrate the demand for BUS communication protocols are introduced	L2 - Understand
CO3	Analyse the need and standards in Substation automation	L2 - Understand

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CO4	Deployment of PAN for metering networked commercial applications	L3 – Apply
CO5	Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded networked communications	L2 - Understand

REFERENCE BOOKS:	
1.	Control and automation of electrical power distribution systems, James Northcote-Green, Robert Wilson, CRC, Taylor and Francis, 2006
2.	Krzysztof Iniewski,"Smart Grid ,Infrastructure& Networking",TMcGH,2012
3.	Robert Faludi,"Building Wireless Sensor Networks,O'Reilly,2011
4.	Mohammad Ilyas And ImadMahgoub, 'Handbook of sensor Networks: Compact wireless and wired sensing systems', CRC Press,2005
5.	Shih-Lin Wu,Yu-Chee Tseng,{"Wireless Ad Hoc Networking,PAN,LAN,SAN,Aurebach Pub,2012
6.	Sanjay Gupta, "Virtual Instrumentation, LABVIEW", TMH, New Delhi, 2003
7.	Ernest O. Doeblin and Dhanesh N Manik, " Measrement Systems – Application and Design", 5th Edn, TMH, 2007.
8.	BhaskarKrishnamachari, 'Networking wireless sensors', Cambridge press 2005
WEB REFERENCES:	
1	https://genuspower.com/how-to-ensure-power-quality-monitoring-and-control-using-smart-metering-solutions
2	https://energy.ec.europa.eu/topics/markets-and-consumers/smart-grids-and-meter
ONLINE COURSES:	
1	https://onlinecourses.nptel.ac.in/noc21_ee68/
2	https://onlinecourses.nptel.ac.in/noc21_ee32/
VIDEO REFERENCES:	
1	https://www.youtube.com/watch?v=r_Job1rEbT0
2	https://www.youtube.com/watch?v=Q_OdV8m6cqk&list=PLLy_2iUCG87AjWoOk0A3y4hpGQVTdtl6G

Mapping of COs with POs

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	1	2	
CO2	1		2	2	3	
CO3	3	1	2			
CO4	2		2	3	3	
CO5	2	1	2			
Avg.	**2.2**	**1**	**2**	**2**	**2.66**	

1–Low, 2 –Medium, 3–High.

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ME23ET412	SMART SYSTEM DESIGN	CP	L	T	P	C
		3	3	0	0	3
Programme &Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

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

UNIT–I	INTRODUCTION	9

Overview of a smart system(L2) - Design Requirements(L2) - Hardware and software selection & co-design(L2) - Smart sensors and Actuators(L2) – Communication protocols used in smart systems (L2)– Data Analytics: Need & Types (L2)– Open-source Analytics Platform for embedded systems (IFTTT & Thingspeak) (L2)– Smart Microcontrollers - Embedded system for Smart card design and development(L3) – Recent trends(L2).

UNIT–II	HOME AUTOMATION	9

Home Automation – Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security - System Architecture - Essential Components - Linux and Raspberry Pi (L2) - Design and Real-Time implementation(L3)

UNIT– III	SMART APPLIANCES AND ENERGY MANAGEMENT	9

Energy Management: Demand-side Load Management: Energy scheduling(L2) – Significance of smart appliances in energy management(L2) - Embedded and Integrated Platforms for Energy Management(L2) - Smart Meters: Significance, Architecture & Energy Measurement Technique (L3) - Smart Networks for Embedded Appliances(L3) – Security Considerations(L3).

UNIT – IV	SMART WEARABLE DEVICES	9

Application of Smart Wearables in Healthcare & Activity Monitoring (L2)- Functional requirements–Selection of body sensors(L2), Hardware platform(L2), OS and Software platform(L2) – Selection of suitable communication protocol(L3). Case Study: Design of a wearable, collecting heart-beat, temperature and monitoring health status using a smartphone application(L3).

UNIT–V	EMBEDDED SYSTEMS AND ROBOTICS	9

Robots and Controllers components(L2) - Aerial Robotics (L3)- Mobile Robot Design(L3) - Three-Servo Ant Robot(L3) - Autonomous Hex copter System(L3).

Total : 45 Periods

	Course Outcomes: Upon completion of this course the students will be able to:	**BLOOM'S Taxonomy**
CO1	Understand the concepts of smart system design and its present developments.	L2 - Understand
CO2	Illustrate different embedded open-source and cost-effective techniques for developing solution for real time applications.	L2 - Understand
CO3	Acquire knowledge on different platforms and Infrastructure for Smart system design	L2 - Understand
CO4	Infer about smart appliances and energy management concepts.	L2 - Understand
CO5	Apply and improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies	L3 - Apply

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REFERENCE BOOKS:	
1.	Thomas Bräunl, Embedded Robotics, Springer, 2003.
2.	Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013.
3.	Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw- Hill, 2008
4.	NilanjanDey, Amartya Mukherjee, Embedded Systems and Robotics with Open-Source Tools, CRC press, 2016.
5.	Steven Goodwin, Smart Home Automation with Linux and Raspberry Pi, Apress, 2013
6.	Karim Yaghmour, Embedded Android, O'Reilly, 2013
7.	C.K.Toh, AdHoc mobile wireless networks, Prentice Hall, Inc, 2002. 50
8.	KazemSohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Networks Technology,Protocols, and Applications, John Wiley & Sons, 2007.
9.	Anna Ha´c, Wireless Sensor Network Designs, John Wiley & Sons Ltd, 2003.
10.	Robert Faludi, Wireless Sensor Networks, O'Reilly, 2011.
WEB REFERENCES:	
1.	https://nptel.ac.in/courses/108105063
2.	https://medium.com/@muflorentine3/smart-sensors-and-actuators-3e5c0d37fde6
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc21_me76/
2.	https://nptel.ac.in/courses/107106090
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=xrwz9IxpMJg
2.	https://www.youtube.com/watch?v=j8vYClEnyk0

Mapping of COs with POs						
CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		3	2			
CO2	2				2	
CO3				2	3	
CO4						
CO5						
Avg.	**2**	**3**	**2**	**2**	**2.5**	
1–Low, 2 –Medium, 3–High.						

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ME23ET413	EMBEDDED COMPUTING	CP	L	T	P	C
		3	3	0	0	3
Programme &Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

1	To expose the students to the fundamentals of Network communication technologies.
2	To teach the fundamentals of Java , Internet and Java card
3	To develop distributed embedded system with Java
4	To teach the smart card and Apps development
5	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(L2) –Open Interconnection standards(L2) – networking devices Network diagram(L2) –Network management (L2)– Network Security(L3) – Cluster computers(L3).

UNIT–II	JAVA TECHNOLOGY FOR EMBEDDED SYSTEMS	9

Basic concepts of Java(L2) - IO streaming(L2) – Object serialization(L2) – Networking (L2)– Threading – RMI (L2)– distributed databases(L2) –– Advantages and limitations of Internet (L2)– Web architecture for embedded systems(L3) – security model for embedded systems(L3).

UNIT– III	SMART CARD TECHNIQUES	9

Smart Card basics(L2) – Java card technology overview(L2) – Java card Types(L2) - Card components Smart Card Microcontrollers(L2) - Contactless Cards(L2) - Smart Card Operating Systems(L2)– smart card Security Techniques(L3).

UNIT – IV	ANDROID FRAMEWORK	9

Android SDK(L2) – Access to Hardware(L2) - Framework development(L2)- Peer-to-Peer communication(L2)-Android security design and architecture (L2)– Case study(L3)

UNIT–V	DEVELOPING DISTRIBUTED REAL-TIME SYSTEM APPLICATIONS	9

Developing MATLAB Real-Time Targets(L2) - Using the xPC Target(L2) - Building various Distributed Real Time Applications(L3).

Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Deliver insight into involving JAVA concepts& internet based Communication to establish decentralized control mechanism of system	L2 - Understand
CO2	Interpret the software and hardware architecture for distributed computing	L2 - Understand
CO3	Develop solution for smart card	L3 – Apply
CO4	Develop Apps based on android SDK.	L3 – Apply
CO5	Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system computing environment.	L2 - Understand

REFERENCE BOOKS:

1.	AmitavaGupta , Anil Kumar Chandra and Peter Luksch " Real-Time and Distributed Real-Time Systems Theory and Applications " CRC Press 2016 International Standard Book Number-13: 978-1-4665-9849-2 (eBook - PDF)
2.	Wolfgang Rankl and Wolfgang Effing "Smart Card Handbook" John Wiley & Sons Ltd , Third Edition , 2003

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3.	Reto Meier "Professional Android application development" Wiley Publishing , Inc , 2009
4.	Joshua " Android hacker's Handbook" John Wiley & sons , 2014
5.	Dietel&Dietel, "JAVA how to program", Prentice Hall 1999.
6.	SapeMullender, "Distributed Systems", Addison-Wesley, 1993
WEB REFERENCES:	
1.	https://archive.nptel.ac.in/courses/106/105/106105191/
2.	https://archive.nptel.ac.in/courses/106/106/106106156/
ONLINE COURSES:	
1.	https://onlinecourses.swayam2.ac.in/nou21_ge41/
2.	https://onlinecourses.nptel.ac.in/noc22_cs47/
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=-foyVzTOf8o&list=PLJ5C_6qdAvBEJ6-TBzKoa1Ov21lwDzJfM
2.	https://www.youtube.com/watch?v=OjdT2l-EZJA&list=PLfn3cNtmZdPOe3R_wO_h540QNfMkCQ0ho

Mapping of COs with POs						
CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	1	-	2	2
CO2	2	3	2	-	-	-
CO3	3	1	2	3	2	3
CO4	3	1	2	3	2	3
CO5	2	1	2	-	-	3
Avg.	**2.4**	**1.5**	**1.8**	**3**	**2**	**2.25**
1–Low, 2 –Medium, 3–High.						

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ME23ET414	EMBEDDED SYSTEMS SECURITY	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version: 1.0				

Course Objectives:

1	To introduce the fundamentals related to Cryptography and Data Security.
2	To teach the mathematical foundations for Cryptography.
3	To impart knowledge about Embedded Cryptography and Data Protection Protocols.
4	To make them understand the practical aspects of Embedded System Security.
5	To involve the students in Discussions/Tutorials/Programming to familiarize the concepts for improved employability skills.

UNIT–I	BACKGROUND AND INTRODUCTION	9

Computer and Network Security Concepts: Computer Security Concepts – The OSI Security Architecture – Security Attacks(L2) – Security Services (L2)– Security Mechanisms(L2) – Fundamentals of Security Design Principles(L2) – Attack Surfaces and Attack Trees(L2) – 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 (L2)– Testing for Primality(L2) – The Chinese Remainder Theorem – Discrete Logarithms (L3)

UNIT–II	SYMMETRIC CIPHERS	9

Classical Encryption Techniques: Symmetric Cipher Model – Substitution Techniques – Transposition Techniques(L2). Block Ciphers and the Data Encryption Standard (DES) (L2): Traditional Block Cipher Structure – The Data Encryption Standard (L2) – A DES Example – Strength of DES(L2). Advanced Encryption Standard: Finite Field Arithmetic – AES Structure – AES Transformation Functions(L2) – AES Key Expansion – An AES Example – AES Implementation(L3).

UNIT– III	EMBEDDED SYSTEMS SECURITY	9

Embedded Security Trends(L2) – Security Policies – Security Threats(L2). System Software Considerations: The Role of Operating System(L2) – Microkernel versus Monolithic (L2)– Core Embedded OS Security Requirements (L2)– Access Control and Capabilities (L2)– Hypervisors and System Virtualization(L2) – I/O Virtualization (L2)– Remote Management (L2)– Assuring Integrity of the TCB(L3).

UNIT – IV	EMBEDDED CRYPTOGRAPHY AND DATA PROTECTION PROTOCOLS	9

The One-time Pad(L2) – Cryptographic Modes(L2) – Block Ciphers(L2) – Authenticated Encryption(L2) – Public Key Cryptography(L2) – Key Agreement – Public Key Authentication (L2)– Elliptic Curve Cryptography – Cryptographic Hashes(L2) – Message Authentication Codes(L2) – Random Number Generation(L2) – Key Management for Embedded Systems(L3) – Cryptographic Certifications(L2). Data Protection Protocols for Embedded Systems: Data-in-Motion Protocols – Data-at-Rest Protocols(L2). Emerging Applications: Embedded Network Transactions (L2)– Automotive Security(L3) – Secured Android(L3).

UNIT–V	PRACTICAL EMBEDDED SYSTEM SECURITY	9

Network Communications Protocols and Built-in Security – Security Protocols and Algorithm– 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(L3).

Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Explain the significance of Security.	L2 - Understand
CO2	Understand the major concepts and techniques related to Cryptography	L2 - Understand

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CO3	Demonstrate thorough knowledge about the aspects of Embedded System Security.	L2 - Understand
CO4	Delivers insight onto role of Security Aspects during Data Transfer and Communication.	L2 - Understand
CO5	Applying the Security Algorithms for Real-time Applications.	L3 - Apply

REFERENCE BOOKS:	
1.	"Cryptography and Network Security Principles and Practice", 7th Edition – Global Edition, William Stallings, Pearson Education Limited, 2017.
2.	Embedded Systems Security - Practical Methods for Safe and Secure Software and Systems Development", David Kleidermacher and Mike Kleidermacher, Newnes (an imprint of Elsevier), 2012
3.	"Practical Embedded Security - Building Secure Resource-Constrained Systems", Timothy Stapko, Newnes (an imprint of Elsevier), 2008.
WEB REFERENCES:	
1.	https://www.geeksforgeeks.org/cryptography-and-network-security-principles/
2.	https://blackberry.qnx.com/en/ultimate-guides/embedded-system-security
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc22_cs90/
2.	https://nptel.ac.in/courses/106106199
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=1plMO7ChXMU&list=PLJ5C_6qdAvBFAuGoLC2wFGruY_E2gYtev
2.	https://www.youtube.com/watch?v=-dNsW2AOGYY&list=PLyqSpQzTE6M-g0Xgn0icEHvUS7WQxvenv

Mapping of COs with POs

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

1–Low, 2 –Medium, 3–High.

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ME23ET415	ROBOTICS AND AUTOMATION	CP	L	T	P	C
		3	3	0	0	3
Programme &Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

1	To teach the need of embedded system technology for robot building.
2	To study the Various Parts of Robots and Fields of Robotics.
3	To study the Various Kinematics and Inverse Kinematics of Robots.
4	To study the Trajectory Planning for Robot.
5	To study the Control of Robots for Some Specific Applications.

UNIT–I	INTRODUCTION TO ROBOTICS & AUTOMATION	9

Overview of Robotics & Automation(L2) – Principles and Strategies of Automation System(l2) – Hardware and software for Automation(L2)- Embedded Processors for Automation(L2)-Different Types of Robots(L2) – Various Generations of Robots(L2) - Asimov's Laws Of Robotics(L2) – Key components of a robot(L2) - Design Criteria for Selection of a Robot (L3)– Role of embedded system in Robotics and Automation (L2)- Recent trends(L3).

UNIT–II	SENSORS AND DRIVE SYSTEMS	9

Hydraulic, Pneumatic and Electric Drive Systems(L2) – Understanding how motor power, current torque, friction co-efficient affect the design of a Robot(L2) - Determination of Motor HP and Gearing Ratio(L2) – Variable Speed Arrangements. Sensors(L2) – Classification based on sensing type (including Optical, Acoustic, Magnetic)- Proximity Sensors – Ranging Sensors(L2) – Speed & Displacement Sensing(L2) - Tactile Sensors(L2) – Vision Sensing (L2) - Smart Sensors(L2) - MEMS sensors(L3).

UNIT– III	MANIPULATORS AND GRIPPERS	9

Introduction to Manipulators (L2)- Joints and Degrees of Freedom (L2)- Construction of Manipulators (L2)– Manipulator Dynamics and Force Control (L2) – Electronic And Pneumatic Manipulator Control Circuits(L2) – End Effectors(L2) – Various Types Of Grippers (L2)– Design Considerations(L3).

UNIT – IV	KINEMATICS AND PATH PLANNING	9

Kinematic Equations (L2)– Forward and Inverse Kinematics (L2)- Solution Of Inverse Kinematics Problem (L2)– Jacobian based Velocity Kinematics– Various Path Planning Algorithms(L2) – Hill Climbing Techniques (L2)- Robot Operating System(L2) - Simulation and modeling of a simple Path Planning application(L3).

UNIT–V	CASE STUDIES	9

Robot Cell Design (L2)- Humanoid Robot (L3)- Robots in healthcare applications (L3)– Robot Machine Interface(L2) – Robots in Manufacturing and Non-Manufacturing Applications (L3)- Self balancing robots (L3)- Micro/nano robots(L2).

Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Choose suitable embedded boards for robots	L2 – Understand
CO2	Demonstrate the concepts of robotics & automation and working of Robot	L2 - Understand
CO3	Analyze the Function of Sensors and actuators in the Robot	L2 - Understand

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CO4	Develop Program to Use a Robot for a Typical Application	L2 - Understand
CO5	Apply and improve Employability and entrepreneurship capacity due to knowledge upgradation on Embedded system based robot development	L3 - Apply

REFERENCE BOOKS:	
1.	Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., "Industrial Robotics", Mc Graw-Hill Singapore, 1996.
2.	Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998
3.	Deb. S.R.,"Robotics Technology And Flexible Automation", John Wiley, USA 1992
4.	Klafter R.D., Chimielewski T.A., Negin M., "Robotic Engineering – An Integrated Approach", Prentice Hall of India, New Delhi, 1994
5.	Mc Kerrow P.J. "Introduction to Robotics", Addison Wesley, USA, 1991.
6.	Issac Asimov "Robot", Ballantine Books, New York, 1986.
7.	Barry Leatham – Jones, "Elements of Industrial Robotics" PITMAN Publishing, 1987
8.	MikellP.Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, "Industrial Robotics Technology, Programming And Applications ", McGraw Hill Book Company 1986.
9.	Fu K.S. Gonzaleaz R.C. And Lee C.S.G., "Robotics Control Sensing, Vision and Intelligence" McGraw Hill International Editions, 1987
WEB REFERENCES:	
1.	https://nptel.ac.in/courses/112101098
2.	https://archive.nptel.ac.in/courses/112/105/112105249/
ONLINE COURSES:	
1.	https://nptel.ac.in/courses/112101098
2.	https://onlinecourses.nptel.ac.in/noc21_me76/
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=yDEJxYGAoso&list=PLbRMhDVUMngdCkMipemSKP_dCgZLLfOe8
2.	https://www.youtube.com/watch?v=rYWJdZ5qg6M&list=PLbRMhDVUMngcdUbBySzyzcPiFTYWr4rV_

Mapping of COs with POs

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2		3		
CO2		3				
CO3						
CO4				2	3	1
CO5			2	1		3
Avg.	**1**	**2.5**	**2**	**2**	**3**	**2**

1–Low, 2 –Medium, 3–High.

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ME23ET416	RECONFIGURABLE PROCESSOR AND SoC DESIGN	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

1	To familiarize the need and role of Reconfigurable Processor for embedded system applications
2	To introduce the Reconfigurable Processor technologies
3	To teach the salient features and architecture of FPGA
4	To provide an insight and architecture significance of SoC.
5	To impart the knowledge of Reconfigurable embedded Processor for real time applications.

UNIT–I	INTRODUCTION	9

Introduction to reconfigurable processor(L2)- Reconfigurable Computing-Programming elements and Programming Tools for Reconfigurable Processors, ASIC design flow(L2)- Hardware/Software Co-design FPAA Architecture overview- recent trends in Reconfigurable Processor & SoC(L3).

UNIT–II	FPGA TECHNOLOGIES	9

FPGA Programming technology (L2)- Alternative FPGA architectures: MUX Vs LUT based logic blocks(L2) – CLB Vs LAB Vs Slices(L2)- Fast carry chains(L2)- Embedded RAMs- Routing for FPGAs(L2)- Circuits and Architectures for Low(L3)-Power FPGAs- Physical Design(L3).

UNIT– III	FPGA ARCHITECTURE	9

FPGA architecture overview-(L2) Challenges of FPGA processor design(L2)-Opportunities of FPGA processor design(L2) - Designing SoftCore Processors(L2) – Designing Hardcore Processors(L2) – hardware/software co-simulation(L2)- FPGA to multi core embedded computing(L3)- FPGA based on-board computer system(L3).

UNIT – IV	RECONFIGURABLE SOC PROCESSORS	9

SoC Overview (L2)–Architecture and applications of Virtex II pro, Zynq-7000, Excalibur, Cyclone V - A7, E5- FPSLIC(L3)- Multicore SoCs(L3).

UNIT–V	RECONFIGURABLE PROCESSOR AND SOC APPLICATIONS	9

Reconfigurable processor(L2) - based DC motor control- digital filter design(L2) - mobile phone development High Speed Data Acquisition(L2) - Image Processing application(L3) - controller implementation for mobile robot- Crypto-processor(L3).

Total : 45 Periods

	Course Outcomes: Upon completion of this course the students will be able to:	**BLOOM'S Taxonomy**
CO1	Illustrate the need of reconfigurable computing and hardware-software co design.	L2-Understand
CO2	Demonstrate the significance of FPGA technology	L2-Understand
CO3	Apply the concept of FPGA technology and understand FPGA architectures	L2-Understand
CO4	Interpret the operation of SoC processor.	L2-Understand
CO5	Relate and improve Employability and entrepreneurship capacity due to knowledge up-gradation on reconfigurable computing and SoC design.	L3 - Apply

REFERENCE BOOKS:

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

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WEB REFERENCES:	
1.	https://www.electronicdesign.com/technologies/embedded/digital-ics/processors/dsp/article/21753427/reconfigurable-socs
2.	https://ieeexplore.ieee.org/document/6926215
ONLINE COURSES:	
1.	https://www.coursera.org/learn/copy-of-fpga-intro
2.	https://nptel.ac.in/courses/117108040
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=ht7nEjNydDU&t=3s
2.	https://www.youtube.com/watch?v=PRQXzjTrCJY

Mapping of COs with POs						
CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1						
CO2		2	3			
CO3			2	1	2	
CO4		1	3			
CO5						3
Avg.	**0**	**1.5**	**2.66**	**1**	**2**	**3**
1–Low, 2 –Medium, 3–High.						

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ME23ET417	MEMS AND NEMS TECHNOLOGY	CP	L	T	P	C
		3	3	0	0	3
Programme &Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

1	To introduce the diverse technological and functional approaches of MEMS/NEMS and applications.
2	To understand the microstructures and fabrication methods
3	To provide an insight of micro and nano sensors, actuators.
4	To emphasis the need for NEMS techology
5	To update the ongoing trends and real time applications of MEMS and NEMS technology.

UNIT–I	INTRODUCTION TO MEMS and NEMS	9

Overview of Micro electro mechanical systems and Nano Electro mechanical systems, devices and technologies(L2), Laws of scaling(L2)- Survey of materials(L2)- Smart Sensors-Applications of MEMS and NEMS (L3).

UNIT–II	MICRO-MACHINING AND MICROFABRICATION TECHNIQUES	9

Photolithography(L2)- Film deposition, Etching Processes(L2)- wafer bonding(L2)- Bulk micro machining, silicon surface micro machining(L2)- LIGA process(L3).

UNIT– III	MICRO SENSORS AND MICRO ACTUATORS	9

Transduction mechanisms in different energy domain(L2)- Micromachined capacitive, Piezoelectric , piezoresistive and Electromechanical and thermal sensors/actuators and applications(L3)

UNIT – IV	NEMS TECHNOLOGY	9

Atomic scale precision engineering(L2)- Nano Fabrication techniques (L2)- NEMS in measurement, sensing, actuation and systems design(L3).

UNIT–V	MEMS and NEMS APPLICATION	9

Introduction to Micro/Nano Fluids and applications- Bio MEMS- Optical NEMS- Micro and Nano motors(L2)- Recent trends in MEMS and NEMS(L3).

Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Explain the material properties and the significance of MEMS and NEMS for industrial automation.	L2 - Understand
CO2	Demonstrate knowledge delivery on micromachining and micro fabrication.	L2 - Understand
CO3	Apply the fabrication mechanism for MEMS sensor and actuators	L2 - Understand
CO4	Apply the concepts of MEMS and NEMS to models ,simulate and process the sensors and actuators.	L2 - Understand
CO5	Improved Employability and entrepreneurship capacity due to knowledge up gradation on MEMS and NEMS technology.	L2 - Understand

REFERENCE BOOKS:

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

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7.	Lyshevski, S.E. " Nano- and Micro-Electromechanical Systems: Fundamentals of Nano-and Microengineering " (2nd ed.). CRC Press,2005.
WEB REFERENCES:	
1.	https://link.springer.com/referenceworkentry/10.1007/978-0-387-30877-7_9
2.	https://mechheart.com/difference-between-mems-and-nems-devices/
ONLINE COURSES:	
1.	https://archive.nptel.ac.in/courses/108/108/108108113/
2.	https://nptel.ac.in/courses/117105082
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=j9y0gfN9WMg
2.	https://www.youtube.com/watch?v=Ak7Y-vlWbnA&t=1s

Mapping of COs with POs						
CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3		2	
CO2	3	3	2		2	
CO3	3	3	3	3		
CO4	3	3	3		3	
CO5	3	2	3	2	3	
Avg.	**3.2**	**6**	**2.8**	**2**	**2.4**	
1–Low, 2 –Medium, 3–High.						

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ME23ET418	ENTREPRENEURSHIP AND EMBEDDED PRODUCT DEVELOPMENT	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

1	To develop an understanding on business promotion process.
2	To expose students on the skills required for success in business.
3	To impart embedded system technology-based entrepreneurship. Architecture
4	Creative thinking in developing automation into consumer products of market value
5	Developing an embedded product with hardware-software components.

UNIT–I	INTRODUCTION TO ENTREPRENEURSHIP	9

Entrepreneurial culture and structure(L2) -theories of entrepreneurship (L2)- entrepreneurial motivation (L2)- establishing entrepreneurial systems (L2)- financial information and intelligence, rewards and motivation (L2)- concept bank(L2) -Role of industrial Fairs- challenges in entrepreneurship(L3).

UNIT–II	RESPONSIBILITIES IN ENTREPRENEURSHIP	9

Steps for starting a small industry -selection of type of organization(L2) -Incentives and subsidies (L2)- Central Govt. schemes and State Govt. Schemes -incentives to SSI -registration, Registration and Licensing requirements for sales tax, CST, Excise Duty -Power (L2)-Exploring export possibilities(L2)- incentives for exports (L2) - import of capital goods and raw materials(L2)- Entrepreneurship development programmes in India(L2) - Role and Improvement in Indian Economy(L2).

UNIT– III	CONCEPTS OF PRODUCT DEVELOPMENT	9

Generic product Development Phases(L2)- Product Development Process Flows(L2)- Basics of Concept Generation(L2)-Five Step Method(L2)- Creative thinking methods and problem solving(L2)- design concepts– Product Architecture-(L2) component standardization(L2) –Bill of materials(L2)- Product development management(L2)- Portfolio Architecture- Benchmarking(L2)

UNIT – IV	APPROACHES FOR NEW PRODUCT DEVELOPMENT	9

Idea Generation(L2)- Industrial Design(L2) -Brainstorming Methods(L2) - SWOT Analysis(L2)- Concept Development & Testing(L2)- Risk Management Process(L2)- Critical Path Analysis & PERT(L2)- Reverse Engineering Methodology(L2)- need for Involving CAE, CAD, CAM tools(L2) - Prototype basics (L2)- Rapid Prototyping(L2) - Prototyping Techniques(L3) - Planning for prototypes(L3)- Economic & Cost Analysis(L3)

UNIT–V	SCOPE IN EMBEDDED SYSTEM FIELD	9

Entrepreneurship opportunities in Embedded system technologies (L2)- Embedded system Product development (L2)-Entrepreneurial skills for embedded system hardware and software architecture, software and hardware co-design and challenges(L2); problems of entrepreneurship in Embedded system field(L2)- case studies(L3): Mobile phone development(L2)- automation components(L2)- Washing machine- Food Processing system and devices (L2)- High Performance embedded computers(L2)- Industrial Controllers(L3)

Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Analyze the internal/external factors affecting a business/organization to evaluate business opportunities.	L2 - Understand
CO2	Demonstrate extemporaneous speaking skills developed through in-class discussion of text materials, case study analyses, and current entrepreneurship-related issues.	L2 - Understand

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CO3	Apply and Relate Key concepts underpinning entrepreneurship and its application in the recognition and exploitation of product/ service/ process opportunities	L2 - Understand
CO4	Interpret various aspects of design such as industrial design, design of Consumer specific product , its Reverse Engineering manufacture ,economic analysis through	L3 – Apply
CO5	Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.	L2 - Understand

REFERENCE BOOKS:

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

WEB REFERENCES:

1.	https://archive.nptel.ac.in/courses/112/107/112107217/
2.	https://www.techtarget.com/searchcio/definition/product-development-or-new-product-development-NPD

ONLINE COURSES:

1.	https://onlinecourses.nptel.ac.in/noc21_mg70/
2.	https://onlinecourses.nptel.ac.in/noc21_me83/

VIDEO REFERENCES:

1.	https://www.youtube.com/watch?v=Tzzfd6168jk&list=PLyqSpQzTE6M8EGZbmNUuUM7Vh2GkdbB1R
2.	https://www.youtube.com/watch?v=Hgj_kRrvbhQ&list=PL7oBzLzHZ1wXW3mtolxV5nIGn48NLKwrb

Mapping of COs with POs

CO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2				
CO2	3	3				
CO3	3	3				
CO4	3	3		1		
CO5	3	2	3	2	3	
Avg.	**3.2**	**6**	**3**	**1.5**	**3**	

1–Low, 2 –Medium, 3–High.

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ME23ET419	EMBEDDED SYSTEM FOR BIOMEDICAL APPLICATIONS	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

1	To Introduce Fundamentals of Biomedical Engineering
2	To understand the concept of wearable health devices
3	To study the hardware for image processing applications
4	To have a basic knowledge of Embedded system in diagnostic applications
5	To study about the various assist devices used in the hospitals.

UNIT–I	INTRODUCTION TO BIOMEDICAL ENGINEERING	9

Origin of bio potential and its propagation(L1)- Resting and Action Potential(L2) – Bio signals characteristics and Types of electrodes (L1)- Types of transducers and applications(L3)-Bio-amplifiers(L2)- Types of recorders components of a biomedical system(L3)

UNIT–II	WEARABLE HEALTH DEVICES	9

Concepts of wearable technology in health care (L2)-Components of wearable devices (L2)-Biosensors (L2)- Blood glucose sensors (L2) - Head worn- Hand worn- Body worn-pulse oxymeter-Cardiac pacemakers (L2)– Hearing aids and its recent advancements(L3)-wearable artificial kidney (L2).

UNIT– III	EMBEDDED SYSTEM FOR MEDICAL IMAGE PROCESSING	9

Introduction to embedded image processing (L1). ASIC vs FPGA (L2) - memory requirement-, power consumption- parallelism(L2) - Design issues in VLSI implementation of Image processing algorithms (L2) - interfacing. Hardware implementation of image processing algorithms: Segmentation and compression (L3)

UNIT – IV	EMBEDDED SYSTEM FOR DIAGNOSTIC APPLICATIONS	9

ICCU patient monitoring system (L2)– ECG-EEG-EMG acquisition system(L2)-MRI scanner (L2)- CT scanner(L2) Sonography(L2)

UNIT–V	CASE STUDY	9

Respiratory measurement using spirometer- IPPB unit for monitoring respiratory parameters(L4) -ventilators(L4) -Defibrillator(L4)- Glucometer(L4)-Heart- Lung machine(L4)

Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		**BLOOM'S Taxonomy**
CO1	Demonstrate the fundamental art of biomedical engineering.	L2 - Understand
CO2	Illustrate about wearable health devices and its importance	L2 - Understand
CO3	Implement image processing applications using software and hardware	L2 - Understand
CO4	Compare various embedded diagnostic applications.	L2 - Understand
CO5	Build and analyze of some biomedical equipment.	L4 - Analyze

REFERENCE BOOKS:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2007.
2. John G.Webster, "Medical Instrumentation Application and Design", 3rd Edition, Wiley India Edition, 2007

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3.	Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
4.	L.A Geddes and L.E.Baker, Principles of Applied Biomedical Instrumentation, 3rd Edition, John Wiley and Sons, Reprint 2008
5.	Richard S.Cobbold, Transducers for Biomedical Measurements; Principle and applicationsJohn Wiley and sons, 1992.
WEB REFERENCES:	
1.	https://www.dedicatedcomputing.com/markets/healthcare/
2.	https://www.intechopen.com/chapters/75395
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc22_bt34/
2.	https://onlinecourses.nptel.ac.in/noc21_bt50/
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=TpPXxJ7fPDs&list=PLyqSpQzTE6M_ZBtBMkhFNMg6RA8vsBdBk
2.	https://www.youtube.com/watch?v=f08efmygAIM&list=PLyqSpQzTE6M9wr5IpP7WZxP9trrHht3N5

Mapping of COs with POs

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	3			
CO2		3	2	3		
CO3			2		3	
CO4	3	1	1		2	
CO5	1	3	3		-	
Avg.	**1.66**	**2.25**	**2.2**	**3**	**2.5**	
1–Low, 2 –Medium, 3–High.						

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ME23ET420	PYTHON PROGRAMMING FOR MACHINE LEARNING	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

1	Students will understand and be able to use the basic programming principles such as data types, variable, conditionals, loops, recursion and function calls.
2	Students will learn how to use basic data structures such as List, Dictionary and be able to manipulate text files and images
3	To make the students familiar with machine learning concepts & techniques.
4	Students will understand the process and will acquire skills necessary to effectively attempt a machine learning problem and implement it using Python.
5	To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved research/employability skills

UNIT–I	INTRODUCTION TO MACHINE LEARNING AND PYTHON	9

Introduction to Machine Learning: Significance, Advantage and Applications (L1)– Categories of Machine Learning (L2)– Basic Steps in Machine Learning(L2): Raw Data Collection, Pre-processing, Training a Model, Evaluation of Model, Performance Improvement Introduction to Python and its significance (L2)– Difference between C, C++ and Python Languages; Compiler and Interpreters(L2) – Python3 Installation & Running (L2)– Basics of Python Programming Syntax: Variable Types, Basic Operators, Reading Input from User (L2)– Arrays/List, Dictionary and Set (L2)– Conditional Statements(L3) – Control Flow and loop control statements(L3)

UNIT–II	PYTHON FUNCTIONS AND PACKAGES	9

File Handling: Reading and Writing Data(L2) – Errors and Exceptions Handling (L2)– Functions & Modules(L2) – Package Handling in Python(l2) – Pip Installation & Exploring Functions in python package(L2) – Installing the Numpy Library and exploring various operations on Arrays(L2): Indexing, Slicing, Multi-Dimensional Arrays, Joining Numpy Arrays, Array intersection and Difference, Saving and Loading Numpy Arrays(L3) – Introduction to SciPy Package & its functions(L2) - Introduction to Object Oriented Programming with Python(L1)

UNIT– III	IMPLEMENTATION OF MACHINE LEARNING USING PYTHON	9

Description of Standard Datasets: Coco, ImageNet, MNIST (Handwritten Digits) Dataset, Boston Housing Dataset (L2)– Introducing the concepts of Regression – Linear, Polynomial & Logistic Regression with analytical understanding (L2)- Introduction to SciPy Package & its functions(L2) – Python Application of Linear Regression and Polynomial Regression using SciPy(L3) – Interpolation, Overfitting and Underfitting concepts & examples using SciPy(L3)

UNIT – IV	CLASSIFICATION AND CLUSTERING CONCEPTS OF ML	9

Introduction to ML Concepts of Clustering and Classification (L1)– Types of Classification Algorithms (L2)– Support Vector Machines (SVM) - Decision Tree - Random Forest(L2) – Introduction to ML using scikitlearn(l1) – Using scikit-learn, Loading a sample dataset, Learning & prediction, interpolation & fitting, Multiclass fitting (L2)- Implementation of SVM using Blood Cancer Dataset, Decision Tree using data from csv(L3) Types of Clustering Algorithms & Techniques(L2) – K-means Algorithm, Mean Shift Algorithm & Hierarchical Clustering Algorithm(L2) – Introduction to Python Visualization using Matplotlib(L1): Plotting 2- dimensional, 3-dimensional graphs; formatting axis values; plotting multiple rows of data in same graph(L3) – Implementation of K-means Algorithm and Mean Shift Algorithm using Python(L3)

UNIT–V	INTRODUCTION TO NEURAL NETWORKS AND EMBEDDED MACHINE LEARNING	9

Introduction to Neural Networks & Significance(L1) – Neural Network Architecture(L2) – Single Layer Perceptron & Multi-Layer Perceptron (MLP) (L2) – Commonly Used Activation Functions (L2)- Forward Propagation, Back Propagation, and Epochs (L2)– Gradient Descent – Introduction to Tensorflow and Keras ML Python packages(L1) – Implementation of MLP Neural Network on Iris Dataset (L3)– Introduction to Convolution Neural Networks(L1) – Implementation of Digit Classification using MNIST Dataset ML for Embedded Systems: Comparison with conventional ML(L3) – Challenges & Methods for Overcoming (L2)– TinyML and Tensorflow Lite for Microcontrollers – on-Board AI – ML Edge Devices:

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Arduino Nano BLE Sense, Google Edge TPU and Intel Movidius(L2)	
	Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		**BLOOM'S Taxonomy**
CO1	Develop skill in system administration and network programming by learning Python.	L3 - Apply
CO2	Demonstrating understanding in concepts of Machine Learning and its implementation using Python	L2- Understand
CO3	Relate to use Python's highly powerful processing capabilities for primitives, modelling etc	L2- Understand
CO4	Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design	L3 - Apply
CO5	Apply the concepts acquired over the advanced research/employability skills	L3 - Apply

REFERENCE BOOKS:	
1.	Mark Lutz,"LearningPython,Powerful OOPs,O'reilly,2011.
2.	Zelle, John "M. Python Programming: An Introduction to Computer Science.", Franklin Beedle& Associates, 2003
3.	Andreas C. Müller, Sarah Guido, "Introduction to Machine Learning with Python", O'Reilly,2016
4.	Sebastian Raschka , VahidMirjalili, "Python Machine Learning - Third Edition", Packt, December 2019
WEB REFERENCES:	
1.	https://www.edureka.co/blog/install-numpy/
2.	https://aws.amazon.com/what-is/neural-network/
ONLINE COURSES:	
1.	https://www.udemy.com/course/machinelearning
2.	https://onlinecourses.nptel.ac.in/noc19_cs52/
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=xbYgKoG4x2g&list=PL53BE265CE4A6C056
2.	https://www.youtube.com/watch?v=eoPsX7MKfe8&list=PLIdgECt554OVFKXRpo_kuI0XpUQKk0ycO

Mapping of COs with POs						
CO	**PO**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			2	3	3	
CO2	3	1	3		3	
CO3	2	1	2		3	
CO4	3	2	3	3	3	
CO5					3	
Avg.	**2.66**	**1.33**	**2.5**	**3**	**3**	
1–Low, 2 –Medium, 3–High.						

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ME23ET421	RENEWABLE ENERGY AND GRID INTEGRATION	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

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

UNIT–I	INTRODUCTION	9

Introduction to renewable energy systems(L1), environmental aspects of electric energy conversion(L2), impacts of renewable energy penetration to grid(L2). Grid Codes in India and other countries(L2). Basic power electronic converters for renewable energy integration to grid-Qualitative analysis(L2) -Boost and buck-boost converters, three phase AC voltage controllers(L3)- AC-DC-AC converters, PWM Inverters, Grid Interactive Inverters-matrix converters(L3).

UNIT–II	PHOTO VOLTAIC ENERGY CONVERSION SYSTEMS	9

Introduction(L1), Photo Voltaic (PV) effect, Solar Cell, Types(L2), Equivalent circuit of PV cell, PV cell characteristics (I/V and P/V) for variation of insolation(L2), temperature and shading effect, Stand-alone PV system(L2), Grid connected PV system(L2), Design of PV system-load calculation(L3), array sizing, selection of converter/inverter, battery sizing(L3).

UNIT– III	WIND ENERGY CONVERSION SYSTEMS	9

Introduction(L1), 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(L2)-Induction Generator and Permanent Magnet Synchronous Generator(PMSG) (L2), Grid Connected-Single and Double output system, Self-excited operation of Induction Generator and Variable Speed PMSG(L3).

UNIT – IV	STANDARDS AND FRAMEWORK	9

Case studies of PV-Maximum Power Point Tracking (MPPT) and Wind Energy system(L3)

UNIT–V	HYBRID STORAGE SYSTEMS AND GRID MANAGEMENT	9

Energy Storage systems(L2), Need for Hybrid Systems(L2), Features of Hybrid Systems(L2), Range and types of Hybrid systems (Wind-Diesel, PV-Diesel and Wind-PV)(L3).

Total : 45 Periods

	Course Outcomes: Upon completion of this course the students will be able to:	**BLOOM'S Taxonomy**
CO1	Relate the power generation of different renewable energy sources to grid impact and grid codes	L2- Understand
CO2	Explain the design principles of solar energy management systems	L3- Apply
CO3	Understand the power conversion system of wind generators	L2- Understand
CO4	Analyze the different Maximum Power Point tracking Techniques	L2- Understand
CO5	Build grid connected and stand alone renewable energy management system	L2- Understand

REFERENCE BOOKS:

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1.	S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 2009.
3.	Haitham Abu-Rub, Mariusz Malinowski and Kamal Al-Haddad, "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications", IEEE Press and John Wiley & Sons Ltd Press, 2014.
4.	Rashid .M. H "power electronics Hand book", Academic press, 2001
5.	Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995.
6.	Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company, New Delhi.
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2.	https://www.nrel.gov/docs/fy15osti/63033.pdf
ONLINE COURSES:	
1.	https://www.coursera.org/learn/renewable-power-electricity-systems
2.	https://nptel.ac.in/courses/103103206
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=mh51mAUexK4&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk
2.	https://www.youtube.com/watch?v=cGHlV0EavaQ

Mapping of COs with POs

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	1	-	1	-
CO2	1	1	2	-	1	-
CO3	2	-	1	1	1	2
CO4	1	2	1	2	-	2
CO5	3	3	2	-	2	-
Avg.	**1.6**	**2**	**1.4**	**1.5**	**1.25**	**2**
1–Low, 2 –Medium, 3–High.						

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ME23ET422	ELECTRIC VEHICLES AND POWER MANAGEMENT	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

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

UNIT–I	ELECTRIC VEHICLES AND VEHICLE MECHANICS	9

Electric Vehicles (EV)(L2), Hybrid Electric Vehicles (HEV) (L2), Engine ratings- Comparisons of EV with internal combustion Engine vehicles(L2)- Fundamentals of vehicle mechanic(L2).

UNIT–II	ARCHITECTURE OF EV's AND POWER TRAIN COMPONENTS	9

Architecture of EV's and HEV's (L2)– Plug-n Hybrid Electric Vehicles (PHEV) (L2)- Power train components and sizing, Gears, Clutches, Transmission and Brakes(L2).

UNIT– III	POWER ELECTRONICS AND MOTOR DRIVES	9

Electric drive components (L2)– Power electronic switches(L2)- four quadrant operation of DC drives(L2) – Induction motor and permanent magnet synchronous motor-based vector control operation(L2) – Switched reluctance motor (SRM) drives(L3)- EV motor sizing(L3).

UNIT – IV	BATTERY ENERGY STORAGE SYSTEM	9

Battery Basics(L2)- Different types- Battery Parameters-Battery life & safety impacts (L2)-Battery modeling(L3)-Design of battery for large vehicles(L3).

UNIT–V	ALTERNATIVE ENERGY STORAGE SYSTEMS	9

Introduction to fuel cell(L1) – Types, Operation and characteristics(L2)- proton exchange membrane (PEM) fuel cell for E-mobility(L2)– hydrogen storage systems(L2) –Super capacitors for transportation applications(L3)

Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Understand the concept of electric vehicle and energy storage systems.	L2 – Understand
CO2	Describe the working and components of Electric Vehicle and Hybrid Electric Vehicle	L2 – Understand
CO3	Know the principles of power converters and electrical drives	L2 – Understand
CO4	Illustrate the operation of storage systems such as battery and super capacitors	L3 – Apply
CO5	Analyze the various energy storage systems based on fuel cells and hydrogen storage	L2 – Understand

REFERENCE BOOKS:

1.	Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" CRC Press, Taylor & Francis Group, Second Edition (2011).
2.	Ali Emadi, Mehrdad Ehsani, John M.Miller, "Vehicular Electric Power Systems", Special 63 Indian Edition, Marcel dekker, Inc 2010.
3.	Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.

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4.	C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001
5.	Wie Liu, "Hybrid Electric Vehicle System Modeling and Control",Second Edition, John Wiley & Sons, 2017.
WEB REFERENCES:	
1.	https://archive.nptel.ac.in/courses/108/106/108106182/
2.	https://archive.nptel.ac.in/courses/108/106/108106170/
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc22_ee53/
2.	https://onlinecourses.nptel.ac.in/noc21_ee112/
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=UgtjRob5qMg&list=PLyqSpQzTE6M9spod-UH7Q69wQ3uRm5thr
2.	https://www.youtube.com/watch?v=V004WUdpHeA&list=PLlYm0-AHZdZRLYSylFinxkspWmcgNvbtl

Mapping of COs with POs

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	2	3	
CO2	3	3	3	2	3	
CO3	3	3	3	2	3	
CO4	3	3	3	2	3	
CO5	3	3	3	2	3	
Avg.	**3**	**3**	**3**	**2**	**3**	
1–Low, 2 –Medium, 3–High.						

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ME23ET423	SMART GRID	CP	L	T	P	C
		3	3	0	0	3
Programme & Branch	M.E. EMBEDDED SYSTEM TECHNOLOGIES	Version : 1.0				

Course Objectives:

1	To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
2	To know about the function of smart grid
3	To familiarize the power quality management issues in Smart Grid
4	To familiarize the high performance computing for Smart Grid applications
5	To get familiarized with the communication networks for Smart Grid applications

UNIT–I	INTRODUCTION TO SMART GRID	9

Evolution of Electric Grid(l2), Concept, Definitions and Need for Smart Grid(l2), Smart grid drivers, functions, opportunities, challenges and benefits(l2), Difference between conventional & Smart Grid(L2), Comparison of Micro grid and Smart grid(l2), Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India(L2) – Case Study(L3).

UNIT–II	SMART GRID TECHNOLOGIES	9

Technology Drivers, Smart Integration of energy resources(L2), Smart substations(L2), Substation Automation(L2), Feeder Automation(L2), Transmission systems: EMS, FACTS and HVDC(L2), Wide area monitoring(L2), Protection and control, Distribution systems: DMS(L2), Volt/Var control, Fault Detection(L2), Isolation and service restoration(L2), Outage management(L2), High-Efficiency Distribution Transformers(L2), Phase Shifting Transformers(L2), Plug in Hybrid Electric Vehicles (PHEV(L2)) (L3) – Grid to Vehicle and Vehicle to Grid charging concepts(L2)

UNIT– III	SMART METERS AND ADVANCED METERING INFRASTRUCTURE	9

Introduction to Smart Meters(L1), Advanced Metering infrastructure (AMI) drivers and benefits(L2), AMI protocols, standards and initiatives(L2), AMI needs in the smart grid(L2), Phasor Measurement Unit(PMU) & their application for monitoring & protection(L2). Demand side management and demand response programs(L2), Demand pricing and Time of Use, Real Time Pricing(L3), Peak Time Pricing(L3).

UNIT – IV	POWER QUALITY MANAGEMENT IN SMART GRID	9

Power Quality & EMC in Smart Grid(L2), Power Quality issues of Grid connected Renewable Energy Sources(L2), Power Quality Conditioners for Smart Grid(L2), Web based Power Quality monitoring(L3), Power Quality Audit (L3).

UNIT–V	HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS	9

Architecture and Standards(L2) -Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols(L2), Basics of Web Service and CLOUD Computing(L3), Cyber Security for Smart Grid(L3).

Total : 45 Periods

Course Outcomes: Upon completion of this course the students will be able to:		BLOOM'S Taxonomy
CO1	Relate with the smart resources, smart meters and other smart devices.	L1 - Remember
CO2	Explain the function of Smart Grid	L2 – Understand
CO3	Experiment the issues of Power Quality in Smart Grid.	L2 – Understand
CO4	Analyze the performance of Smart Grid	L2 – Understand
CO5	Recommend suitable communication networks for smart grid applications	L2 – Understand

REFERENCE BOOKS:

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1.	Stuart Borlase 'Smart Grid: Infrastructure, Technology and Solutions', CRC Press 2012.
2.	JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, 'Smart Grid: Technology and Applications', Wiley, 2012
3.	Mini S. Thomas, John D McDonald, 'Power System SCADA and Smart Grids', CRC Press, 2015
4.	Kenneth C.Budka, Jayant G. Deshpande, Marina Thottan, 'Communication Networks for Smart Grids', Springer, 2014
5.	SMART GRID Fundamentals of Design and Analysis, James Momoh, IEEE press, A John Wiley & Sons, Inc., Publication.
WEB REFERENCES:	
1.	https://www.researchgate.net/publication/224078022_Power_Quality_and_EMC_in_Smart_Grid
2.	https://amity.edu/icactm/Proceeding/Paper%20Index%20Content/24%20T4%20P9%20ID%209.pdf
ONLINE COURSES:	
1.	https://onlinecourses.nptel.ac.in/noc21_ee68
2.	https://onlinecourses.nptel.ac.in/noc23_ee124/
VIDEO REFERENCES:	
1.	https://www.youtube.com/watch?v=KgVFJnmJvKk&list=PLSJzHGpGe6lP5biCvZrtQdHf80tnSXRBr
2.	https://archive.nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee65/

Mapping of COs with POs

CO	PO					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2		2	2	
CO2	3		2	2		
CO3	2		1			
CO4	1			3	3	
CO5		2	2	2	2	
Avg.	**2.25**	**2**	**1.66**	**2.25**	**2.3**	

1–Low, 2 –Medium, 3–High.

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